From:	cac@Cannabis
To:	Dempsey, Christina@Cannabis
Subject:	FW: Industrial Hemp
Date:	Wednesday, September 7, 2022 10:32:05 AM
Attachments:	CDA Report on Hemp in Animal Feed 12-29-2017.pdf Hemp - The New American Industrial Revolution.pdf Animal Feeding Trials.pdf whitepaper_an-energy-crop-to-transform-kentucky-and-west-virginia.pdf Canadian scientists breeding cows that burp less.docx GROWING HEMP IN THE AMERICAN SOUTHWEST.pdf Effects_of_increasing_amounts_of_hempseed_cake_in_.pdf

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From: Alex Brant-Zawadzki <alex.brantzawadzki@gmail.com>
Sent: Tuesday, August 30, 2022 6:36 PM
To: cac@Cannabis <cac@cannabis.ca.gov>
Cc: CDFA PHPPS Industrial Hemp Program@CDFA <CDFA.PHPPS_Industrial_Hemp_Program@cdfa.ca.gov>
Subject: Industrial Hemp

Hello. I'm Alex Brant-Zawadzki, a long-time proponent and advocate and even lobbyist for Industrial Hemp.

I even wrote my masters thesis on it, from University of San Francisco's Leo T. McCarthy Center for Public Service and the Common Good. It is attached.

I would very much like to discuss the topic of industrial hemp additives in livestock feed.

Methane is a huge contributor to climate change. Cows pigs etc produce enormous amounts around the globe.
Industrial hemp added to animal feed significantly reduces methane output by interfering with the formation of the

methane molecules in the first place. It also produces healthier, happier, heavier livestock. Attached are studies to attest to those facts.

"Cows are responsible for nearly three-quarters of total methane emissions, according to Environment Canada. Most of the gas comes from bovine burps, which are 20 times more potent than carbon dioxide as a greenhouse gas"

I have spoken with Dr. Ermias Kebreab at UC Davis. He has run feed trials with seaweed to great effect. Attached is THAT study. He has expressed interest in a trial with hemp additives as well but we have had difficulty securing the roughly $175k funding he needs.

Also attached is the Stakeholder Review of the Feasibility of Industrial Hemp By-Products as Animal Feed Ingredients that the Colorado Dept of Agriculture prepared for the legislature in 2017

Please, please, please allow the topic of industrial hemp in animal feed to be discussed.

I respectfully thank you for your time and your consideration.

Alex B-Z
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COLORADO
Department of Agriculture
Inspection & Consumer Services Division

A Stakeholder Review of the Feasibility of Industrial Hemp By-Products as Animal Feed Ingredients

December 29, 2017

A report to the Colorado Legislature in Response to SB17-109

A Stakeholder Review of the Feasibility of Industrial Hemp By-Products as Animal Feed Ingredients

December 29, 2017

A Report to the Legislature in Response to SB17-109.

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COLORADO
Department of Agriculture
Inspection & Consumer Services Division

Commissioner of Agriculture Don Brown

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Executive Summary

In 2017, the Colorado hemp industry initiated a legislative effort to establish a group of stakeholders with a wide range of expertise to examine the possibility of including industrial hemp (hemp) as an animal feed ingredient. In response to Senate Bill 17-109, the Colorado Department of Agriculture (CDA) conducted a stakeholder review and prepared this report to summarize expert opinion on the potential of approving hemp and its by-products as animal feed ingredients, as well as limitations and concerns in doing so. For this project, the CDA and stakeholders engaged in a series of discussions to examine the current regulatory status of hemp and hemp by-products as animal feed ingredients and explored a process by which the safety and utility of the hemp products would be fully evaluated. Stakeholders identified points of constraint and obstacles related to regulatory requirements, animal health and nutrition, public safety and economics.

Stakeholders reviewed the feasibility of hemp becoming an animal feed ingredient and identified six conclusions and one legislative recommendation. In general, stakeholders concluded that hemp seeds and hempseed by-products show promising potential as a nutritional source for animals and it is plausible for these products to become approved for use as animal feed ingredients. However, the safety and utility of hemp seeds, as well as the safety of any subsequent processing of the seeds, need to be confirmed before animal feed products with hemp can be approved for distribution in the U.S. market.

The details of the six stakeholder conclusions and legislative recommendation are provided in the body of the report, but are summarized here for convenience:

Conclusion 1: Prioritize federal approval
Since animal feed ingredients are subject to regulation by both the U.S. Food and Drug Administration (FDA) and state governing agencies, stakeholders noted that a submission effort should focus on gaining federal approval, rather than approval by states individually. However, there are resources and general support from private industry and academic institutions in Colorado that can contribute to a submission effort, including conducting additional research that will most likely be needed for a comprehensive submission to the FDA.

Conclusion 2: Focus on whole hemp seed and hempseed by-products
An ingredient submission should focus on parts of the plant that have the best chance of receiving federal approval, namely whole hemp seed and hempseed by-products: i.e., hempseed cake and hempseed oil. Other parts of the plant, such as the stalk, flower, root, and leaf could be the focus of a future ingredient submissions if research supports their safety and utility for livestock production and companion animals.

Conclusion 3: Conduct research on economic viability
Economic research on the viability of any new crop is essential. Stakeholders felt there is a lack of domestic economic data specific to hemp seed and hempseed by-products in animal feed. Additional U.S.-based economic studies on hemp by-products for use in animal feed would help address questions regarding the practicality of producing and manufacturing hempseed products for animal feed as well as provide a competitive analysis of existing feed options currently used.

Conclusion 4: Target submission of a Food Additive Petition (FAP)
While there are multiple pathways for a proposed ingredient to become approved for animal feed, stakeholders felt that any submission effort should focus on submitting a Food Additive Petition (FAP) to the Center of Veterinary Medicine at the FDA (FDA-CVM) due to the safety concerns surrounding hemp.

Conclusion 5: Include an experienced consultant in the collaborative effort
Considering the growing interest in hemp by-products in animal feed for both livestock and companion animals, any submission effort should strive to be a collaborative effort that includes a broad number of participants from private, public and academic organizations. While collaboration is a key conclusion from group discussions, stakeholders recommended that a submission effort is coordinated through a consultant with experience in developing and submitting FAPs to the FDA-CVM.

Conclusion 6: Execute a S.A.F.E petition process
Execution of a submission effort will require a "S.A.F.E." petition to be successful, where petitioners should:

- **S** - Start early discussions with the FDA-CVM
- **A** - Assemble and assess existing research
- **F** - Fill in any gaps with additional research
- **E** - Execute a targeted petition that identifies specific species and intended uses

Legislative Recommendation
No direct legislative action is required since the submission would originate from petitioners from the hemp industry and other stakeholders with an interest in submitting a petition. However, stakeholders felt the Colorado Legislature could provide general support for additional research needed to determine the safety and nutritional content of hemp by-products. Additional research could be completed by either private industry or through Colorado universities. Any support for the submission of a FAP will help provide clarity to the public on the safety and allowable use of hemp seed and hempseed by-products as an animal feed ingredient.

1 Background Information

Hemp has emerged as an innovative crop and interest in its marketability is growing. Efforts to highlight the diversity of hemp products has led to the interest in its potential use in animal feed for production animals, horses and household pets (companion animals). Existing research, specifically on hemp seeds and hempseed by-products, show hemp has characteristics that make it a promising nutritional source (European Food Safety Authority (EFSA), 2011, p. 8).

Industry and regulators have seen new animal feed products containing hemp by-products enter the feed and pet treat markets without prior approval. In particular, there has been an emerging trend in the United States to incorporate the compound cannabidiol (CBD) in animal feed, particularly for companion animals, despite the fact that CBD oil has been determined by the FDA to be an unapproved drug rather than an animal feed ingredient. As an unapproved drug, CBD products will not be appropriate for the submission effort discussed in this report.

Currently, no hemp products are approved for use as animal feed ingredients in the United States and are not Generally Recognized as Safe (GRAS) (Washington State Department of Agriculture, 2017, p. 8). As with any new animal feed ingredient, the safety and utility of hemp will need to be evaluated before it can be approved for use. For food production animals, additional review may be necessary to ensure that there are no negative consequences that could potentially affect humans consuming the meat, milk or eggs of animals that were raised on animal feeds containing hemp. A safety review of any new animal feed ingredient helps ensure a safe supply of food, both for animals and humans consuming animal products.

1.1 Hemp Regulation

The following is a broad summary of legislation and other regulatory actions that frame the current regulatory environment in which the stakeholders focused their discussion on the feasibility of hemp as an approved ingredient.

Controlled Substance Act (CSA)

Under the Controlled Substance Act (CSA), the definition of marijuana specifically states that it "does not include the mature stalks of such plant, fiber produced from such stalks, oil or cake made from the seeds of such plant, any other compound, manufacture, salt, derivative, mixture, or preparation of such mature stalks (except the resin extracted therefrom), fiber, oil, or cake, or the sterilized seed of such plant which is incapable of germination" [21 U.S. Code, Section 802 (16)]. This definition identifies what is not a controlled substance, and the stakeholders decided to focus this report on the parts of the plant exempted from the definition of marijuana.

Agricultural Act of 2014.

Congress passed the Agricultural Act of 2014, also referred to as the "Farm Bill" (Agricultural Act of 2014). While this omnibus bill addressed a number of agricultural issues, the industrial hemp provision within the bill did two things relevant to the stakeholder discussion. First, the bill allowed state departments of agriculture and institutions of higher education to grow industrial hemp for purposes of research through a pilot program if regulated under state law. Secondly, the Farm Bill provided a statutory definition for industrial hemp as the plant *Cannabis sativa L*. and any part of such plant, whether growing and not, with a delta-9 tetrahydrocannabinol (THC) concentration of no more than 0.3 percent on a dry weight basis (7 U.S. Code, Section 5940(b)(2)). Thus, providing a statutory distinction between hemp and marijuana. A similar definition for industrial hemp was adopted in Colorado statute in 2014 (Colorado Revised Statute, pp. section 35-61-101(7)).

Statement of Principles on Industrial Hemp

The industrial hemp provisions contained in the Farm Bill left the hemp industry and others with questions of interpretation. As a result, the U.S. Drug Enforcement Administration, U.S. Department of Agriculture, and the U.S. Food and Drug Administration published a *Statement of Principles on Industrial Hemp* in 2016 to address the applicability of federal laws towards activities associated with growing and cultivating industrial hemp (Statement of Principles on Industrial Hemp, 2016). While the statement was nonbinding, it clarified that the Farm Bill did not remove hemp from the controlled substance list, nor did the Farm Bill amend the Federal Food Drug and Cosmetic Act (FD&C). The hemp industry and others felt the Statement of Principles left unresolved issues of interpretation and application of the Farm Bill (Johnson, 2017, pp. 24-25).

Colorado Department of Agriculture Hemp Registry Program

Many states have passed laws and regulations designed to implement programs to regulate the legal cultivation of hemp as an agricultural crop within their jurisdictions. As of 2017, more than 35 states or territories have enacted or introduced legislation favorable to hemp cultivation (Johnson, 2017, p. 15). In Colorado, legislation was adopted in 2013 that established the Industrial Hemp Regulatory Program within the CDA, in which registration and regulations pertaining to the cultivation of hemp were established under Title 35, Article 61 of the Colorado Revised Statutes. Since its inception in 2014, participation in the Industrial Hemp Regulatory Program has grown to 527 active registrations and 11,853 registered acres by the end of 2017.

1.2 Regulation of Animal Feed

The Association of American Feed Control Officials

The Association of American Feed Control Officials (AAFCO) was established in 1909 and the membership is comprised of state and federal feed control officials. AAFCO facilitates the development of uniform regulation of animal feed among the states through the development of a model bill, model regulations, ingredient definitions and laboratory proficiency testing. Although the association does not have any regulatory authority, AAFCO provides a forum for which control officials and industry meet in partnership to address problems in administering and enforcing feed laws, identifying emerging issues, studying problems, developing analytical methods, developing strategies, as well as providing guidance and outreach (AAFCO 2017 Official Publication , 2017). AAFCO has a Memorandum of Understanding with the FDA, under which AAFCO provides an animal feed ingredient definition process that includes FDA scientific and technical review.

In 2017, AAFCO released a policy statement to address the growing interest in hemp in animal feed. Within the statement, AAFCO encouraged the hemp industry to submit data to address potential safety concerns related to the presence of THC and CBD before approving hempseed products for distribution. A full copy of the AAFCO guidelines can be found in Appendix B.

The Food and Drug Administration-Center for Veterinary Medicine

Federal responsibility for the regulation of food is primarily delegated to the Food and Drug Administration (FDA), which enforces the Federal Food, Drug and Cosmetic Act (FD&C Act). The FD&C Act is the primary federal regulation governing the manufacture and distribution of animal feed products and establishes standards for adulteration and misbranding. Within the FDA, the Center for Veterinary Medicine reviews substances intended for animal food to determine their suitability through the FAP and GRAS notification processes.

In 2015, the FDA-CVM published a guidance document for industry that outlines the FAP process (FDA GFI221, 2015), providing valuable information on how to prepare and submit a FAP to any interested party. General information that should be included in a FAP entails:

- Identity and composition of the additive, including manufacturing methods and controls;
- Intended use, use level, and labeling (cautions, warnings, shelf life, directions for use);
- Data establishing the intended effect (physical, nutritional, or other technical effect);
- Analytical methods (for the additive and for animal foods containing the additive);
- Safety evaluation (target animal and human food)
- Proposed tolerances for the food additive;
- Proposed regulation; and
- Environmental assessment.

The United States Department of Agriculture Food Safety Inspection Service

The United States Department of Agriculture Food Safety Inspection Service (USDA-FSIS) is responsible for ensuring that the nation's commercial supply of meat, poultry, and egg products is safe, wholesome, and correctly labeled and packaged. The USDA-FSIS regulates the sale of meat through the inspection of animals both before and after slaughter, including testing for residues of drugs and other adulterants. The USDA-FSIS also regulates the labeling of these products.

Colorado Department of Agriculture-Division of Inspection and Consumer Services

The CDA regulates commercial animal feed in Colorado. The Colorado feed law and regulations are based on the AAFCO Model Bill and Model Regulations published in the AAFCO Official Publication. The department reviews products for distribution within Colorado and works with animal feed manufacturers to ensure good manufacturing practices are being followed. The department's product review involves determining the acceptability of ingredients for use in animal feed, and that ingredients entering Colorado's marketplace are officially defined by AAFCO and reviewed by FDA-CVM. The CDA samples animal feed and analyzes it for nutrient content as well as testing for the presence of adulterants and contaminants.

Approval options for new animal feed ingredients

There are a number of pathways through which a proposed new animal feed ingredient can be reviewed for safety and utility before it becomes an approved ingredient. Approval for new animal feed ingredients is typically done through the submission of either an animal feed ingredient definition to AAFCO, or directly to the FDA-CVM as a Food Additive Petition. A firm may also conclude that an ingredient is "Generally Recognized as Safe" (GRAS) for a given intended use if sufficient information is available in the public domain to support the safety of that use. This GRAS conclusion can then be shared with FDA to become a GRAS-notified ingredient. Because of the lack of sharing of detailed safety data, states do not typically recognize GRAS conclusions. AAFCO does publish in the Official Publication a list of GRAS notices that have received “no questions” letters from FDA-CVM.

2 Project Overview

2.1 Project Scope and Objective

The primary scope of the project was for the CDA to assemble a stakeholder group to explore the feasibility of including hemp products in animal feed. For this project, stakeholder discussion of feasibility centered on the regulatory approval processes for new animal feed ingredients, including discussion of the regulatory requirements needed to demonstrate the safety and utility of hemp and hemp by-products. In addition, the scope of the project included discussions of animal nutrition and public health, and economic viability of hemp seed and hempseed by-products as a feeding option for livestock and companion animals.

The primary objective was to evaluate whether hemp seed and hempseed by-products can be properly reviewed and approved for safe use, and to identify obstacles and challenges that will need to be addressed in any submission effort.

2.2 Formation of the Stakeholder Group

The CDA assembled a large stakeholder group in order to gain a wide range of perspectives on the various issues. Considering the broad implications and impact of these issues, it was important to include representatives from across the United States, including other state departments of agriculture and federal agencies. The stakeholder group included:

- Hemp producers and processors
- Animal feed manufacturers
- State and federal regulatory agencies
- Veterinarians
- Toxicologists
- Nutritionists
- Non-Governmental Organizations (NGOs)
- Academic faculty
- Ranchers
- Agricultural economists
- Meat export associations
- Attorneys specializing in hemp law

A complete list of stakeholders is provided in Appendix D.

2.3 Approach to Stakeholder Discussions

The CDA worked with a third party to facilitate stakeholder discussions and assist in identifying areas of consensus among the stakeholders. The project utilized large group discussions, breakout subgroup meetings and one-on-one interviews with stakeholders to formulate key insights and conclusions about the possibility of hemp as an animal feed ingredient. Stakeholders were broken into subgroups to explore three areas of focus.

- **Subgroup 1: Regulatory Requirements**
  Focused on the current regulatory environment and what will be required to submit a petition for hemp to be approved as a safe ingredient.

- **Subgroup 2: Animal Nutrition/Safety and Public Health**
  Focused on animal nutrition, safety questions and any concerns related to the consumption by the public of animal products.

- **Subgroup 3: Agricultural Economics**
  Focused on the economic questions regarding using hemp in animal feed and the implications for agricultural industries, namely ranching and hemp production.

To form the discussion framework, subgroups identified specific questions in their area of focus. In subsequent discussions, key insights were noted by the CDA and the third-party facilitator. These key insights were then summarized into a collective response to the questions and then used to formulate the broad conclusions regarding the feasibility of hemp becoming an animal feed ingredient. A summary of subgroup questions and insights provided by the stakeholders can be found in Appendix C.

Stakeholders reviewed a draft of key insights and conclusions and made additional comments and edits. Stakeholders were provided the opportunity to draft a minority opinion for any areas in which consensus among the groups was not possible, or if any individual stakeholder held an opposing position. However, general consensus was achieved on the conclusions in this report and no minority opinions were submitted.

2.4 Constraints and Limitations of the Project

This project was not an academic research project or a scientific study of the use of hemp by-products in animal feed. Rather, the intention of the project was to summarize the discussions among experts on the feasibility of approving hemp products for safe use in animal feed. With limited time for discussion, the project focused on a high-level review of stakeholders' concerns, areas of agreement, and general comments. There is regulatory guidance and a number of published studies publicly available for those interested in a more detailed perspective of the issues involved with hemp by-products in animal feed.

This report is meant to serve as a point of reference for the Colorado Legislature, the public, and for petitioners interested in understanding the submission process.

3 Stakeholder Conclusions and Recommendation

While the demand for industrial hemp is increasing nationally, there is confusion about the status of hemp for use in animal feed. If approved, hemp seeds and hempseed by-products could provide benefits in multiple areas. Preliminary examination of the available data would suggest that hemp seed and other components may provide nutritional benefits for animals. In addition, there appears to be an interest and ongoing effort from the hemp industry to pursue approval from FDA-CVM. If industrial hemp can be approved for use as an animal feed ingredient, hemp production and processing could further contribute to the establishment of hemp as a new agricultural commodity that could help meet increasing animal feeding options and crop choice demands. As the submission process continues to move forward, Colorado is positioned to play a key role in providing clarity on the possible use of hemp in animal feed.

Table 1: Summary of stakeholder conclusions

Conclusions

1. Prioritize federal approval

2. Focus on whole hemp seed and hemp seed by-products

3. Conduct research into economic viability

4. Target submission of a food additive petition

5. Include an experienced consultant in a collaborative effort

6. Execute a S.A.F.E. petition process

Legislative Recommendation:

Support research and a submission of an FAP application to determine the safety and utility of hemp seed products as animal feed ingredients.

Conclusion 1: Prioritize federal approval

Stakeholders felt that even though individual states may approve individual animal feed ingredients, a submission effort should focus on federal approval, specifically through the regulatory review process of the FDA-CVM. Hemp brings unique challenges and complexities that are not necessarily found with other animal feed ingredients because of THC and other cannabinoids present in the plant. Stakeholders expressed concern that regulatory action could be taken against animal feed manufacturers and livestock producers if hemp were fed to animals without seeking federal approval.

Federal approval through the FDA-CVM would provide clarity to the public and industries on questions regarding the safety and allowable use. Stakeholders were of the opinion that individual states should exercise caution in unilaterally approving hemp to be used in animal feed. Doing so could create uncertain outcomes for agricultural industries considering that the commercial market for both animal feed and livestock extend beyond Colorado's borders.

While the focus should be on federal approval, Colorado industries can play a key leadership role in any submission effort. There are a number of Colorado organizations, both private and academic, that can contribute to the development of a petition submission to the FDA. These organizations can assist in assembling and reviewing data and other application materials.

Conclusion 2: Focus on whole hemp seed and hempseed by-products
Any initiative to seek approval for hemp as an animal feed ingredient should focus on the parts of the plant that have the best chance of receiving federal approval, namely whole hemp seed and hempseed by-products such as cake and oil from the seed. Other parts of the plant, such as the stalk, flower, root, leaves, and compounds/cannabinoids, could be the focus of future submissions if data supports their utility and safety.

Available research suggests that non-viable hemp seeds have a beneficial nutritional profile. (European Food Safety Authority (EFSA), 2011, pp. 2, 6-9). Alongside the macronutrients (protein, carbohydrate, and fat) and micronutrients, other components may include but not be limited to the omega 6 and 3 fatty acids and tocopherols.

Research indicates that hemp seeds themselves do not contain THC or other cannabinoids. Concern is focused on trace amounts of cross contamination of cannabinoids from the hemp flower during processing (European Food Safety Authority (EFSA), 2011, p. 8). Stakeholders spent time discussing the possibility of including non-seed parts of the industrial hemp plant, e.g., the flower as an animal feed ingredient. However, the FAP process is intended for substances that supply nutrients, add aroma/flavor, aid stability, or alter a food's characteristics (FDA, Food Additive Petitions for Animal Food, 2017). Petitioners interested in gaining approval for other parts of the plant, for other purposes, should consult with FDA-CVM.

Conclusion 3: Conduct research into economic viability
Generally speaking, hemp is a new and emerging market with significant economic fluctuations year after year. The consensus of the stakeholders was that it may be too early to draw economic conclusions since production practices vary greatly and have yet to be standardized.

The economic viability of hemp by-products in animal feed is important. Stakeholders commented that it is challenging to know the value of hemp seeds and hempseed by-products as animal feed because price discovery has not occurred. In order for hemp by-products to be a viable option for ranchers and animal feed manufactures, they will need to be competitive with existing animal feed ingredients, particularly in regard to their use as protein or possibly hemp fiber sources. If hemp is not a competitive alternative to existing ingredients then the potential scalability of the hemp/animal feed market will be limited to a very small niche market. Colorado has a number of academic and industry resources that could collaborate to provide the necessary research to assist in determining economic feasibility.

Conclusion 4: Target submission of a Food Additive Petition (FAP)
Due to the unresolved safety concerns of hemp seeds containing THC from cross-contamination during processing, stakeholders felt a submission effort should focus on submitting a FAP to the FDA-CVM over other application pathways, such as an application for an ingredient definition from AAFCO. When there are questions about safety, the FDA requires the ingredient to be submitted through the FAP process.

Stakeholders felt that given the complex issues of hemp, particularly with the presence of small amounts of THC, any initiative to seek approval would be required to go through a FAP process. The FAP process could establish appropriate specifications that could alleviate many of the concerns and questions about the safety and allowable use of hemp seed and hempseed by-products. Petitioners interested in a FAP submission should utilize the FDA-CVM's guidance document on the FAP process to better understand the specific requirements that will be needed for a submission.

Conclusion 5: Include an experienced consultant in a collaborative effort
Considering the growing interest in hemp in animal feed and the wide impact on stakeholders, any initiative to seek approval should be collaborative and include a broad number of constituents across diverse disciplines. Through stakeholder discussions, it became evident that the use of hempseed products is of interest to professions and industries beyond just hemp producers and animal feed manufacturers. Ranchers and other livestock producers, veterinarians, nutritional experts, academics, economists, regulatory officials, and other professional experts should be involved in further discussions and offer assistance where appropriate in the development and submission of a FAP. Due to the different perspectives on and depth of this issue, a number of stakeholders felt the dialogue should continue in advance of any preparation and submission of a FAP.

Research and other supporting documentation that will need to be submitted with a FAP will be extensive, particularly if the petition covers multiple species, life stages, and intended uses. The assemblage of the petition material may require the involvement of more than just one organization. Moreover, the submission effort should be overseen by a company or consultant with significant experience with the FAP process and the requirements set forth by FDA-CVM.

Conclusion 6: Execute a S.A.F.E petition process
The stakeholders examined the general requirements in preparing and submitting a FAP application for hempseed products and identified a basic S.A.F.E. petition process which petitioners may use as guidance to submit a FAP to the FDA-CVM:

S - Start early discussions with FDA
The FDA-CVM encourages pre-submission consultations. Consultations can help streamline the process by ensuring that petitioners address required elements efficiently and completely. The FDA-CVM can provide input on the types of data and information that should be included in a petition and will comment on protocols for any planned research.

A - Assemble and assess existing research materials
Petitioners should evaluate existing research on feeding hemp seeds and hempseed by-products for various species to determine the significance of the data in regard to submitting a FAP. While peer-reviewed research is beneficial, it is not necessarily required for a FAP. Engaging with an experienced consultant will help review existing research. Research should address intended use, use level, analytical methods, safety, and any potential tolerances for residues.

F - Fill in gaps with additional research
Additional research may need to be conducted to support the safety and utility of these substances for a given intended use. It was discussed by the stakeholders that one well-prepared study can be effective in addressing the safety and utility of hemp in animal feed;

however, most FAPs have more than one study to compensate for any limitations in the data. Additionally, a FAP that is broad in scope for multiple species will require a wider range of data to address the requirements for each species separately. If any new studies are planned, detailed protocols should be submitted to FDA-CVM before conducting the studies to help ensure that the studies will meet desired objectives.

Additional research or studies can be done through a number of Colorado resources, either through private companies or academic institutions. Nevertheless, additional research should use hemp seeds that are legally imported or grown in compliance with state regulatory guidelines.

E - Execute a targeted petition

Stakeholders discussed that a submission effort may need to include separate petitions for hemp seeds, hempseed cake, and hempseed oil. However, within each petition, petitioners could include multiple animal species, including both production and companion animals. The petition(s) should include all species that are feasible from a nutritional and safety perspective. Each FAP should clarify the species, life stages, durations, and other variables. Studies may not be required in each individual species, but sufficient data and information would need to support the safety and utility of any potential cross-species extrapolation if data is not available in all intended species.

Legislative Recommendation

The specific legislative action was not indicated by the stakeholders since the responsibility for the assemblage and submission of a petition to the FDA-CVM would be completed by the hemp industry. However, stakeholders felt that the Colorado Legislature could provide general support for the submission of a FAP, specifically for any additional research that might be needed to determine the safety and utility of hempseed products. Additional research and study could be completed by either private industry or universities in Colorado.

Conclusion

The steps for approval outlined in the submission effort should bring clarity to agricultural industries and the general public on the safety and nutritional benefits of hemp seeds and hempseed by-products in animal feed. Moreover, completion of a review and subsequent approval will help establish standards in regard to its allowable use. If approved, hemp seeds in animal feed could further highlight the diverse use of hemp as an emerging crop. While additional research into this area of study is required, Colorado has a number of resources and interests within the hemp industry and other disciplines that could contribute to the pursuit of any submission effort.

Appendix A: Abbreviations and Terms

- **AAFCO**: Association of Feed Control Officials
- **By-product**: secondary products produced in addition to the principal product.
- **Companion animals**: animals kept for uses other than the production of food or fiber. Includes dogs, cats, and horses.
- **Cannabinoids**: a class of diverse chemical compounds that acts on cannabinoid receptors in cells that alter neurotransmitter release in the brain.
- **CBD:** Cannabidiol is one of at least 85 active cannabinoids identified in cannabis. It is a major phytocannabinoid, accounting for up to 40% of the plant's extract.
- **CDA**: Colorado Department of Agriculture
- **CofA**: certificate of analysis, a document provided by a testing laboratory certifying the content of a product.
- **CSA**: Controlled Substances Act; the statute establishing federal U.S. drug policy under which the manufacture, importation, possession, use and distribution of certain substances is regulated.
- **DEA**: Drug Enforcement Agency
- **FAP**: Food Additive Petition
- **FDA-CVM**: United State Food and Drug Administration-Center for Veterinarian Medicine
- **FD&C Act**: Federal Food, Drug, and Cosmetic Act
- **GRAS**: Generally Recognized as Safe; substance is generally recognized, among qualified experts, as having been adequately shown to be safe under the conditions of its intended use
- **Hempseed by-products**: A component of the whole hemp seed, namely hempseed cake (meal) and hempseed oil.
- **Hempseed cake**: the by-product remaining after the extraction of hempseed oil from the whole hemp seed.
- **Least cost ration formulation**: formulating animal feeds based on the relative costs of ingredients. The composition of the animal feed will change based on changes in ingredient prices.
- **Petitioner**: the entity submitting a Food Additive Petition.
- **Production animals**: livestock animals that are raised to produce fiber or food products for human consumption.
- **THC**: Delta 9 tetrahydrocannabinol, the psychoactive substance found in *cannabis.*
- **USDA-FSIS**: United States Department of Agriculture Food Safety Inspection Service

Appendix B: AAFCO Guidelines on Hemp in Animal Food

AAFCO Guidelines on Hemp in Animal Food
March 5, 2017

For more information visit the aafco.org website.

Ingredients used in animal food (pet, livestock, and poultry) in the United States undergo a scientific review prior to being allowed for sale or distribution. The most comprehensive list of ingredients defined for animal food use is found in the Association of American Feed Control Officials Official Publication (AAFCO OP). Ingredient definitions and their common name come into the OP through one of three routes. They can be the subject of a Food Additive Petition to the FDA (FAP); receive a letter of no questions from the FDA to a generally recognized as safe (GRAS) notification (new—subject to membership approval); or the most popular route, be requested of AAFCO. Each of these routes has some level of a safety and utility review done by the FDA-CVM. States and others then rely on the AAFCO OP to allow feeds to be made with defined ingredients. The common ingredient name established by AAFCO is reflected in the feed's ingredient statement. The FDA and a few states also recognize self-conclusions by firms of GRAS for an intended use.

Hemp production is increasing in the United States. In 2015, AAFCO asked the hemp industry to come forward and present information for the scientific review to establish definitions for animal foods made from the hemp plant. We expected information on hempseed oil, hempseed meal, and whole hemp seeds. To date, the industry has not provided any data showing that ingredients derived from the hemp plant are safe and useful in animal food. AAFCO is encouraging the industry to submit their data promptly. Regulatory members continue to ask for the information prior to distribution of hempseed products in their state. To allow an entire industry to enter the market without the appropriate safety data is unfair to other ingredient manufacturers that are doing their due diligence. There are some potential safety concerns related to the presence of certain compounds, including THC (tetrahydrocannabinol) and CBD (cannabidiol), in parts of the hemp plant that must be addressed.

One thing has become clear as we have had discussions with the hemp industry, materials and products that are CBD infused need to be treated as drugs. There is no nutritional intended use for this compound. This means that several parts of the hemp plant will not be appropriate for animal feeding.

Quoting from the FDA and Marijuana website: "FDA has therefore concluded that it is a prohibited act to introduce or deliver for introduction into interstate commerce any food (including any animal food or feed) to which cannabidiol has been added."

For further information:

AAFCO Ingredient Definition Process: http://www.aafco.org/Regulatory/Committees/Ingredient-Definitions

AAFCO Hemp Seed Oil Investigator: brett.boswell@state.mn.us

AAFCO Hemp Seed Meal, Whole Hemp Seed Investigator: bchurch@mt.gov

FDA Food Additive Petitions:
http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/ucm056809.htm

FDA GRAS Notification:
http://www.fda.gov/AnimalVeterinary/Products/AnimalFoodFeeds/GenerallyRecognizedasSafeGRASNotifications/default.htm

FDA and Marijuana: Questions and Answers

http://www.fda.gov/NewsEvents/PublicHealthFocus/ucm421168.htm#dietsuppsexclude

DEA Announces Actions Related to Marijuana and Industrial Hemp
http://www.oisc.purdue.edu/seed/hemp/dea_cannabis.pdf

DEA Eases Requirements for FDA-Approved Clinical Trials on Cannabidiol

http://www.oisc.purdue.edu/seed/hemp/dea_cbd_research.pdf

Appendix C: Summary of Stakeholder Discussions

Stakeholder subgroups focused the discussion on specific questions related to their areas of focus. The following is a summary of the key insights from stakeholders regarding the questions discussed.

Subgroup 1: Regulatory Requirements

Question 1: How will regulations establish the safety, utility and toxicity limits of products for different target species?

- The regulatory framework provides different pathways that are designed to determine the safety, utility and toxicity. Specifically: GRAS, AAFCO ingredient definition, FDA Food Additive Petition. However, submission through the FAP is be preferred and is considered the most appropriate pathway. It was the consensus of the group that this pathway would be the most rapid avenue for review and approval.
- The regulatory review focuses on the safety and utility of the proposed new ingredient. The AAFCO Ingredient Definition process is an option but would not result in an official federal approval by FDA-CVM.
- Additional research may be needed in order to submit a petition.
- It is recommended that petitioners review study protocols prior to submitting a FAP. An initial meeting with FDA-CVM is recommended to clarify the FAP requirements.

Question 2: Is there a specific collective strategy to obtain approval of parts of the hemp plant as allowable ingredients?

- Petitioners should focus on parts of the plant that show good potential for nutritional benefits and are exempt from the CSA, namely sterilized hemp seeds and hempseed by-products. The legality of resin, flower, or any other part or derivative of the hemp plant are being disputed at the federal level should not be considered for a FAP at this time.

Question 3: Beyond the ingredient approval process, what other regulatory concerns need to be addressed?

- Often the biggest hurdle is documenting the chemistry and manufacturing specifications documented. Additional applications could be less of an effort for subsequent species once that hurdle is addressed in the first petition.
- Any additional research should be compliant with state and federal laws related to the legal production and cultivation of hemp under state industrial hemp programs.
- The consequences of interstate commerce and global export of livestock or feed using hemp by-products should be considered. For example, could this result in trade barriers from other countries or impact reciprocity of feed and livestock between states? FDA approval and subsequent adoption by AAFCO as a defined animal feed ingredient typically allow for a national recognition of the allowable use in animal feed.

Question 4: What are the challenges or obstacles that need to be addressed in submitting an application for any part of the hemp plant to become an approved ingredient?

- The primary concern of stakeholders was the determination of whether there is enough research to submit a FAP, particularly in regard to questions of safety. If not additional research to fill in any gaps.
- A FAP for hemp should include an expert in the submission of applications for animal feed ingredients. The process should include a number of participants.
- Undertaking research to collect data can be costly and would need financial support.

Question 5: What types of studies should the group consider as first steps?

- Petitioners submitting a FAP should examine existing data on safety and utility, identify gaps in the data that still need to be researched; and begin the conversation with regulators. For food-producing animals, data will be needed on tissue residues and the safety of those products for use as food for humans.
- One comprehensive controlled study may be very helpful in addressing safety and utility, but most cases typically require a few studies or corroboration to support an approval. Incorporation of multiple sources including peer-reviewed and published data is beneficial, though the submission can include well-designed studies that have not been peer-reviewed.

Question 6: What challenges will animal feed regulators find in monitoring these ingredients in the animal feed supply (storage, inspection, recordkeeping, labeling etc.)?

- The focus of the discussion centered on the production chain from the hemp producer to the animal feed manufacturer. The challenge is to ensure that animal feed does not contain hemp with greater than .3% THC, or that has been cross-contaminated with THC during processing. Before taking possession of hemp, processors test loads of hemp products to ensure it is not above .3% THC.
- While not specifically related to regulatory challenges, stakeholders noted that animal feed manufacturers test other commodities before they come into a facility as a control for some hazards, such as mycotoxins in grain. Animal feed manufacturers using hempseed products may need to consider a similar control process.
- State animal feed programs would not have the capacity to test all hemp seed loads. A certified seed program with certificates of analysis (CofAs) would be beneficial to ensure hempseed products meet all standards defined in an approved FAP.
- If approved, proper labeling requirements would need to be addressed through state regulation.

Question 7: Prior to any approval, what has been done or could be done by industry and regulators about the trend of hemp by-products in animal feed?

- Industry and CDA need to educate on the current regulatory environment. At an appropriate time, the hemp industry may wish to craft language for the education of consumers and producers.
- Discussions about public interest in hemp have occurred in recent AAFCO conferences. The AAFCO board put out a policy statement in March 2017 that highlights their request for the

hemp industry to conduct a scientific review prior to the description of hempseed products. To date, there has not been an application request for definitions for hemp seed or hempseed by-product to AAFCO.

Question 8: What other countries have approved hemp ingredients in animal feed and how are they regulating hemp in animal feed?

- Other countries in Europe and Canada have looked into the research, with some countries allowing hemp as animal feed. Those countries could be a good place to look for data. Stakeholders discussed that the laws and regulations from other countries can be different from animal feed regulation in the United States and may not be sufficient. Research from those countries should be carefully reviewed.
- Currently, hemp is not allowed in animal feed in Canada.
- The industry should consolidate and present the best available data.

Question 9: What is the maximum allowable level of cannabinoids in the finished ingredient?

- Stakeholders commented this project cannot make a determination on specific allowable levels. Maximum allowable levels will be determined through the petition process. Available research data can provide a reference point and possibly be used in a submission. Stakeholders pointed to the scientific opinion of the European Food Safety Authority recommendation that recommended the introduction of an upper level of THC for hemp seed-derived animal feed materials of 10mg/kg. (EFSA FFEDAP, 2011 p. 14)
- Life stage of the animal and the duration are important variables to determine the amount consumed.

Question 10: What sort of education requirements will be necessary for both the industry and the public to enable decision-making?

- Once approved for use, it will be important the public and industries are aware of the regulations and any specific requirements or limitations that would arise.
- Limiting the approval to a specific definition of hempseed by-products will provide clarity to the public and industries on what is and is not allowed.
- Education efforts can be done collaboratively through the hemp and animal feed industries working with animal feed regulators and other impacted professions. Educational initiatives should also address the specific intended use and claims would be limited to those acceptable for animal feed (nutritional) products.

Subgroup 2: Animal Nutrition, Safety and Public Health

Question 1: What are potential ingredients that can be used in animal feeds?

- Whole hemp seed and hempseed by-products have a beneficial nutritional distribution of protein, fats, and fiber.
- There are concerns among stakeholders about THC and CBD exposure to the animal and concerns about transmission to the consumer of the animal product. There is not enough data at this point to be conclusive, specifically, on an acceptable average daily intake (ADI) level for THC and other cannabinoids.

Question 2: What health concerns are associated with animals consuming hemp by-products?

- The broad concern is the presence of THC and other cannabinoids in the animal feed products. Cross-contamination during processing from other plant parts into hempseed by-products is a possibility.
- Petitioners may need to consider the possible uptake of contaminants from the environment. Hemp is a bioremediator, which means it can absorb metals and other pollutants from the soil. Studies have shown hemp to be effective at removing cadmium, a heavy metal. It may be important to test the plant to confirm that it does not have harmful levels of cadmium or other heavy metals or pollutants.

Question 3: What are the effects of hemp processing on the nutritional content of those ingredients?

- Limited information is available for the role of hemp processing.
- Hempseed products can be heat-sensitive and need to be handled at low temperatures so that product quality is not adversely affected. The shelf life of each product will need to be studied and verified.

Question 4: What are the safety concerns for different species of animals and their life stages? Should they be considered separately?

- Safety concerns are primarily focused on the presence of cannabinoids and the possible impact on animal and human health. Certain parts of the plant will present a lower risk than the whole plant or other parts of the plant.
- One comprehensive FAP could cover multiple species for each separate ingredient, such as hempseed oil. However, the FAP will need to provide separate information, including supporting data for each species and life stage.
- Options for species to include beef cattle, swine, poultry (eggs v. meat), and companion animals (dogs, cats, horses). The FAP can be more narrowly defined based on what the data can support regarding the safety and utility of each species.
- Companion animals and horses have different considerations concerning safety. With companion animals, there is not a food risk of human exposure. However, ingredients go into the home and broader consumer protection may be a concern.

- Another consideration for companion animals is that they may be fed products with hemp over a much longer period than livestock and long-term exposure should be considered.
- The petition should balance those species for which there are an economic benefit and enough available data.

Question 5: What are the health concerns with humans consuming animals who have been fed hemp products?

- Plant components that are unknown, such as secondary metabolites that may exert toxicity to animals that were previously unknown. (This is related to the GRAS assumption and differences that may exist in tolerable dose across species.)
- For approval in production animals intended for human consumption, the residual effects of hemp, if any, would need to be evaluated.
- Stakeholder discussion focused the question of transfer rates of cannabinoids in the animal tissues and milk. This will need to be a focus of study in order to determine how much will be passed on to someone consuming the animal food products. A FAP submission will need to address this concern.

Question 6: What is the general availability of scientific data on the utility /safety? What additional research remains to be designed and completed?

- Studies have been conducted in other countries, namely European countries and Canada. Data from these studies may be accepted in a petition provided they are related and the conditions are the same. Studies will need to be specific to what the FAP is requesting for approval.
- Generally speaking, there is publicly available data that can serve as a foundation for support for a new ingredient. In some cases, existing data may be proprietary and may or may not be available for use.

Question 7: Will the levels of inclusion differ for each species and life stage?

- Species' differences in safety and tolerability to plant components is real and should not be dismissed for hemp.
- For example, some foods (e.g. grapes) are toxic to dogs, while many other animals are fine.
- Regarding age, younger animals could be more susceptible to toxicity by dose (e.g. hemp seed dose may be an issue for some food production animals but not necessarily companion animal, with or without respect to age).

Question 8: What specifications may be added to a hemp definition to prevent marijuana from being marketed or added to animal feed?

- Regulation can set maximum acceptable THC limits for animal feed ingredients and possibly complete diets.
- The definition of hemp contains a maximum THC concentration. Hemp authorized by Colorado (certified seed) is guaranteed not to be marijuana, but there may be contamination risks for non-seed parts of the plant. Focusing on the seed avoids the majority of the challenges related to marijuana.

Question 9: How does feeding hempseed by-products to animals change the nutritional quality of the food product(s)?

- Dietary composition of the finished food product may be influenced by changes in body composition and for animal products such as egg and milk. For example, chickens fed diets high in flax seed produce eggs high in omega-3 fatty acids.
- Ruminants are influenced less by nutrition than non-ruminants.

Question 10: What research will be permitted by the State of Colorado?

- There are no CDA restrictions on research so long as you are not selling the animal feed. If you're studying it, and not distributing it, then it's not within our purview. Petitioners should consult with the FDA-CVM during any pre-petition discussions regarding the execution of new research to determine what is allowed and not allowed, such as the disposal of test animals.
- The 2014 Farm Bill provides for research on the growth, cultivation or marketing of industrial hemp inside pilot programs set up in states where industrial hemp is legal. Neither the 2014 Farm Bill or the associated state laws or Rules of the Industrial Hemp program limit the research being done at institutions of higher education in Colorado, those holding a commercial registration in a pilot program or those purchasing material grown under the state's program or imported legally.

Subgroup 3: Agricultural Economics

Question 1. How do production costs and break-even points for hemp by-products compare to other animal feed sources; including costs to transport, costs to store, and costs to process? Are there points of scale where hemp by-products become viable from a producer or processor standpoint?

- It's challenging to know the value of the crop because we have not yet achieved price discovery. Hemp is an emerging market with significant changes year after year. It is too early to draw economic conclusions since production practices vary greatly and have yet to be standardized. Because of the fluctuation of the industry, data has been tough to find. It may be necessary to consider using other countries markets to establish rough numbers; however, laws and practices in other countries will not necessarily translate to Colorado.
- Colorado State University Extension has developed a fact sheet that includes a fiber budget and a seed budget. This offers a format for the information, though much of the information is extrapolated from other crops. Colorado State University Extension will need help from hemp producers that have financial records that will provide data necessary to develop budgets for Colorado. The hemp industry in Colorado could provide the names of 6-8 producers to determine what information is known and what holes exist.
- There are two different approaches to hemp production: 1) the traditional farmer with industrial intent, and 2) female-only non-pollinated growers who grow from clones that are growing for cannabinoid value. Analysis of the traditional farming approach would be the most appropriate economic review given the focus on the hemp seed and its by-products, and not the rest of the plant.

- The cost of water is a key driver to consider. Cost per acre-foot of water is materially higher in some areas of Colorado versus others, making statewide conclusions about economic viability less reliable.

Processing:

- There are a variety of hemp processors in Colorado that could provide information on processing costs, maintenance requirements, transportation, etc. It is recommended groups of commercial processors that include large scale animal feed processors be convened to examine the economic considerations of processing. They may need to extrapolate from existing hemp crops because it is likely that they might not have enough product flowing through the pipeline.
- There is emerging interest in a business model in which farmers will produce hemp seed, process it themselves, and animal feed it to animals on the farm.

Question 2: What end forms are most practical/economically viable for animal feeds?

- Least cost ration formulation is a key method for evaluation in livestock animal feed; protein content is 45% for soybean meal v. 35% for hemp meal. Hempseed by-products need to be on par with production costs for established animal feed options. The yields need to be higher to compete for the commodity pricing that exists, particularly for protein.
- Pet markets do not work on the least cost ration formulation and they do not change the formulation as often as would a livestock animal feed manufacturer.
- Transportation costs from the processor to the animal feed location would play a role in the economic feasibility. There are processing capabilities currently in Colorado, any examination would benefit from local processing.
- Hemp seed is just one of the by-products of the harvest. This might allow for farmers to make money while selling the seed and other components (e.g. CBDs & fiber) separately into different markets. There may well be more co-product benefit with hemp associated with the dry material.
    - Price per unit is less commoditized/competitive in the pet food industry.
    - Volume overall will be far greater as a livestock animal feed versus pet products.
- Production and processing standards for hemp still needs to develop.

Question 3. How might hemp factor into the rotation of traditional crops such as wheat and corn (e.g. what impact does it have on the soil)?

- Estimating the economic benefit of crop rotation for hemp is beyond the scope and research available at this time. However, interest on hemp as a rotational crop was high among stakeholders. It was recommended to pursue further exploration into crop rotation. However, this specific question goes beyond the economic focus on hemp by-products in animal feed. We do not have enough information on hemp as it pertains to Colorado soils, climate, and conditions. Canada has good data, but we cannot extrapolate it.

Question 4. What role can the State of Colorado play on agricultural economics, through state universities, to assist in determining economic viability?

- Colorado universities and colleges are working various studies on hemp, including economic viability. These institutions could help pursue the development of any economic (and nutritional) research needed specific to the use of hemp as an animal feed ingredient. Economic research could focus on hemp production and processing as well as an animal feed option for livestock producers.
- Economists with CSUE are another resource to help explore the economics, though funding will need to be justified and secured. CSU also has farm test plots and eventually will cooperate with producers for on-farm testing.
- Collaboration can occur among producers in regard to production data.

Question 5. How is the estimated economic value of hemp calculated? (Every part of the plant, primary and secondary products)

- The economic value is still hard to quantify because of the lack of research. Stakeholders conclude completion of additional research that focuses on production data for hemp producers, as well as an economic comparison to other animal feed ingredient options for livestock producers and animal feed manufactures, is needed.
- While the focus on a FAP would be for hempseed by-products, the economic value is currently focused on cannabinoids-particularly CBD. However, CBD and other cannabinoids are beyond consideration as an animal feed ingredient because of their designation by the FDA as a drug. Nevertheless, from an economic perspective, it is important to note.

Question 6. What negative/positive economic impacts could hemp in animal feed for livestock have on farmers, livestock producers, and animal feed producers for companion animals following legislative approval?

- Increasing the supply would likely lower prices and expand the market. Currently, the market is a very small niche, primarily for pet treats. Receiving federal approval would also create a marketing advantage. Once approved, hemp by-products could result in increasing demands for other hemp-based pet products.
- The livestock animal feed issue (as an ingredient and as a crop) is one of substitution: if hemp is planted, something else cannot be planted. If the seed is used in animal feed, then other ingredients will not be used. Colorado is a livestock-feeding state, so there is a potential upside if the ration equation works out.

Appendix D: List of Stakeholder Participants

Stakeholders:

Neil Ahle, *Chief Medical Officer*, High Plains Nutrition LLC

Bill Bookout, *President*, National Animal Supplement Council

David Bossman, Agwin Group, LLC

Michelle Boyd, *Grant Coordinator*, Iowa Department of Agriculture and Land Stewardship

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David Bush, *Senior Attorney,* Hoban Law Group

Veronica Carpio, *Hemp farmer/seed breeder/hemp consultant,* Grow Hemp Colorado

Bob Church, *Program Manager,* Montana Department of Agriculture/AAFCO

Charlotte Conway, *Deputy Division Director*, FDA-Center for Veterinary Medicine

Bryan C. Cook, *Farm Loan Manager,* USDA

Amy Daley, *Veterinarian and Producer/Farmer*, CVMA, Roaring Fork Equine Medical Center, and Grass Valley Ranch

Meagan Davis, *Director, Feed Program,* Louisiana Department of Agriculture and Forestry

Norm Dalsted, *Professor,* Colorado State University

Richard Ten Eyck, *AAFCO Ingredient Definitions Chair*, Association of American Feed Control Officials

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Emily Febles, *Industrial Hemp Program Manager,* State of North Carolina

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Eric Ward, *Owner,* Colorado Grow Op

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Brent Young, *Regional Extension Specialist,* CSU Extension

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Hollis Glenn, *Division Director,* Division of Inspection and Consumer Services

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Scott Ziehr, *Regulatory Administrator,* Division of Inspection and Consumer Services

Project Facilitator: Government Performance Solutions, Inc.

Greg Bellomo, *Managing Partner*

Kate Newberg, *Principal Consultant*

Brian Pool, *Partner*

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Executive Summary

In September of 2013, California passed SB 566, the California Industrial Hemp Farming Act (CIHFA). The legislation removed state-level prohibitions on hemp cultivation, but would “not become operative unless authorized under federal law”.[1] Meanwhile, the Agricultural Act of 2014[2] (Farm Bill) signed into law in February contains a section[3] allowing for pilot programs through universities and state Departments of Agriculture to cultivate industrial hemp for research purposes. Partly because of the relatively vague wording of both the federal and state legislation, and partly because of the relatively vague wording of the Justice Department’s clarifications, it is now arguably legal to grow industrial hemp in at least thirteen states – according to Kentucky Attorney General John Conway, "absent any federal guidance to the contrary, [the Farm Bill] appears to exempt hemp pilot programs from the Controlled Substances Act, allowing the sale of hemp in Kentucky by those programs." (As cited in Patton, 2014)

Vote Hemp, the lobbying arm of the Hemp Industries Association, worked in concert with California State Senator Mark Leno’s office to draft SB 566, which sailed through the State Legislature with almost unanimous support and no credible opposition. (Office of CA State Sen. Mark Leno, 2013) Not only was this facilitated by an ever-growing close-to-critical mass of support for an end to industrial hemp prohibition nationwide, but it also bolstered that support through its victory. In the 2013 legislative

[1] Cal. Industrial Hemp Farming Act, Cal. Food and Agriculture Code § 81010
[2] (H.R. 2642; Pub.L. 113–79)
[3] Colorado Constitution article XVIII § 16

session alone, twenty states introduced some form of hemp legislation – some for the first time, some for the fifth time[4]. In 2012 both Washington and Colorado passed legislation legalizing marijuana for adult recreational use. Washington's legislation [5] called for studies into regulating industrial hemp as well, while Colorado's legislation [6] set up a regulatory framework for hemp cultivation.

The movement to end hemp prohibition was more successful in 2013 than it has ever been. A growing number of states are passing hemp cultivation regulations; there is a growing awareness of the differences between hemp and psychoactive marijuana, as well as a growing awareness of hemp's current utility and especially its potential utility; the rise of the sustainability movement is pushing consumers, producers and growers to find crops, methods and products with smaller carbon footprints; and the venture capital community is abuzz over recent discoveries in potential new applications of hemp, such as fire-resistant building materials, biofuel, and the next generation of super-capacitors. Hence the success of SB 566 - and as California goes, so goes the nation.[7]

The Justice Department's response to these laws has been interpreted to mean that as long as states have robust marijuana regulations, the federal government won't see a need to take action to enforce federal marijuana laws – the enforcement of which has been left up to the states in the past anyway. Considering the federal government

[4] A full and up-to-date accounting of the current legislative state of hemp in the states can be found on Vote Hemp's website at http://votehemp.com/legislation.html

[5] Access Washington, Revised Code of Wa. Title 69 § 50

[6] Colorado Constitution article XVIII § 16

[7] The sociopolitical aphorism "As California goes, so goes the nation" is most accurately attributed to columnist Westbrook Pegler.

fails to distinguish between marijuana and hemp, this would mean states with sturdy hemp legislation like SB 566 can now legally cultivate hemp.

Even though the Farm Bill only allowed for cultivation of hemp by research institutions for research purposes, it did not place any restrictions on what farmers could do with the hemp once it has been cultivated (Patton, 2014). The Controlled Substances Act (CSA) only restricts hemp cultivation, not hemp trafficking. Thus, farmers in some pilot programs will be able to sell for commercial purposes much, perhaps even all of the hemp they grow for research purposes, and thus for all practical purposes commercial hemp cultivation has returned to America.

Background

Industrial hemp is among the more versatile materials on the planet. However, the federal government considers hemp to be no different from its illegal, psychoactive cousin marijuana, and thus forbids the cultivation of hemp in America.

“The term "marihuana" means all parts of the plant Cannabis sativa L., whether growing or not; the seeds thereof; the resin extracted from any part of such plant; and every compound, manufacture, salt, derivative, mixture, or preparation of such plant, its seeds or resin. Such term does not include the mature stalks of such plant, fiber produced from such stalks, oil or cake made from the seeds of such plant, any other compound, manufacture, salt, derivative, mixture, or preparation of such mature stalks (except the resin extracted therefrom), fiber, oil, or cake, or the sterilized seed of such plant which is incapable of germination.” – *Controlled Substances Act 21 U.S.C. §802(16)*

We can process hemp and manufacture hemp and produce hemp, we just cannot grow hemp. Or at least, we could not. Some, including Kentucky Atty. Gen. John Conway, now argue that we can (Patton, 2014), although this depends on how each state chooses to interpret its own legislation. But historical precedent tells us that if humans can grow hemp, we will.

Humankind’s existence has been closely intertwined with hemp for long enough that scientists believe our two species have actually exchanged DNA. According to Dr. William Courtney, broad host viruses “transduct plasmid host DNA between plants, animals and bacteria, accounting for the lateral co-evolution of Endo/Exogenous

Cannabinoids.[8]" (Courtney, 2010) There are receptors in the human brain known as endogenous cannabinoid receptors, so-called because they only seem to react with a group of chemicals found in cannabis, including THC (tetrahydrocannabinol) and CBD (cannabidiol), known as exogenous cannabinoids because they are created outside the human body. This is more than a trivial factoid: it undergirds the notion that hemp has held great utility for humanity for quite some time, to the point where our bodies have adapted methods of interacting with that specific plant.

Due to its variety of applications, hemp's value at any given point has an extreme "own-price elasticity" (Thompson, Berger, & Allen, 1998, p. 28) such that as it becomes more widely grown and its value falls, the speed of that fall is arrested by greater utilization. In other words, as soon as the price falls enough for hemp to become more cost-effective for more applications[9], demand begins to rise once again, as does its value. The implication is that there is greater security for farmers in growing hemp. Even if it becomes as ubiquitous as crops like corn or wheat, any drop in value is counter-balanced by an accompanying rise in demand due to a greater cost-effectiveness which itself depends on not causally driving the value of hemp back up to where it was. Thus wider adoption of hemp farming still leads to a decrease in the value of the crop, but much more gradually so. To put it simply, hemp begets hemp.

A renewed interest in hemp is resulting in novel research, which in turn is revealing entirely new applications for hemp which in turn could have enormous

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[8] The transfer occurs via little loops of DNA called plasmids that bacteria can transfer between plants and humans through such exchanges as human ingestion of the plant
[9] Provided that people are aware of these new applications

impacts on many aspects of our lives. For example, hemp building materials last longer than conventional concrete and drywall, while offering superior heat and sound insulation and absorbing more moisture – which, combined with its anti-microbial properties, makes for a healthier breathing environment. (Hedenqvist, 2009; Nissen, 2010) Hemp is a phytoremediator, meaning it can actually decontaminate soil poisoned by heavy metals and toxic chemicals, even to the point of removing radioactivity. (Aina, 2004; Arru, 2004; Campbell, 2002; Citterio, 2003; Linger, 2002; Loser, 2002; Meers, 2005) Hemp fibers can be used to strengthen gluten-based plastics, which would allow for non-toxic, biodegradable plastic (Thompson, Berger & Allen, 1998). An Austrian company is making shipping pallets from hemp resin which can be composted (Govt. of New South Wales, 2011). According to the National Wooden Pallet & Container Foundation, shipping pallets comprise approx. 40% of lumber operations worldwide and 44% of the U.S. hardwood harvest. There are more than 1.2 billion pallets in service in the United States each day. (Scholnick, 2009).

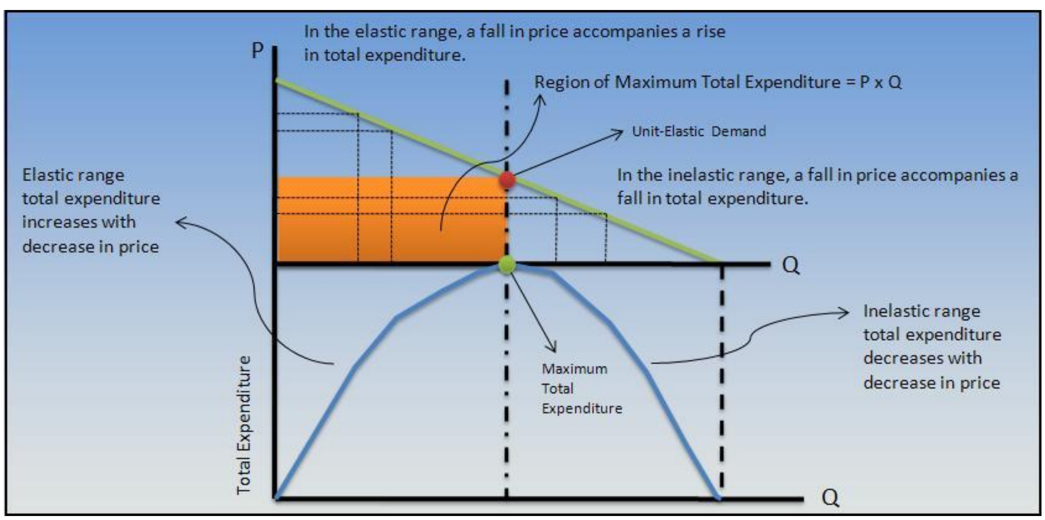

Figure 1: Because of hemp's high own-price elasticity, when its price drops, it becomes cost-effective for more uses, increasing demand, and thus overall expenditure on hemp rises. In other words, the cheaper it is, the more people buy. (*Simplilearn.com*)

Industrial hemp has the potential to reduce American dependence on foreign oil in particular, and petroleum in general, through biodiesel fuel, cellulosic ethanol, biomass feedstock, and hurd gasification (Li, 2010; Prade, 2012). When used in building materials such as concrete, hemp provides superior strength and insulation, which also brings inherent energy savings (Awwad, 2011;). Hemp drywall and insulation are more fire-retardant and absorbent than conventional materials (Small & Marcus, 2002). As an additive to strengthen gluten-based composites, hemp can be used to make plastic which, unlike its petroleum-based predecessor, is biodegradable (Hedenqvist, 2009). Recent discoveries involving hemp-based carbon nano-sheets have major implications for the future of electronics (Bourzac, 2013; Mitlin, 2013). In a few years' time people might even use hemp to make condoms (Anthony, 2013). Meanwhile, the sustainability movement in America has grown more powerful, just as the organic movement has become more widespread, leading to a greater demand for crops and products like hemp that are more inherently sustainable (Bardelline, 2010; Hotakainen, 2013).

Hemp is also being acknowledged as a prime source of energy, with one of the best well-to-wheel ratios[10] of any of the so-called 'energy crops' (Prade, Svensson & Mattson, 2012). Cellulosic ethanol derived from hemp contains more net energy and releases significantly fewer greenhouse gases into the atmosphere than ethanol derived from corn, while requiring less water and little to no herbicides or pesticides (Biello, 2008). Finally, hemp-based carbon nanosheets could transform the way we use electricity and store energy (Mitlin, 2013) (Bourzac, 2013).

[10] The form of life-cycle analysis used to evaluate transport fuels and vehicles, examining the ratio of carbon consumed versus carbon expended in the production and combustion of the fuel.

Law enforcement groups routinely express concern that even if hemp is completely harmless, its physical resemblance to marijuana would pose great difficulties for law enforcement, as evidenced in letters in opposition to California hemp legislation[11]. In fact, as you can see from Figure 3, most hemp growths look nothing like illicit marijuana growths (Patton, 2013; Kosolov, 2009; Small & Marcus, 2002).

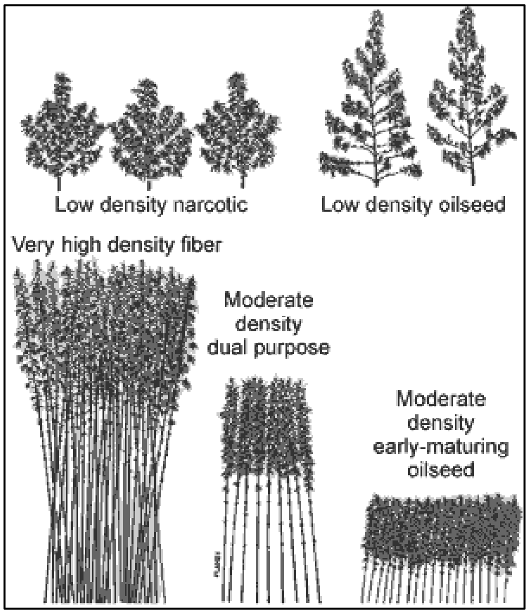

Figure 2: Typical architecture of categories of cultivated Cannabis sativa. Small & Marcus 2002

In the past, fallacious arguments against industrial hemp cultivation were employed to unsettle policy-makers, but new research and technology is alleviating such concerns. Dr. George Weiblen of the University of Minnesota has demonstrated that in fact hemp and marijuana are genetically distinct (Weiblen G. a., 2006). Not only that, but Dr. Weiblen has developed what is essentially a technique for cannabis DNA fingerprinting, which employs methods that could be replicated in any forensics lab and is already being utilized by state and federal law enforcement agencies (Weiblen G. , 2013).

A sort of grand conjunction of legislative changes, greater awareness, greater demand and more effective lobbying occurred in 2013, leading to the accumulation of the sorts of political, social and economic energies necessary and sufficient to effect real

[11] See Appendices C, D

change. That change is evident in the success of the California Industrial Hemp Farming Act, the progress on the federal Industrial Hemp Farming Act and the industrial hemp amendment to the Farm Bill.

At the same time, states have passed laws legalizing the sale of psychoactive marijuana, ostensibly the cause of hemp's relegation to illegality in the first place. Most importantly, the pro-hemp movement is dramatically more effective now that there is a sharp disambiguation between industrial hemp cultivation and the effort to legalize marijuana (Grim, 2013).

Primary Assertions

Although California state law has dismantled prohibitions on hemp cultivation, it has only done so in cases where federal law allows for it. But while federal law allows farmers to grow hemp for research purposes, it does not disallow them from selling it for commercial purposes. Therefore, for practical purposes it is now legal to cultivate industrial hemp in America – or at least in states like Kentucky, Colorado and California. Provided a farmer works with the state Dept. of Agriculture and an established research institution, that farmer can grow industrial hemp for research purposes. It is not unreasonable to suspect this research will turn up yet more novel applications for hemp, and certainly increase awareness of its current merits as a commodity.

A greater appreciation for hemp in conjunction with a worldwide focus on sustainability, a struggling economy, and a more fertile legislative environment suggests that a strong commercial market is at least possible. Indeed, the domestic market for hemp products was more than $581 million in 2013 (Hemp Industries Association, 2014). Thus, provided a farmer harvests hemp for a legitimate research purpose, that farmer ought to be able to sell at least part of that hemp commercially. Markets for hemp already exist and will likely increase as hemp cultivation is more widely adopted and a domestic supply is developed. Thus, even though hemp cultivation is limited, commercial cultivation is viable, and thus we are finally in a position to begin developing a domestic hemp industry.

For the first time, a definition of industrial hemp has been enshrined in federal law, differentiating it from marijuana and controlled substances[12]. California's hemp proponents struggled for years to even get a hemp bill through the legislature, and succeeded more than once, only to see their hard work succumb to multiple gubernatorial vetoes. Earlier in 2013 Sen. Ron Wyden of Oregon called out hemp lobbyists after legislation to regulate hemp cultivation failed in his state, blaming them for conflating hemp with marijuana (Grim, 2013). But by the year's end, Vote Hemp was able to learn from this quickly enough to facilitate two major victories – the passage of SB 566 and a successful high-profile lobbying effort on Capitol Hill in support of federal hemp legislation, which led to the inclusion of a section in the farm bill allowing for hemp cultivation.

It seems we have reached some sort of critical mass of support for an end to industrial hemp prohibition. Responsible factors include the ever-increasing number of states passing hemp cultivation regulations; a growing awareness of the differences between hemp and marijuana; the rise of the organic movement; the rise of the sustainability movement; and recent developments in potential applications of hemp, such as building materials, biofuels, plastics and superconductors. Each of these factors plays out in state and federal hemp politics - and not necessarily the same way in each. Together they have enabled the formation of something greater - a gestalt, greater than the sum of its parts; the force needed to effect change.

[12] "The term `industrial hemp' means the plant Cannabis sativa L. and any part of such plant, whether growing or not, with a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis." Farm Bill sec 7606 (b) (2)

Another measure of public support for hemp cultivation is the lack of credible opposition. In California, by the time SB 566 had its first hearing before a committee in the State Legislature, it had received more than thirty letters of support and only one letter of opposition (Rules Committee, Cal. State Senate, 2013). It was a joint letter from both the California Narcotics Officers Association and the California Police Chiefs Association, and written by John Lovell, a lobbyist and legal consultant to many CA law enforcement groups. It was the same letter the same organizations had submitted two years prior, in opposition to similar legislation; the letter – purported to be written in 2013 - asserted that 2005 was the last year for which figures were available for European hemp cultivation acreage; it cited as the foremost expert on hemp economics an academic who left academia ten years ago[13]; but what really scuttled the opposition was that its concerns were all refuted by one particularly strong letter of support from one particularly strong supporter – the California State Sheriffs Association. By the time the bill was on the governor's desk the one solitary letter of opposition had been withdrawn; apparently the Sheriffs were able to quell the concerns of their deputies.

While the sustainability movement is gaining steam and has shown, along with the organic movement, that people are willing to pay more to support their values, the sentiment does not sustain political clout, as evidenced by the failure of recent efforts in California and Washington to mandate the identification of genetically-modified foods on the packaging. However, that does not change the fact that businesses which thrive

[13] V. Vantreese-Askren, personal communication, April 4 2013 (Appendix A)

on hemp, such as Nutiva and Dr. Bronner's Magic Soaps, now have much greater resources with which to support the hemp lobby (Harkinson, 2013).

Just as hemp's various sustainable applications can only be appreciated once there is a greater level of awareness, its most cutting-edge technological applications such as biodegradable plastics (Hedenqvist, 2009), biofuels and super-capacitor electrodes, while among its most exciting possibilities, by virtue of their own novelty are also among its least-known potential applications, and thus cannot be relied upon to generate any serious call for change. In case of hemp tech, people will believe it when they see it. Still, the mere potential is enough to draw the attention of industries like clean energy and green tech, which serves to further the resources of the pro-hemp movement. Even Ford Motor Company has expressed an interest in working with farmers who are participating in the pilot programs[14].

In October, Gallup reported that 58% of Americans supported the legalization of marijuana (Newport, 2013), a sentiment shared by 65% of Californians (Tulchin Research, 2013). Those are Americans who think we should legalize not just hemp, but all marijuana. More states have passed or at least introduced hemp legislation than have not. Hemp has already been harvested in Colorado (Zak, 2013), and growers in Kentucky and California are getting ready to plant in 2014 (Asch, 2013) (Lammers, 2014). As far as the states are concerned, they are ready for hemp and waiting on the federal government. But if such widespread support hasn't been enough to legalize marijuana, then widespread support to legalize hemp cannot be expected to meet with

[14] C. Majeske, personal communication, March 25 2014 (Appendix B)

any more success – especially when the federal government has not historically distinguished between hemp and marijuana.

Discussion

In 2011, Gov. Brown refused to sign SB 676, the previous effort at a California hemp cultivation bill. His reasoning was succinct:

"Federal law clearly establishes that all cannabis plants, including industrial hemp, are marijuana, which is a federally regulated controlled substance. Failure to obtain a permit from the U.S. Drug Enforcement Administration prior to growing such plants will subject a California farmer to federal prosecution.

Although I am not signing this measure, I do support a change in federal law. Products made from hemp - clothes, food, and bath products - are legally sold in California every day. **It is absurd that hemp is being imported into the state, but our farmers cannot grow it**."[15] *(emphasis added)*

Vote Hemp director Patrick Goggin worked with Sen. Mark Leno's office to draft new legislation that could deal with the obstacle of federal supremacy. Rather than continue to beat against the door, they looked for another way in. Modeled after similar legislation that had proved successful in Kentucky, the new legislation would only become operative when authorized under federal law. It does not legalize hemp cultivation per se, it just sets up a legal framework by which once federal restrictions are removed California will be able to start immediately, rather than having to go through the process of dismantling state-level hemp prohibitions after the fact.

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[15] Governor Brown's full veto message is available online at http://www.votehemp.com/PDF/SB_676_Veto_Message.pdf

Little encouragement was needed to pass SB 566 through the California state legislature. It had a respected Republican co-sponsor from conservative bastion Orange County[16], it received almost unanimous support in both the House and the Senate, and the only issue became the matter of how many letters of support we could manage to collect. There was low-hanging fruit in the lists of supporters of prior hemp legislation in California, along with Vote Hemp/Hemp Industries Association's California membership rolls. Most prior supporters agreed to sign on again, though some expressed frustration with the failures of the past. At that point, in the spring of 2013, Sen. Rand Paul (KY) had already introduced an Industrial Hemp Farming Act in the U.S. Senate (Office of Sen. Rand Paul, 2013), the first time there had been a companion bill to industrial hemp legislation regularly passed in the House. As such, there was reason to be cautiously optimistic about the possibility of federal action on hemp in the near future.

Even as recently as ten or fifteen years ago, hemp cultivation was nothing more than "the focus of official interest" (USDA, 2000) – and only a handful of states were interested. Kentucky established a Hemp and Related Fiber Crops Task Force in 1994. Vermont, Hawaii, and North Dakota were the only states to have authorized agronomic and economic feasibility studies, and only three states[17] had already published hemp feasibility study results. (Ehrensing, 1998; Kraenzel et al, 1998; McNulty, 1995; Thompson et al, 1998) In 1999, nine states[18] passed legislation concerning the research, study, or production of industrial hemp as a crop (Nelson, 1999) The first test plots of

[16] State Rep. Allan Mansoor, Costa Mesa
[17] Kentucky, Oregon, and North Dakota
[18] Arkansas, California, Hawaii, Illinois, Minnesota, Montana, New Mexico, North Dakota, and Virginia

industrial hemp in the United States were planted in Hawaii in December 1999 . To gain DEA approval of the project, the scientists had to foot the bill for a twelve-foot high security fence, infrared surveillance cameras and even security patrols. After four short years the program shut down due to lack of funding (Borreca, 2003).

In 2012, Washington and Colorado became the first two states to decriminalize and fully legalize marijuana for adult recreational use. In the year since those election results, there has been a flurry of discussion and legislation (Hotakainen, 2013). Despite uncertainty as to the federal government's response, at least ten plucky farmers, including Ryan Loflin in Colorado, decided to go ahead and grow some hemp in 2013 (Zak, 2013). Luckily for Loflin, in August, a good two months before the harvest (Associated Press, 2013), the Department of Justice provided some much-needed clarification. It released a guidance memorandum in which Dep. Atty. Gen. James Cole explained that traditionally, the government had relied on state and local authority to deal with narcotics matters, addressing eight key priorities.

> "Indeed, a robust system may affirmatively address those priorities … In those circumstances, consistent with the traditional allocation of federal-state efforts in this area, enforcement of state law by state and local law enforcement and regulatory bodies should remain the primary means of addressing marijuana-related activity." (Cole, 2013)

Those priorities were:

- Preventing the distribution of marijuana to minors;
- Preventing revenue from the sale of marijuana from going to criminal

enterprises, gangs and cartels;

- Preventing the diversion of marijuana from states where it is legal under state law in some form to other states;
- Preventing state-authorized marijuana activity from being used as a cover or pretext for the trafficking of other illegal drugs or other illegal activity;
- Preventing violence and the use of firearms in the cultivation and distribution of marijuana;
- Preventing drugged driving and the exacerbation of other adverse public health consequences associated with marijuana use;
- Preventing the growing of marijuana on public lands and the attendant public safety and environmental dangers posed by marijuana production on public lands;
- Preventing marijuana possession or use on federal property

In other words, as long as a state can handle those responsibilities itself, federal government will find intervention “less necessary”.

Initially after the memo was released, there was hesitancy in the hemp movement (Hopkins, 2011), as the memo referred specifically to marijuana legalization, not hemp cultivation. But therein lies the key: the government’s legal definition of marijuana does not distinguish between industrial hemp and psychoactive varieties of marijuana. For decades, this has been the bane of the hemp movement – being saddled with all the stigmas and illegalities associated with “The Devil’s Weed”[19]. This failure of disambiguation now serves to bolster the cause of hemp proponents, at least in those states which have passed sturdy regulatory legislation such as SB 566.

In a letter of clarification to Oregon Rep. Earl Blumenauer, who had inquired as to the application of the Cole memo to industrial hemp in regards to his own state’s hemp regulations, US Attorney S. Amanda Marshall confirmed that “[s]ince ‘industrial hemp’ is marijuana, under the [Controlled Substances Act] these eight enforcement priorities apply to hemp just as they do to all forms of cannabis.” She described the federal government’s approach using such quintessentially Reaganesque idioms as “trust but verify”[20].

> “In other words, as long as the state follows through in imposing strict controls regulating marijuana-related conduct, it is less likely that any of the Department’s eight enforcement priorities will be threatened and federal action will be less necessary.” (as cited in Crombie, 2013)

While a reduced likelihood of enforcement is encouraging to farmers, federal action that is “less necessary” still sounds like it could be *slightly* necessary, a possibility that is still too great for some farmers and those interested in capitalizing on a hemp industry.

What a difference a decade makes. To say that things have changed would be an understatement. According to Vote Hemp’s website,

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[19] 1936 Anti-marijuana propaganda film, available at https://www.youtube.com/watch?v=7YBk4JW7bSc

[20] “Trust but verify” was popularized by drug warrior Ronald Reagan in reference to working with the Soviet Union. Reagan is also the President who officially declared a national “War on Drugs” in 1982, though Richard Nixon first uttered those words in 1971.

> "So far in the 2014 legislative season industrial hemp legislation has been introduced or carried over in Puerto Rico and twenty-three states: Alabama, Arizona, Connecticut, Hawaii, Illinois (carried over from 2013), Indiana, Kentucky, Maryland, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire (carried over from 2013), New Jersey (carried over from 2013) and new bill introduction as well, New York, Oklahoma, South Carolina, South Dakota, Tennessee, Utah, Washington (two bills were carried over from 2013), West Virginia, and Wisconsin. The New Jersey bills from 2013 were passed in January of 2014, but were pocket vetoed by Governor [Chris] Christie." (Vote Hemp, 2014)

Here in California, the removal of state-level prohibitions on hemp cultivation came only after years of trial and error. One particularly confounding aspect to hemp legalization in California has been medical marijuana advocacy. Some medical marijuana advocates see the legalization of industrial hemp as a half-measure or a compromise of principles. Only in California could legislation to legalize industrial hemp be publicly opposed by the late Jack Herer, the so-called "godfather" of the hemp revolution (The 420 Times, 2013). His concern, as voiced in a letter to then-Governor Arnold Schwarzenegger, was that industrial hemp fields will wreak havoc on medical marijuana crops by cross-pollinating with the psychoactive plants and ruining their potency[21]. Meanwhile, some critics see hemp as a gimmick designed to encourage the legalization of marijuana. It is not. In fact medical marijuana farmers lobby against

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[21] Appendix E

industrial hemp for fear that its pollen could destroy the efficacy of their medical crops (Johnson, 2012). If anything, marijuana was criminalized with the goal in mind of bringing about de-facto hemp prohibition – or at least that is the theory long espoused by Herer and his devotees (Herer, 1985).

The Cole memo was a game-changer. It demonstrated a paradigm shift in the Justice Department's position on hemp. Ever since Colorado and Washington had legalized recreational marijuana use, the public had held its breath to see how the federal government would react (Hall, 2013; Hopkins, 2011). California and Oregon had recently been jarred by raids on dispensaries and seizures of medical marijuana even though President Obama had arguably promised a more hands-off approach (Sullum, 2011); would the government handle these new states in a similarly haphazard fashion? The answer turned out to be no. Instead, the DOJ said it would not see a need to interfere with an individual state's marijuana laws, provided those laws are managed responsibly and in a way that does not interfere with other states. As the government does not distinguish between industrial hemp and marijuana, any rules they apply to medical marijuana must, by their own definition, apply to hemp as well.

Rather than move forward before a federal distinction between hemp and marijuana is established under the Controlled Substances Act, Vote Hemp is waiting to declare victory until it can seek opinions from individual states and attorneys generals about their interpretation of the law. The concern is to avoid giving farmers a false sense of security, as Kentucky's attorney general Jack Conway claimed was happening in his state. (Hall, 2013; Lammers, 2014) If farmers erroneously believe they can grow hemp legally, they run the risk of having their entire crop destroyed, which could be ruinous.

However, since the passage of the farm bill, Conway's office has started working together with Commissioner Comer to help farmers enroll in pilot hemp programs. (Patton, 2014) Still, this serves as an example of the damage U.S. regulations have done to the hemp market, both nationally and internationally.

For proof that US regulations depress the hemp market, look no further than Hanes. Starting in 2008, Hanes worked for years with Naturally Advanced Technologies (NAT) on a technique using a wash developed by the National Research Council of Canada to treat hemp fibers in a way that rendered them able to be processed with existing cotton equipment. Hanes was able to develop clothing with a blend of 80% cotton and 20% hemp that had 50% less shrinkage along with increased strength and moisture wicking. They went so far as to purchase 10,000 lbs. for further testing.

In March of 2010 Hanes inked a 10-year contract with NAT. Although the CRAiLAR fabric was more expensive than cotton at the time, "the Hanes brands tests showed that the material's shrink-resistance and dye-retention properties would reduce manufacturing costs to a point that would even out the higher initial cost of Crailar." (Bardelline, 2010) Not one month later, Hanes was singing a different tune. Another release went out announcing another 10-year deal between Hanes and NAT – but something had changed. This time the announcement heralded NAT's "commercialization" of flax fibers, not hemp. The only reference to hemp in a *Wall Street Journal* article on the development did not even reference the initial deal, though it does offer an insight into why hemp's superior shrink-resistance, moisture wicking, dye retention and strength were not strong enough for Hanes.

"Until last year, NAT had focused on developing hemp, but it switched to flax when it found it could process that fiber twice as efficiently. Hemp also has other drawbacks: It's derived from the marijuana-producing cannabis plant, which can't be grown in the U.S., and it may be difficult to sell to mainstream consumers.

That was a concern for Hanes. 'We were having a heck of a time with the hemp, thinking, 'How are we going to market this?' said Hanes's Mr. Hall." (Dodes, 2011)

In other words, despite hemp's otherwise superior qualities outweighing its greater cost, US regulatory pressure alone was enough to scuttle the hemp CRAiLAR deal. Anna Owen, one of the coordinators of Hemp History Week, recently provided a succinct demonstration of how Canadian commerce is also impacted by our outdated laws. Her research demonstrated the impact of hemp farming prohibition in the U.S. in an interview with a leading hemp food processing and product manufacturing company looking to one day have acreage in the U.S.:

> "In Manitoba, companies expressed support for the U.S. to end hemp-farming prohibition. For example, a representative from Company "B" stated, "we can't wait to plant our first hemp field in the U.S." (R9). Some view the prospect of U.S. hemp farming as an opportunity to grow the hemp industry. Having U.S. farmland available for hemp would also buffer climatic challenges in Manitoba such as flooding. Moreover, some Canadian hemp food companies are well positioned due to their ownership of hemp knowledge from seed to manufacturing." (Owen, 2012)

It seems farmers in Canada have expressed interest; if the interest is there, that means they would be doing more business if they could; thus there would be a greater level of commerce if the US relaxed its hemp restrictions.

In Tasmania farmers face similar frustrations. Phil Reader, president of Tasmania's Industrial Hemp Association, is at the vanguard of an effort to legalize hemp grain for human consumption in Australia. It was legalized in Tasmania years ago, but Australian restrictions depress the market (Tasmanian Farmers and Graziers Association, 2012). Australian police are concerned that hemp might impact their unique roadside THC test - "It's only divisive through the ignorance of Federal politicians and bureaucrats not wanting to change anything," Reader told Australia's *Farm Weekly* (Vallely, 2013). As long as hemp is illegal to grow for human consumption in Australia, Tasmanian farmers are at a loss.

A domestic hemp industry would eliminate some of the uncertainty in the international hemp market, not to mention demonstrate hemp's commercial and political viability. As such, it is only a matter of time before Australia's hemp food ban goes the way of the dodo. That's assuming public opinion is in line with an article for the Australian Broadcasting Corporation's Rural section in which Rosemary Grant boldly asserts, "It's arguable the hemp plant has more uses than any other species under broadacre cultivation today." (Grant, 2014)

In November of 2013 a representative of Whole Foods addressed a crowd of people assembled in the Phoenix Hotel in Washington D.C. for the annual Hemp Industries Association conference and lobby day. He wanted to emphasize how important the hemp market already was to Whole Foods, which carries over 90 brands that use hemp ingredients and over 400 hemp products. The market was growing at a rate of 25%, he said, faster than their growth in GMO-free foods and faster even than their organic market. Hemp is ready-made for the organic market. Hemp grows fast. Hemp does not poison the earth. Hemp rejuvenates the soil. It is biodegradable; compostable; non-toxic; anti-microbial – which, combined with its toughness, makes hemp an ideal material for reusable diapers. There is plenty of hemp being sold already in the United States. The domestic market is there, but with no domestic product.

There is plenty of hemp being sold *to* the United States. We still have to import industrial hemp, augmenting the cost in a way that masks potential market demand. The problem is, corporations tend to be fiscally conservative, avoiding risk, and as long as industrial hemp is considered no different from marijuana, it is too risky to invest in. Manufacturers who might prefer to use hemp are dissuaded by both the cost of importing the hemp as well as the legal status of marijuana. For example, at the 2012 San Francisco Green Fest, Ford Motor Company had a display touting their use of Natural Fiber Reinforced Plastics:

> “Natural fibers such as wheat straw, hemp, coconut coir, and cellulose are used in place of glass fibers for plastic reinforcement.”

Figure 3: Ford sustainability display material at San Francisco Green Fest 2012. Note the language on the sign - "…wheat straw, hemp, coconut coir…"

Yet when contacted on behalf of HIA to ask for a sample hemp component for lobbying purposes, Ford's Global Sustainability Integration department denied that Ford used any hemp components.[22] Green Fest sign aside, Ford's own sustainability reports have touted for years that "almost 300 parts used across Ford's European vehicles are derived from sources such as cotton, wood, flax, hemp, jute and natural rubber" (Ford Motor Company, 2012; Ford Motor Company, 2013). When asked about this discrepancy in October of 2013, Ford explained that their American production line did not incorporate hemp products.[23]

A week later, at the 2013 Green Fest in San Francisco, although once again Ford was a primary sponsor, and once again showcased their sustainable practices, this time there was no mention of hemp whatsoever [Figure 3]. Perhaps they were worried about being attacked for misleading the sustainability movement. It remains unclear as to whether Ford in fact uses hemp in its domestic models, and it probably does not. Why

[22] C. Majeske, personal communication, October 25 2013
[23] Ibid., October 29 2013

would they? It is not legal to cultivate hemp domestically, and thus hemp components are prohibitively expensive over here. Either that or someone at Ford is concerned about the possibility of a lawsuit if, once it is revealed their door panels contain hemp-based fiberglass, some sullen adolescent causes a tragedy when he tries to smoke his father's Focus and burns the family house down.

One cannot blame Ford for trying to look after its image as a corporate citizen; responsibility, or at least the appearance thereof, is all the rage in corporate America. According to accounting firm KPMG's 2011 International Corporate Responsibility Reporting Survey[24], 83% of U.S. companies reported on their corporate social responsibility (CSR) initiatives that year – up from 74% in 2008. In Britain the increase was from 91% to 100%. What was once a publicity stunt has become a "de facto law" for businesses – includes the federal government, the single largest energy consumer in the country, comprising approximately 1.5% of the nation's annual energy consumption in 2010 (Broder, 2010).

In 2009 President Obama signed Executive Order 13514[25], which required agencies to monitor their greenhouse gas emissions. In addition, regulatory agencies that have been traditionally derided as toothless, such as the Environmental Protection Agency, the Federal Trade Commission, and the Securities and Exchange Commission, have begun taking more dramatic steps in recent years, tightening up requirements for financial disclosures, environmental reports and supply chain transparency. The EPA

[24] Report available at http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/corporate-responsibility/Pages/default.aspx
[25] "Federal Leadership in Environmental, Energy and Economic Performance", Oct. 5 2009

has made greenhouse gas reporting mandatory for any facility releasing more than 25,000 metric tons of GHGs (greenhouse gases) per year (Environmental Protection Agency, 2013). That data is all accessible from a website where anyone can log in to see what facilities are pumping gas into their local atmosphere, and how much they are pumping. And thus we can look forward to a greater push towards sustainability for a very simple reason: shame.

The more some companies alter their operations to become more transparent and more sustainable, other companies will feel pressure to do the same. The phenomenon exists in the increasing number of companies publishing corporate responsibility reports as the years go by, as evidenced in the aforementioned KPMG survey. Recreator, a clothing manufacturer that uses hemp in its t-shirts, is an example of this new mind-set. Whereas now they import the hemp they use in their shirts, they would rather use locally grown hemp. They want a completely transparent supply chain, which demands domestic cultivation. As such, Recreator has plans to work with a hemp growers' co-operative to develop a model hemp processing plant. In addition to providing them with a cheaper, local, higher-quality source of hemp, it will also allow them to be involved in the development of the fabric they use from seed to loom. To illustrate the amount of interest in Recreator and its ideology; it just successfully completed a crowdfunding campaign on Kickstarter (Droz, 2014). They were looking for $25,000; they ended up with more than $46,000.

At the moment hemp cultivation is in a state of limbo. According to the CIHFA, once federal law renders it operative, "the Attorney General shall issue an opinion on the extent of that authorization under federal law and California law… and whether federal law imposes any limitations that are inconsistent with the provisions of this act," an opinion which should be completed "as soon as possible" or within four months of the authorization – in this case, the passage of the Farm Bill.

Atty. Gen. John Conway of Kentucky has already declared that hemp grown in his state as part of pilot research programs can also be sold, and the Colorado Dept. of Agriculture has received more than 70 applications to grow hemp (Runyon, 2014). However, the U.S. Dept. of Agriculture has yet to inform farmers whether growing hemp will render them ineligible for federal farm subsidies due to hemp's continued illegality under federal law. According to the Environmental Working Group, USDA subsidies for farms in Colorado totaled over $5.4 billion from 1995 through 2012[26]. Until farmers are confident that cultivating hemp will not disrupt their business model or cut their subsidies, they will not embrace the new crop. However, if Kentucky is any guide, the question is no longer if farmers will embrace hemp, but when they will be able to.

[26] Data courtesy of EWG Farm Subsidies – retrieved from http://farm.ewg.org/region.php?fips=08000

Conclusions

2014 will go down in history as the end of American hemp prohibition, putting a stop to three-quarters of a century of bad policy. Now that research institutions can grow hemp to study, the real work can begin: maximizing the utility of this exceptionally useful plant. And while the hemp can only be cultivated on behalf of a research institution for research purposes, once it has been harvested it is no longer considered marijuana under the CSA and a farmer could do whatever s/he pleased with it.

Of all the points made in this paper, that is perhaps the most significant. Simply put, farmers can grow hemp for commercial purposes, provided that the crop in question is being grown for some research purpose. Chances are slim that any one farmer will be able to take part in enough research programs to utilize every part of the hemp plant. And again, industrial hemp is not illegal, but growing it can be. If it is legally grown, and legally cultivated, it is legal to sell.

This year, 100 farmers across Colorado will cultivate 1,300 acres of hemp for research and development (Baker, 2014). On April 30, Hawaii's governor signed into law a bill which allows the University of Hawaii College of Tropical Agriculture and Human Resources to establish a two-year industrial hemp remediation and biofuel crop research program (Voegele, 2014). Researchers at Cornell University and the State University of New York's College of Environmental Science and Forestry have expressed interest in growing hemp for research, should pending legislation permit cultivation in their state (Waldman, 2014). Kentucky farmers have already planted their first crop of industrial hemp seeds in over 50 years as part of five separate pilot research programs with five different universities (Haire, 2014). To date, thirty-three states and Puerto Rico have introduced pro-hemp legislation and twenty-two have passed pro-hemp legislation (votehemp.com).

Understandably, the business community is still not convinced of hemp’s viability. An artificially-induced lack of market demand is still a lack of market demand. What is needed is an example. Hemp is bulky to transport and thus it is best to process it as close to where it is cultivated as possible. Hemp processing facilities ought to be constructed up and down the state. They can be outfitted to process other materials as well, to provide investment and job security should the legislative tide turn and hemp suffer any further legal indignities. Only when a model hemp processing facility is constructed - one that can demonstrate the practicality, utility and profitability of cultivating hemp – only then will corporate America truly feel comfortable embracing this new ancient technology.

Appendix A

Personal Communication with Dr. Valerie Vantreese-Askren

Industrial Hemp

Valerie Askren <valerie.askren@gmail.com> Mon, Apr 1, 2013 at 8:29 AM
To: Alex Brant-Zawadzki <alex.brantzawadzki@gmail.com>

Hello Alex,

Thank you for your inquiry. I do not track the U.S. nor the world hemp market any more. I continue to stand by my work as accurate at the time of publication.

I resigned from the University of Kentucky after the birth of my 8 year old twins and am now involved with other professional endeavors.

I wish you the best with your work.
Valerie

On Mon, Apr 1, 2013 at 8:09 AM, Alex Brant-Zawadzki <alex.brantzawadzki@gmail.com> wrote:

> Dr. Askren;
>
> Good day to you. I hope you had a happy Easter.
>
> My name is Alex. I'm a graduate student in Public Affairs at the University of San Francisco, specifically the Leo T. McCarthy Center for Public Service and the Common Good.
>
> I have an odd and impertinent request for you.
>
> As part of my coursework, I'm currently working with CA State Sen. Mark Leno's office and Vote Hemp to support passage of SB 566, which would facilitate the legalization of hemp cultivation here in CA.
>
> Although we just achieved a major coup - a letter of support from the CA State Sheriffs Association - we are being opposed by the CA Narcotics Officers Association and the CA Police Chiefs Association.
>
> I thought you might be interested and/or amused to know that their letter of opposition cites you heavily, especially the conclusions of your 1998 report on US hemp cultivation, passing it off as if it was up-to-date information. At least they refer to you as the foremost expert in the nation on the economics of hemp cultivation. Kudos!
>
> When I saw your name in their letter, it reminded me of your 1998 paper, as I had cited it repeatedly in a white paper I wrote in the fall. I was concerned, as I knew that your observations upon which they rely so heavily had been made fifteen years ago.
>
> I looked you up and came across your recent hiking publications, and your work with the Sierra Club. It turns out that historically the Sierra Club has supported hemp cultivation for environmental reasons.
>
> If you don't mind me asking - over the course of the past fifteen years, have your views on the viability and/or utility of an American hemp industry changed at all?
>
> And if so, I don't suppose you'd be willing to write a very brief letter attesting to that fact?
>
> The Narcs/Polics Chiefs letter also used data on total acreage of European hemp cultivation from 2005,

Appendix A

Personal Communication with Dr. Valerie Vantreese-Askren

claiming it was "the most recent year for which figures are available". Which hasn't been true since 2010. It's like they think they can submit whatever they want and no one's going to check to see if the information is actually up to date.

Anyhow, I apologize for the impertinence. I realize this is something of an intrusion, and it might appear that I'm asking you to discredit your body of work, which I'm not - I just see what strikes me as an academic injustice being done to further a political agenda, and I thought you might like to know that your research from the 20th century is being presented as modern science. And, frankly, I hoped you might want to do something about it.

I've attached the letter of which I speak.

I thank you for your time and I wish you all the best in the coming months.

With respect,

Alex B-Z
alex.brantzawadzki@gmail.com
linkedin.com/in/alexbz
facebook.com/alexbz
twitter.com/beezling

Appendix B

Personal Communication with Carol Majeske

Industrial hemp

Majeske, Carrie (C.N.) <cmajeske@ford.com> Tue, Oct 29, 2013 at 5:47 AM
To: Alex <support@votehemp.com>

Hi Alex,
Yes, I was focused on North America and recognize the possibility of hemp in other regions but I'm not aware of them specifically. I will reach out to my colleagues to confirm. It's also important to note that we're using different natural fibers as well: wheat straw, coconut, cellulose, kenaf. I believe the compression molded door component was kenaf, but I'll confirm that as well, and see what I can get in terms of samples.

Stay tuned....

Carrie

-----Original Message-----
From: Alex [mailto:support@votehemp.com]
Sent: Monday, October 28, 2013 11:43 AM
To: Majeske, Carrie (C.N.)
Cc: Viera, John (J.J.); Hobbs, Karen (K.M.); Mielewski, Deborah (D.F.); Ben Droz
Subject: RE: Industrial hemp

Carrie;

Apologies for repeating my questions - I somehow missed your initial (and timely) response. The e-gremlins have been hard at work on my inbox as of late.

Thanks for getting back to me, but I must admit I'm a bit confused.

Either I was too vague in my choice of terminology, or you're referring specifically to Ford's American manufacturing, because according to your own Sustainability Reports, "[a]lmost 300 parts used across Ford?s European vehicles are derived from sources such as cotton, wood, flax, hemp, jute and natural rubber." Also, some sources suggest the natural fiber compression-molded door panels on the 2011 Ford Focus are made with hemp.

Also, at events such as the 2012 Green Festival (see attached photo) and the 2013 Green Fest, where our executive director spoke with John Viera, Ford has displayed signs which read, "Natural fibers such as wheat straw, hemp, coconut coir and cellulose are used in place of glass fibers for plastic reinforcement."

Hence my apparent error. Would there be any way to get a hold of a sample component from among those nigh-300 parts, or would we have to contact Ford's European operation?

Thanks for your time.

With respect and appreciation,

Alex B-Z
Grassroots Outreach Coordinator
Hemp Industries Association / Vote Hemp
support@votehemp.com
949-230-2664

Appendix B

Personal Communication with Carol Majeske

http://www.votehemp.com:2095/cpsess817303862/horde/imp/view.php?actionID=compose_attach_preview&id=1&messageCache=161286604152̈6e85d68e42d
L to R: Steve Levine, HIA past president, Eric Steenstra, Vote Hemp president, and John Roulac, founder & CEO of Nutiva. Taken at the San Francisco Green Festivals 2012 by Hemp Industries Association (HIA) president Anndrea Hermann.

Quoting "Majeske, Carrie (C.N.)" <cmajeske@ford.com>:

\> Hello Alex.
\> Thanks for your connecting with Ford. Right now we don't use hemp in
\> any production parts, but there is promising research underway to
\> develop an application, so we'll be ready when hemp is grown/available
\> in the US. Ford recently provided a statement to
\> Senator McConnell's office, supporting hemp within the Farm Bill.
\> We look forward to seeing your work come to fruition, hopefully
\> coincident with our research!
\>
\> Sincerely,
\>
\> Carrie Majeske
\> Ford Motor Company, Global Sustainability Integration One American
\> Road, Suite 208-A2, Dearborn, MI 48126
\> (313) 322-1116 / cmajeske@ford.com
\>

Alex Brant-Zawadzki
Grassroots Outreach Coordinator
Hemp Industries Association
support@votehemp.com
949.230.2664

Appendix C

CNOA/CPCA Letter of Opposition to SB 676

MEMORANDUM

TO: HONORABLE MARK LENO
FROM: CALIFORNIA NARCOTIC OFFICERS ASSOCIATION
CALIFORNIA POLICE CHIEFS ASSOCIATION
SUBJECT: OPPOSITION TO SENATE BILL 676
DATE: APRIL 4, 2011

The California Narcotic Officers' Association and the California Police Chiefs Association would like to register their strong opposition to Senate Bill 676, which is slated to be before the Senate Committee on Agriculture on April 5. We believe there are a number of very serious issues in connection with this bill – taken either individually or together, those issues call for the rejection of SB 676.

To begin with, cultivation of hemp is illegal in the United States. Enactment of SB 676 will not change that state of affairs at all because the prohibition against cultivation of industrial hemp is found in federal law, which would be unaffected by passage of SB 676. That federal law, 21 USC 802 (16), has been on the books since 1970 and makes it clear that it is illegal to cultivate any cannabis plants. Although proponents of SB 676 would have you believe that this is not the case, the truth is that even Eric Steenstra, President of Vote Hemp, has admitted that "under current national drug control policy, industrial hemp can be imported, but it cannot be grown by American farmers." (Vote Hemp news release February 13, 2007)

It was the unassailable fact that federal law prohibits the cultivation of hemp that contributed to Governor Schwarzenegger's veto of AB 1147 and of AB 684 in two successive sessions Since that time, nothing has changed with respect to federal law. The very best thing that can be said about this bill is that it is seriously premature and that any action on it should be deferred until cultivation of hemp is legalized – something this bill cannot do.

Proponents argue that the recent 9th Circuit ruling in Hemp Industries v. Drug Enforcement Administration, (9th Cir. 2004) 357 F.3d 1012, permits the cultivation of industrial hemp. This is simply not the case. That case was decided on very narrow procedural grounds which found that DEA had not gone through its own procedural hoops in ordering destruction of hemp related products. The best evidence of this fact is that Congressman Paul subsequently introduced a federal bill to legalize hemp cultivation. Had the Hemp Industries case actually legalized hemp cultivation, the Congressman's bill would not have even been necessary.

There are very sound public policy reasons for prohibiting the cultivation of hemp. Hemp is indistinguishable from marijuana and its cultivation will seriously compromise our marijuana enforcement efforts. Please take a look at any Internet photographs of hemp and marijuana plants. You will find that the photographs are indistinguishable, one from the other! The burdens this will place on law enforcement are simply incalculable. Since hemp and marijuana are indistinguishable either through ground or aerial surveillance, all enforcement operations will have to await lab tests prior to taking any action. The reality is that labs are backed up with other forensic issues and marijuana enforcement will in all likelihood be curtailed – something that is very unfortunate coming at a time when large criminal combines are firmly ensconced in marijuana production. Hemp could be a useful device by drug traffickers to evade detection, as well; for example, a marijuana producer might grow a portion of his/her grow area in hemp (the THC reduction caused by hemp-marijuana cross pollination,

Appendix C

CNOA/CPCA Letter of Opposition to SB 676

contrary to assertions of proponents, does not occur in a plant's first generation) as a way to fool law enforcement.

There is even a humorous dimension to the hemp/marijuana confusion: In several British communities law enforcement has reported theft of hemp from hemp farms. Investigation revealed that the thefts were being carried out by persons under the impression that the hemp would get them high. As a result, several agencies have taken to posting signs around hemp farms informing passers-by that the products being grown on this farm will not get anyone high and that there is no need to steal them!

Proponents argue (with a vigor that calls to mind the patent medicine salesmen of the old west) that hemp cultivation will be a virtual economic and ecological panacea for Californians. Again, this is simply not true. According to Dr. Valerie Vantreese-Askren, Professor of Agricultural Economics at the University of Kentucky, hemp is a niche market product and is destined to remain so. Dr. Vantreese-Askren points out that cultivation costs are highly labor intensive and effectively mean that American farmers will not be able to compete against heavily subsidized Chinese and European hemp producers.

Dr. Vantreese-Askren, who is recognized as the leading authority on the economics of hemp cultivation, is dubious about the viability of a hemp cultivation industry in the United States because American hemp farmers would be unable to compete with the heavily subsidized Chinese and European cultivation industries. Moreover, Dr. Hayo M. G. van der Werf, with the French National Institute of Agronomic Research, and former editor of the Official Journal of the International Hemp Association, has stated that many of the claims for hemp's benefits are "inaccurate" and "may be due to the emotional commitment many individuals have in making this a viable crop." Finally, European production of hemp has reduced significantly over the last decade. In 1998, over 100,000 of acres of hemp were produced in Europe. In 2005, the last year statistics are available, that number had dropped to 39,000 acres – hardly production patterns that suggest an economic panacea.

Hemp production is illegal and passage of SB 676 will not change that; hemp and marijuana are indistinguishable and hemp can be used by marijuana growers to evade detection; there is no real economic viability to hemp cultivation. For these reasons, CNOA respectfully requests that you vote "no" on Senate Bill 676.

Appendix D

CNOA/CPCA Letter of Opposition to SB 566

California Narcotic Officers' Association
California Police Chiefs Association

1127 11th Street, Suite 523
Sacramento, CA 95814
Phone: (916) 447-3820 Fax: (916) 441-1974
jlovell@johnlovell.com

March 22, 2013

Honorable Mark Leno
Member of the Senate
State Capitol
Sacramento, CA 95814

Dear Senator Leno:

The California Narcotic Officers Association and the California Police Chiefs Association regret that they must oppose Senate Bill 566, which would legalize the cultivation of industrial hemp in California. This bill will undermine law enforcement efforts to curtail marijuana cultivation and will result in significantly increased costs in connection with the prosecution of marijuana trafficking cases.

Grown in the wild, hemp and marijuana are visually indistinguishable. The impact of legalizing hemp will be that marijuana cultivators will be able to camouflage their illegal grows with a perimeter of same sex hemp plants. Effectively this will require law enforcement to test plants for THC content before taking any action – and beguiling hemp camouflage can enable the cultivator to potentially escape accountability altogether. Since the state crime labs currently are not equipped to test for THC content, they will either have to incur the costs of gearing up for this function, or local agencies will have to incur the additional costs of finding a private lab to conduct testing.

The cost of THC testing has another dimension in the context of marijuana trafficking prosecutions – if SB 566 becomes law, every prosecution for marijuana trafficking, cultivation, or transportation, will now require prosecutors to test the seized product for THC content. Again, according to the Attorney General's office, there are no state crime labs that test for THC content. The increased costs for marijuana trafficking prosecutions are incalculable.

Perhaps the additional costs to law enforcement could be justified if there were some countervailing economic benefit from hemp production. The best evidence suggests, however, that no such countervailing economic benefit will occur. Although SB 566 proponents argue (with a vigor that calls to mind the patent medicine salesmen of the old west) that hemp cultivation will be a virtual economic and ecological panacea for Californians, the assertions are without foundation. According to Dr. Valerie Vantreese-Askren, Professor of Agricultural Economics at the University of Kentucky, hemp is a niche market product and is destined to remain so. Dr. Vantreese-Askren points out that cultivation costs are highly labor intensive and effectively mean that American farmers will not be able to compete against heavily subsidized Chinese and European hemp producers.

Appendix D

CNOA/CPCA Letter of Opposition to SB 566

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We respectfully request a "no" vote on Senate Bill 566.

Sincerely,

John Lovell
Legislative Counsel

CC: Dr. Anne Megaro, Chief Counsel Senate Committee on Agriculture
Doug Yoakam, Republican Counsel Senate Committee on Agriculture

Appendix E

Letter from Jack Herer to Gov. Arnold Schwarzenegger

Jack Herer
P.O. Box 2050
Lower Lake, CA 95457

September 4, 2006
Governor Arnold Schwarzenegger
State Capitol Building
Sacramento, CA 95814

Dear Governor Schwarzenegger,

I have been writing about industrial hemp and campaigning for the legalization of all forms of cannabis hemp since 1985. Growing hemp as nature designed it is vital to our urgent need to reduce greenhouse gases and ensure the survival of our planet. However, AB1147 in its present form could severely compromise hemp's scarce remaining germplasm and endanger the lives of Californians who legally grow cannabis for medicine.

A provision that seeds originate from native California hemp strains was struck from AB1147 at the last minute, and if you sign it, only cannabis with a miniscule amount of THC (0.3 %) could be grown in our state. Lower THC strains grown in Canadian studies have resulted in lesser yields and shorter stalks than those with natural amounts of the cannabinoid, which serves as a sunscreen for the plant.(1) Without its natural sunscreen, yields of the crop will be insufficient to justify hemp cultivation in California, and pollen from low-THC hemp could infect native hemp and ruin its seeds. We cannot let this happen.

A 1916 USDA report found hemp could make four times as much paper per acre as trees, superior paper that does not need chlorine bleach. Its seed oil is the healthiest food on the planet. Hemp is the best plant in the world to make building materials, fabric and fuel, from both its stalk and seed. Currently biodiesel fuel is primarily made of soy, and 81 percent of the U.S. soy crop is genetically modified. Biotechnology forces are mobilizing to cash in on the biodiesel bonanza.

On August 15, Monsanto, which has experimented with hemp, acquired Delta and Pine Land Company, the developer of terminator technology - plants that are genetically modified to produce sterile seeds at harvest. D&PL claims that it is already growing genetically modified cotton and tobacco containing terminator genes. Under the guise of a group called CropLife America, Monsanto, Dow Chemical, DuPont and other corporations spent $621,000 to oppose Mendocino county’s anti-GMO Measure H in 2004. In response, Measure H backers brought in 73-year-old Canadian farmer Percy Schmeiser, whose canola crops were contaminated with Monsanto's patented "Round-up Ready" GMO/GE canola, causing him to be sued by Monsanto for "property theft" and "patent infringement."

Cross-pollination is also an issue for medicinal marijuana growers, who are protected by Proposition 215, made law by California voters in 1996. John LaBoyteaux, an organic farmer, testified before the Senate Agriculture Committee on June 29 saying he and his fellow farmers planned to grow low-THC hemp in a malicious attempt to ruin marijuana gardens in Northern California. Pollen can travel for miles, and large fields of low-THC could well accomplish this mean-spirited goal. It could also drive the crop further indoors, causing environmental problems, over consumption of electricity, diesel spills, and noise. This is a life or death issue for Californians with AIDS, cancer, and other serious illnesses.

For all of these reasons and more, I ask you to veto AB1147 and instead call for the legalization of cannabis in its natural form.

I know that you have bravely and honestly admitted your own youthful marijuana use, and I see that it hasn't hurt your health or ability to accomplish your goals. We want hemp without harassment and no more marijuana smokers clogging California prisons.

Cannabis industries could be a boon for California like our state has never before seen, enabling us to stop using petrochemicals and felling out forests, while recovering our forested lands and protecting our farmlands. It is in your hands to make this happen and make yourself a hero to the planet and its people.

Sincerely,

Jack Herer

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Chapter 10

Animal feeding trials

This chapter relates to the design of feeding trials which aim to adapt technologies for use under smallholder farming conditions. In general, such trials will be done on the farms themselves with close participation of the farmers in the planning, execution and evaluation of the interventions. Certain interventions will have finite objectives concerned with responses of a certain species or element of the farming practice to variations in inputs. In all cases the activity should be planned to take account of the overall farming system and the impact that the intervention will have on that system.

INTRODUCTION

As far as possible, animal feeding trials should be done on farms since the objectives usually are to test interventions in a situation where conditions of management and resource availability are typical of the real-life farmer situation. The farm and the farmers serve as a forum for discussions of practical problems and provide the appropriate setting for participatory adaptation of technologies. By contrast, experiments at the station will have as their aim the study of new feed resources (e.g., with the nylon bag method of assessing rumen degradation potential; the chick biological test to rate protein- rich leaves for monogastric animals) and under-exploited animal species (e.g., the small non-ruminant herbivores).

EXPERIMENTS ON FARMS

There are four main activities that on-farm work facilitates:

- Economic evaluation of an intervention (e.g., use of molasses-urea blocks for cattle or of urea treatment of straw).
- Biological (and economic) assessment of a nutritional manipulation (e.g., defining a response curve for a given nutritional input as in Figure 5.11).

- Demonstration of appropriate technologies (e.g., biodigesters, recycling manure with earth worms and water plants, agroforestry systems).
- Establishing a forum for discussion, for planning joint participatory activities and as an interface between farmers and scientists

Validation of technologies can be done on any farm scale. The individual farm is the replicate and it is usually relatively easy to have from 8 to 12 farms in such a trial. In Chapter 11, there is an example taken from Vietnam of this kind of economic assessment.

Experiments on smallholder farms

On smallholder farms it is rarely convenient to have more than one treatment. Moreover, the objective is nearly always to assess the economic and social impact of a particular intervention. Smallholder farmers are more concerned with risk and the overall impact of the intervention on their activities in the farming system than in a simple biological response. The experiences in Vietnam with introduction of low-cost plastic biodigesters is a good illustration of this type of reaction (Bui Xuan An *et al.*, 1994). The comments of the farmers (almost invariably the women) were:

- the work is easier because I do not have to look for firewood or spend time tending the fire,
- my kitchen is cleaner and so are the pots and pans, and
- it is very easy to boil water for the tea in the early morning.

For these farmers, the biological efficiency of the biodigester was not an issue. Later, they would come to appreciate that the by-product of the biodigester (the effluent) would be better than the fresh manure for growing crops and fish. But their first concern was the impact of the biodigester on their everyday activities.

The role of the larger farm

It is often argued that the larger farm should be ignored as being unrepresentative of the target group - the poorest farmers. Yet the large farm with a helpful owner or manager can be an asset and a means of helping the poorer ones. Such farms are particularly appropriate for carrying out the second type of experiment (i.e., response function). It is also not too difficult to identify farmers in this category. Often they will be commercial farms employing managers who are themselves agricultural graduates and therefore with the training that facilitates the more precise execution of the intervention and the daily recording that may be necessary. In the CIPAV programme in Colombia, there are several such farms that perform a most valuable function by participating in joint research activities. They are part of an informal organization of producers that meet frequently as a group with CIPAV researchers to discuss joint problems and new possibilities. Several of the advances in the use of tropical feed resources, reported in this manual, have been developed in these collaborative activities.

Certain types of experiments are very suitable for carrying out on these larger farms. Thus the evaluation of the effects of supplements on milk production (e.g., molasses-urea blocks, tree foliages) can be done relatively easily with good statistical control, using analysis of covariance to correct for animal differences (see Chapter 8 and Table 6.3). In this case adequate replication can be obtained on the farm if the herd is of over 30 cows. The use of covariance and blocking of animals by calving date makes it possible to incorporate cows in varying stages of lactation in the trial.

ON-STATION EXPERIMENTS

The general approach

If investment is to be made in experimental facilities then, in general, it is best these are in the form of individual pens. For a given investment in capital, labour and operational costs, more data can be generated from animals in individual pens than in groups. Groups of animals more closely represent the situation on farms. But this should not be attempted in on-station work, which can never reproduce conditions on farms, nor should this be the objective. On-farm activities are proposed for this very purpose.

Facilities that are renewable

In the tropics, protection is needed mainly against the sun and rain. Wind speeds are only excessive in the vicinity of a cyclone, and it is pointless to build structures capable of withstanding events that may never occur. Better to aim for structures that can be recycled and rebuilt using local materials. Bamboo produces renewable materials that can be used to make almost all the structural components needed in a building for all classes of applied animal experiments. Roofs should be made of palm leaves as this produces a structure with excellent thermal insulation characteristics. Only in the case of pigs will concrete be required for the floor. For all animal, pen divisions are easily and conveniently made from bamboo.

The important issue is that the construction material, as much as possible, should be recyclable either for fuel or as compost.

Grow what is needed and recycle the excreta

Provided it is understood from the outset that on-station research is mainly a response to, and occasionally a prelude to on-farm work, then decisions can be taken which will reduce considerably the cost of the experimental facilities. At the outset, the station must possess sufficient land to be able to grow the crops that will produce the feed resources most likely to be investigated, i.e., those being recommended for use by farmers. All too often we see heavy investment in laboratories and animal houses but with no land either to grow the feed or to recycle the animal excreta. There are many examples of such reductionist and inappropriate planning at the level of both international and national research centres.

Research stations, in some instances, can perform a valuable role in creating interest and demonstrating confidence in technologies, which may have little application in an era of cheap fossil fuel, but which almost certainly will play an increasing role as the pressure increases to adopt more sustainable ways of using resources.

For instance, it will mostly be appropriate for smallholder farmers to use animal traction rather than mechanical power. The role of draft animals will be enhanced if they are multi-purpose - producing milk and meat as well as power. In this case it is very important that this strategy is demonstrated on the research station. There are too many examples at research stations in developing countries of mechanical "graveyards" littered with broken tractors and implements.

Research on biodigesters and gasification technology is another area where the research station can set an example for the future.

Animal species

It is not necessary to have facilities on the station to do research with all the target animals. The farming system will be developed on the smallholder farms -- not at the station. Thus it is rarely justified to have milking cows. It is much easier, and more can be done with a given level of funding, when goats are the experimental animals. For example, slatted floors for goats can be made from strips of bamboo. For cattle concrete slabs would be needed. Similarly, sheep are more appropriate than cattle for feed intake and growth studies.

The issue is not whether research findings with sheep or goats can be applied to cattle or buffaloes. The work with the sheep and goats should be directed towards establishing the principles of digestion and metabolism and likely trends in animal response to inputs. The final joint biological and economic evaluation must always be done on farms.

Thus, goats can be used to establish likely responses in milk yield to a range of tree foliages. But the final description of the response curve to one particular tree foliage will be done on a farm where the ecosystem favours growth of that particular tree. The station can grow small plots of a range of trees; the farm will want to concentrate on what is most suitable for the area in which it is situated.

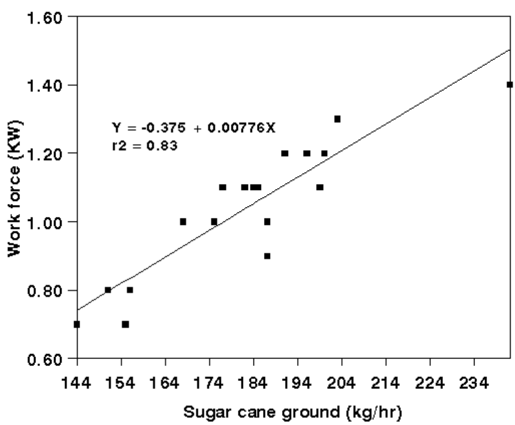
Research stations can play a useful role in introducing under-exploited livestock species (e.g., earthworms, snails and insects), studying their biology and ecology and thus creating interest in their commercial use (Cardozo, 1993).

Facilities for research with draft animals

Most on-station research in tropical developing should be done with two aims always in mind: of doing relevant research at lowest cost. Research on draft animals can be very expensive because of the difficulties of measuring work output. The approach to this issue tends to emphasize sophisticated means of measurement of work output, rather than identify work activities which might be both useful and easy to measure.

A frequent form of draft animal work in developing countries is the grinding of sugar cane to make 'panela' or 'gur'. Earlier work in Bangladesh (Miah and Sarkar, 1990), subsequently confirmed in Colombia (Thu *et al.*, 1994), showed that the rate of grinding the sugar cane was highly correlated with the work output of the animal (Figure 10.1). Setting up the facilities for a sugar cane crusher and employing it for research on draft animals has many advantages. The work force is easily measured; the output of the work is useful (the cane juice can be used in experiments with pigs); it is easy to train the animals; and the work is done in relative comfort (as the crusher is easily situated under some form of roof or shade).

Figure 10.1. Relationship between rate of crushing of sugar cane and work force exerted by the animal (Pairs of buffaloes and cattle) (Source: Miah and Sarkar, 1990).



Design of individual pens

The first requirement is for pens usually for individual animals, or for small groups in the case of pigs and poultry. The pens can be simple, but, they must facilitate adequate care of the animals, especially feeding and cleaning. Floors which are partially slatted, allowing faeces and urine to fall through into a pit below, are more expensive but the investment is justified in the improved environment for the animals (they are always dry and clean) and elimination of unpleasant tasks for the attendants. The feed hoppers should be designed to avoid spillage and to facilitate the collection of residues. Clean water should always be available.

Pens should be in multiples of four and the minimum needed is 16 units. This gives flexibility for feeding trials with up to four treatments in factorial and latin square arrangements. Animals with rumen fistulae must be held individually; the walls of their pens may need to be solid to prevent them damaging the fistula.

Pen construction in tropical regions can be much simpler and cheaper than in temperate countries where avoidance of stress from cold and wind requires more permanent structures equipped with insulation and often heating.

Feed troughs should be constructed carefully, especially for ruminants that will be fed bulky forages. The aim is to minimize spillage and make it difficult for the animal to pull the feed out into the pen.

Appropriate designs of pens and feed troughs are shown in Figures 10.2 to 10.9.

Other facilities

Accurate balances are essential both for weighing animals and feeds. Spring balances should generally be avoided and simple scales which use weights hung from an arm are to be preferred. For cattle it is desirable to be able to weigh by intervals of 500 g and for sheep 200 g. Feed scales should weigh to 100 g.

Figure 10.2. Plans of experimental pens for carrying out feeding trials with cattle. The building is 19.0 m x 7.0 m for 16 pens.

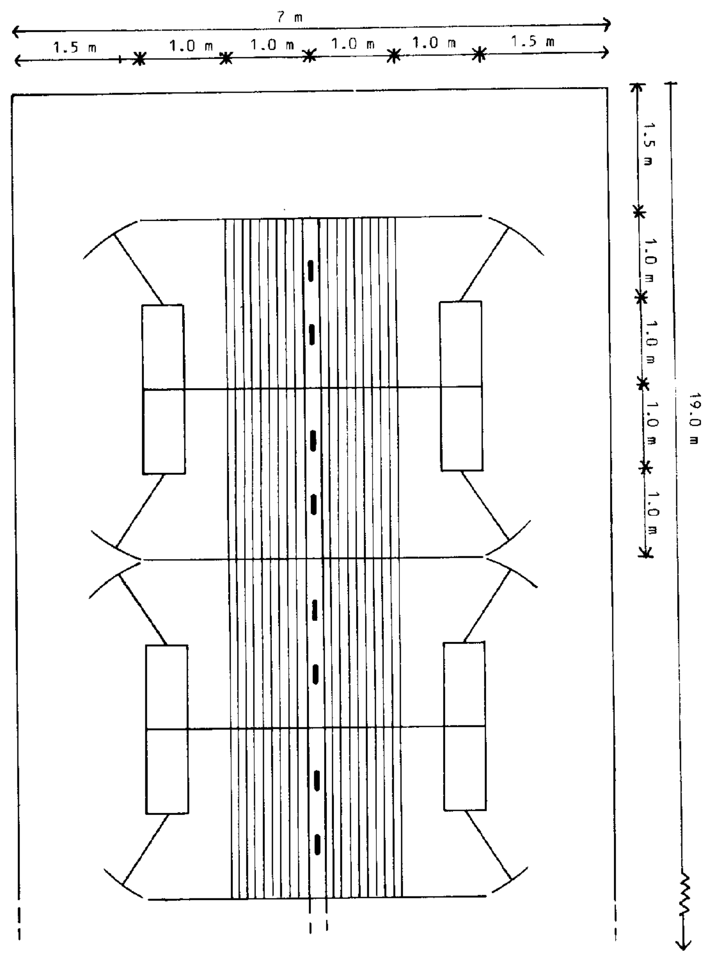


Figure 10.3. Dimensions of cattle slats (in mm).

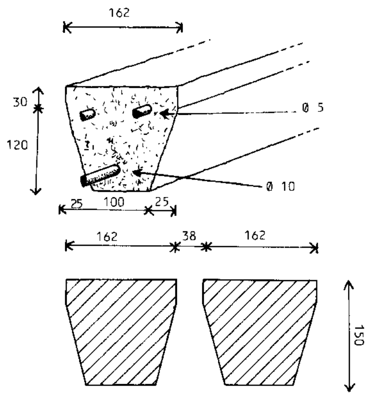


Figure 10.4. Cross-section of cattle pens (in cm).

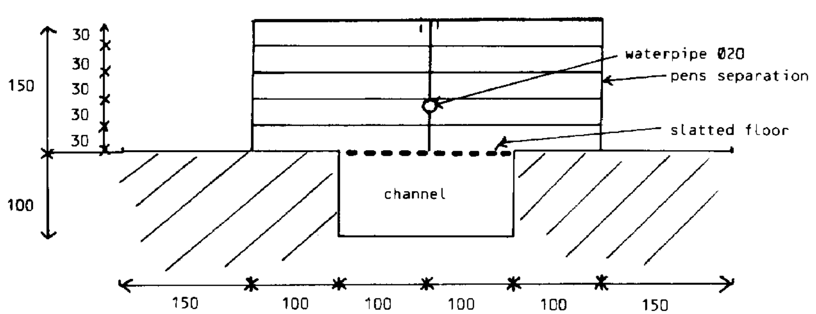


Figure 10.5. Dimensions of feed trough for cattle (in cm).

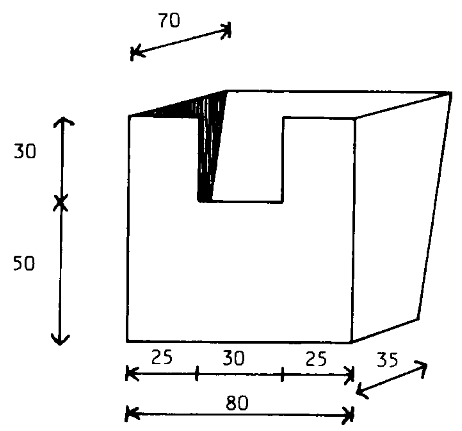


Figure 10.6. Plans of experimental pens for carrying out feeding trials with sheep and goats (in cm).

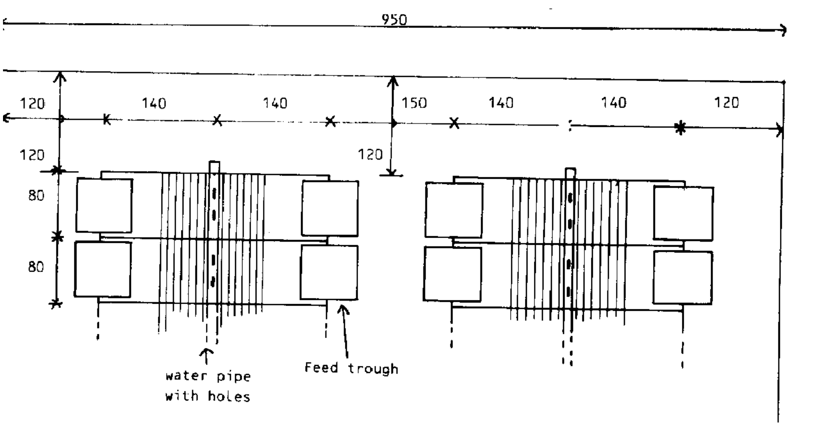


Figure 10.7. Cross-section of experimental pens for sheep and goats (in cm). An elevated floor with the slats made from wood may be a better arrangement.

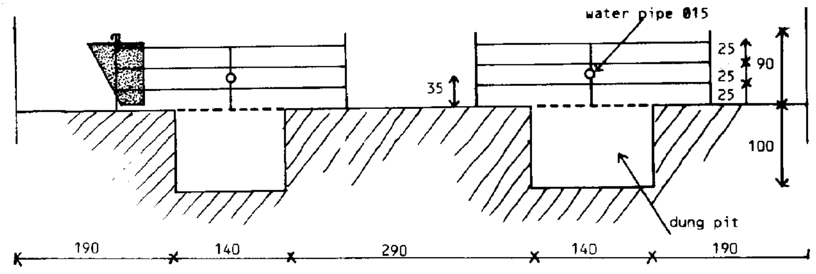


Figure 10.8. Dimensions for slats for sheep and goat pens (in cm).

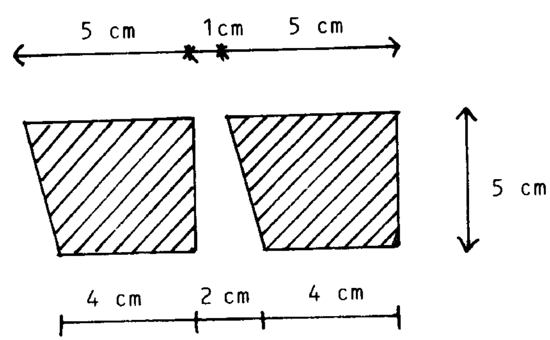
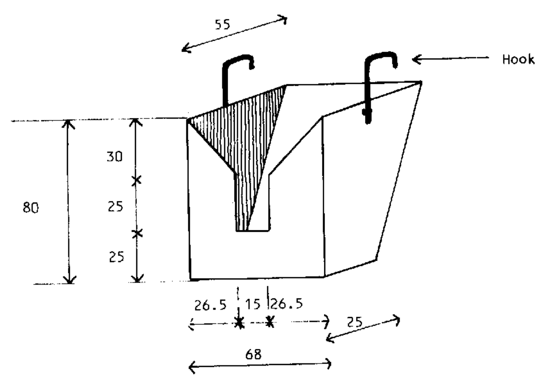


Figure 10.9. Dimensions of feed troughs for sheep (in cm).



RECORDING

The first item of essential equipment is a notebook computer. These are now relatively inexpensive and available locally in most developing countries. Portability is necessary in order to work on farms. Adapters that permit power to be drawn from the battery of a vehicle, or from a solar panel, provide security for continuous working under most circumstances. Data should be entered in a spreadsheet in a form that will facilitate subsequent analysis and presentation (Chapter 8).

An important ancillary role of the portable computer is that it enables the researcher to demonstrate to the farmer the results obtained on that day on her/his farm. In this way, the farmer feels intimately involved in the research and will be much more likely to collaborate in future activities.

© 2014 Patriot Bioenergy Corporation Hemp: An Energy Crop to Transform Kentucky and West Virginia Presented By

Alex Donesky
Wesleyan University

Hemp: An Energy Crop to Transform Kentucky and West Virginia

2014 Whitepaper

Presented By

KHGCA
Kentucky Hemp

WVHGCA
West Virginia Hemp

Biographical Sketch

The Kentucky Hemp Growers' Cooperative Association is a member-owned corporation providing assistance, information, and resources to partner-members endeavoring to produce or sell industrial hemp. Incorporated in 1994, the Cooperative seeks to uphold a tradition of legal and profitable hemp production in Kentucky. The original Kentucky hemp cooperative association was organized during WWII and produced high-quality industrial hemp for vital military stores, including oil, textiles, and cordage for naval vehicles and airplanes. The KHGCA is organized for agricultural purposes and to stimulate economic enrichment in the region.

A sister of KHGCA, the West Virginia Hemp Growers' Cooperative Association intends to expand the potential economic benefits of the hemp industry across the state. As an active member of the Central Appalachia Sustainable Economies (CASE) network, the cooperative seeks to ensure a resilient West Virginia economy by stimulating the emergence of dense industry clusters by way of Integrated Energy Park development.

About the Authors

Katherine M. Andrews, Ph.D., is a Ronin Institute Research Scholar working in the areas of Translational Science and Integrated Energy Systems (http://ronininstitute.org/research-scholars/katherine-andrews/). With a doctorate in biochemistry from the University of Illinois, she completed post-doctoral training in neuroscience and a faculty post in genetics, at Washington University in St. Louis, before moving to the private sector and taking on a series of cross-disciplinary leadership roles that bridged business and science, in fields ranging from computational drug design for the pharmaceutical industry to metabolic engineering of microbes for the production of biofuels. In 2007, she served as co-principal investigator to win a $135 million federal award that launched the DOE Joint Bioenergy Institute (Emeryville, CA), while managing Sandia National Laboratories' Department of Computational Biology. Now based in the Bluegrass Region of Kentucky, she is an executive level strategist who works with all sectors to redefine business models, attract investors, and optimize research and development programs based on both technical and market knowledge.

Alex Donesky is currently a student at Wesleyan University in Middletown, Connecticut where he studies Economics, History and Government. He served as a 2013 Intern with Patriot Bioenergy Corporation and with Sustainable Williamson, studying renewable and biomass energy projects and the development of sustainable methods and technologies.

Roger Ford is an entrepreneur with over 25 years of experience in governmental relations, political strategy, and economic and business development. He is CEO of Patriot Bioenergy Corporation and a partner in Emergy Holdings, Inc. and TerraGas, LLC. He graduated from The University of Pikeville and is working to complete his Masters in National Security at American Military University. Ford is a member of the Southern States Energy Board's Clean Coal and Energy Technology Collaboration Committee, the Board of Directors for the Kentucky Hemp Growers' Cooperative Association, the Board of Directors of the West Virginia Hemp Growers' Cooperative Association, and the Chairman of Sustainable Pike County and Sustainable Williamson, which are both part of the Central Appalachian Sustainable Economies (CASE) Network.

J. Eric Mathis has been at the forefront of initiatives to bridge the gap between the fossil fuel and renewable energy industries through the development and implementation of innovative finance and business models. These models are designed to be beneficial to both industries, creating mutually productive economic linkages between the fossil fuel and renewable industries, and most importantly between the surrounding communities. As an active member of the community, he is helping to develop a comprehensive project entitled Sustainable Williamson that emphasizes health and wellness as a key component for economic revitalization. Using Sustainable Williamson as a template, his most recent endeavor is participating in the creation and implementation of the Central Appalachian Sustainable Economies (CASE) network, an interactive regional network of innovators cultivating new ideas and resources in central Appalachia to grow healthy communities.

White Paper – Hemp: An Energy Crop to Transform Kentucky and West Virginia

Author: Katherine M. Andrews / Co-Authors: Alex Donesky, Roger Ford, and J. Eric Mathis

Executive Summary

Industrial hemp (*Cannabis sativa L.*) has been grown and evaluated for energy purposes in the United States, Ireland, Spain, Germany, Poland, Sweden, and many other countries[1]. A proven Kentucky crop possessing favorable characteristics of high land use efficiency, low requirement for pesticides, and high drought tolerance, hemp offers to comprehensive solution to its current economic and energy challenges. In 2013, the Kentucky Legislature signed Senate Bill 50 (SB50) into law, opening the door for a regulatory framework to be established for farmers to become licensed to grow hemp. Twenty other states have passed similar hemp legislation to re-introduce industrial hemp as an agricultural crop for harvest and manufacturing of diverse products, including oil, structural fiber, and materials. We suggest that hemp is a viable biomass feedstock for the production of fuels, industrial chemicals, advanced materials, and electricity in Kentucky and neighboring states such as West Virginia. Here, we present the results of a preliminary study performed by Patriot Bioenergy Corporation, in collaboration with the Kentucky Hemp Growers Cooperative Association and West Virginia Hemp Growers Association, to assess the technical feasibility of co-firing of hemp with coal for power generation. We suggest that the accelerated adoption of hemp to grow the increasingly intertwined energy, agricultural and manufacturing sectors will particularly benefit rural regions.

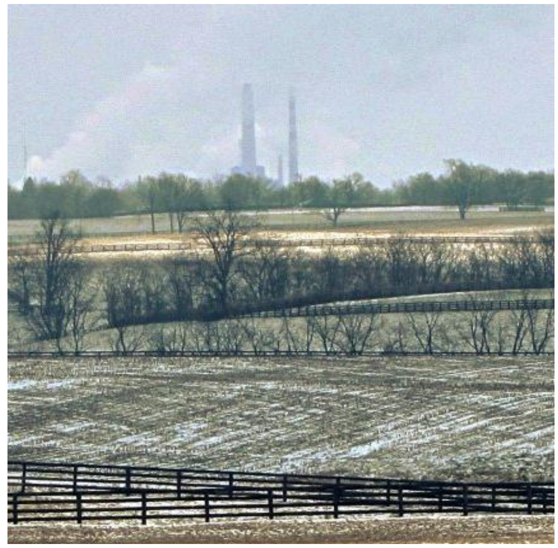
Biomass co-firing is an attractive near term strategy for existing power plants to achieve reduction of carbon dioxide and other pollutants in compliance with new regulations on emissions.

The Energy Challenge

Major technological and commercial hurdles must be overcome in order to strengthen the struggling economies of Kentucky and West Virginia, in a rapidly changing energy landscape in which fossil-derived energy sources are being replaced by renewables. Notably, the use of coal-fired generators has dramatically declined in the Southeast, with the region experiencing the largest shift from coal to natural gas in the United States from 2011 to 2013[2]. As top energy exporters, these states have relied historically on coal as the predominant feedstock for electricity generation to fill local power needs, and for export to other states and the international markets[3,4].

New regulations and policies have reduced the demand for coal, and plants are closing due to a lack of cost effective ways to reduce emissions, particular sulfur and mercury[5]. As a result, regions of the states where coal is mined and converted in power plants are suffering from job losses and an uncertain future.   In order to compete nationally and internationally, we must undertake an 'all-of-the-above' strategy for energy production and export that includes renewables and biomass and supports growth of the economy in rural Kentucky and and West Virginia.

Along with global competition from other energy resources such as natural gas, the coal power industry also faces new regulatory mandates and public policies[6] that require adaptation by the industry to ensure that coal remains viable. Despite higher heat values than Western coal, Appalachian coal is particularly at risk due to its mining costs, sulfur content, and heavy metal composition. Coal mined from the Illinois and Appalachian Coal Basins would benefit from the blending with biomass.



Power facilities such as the E.W. Brown Generating Station in Central Kentucky, are optimally co-located with thousands of acres of land suitable for hemp cultivation.

Photo: K. Andrews © 2010

By blending coal with biomass materials such as hemp, sulfur emissions from power generation can be reduced and less valuable coal that is high in sulfur can remain competitive. While significant public and private investments around the nation have accelerated the development of biomass energy crops and processes for transportation fuels, chemicals, and electricity, no major biomass crops have been adopted in Kentucky to date. State-funded research centers have prioritized combustion and carbon sequestration over biofuels[7]; and although the U.S. Department of Energy has named I-65 'the nation's first biofuels corridor[8,9], only one ethanol plant[10] and one biodiesel[11] plant currently operate in Kentucky at a commercial scale. There are currently no publicly announced plans for second generation "cellulosic" fuel production, made possible through intense research and engineering in the past five years[12,13,14,15]. West Virginia passed SB447 in 2002 and helped to establish early guidelines for hemp production in the United States. The 2013 signing of Kentucky's SB50 into law further enables the potential of hemp as an energy crop to be realized throughout the region and accelerated by integration with existing energy production practices.

Hemp: A Biomass Energy Crop

Industrial hemp has been studied extensively by researchers at national laboratories, universities, and leading international research institutions, for its potential as a bioenergy crop[16,17,18,19,20,21]. Biomass crops have been prioritized by the United States Departments of Energy (DOE) and Agriculture (USDA)[22] for development across the nation due to their great potential for increasing the share of domestic renewable energy. Hemp biomass is routinely included in comprehensive biomass evaluations for specific industrial applications[23,24,25,26], and hemp's molecular structure and chemistry have now been characterized for a variety of purposes[27,28,29,30]. A multitude of recent publications in science and engineering journals have reported the successful conversion of hemp to transportation fuels, chemicals, biodegradable polymers, and a broad range of advanced materials[31,32,33,34,35,36,37,38,39,40,41,42]. Exciting new developments include the use of exfoliated hemp to produce high capacitance graphene nano-sheets for use in large-scale production of energy storage devices[43].

While few annual crops can easily be rotated with food and feed crops – a critical parameter for sustainable energy production - crops for which the whole plant biomass can be harvested and used for energy production can result in high land use efficiency. Detailed life cycle analyses[44,45], agronomic studies[46,47,48,49,50], environmental impact evaluations[51,52,53], and techno-economic assessments[54,55] of hemp under a variety of conditions indicate that industrial hemp is viable for accelerated development and integration[56] at the commercial scale for multiple industrial applications.

Refined biomass for co-firing and power generation

Now demonstrated at more than 150 power-generating sites around the globe[57], biomass co-firing is attractive as a viable near term strategy for existing power plants to adopt in order to achieve reduced emissions of carbon dioxide, sulfur and other pollutants in compliance with new regulations on emissions. Co-firing has the advantages of lowered pollutant emissions, improved carbon footprint due to the consumption of CO_2 by biomass crops, low capital costs as an add-on, and fuel flexibility to accommodate a range of usable biomass fuels depending on regional, seasonal, and weather factors[58].

Scientists at the National Renewable Energy Laboratory (NREL) in Golden, Colorado, have evaluated co-firing in all types of boilers used by electric utilities and demonstrated that boiler efficiency is not lost when co-firing biomass blends[59]. Refining of biomass by torrefaction[60], steam explosion[61,62,63], hydrothermal carbonization[64,65,66,67], and other methods increases the energy density of biomass and yields a more coal-like, hydrophobic consistency along with improved storage and handling[68]. As for fossil fuels, the key characteristics of biomass fuels are the thermal capacity along with physical, chemical, and combustion properties. Refined biomass to be used for combustion must be characterized for properties such as total ash content, melting behavior, chemical composition, and heat value. Here, we present the results of a preliminary technical feasibility study of hemp combustion, performed in parallel with higher sulfur coal that is typical of Appalachian and Illinois coals.

Technical Feasibility

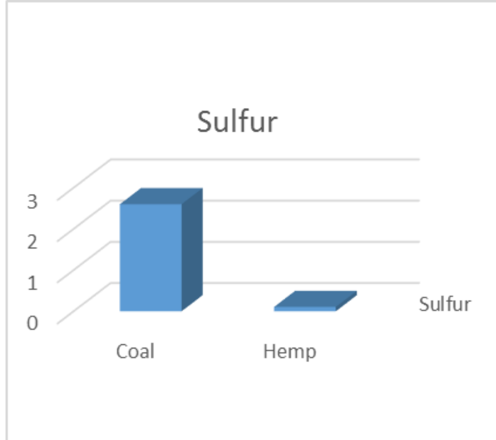
A representative coal sample from the Illinois Coal Basin was obtained for determination of cogeneration thermal capacity and to determine the level of emissions reductions due to blending coal with hemp biomass. Analyses were done according to recognized global standards[69]. As is typical of coal from Appalachia with sulfur content of 3.45%, the coal was used to prepare a series of blended samples for combustion analysis. Testing of a series of co-blended samples was done to understand the impact of increasing the ratio of hemp to coal on energy yield and sulfur emissions. The results are shown in Figure 1 below.

Combustion of the hemp sample yielded 0.10 percent sulfur and 9533 BTU, thus hemp emits only 0.105 pounds of sulfur per million BTUs produced. By comparison, combustion of the coal sample yielded 3.45 percent sulfur and 13210 BTU generated per pound, thus the coal sample emits roughly 2.6 pounds of sulfur per million BTUs produced, well above the levels set by new regulatory standards. A fifty percent blend of dry hemp hurds and coal will reduce the sulfur emissions of the plant to 1.56 pounds of sulfur per million BTUs - a reduction of forty percent - still above new federal levels but within reach of scrubbing technology available today[70].

Our results show that hemp biomass is a promising feedstock for power co-generation, a notion supported by recent engineering and techno-economic studies[71,72]. The introduction of industrial hemp as a biomass energy feedstock can improve the economics of co-firing due to adaptability, high per-acre yield, and potential to be grown on post-mining land and reclamation sites.

Conclusions and Recommendations

There is now a solid body of evidence supporting the use of hemp as a feedstock for energy production as well as manufacturing. Research efforts must therefore shift from proof-of-concept and characterization performed in academic and government laboratories around the world to applied science and engineering associated with private sector deployment and commercialization of technology. Our vision is that existing power plants will serve as hubs for integration of agriculture, energy conversion, and manufacturing in a new economy that benefits from the ability to convert biomass, and particularly hemp, into thousands of valuable products[73]. Favorable economics will be achieved through highly integrated sets of conversion technologies that utilize regionally available biomass and manufacture diverse products ranging from liquid fuel and biogas to fertilizer and animal feed. Research on new technology can be accelerated and engineering will be informed by interfacing with mature processes, such that economic and environmental benefits can be realized. Life cycle analysis and techno-economic assessment of specific engineering applications of hemp-based manufacturing, fuel production, and power generation must now be used on a case by case basis to provide necessary knowledge to aid in decision-making for farmers, researchers, and manufacturers, and investors. Agricultural economic models also provide insights on the expected returns of hemp to compare with expected returns of currently produced crops in the area, and help to identify feedstock issues and project costs and market options for hemp as a biomass crop. These evaluations are routinely undertaken by companies to inform the engineering of physical plant operations, and are anticipated by both the KHGCA and WVHGCA as critical steps in the business development pipeline for the hemp industry in Kentucky and West Virginia.



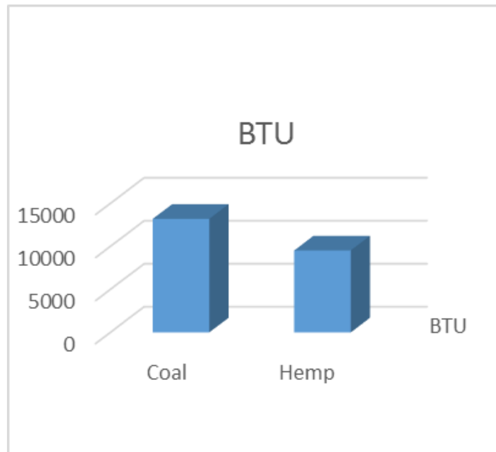


Figure 1. Comparison of energy content (BTU) and sulfur emissions (lb sulfur/million BTU) obtained for test samples.

To stimulate the hemp economy, we recommend that policy makers take the following actions to move forward decisively:

- Prioritize, as a matter of urgency, applied research and development in the form of integrated energy demonstration projects across the region, and develop expertise in life cycle analysis and techno-economic assessments of new energy production and manufacturing processes.

- Provide economic incentives to attract new businesses to the region for biomass processing, manufacturing of fuels, chemicals, and materials from hemp.
- Accelerate the re-development of hemp farming, processing, and manufacturing by creating Ag-Tech hubs for the translation of science and engineering to practice. Shared facilities would allow growers and researchers to rapidly produce seed stocks and develop new strains optimized for energy production, and to provide space and physical resources that enable local outreach and encourage entrepreneurship.
- Support the formation of a regional private-public consortium to create a *Roadmap for Hemp-Based Manufacturing and Energy Production in Rural Kentucky and Central Appalachia*, to serve as a clear path for federal policy makers and funding agencies such as the Departments of Energy (DOE) and Agriculture (USDA) to follow.

"The energy sector must continuously adapt and use viable technologies that are best for Kentucky, West Virginia and our nation. The war on coal has taken its toll. We need to save and create jobs in Kentucky and West Virginia. This white paper poses an adaptive solution. Hemp is indeed a viable option."

- ***David Hadland, President of KHGCA***

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Canadian scientists breeding cows that burp less

2009-06-25

Reuters

Canadian scientists are breeding a special type of cow designed to burp less, a breakthrough that could reduce a big source of greenhouse gases responsible for global warming.

Cows are responsible for nearly three-quarters of total methane emissions, according to Environment Canada. Most of the gas comes from bovine burps, which are 20 times more potent than carbon dioxide as a greenhouse gas.

Stephen Moore, a professor at the University of Alberta in Edmonton, is examining the genes responsible for methane produced from a cow's four stomachs in order to breed more efficient, environmentally friendly cows.

The professor of agricultural, food and nutritional science completed primary tests using traditional techniques to breed efficient animals that produce 25 percent less methane than less efficient animals. But more work needs to be done before the long-term impact is known. Moore's study was published earlier this year in the Journal of Animal Science.

"We are working on producing diagnostic markers for efficient animals. We are looking at the next generation of technologies that will enable us to determine the genetics of an animal through a blood test or testing some hairs that you might pluck from the animal," said Moore.

To shrink cattle's ecological footprint, ranchers could also decrease the time cows are left standing in the field by getting animals to market sooner. That means breeding cattle that grow faster.
Also, through breeding, cattle could become more efficient in converting feed into muscle and producing less methane and waste, said Moore.

Another method already being used to reduce methane emissions is feeding livestock a diet higher in energy and rich in edible oils, which ferment less than grass or low-quality feed.

Farmers in Alberta that feed their livestock edible oils and shorten the time to market can accrue carbon credits that could amount to between one C$1 and C$10 (90 US cents to $8.80) per head.
New Hampshire-based Stonyfield Farm, an organic yogurt producer in which Groupe Danone holds a majority stake, reduced emissions from their cows on an average of 12 percent by adding alfalfa, flax or hemp to livestock feed on a small number of its farms.

"If every US dairy farmer reduced emissions by 12 percent it would be equal to about half a million cars being taken off the road," said Nancy Hirshberg, vice-president of Stonyfield's Natural Resources department.

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SP-21-98

Industrial Hemp White Paper
Growing Hemp in the American Southwest

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The purpose of this paper is to offer introductory guidance for those interested in growing legal, healthy hemp in the American Southwest. This paper is a summary of research done by the Southwest Hemp Educational Council, composed of the University of Nevada, Reno Extension Hemp Educational Committee, as well as commercial hemp growers and horticulturalists from other parts of the Southwest, namely New Mexico State University and the University of Arizona. The Southwest Hemp Educational Council formed to provide necessary educational resources to current and potential hemp growers in the Southwest. This paper is an introduction to hemp and is by no means a comprehensive, all-encompassing guide to its history, cultivation or commercial-use.

The 2014 U.S. Agricultural Act and 2018 Farm Bill changed the landscape of *Cannabis* politics in the United States, and many eager growers jumped at the opportunity to cultivate hemp as a cash crop. However, as 2020 statistics show, the difficult reality of cultivating hemp has discouraged some from expanding their hemp ventures (Drotleff, 2020). Our research indicates that most growers are losing money. To address this, our paper is a guide to navigating some of the legal, environmental and commercial aspects of hemp growing.

This paper covers the following topics:

- Introduction to the *Cannabis* plant itself-- breaking down its anatomy for beginners
- A brief history of *Cannabis* in the United States
- Explanation of the steps one must take to become a legal hemp grower in Nevada and other Southwestern states
- Discussion of proper cultivation procedures for healthy hemp plants
- Explanation of various commercial uses of hemp
- Examination of the performance of hemp and its products in the marketplace
- Questions and suggestions for further research
- Summary of needs assessment survey findings

Introduction to the Plant Itself

Humans have used *Cannabis* for thousands of years to make ropes, cloth, papers, foods, animal feed and medicines. Hemp, or industrial hemp, refers to *Cannabis sativa* that is grown as a crop for its fiber, seed, oil or chemically derived products. Its uses are vast, and its economic potential is enormous (ElSohly, 2010). Hemp, and all *Cannabis*, is generally considered a dioecious (male and female parts are on separate plants) annual. Hemp is usually planted in the spring and matures by the fall. Seeds usually germinate in three to seven days. Industrial hemp is defined in the Federal Farm Bill as “the plant *Cannabis sativa L.* and any part of such plant, whether growing or not, with a delta-9 etrahydrocannabinol concentration of not more than 0.3% on a dry weight basis” (Nevada Department of Agriculture). Tetrahydrocannabinol (THC) is a psychoactive cannabinoid found in most *Cannabis*, but is higher in that which is cultivated as marijuana (for use as a drug).

Typically, *Cannabis* is understood to be a genus of plants that contains about four species, *Cannabis sativa L., Cannabis indica*, *Cannabis sativa* and *Cannabis ruderalis*, though these distinctions are hotly debated, and new research has indicated that *sativa L., ruderalis*, *indica* and *sativa* are different subspecies within the same species (Colbert, 2015). Official scientific distinctions aside, *sativa L.* is most commonly cultivated as hemp, and has some visible differences from *Cannabis indica or sativa*, which is more often cultivated as “marijuana,” defined in the Farm Bill as *Cannabis* harvested at >0.3% delta-9 tetrahydrocannabinol (THC) content.

Cannabis sativa L. is taller, and its leaves are composed of long, thin leaflets. The flowers are loose or “open flower structured,” allowing them to yield higher extractions. *Cannabis sativa L*. has a longer flowering time than *indica* and may start to flower earlier than *indica* as well. *Cannabis indica* is a shorter plant, with fatter leaflets and dense, tight flowers or buds. It has a shorter flowering duration.

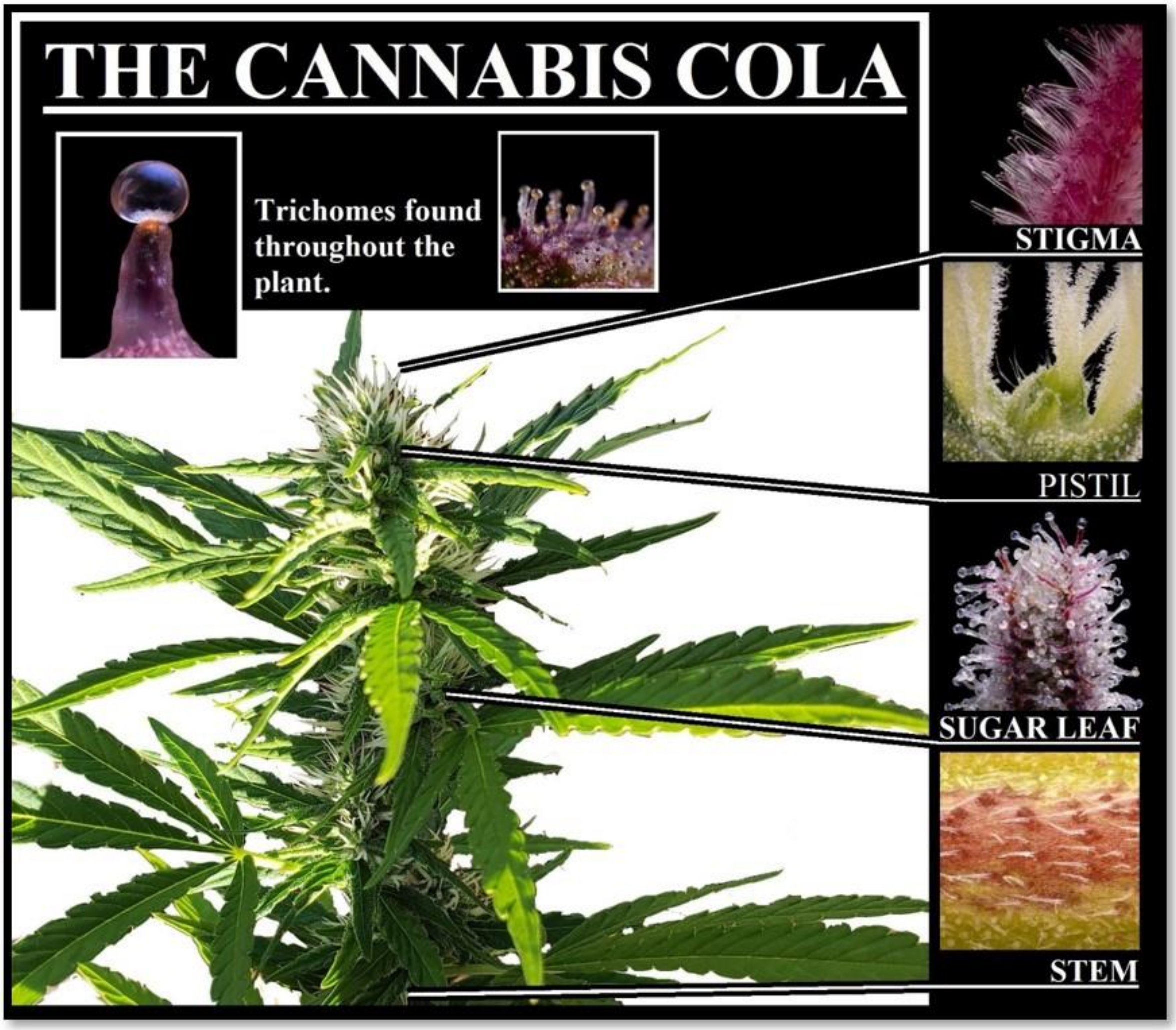

Figure 1. Anatomy of female *Cannabis* plant cola. Photo composed by Marysia Morawska using photos by IG: @zoom_gardens and Marysia Morawska.

Every female *Cannabis* plant is composed of eight main parts: cola, pistils, bracts, trichomes, sugar leaves, fan leaves, stem and roots. The cola is the flowering portion of the plant, which is composed of many small floral clusters covered in trichomes. The flowers are composed of pistils, structures composed of an ovule with two protruding styles capped with stigmas. The stigmas extend past the bract, the small leaves that surround the reproductive cells, to catch male pollen. Trichomes are hairlike appendages that contain cannabinoids and terpenes, the compounds currently most sought after by *Cannabis* growers. Sugar leaves are small leaves that grow out of the buds within the cola. Their trichome covering gives them a sugar-coated appearance.

Sugar leaves are harvested for their cannabinoid and terpene content. Fan leaves are the large, protruding leaves that cover the length of the plant. They are necessary for photosynthesis, but are often removed from the plant when harvested for derived products (The Different Parts of A Marijuana & Cannabis Plant, 2020). The stem, or stalk, is the main support structure of the *Cannabis* plant that transports fluids, nutrients and information from the roots to the rest of the plant. The points where stem and leaves intersect are called nodes. Lastly, the roots anchor the plant, absorb water, dissolve minerals, and conduct these to the stem.

These components are found in all *Cannabis* plants, but the focus of this paper is hemp. The following sections will cover hemp history, hemp regulations in Nevada, growing tips, information about derived products and much more.

Introduction to Hemp in the U.S.

Hemp, alongside tobacco and cotton, was considered a vital crop in the colonial United States and its cultivation predates the formation of the U.S. itself. As hemp historian Robert Deitch explains, "The Virginia Company, by decree of King James I in 1619, ordered every colonist (property owner) to grow 100 plants specifically for export" (2003, p. 16). Only in the 20th century, when competing industries pushed to illegalize it, did hemp cease to be produced legally in this country.

The potential of hemp in the U.S. was stifled for decades by the restrictions imposed by the Federal Bureau of Narcotics, the Marijuana Tax Transfer Act of 1937, and many other illegalization efforts that followed. The legal history of hemp is so layered and complicated that we cannot feasibly recount it all here, but our reference page contains helpful books on the subject.

Thanks to the 2014 U.S. Agricultural Act, 2018 Farm Bill, Senate Bill 305 (SB305) and Senate Bill 396 (SB396), growing, producing or handling industrial hemp in Nevada is legal through the State of Nevada Department of Agriculture Industrial Hemp Program. Rather than import hemp from other states or countries as our state does with food, the in-state cultivation of hemp is not only possible but will cut the unnecessary costs of importing, and will avoid the struggle of navigating interstate *Cannabis* laws, which oftentimes do not match one another.

How to Grow Hemp in Nevada Legally

Entering the hemp industry in Nevada requires approval from the Nevada Department of Agriculture (NDA), attainment of specific certifications and payment of fees. The first step is to decide in which category of the industry one wishes to enter; this will determine the appropriate certification to acquire. As of the time of this publication, the three certification categories and associated fees for the State of Nevada are as follows, however it is recommended to check with your state's Department of Agriculture website, as these are subject to change (Nevada Department of Agriculture, 2019):

Grower: a person who is registered by the Department and cultivates industrial hemp.

- Application Fee: $500-900
- Acreage Fee: ~$5/acre or, Square Footage Fee: ~ 33 cents/1,000 square feet

Producer: a person who is registered by the Department and produces agricultural hemp seed for replication.

- Application Fee: ~$100
- Acreage Fee: ~$5/acre or, Square Footage Fee: ~ 33 cents/1,000 square feet

Handler: a person who is registered by the Department and receives industrial hemp for processing into commodities, products or agricultural hempseed.

- Application Fee: ~$1,000

Applicants may be subject to a law enforcement background check, and cannot have a criminal record relating to possession, production, sale or distribution of a controlled substance within the last 10 years of the application date (NDA, 2019). The NDA may inspect and sample as they see fit at any time and at the expense of the applicant. Inspection costs, at the time of publication, run at $50/hour/inspector for drive time, inspections and sampling, and may include an additional fee for any analysis they conduct (NDA, 2019).

For assistance navigating the regulations, licensing and applications, one may reach out to the NDA Hemp Program coordinator for answers to any additional questions. Hemp production laws may vary by county, and it is recommended to check with regional and local governing agencies to ensure compliance with all regulations. Likewise, each different state also possesses their own specific laws. For general information regarding Utah, New Mexico, Arizona and California, please refer to the Appendix of this publication.

Hemp seed growers and producers must submit a harvest report to the NDA at least 15 days prior to harvest, but new federal rules permit 30 days prior (Agricultural Marketing Service 2021). At that point, an inspection will be scheduled, at the cost of the producer, and a lab analysis will be taken to ensure the crop tetrahydrocannabinol (THC) concentration is below the federally mandated threshold of 0.3% total THC on a dry weight basis (NDA, 2019). Producers are not to dispose of or relocate any crop material prior to NDA approval. Once they have passed inspection, they can then move or sell harvested material at the producers' own risk (NDA, 2019). If harvested material exceeds the threshold, the producer will be instructed by the department on disposal methods and will not be allowed a second test. The Hemp Harvest Report can be found on the NDA website and must be mailed to:

Nevada Department of Agriculture
Attn: Industrial Hemp Program
405 S. 21st St.
Sparks, NV 89431

Or, reports faxed to 775-353-3638, or scan and email them to ajeppson@agri.nv.gov.

Experienced growers know to test their hemp "early and often" so as to not lose too much of their crop. We recommend sending samples to labs for cannabinoid testing every other day when harvest approaches, which usually arrives in late September or early October. We advise growers to harvest their plants not based on physiological maturity, but on test results. Once test results demonstrate the desired and legal cannabinoid balance, the crop should be harvested. Harvesting earlier is advised to avoid excess THC.

Growing Healthy Hemp in the Southwest

Controlled environments, such as greenhouses, can be an easy way to ensure quality, as the plants are not exposed to weather, and their exposure to pests is limited. However, this method is costly and unsuitable for the cultivation of hemp that does not prioritize cannabinoid content for human consumption, such as growing for fiber and grain (M. Morawska, personal communication, Oct. 29, 2020). Many hemp growers grow outside and produce large, quality yields. Doing so is possible with the right horticultural knowledge. In addition to reading this paper, we encourage growers to contact their local Extension and/or community college for horticulture and botany classes to prepare them for this work.

To optimize their yields, growers must take care to plant their hemp at the right time, and in the right conditions. Hemp seedlings can be started indoors during the winter using artificial light before the seedlings are transplanted. To get larger plants that contribute to larger yields, growers should transplant seedlings two weeks after the latest frost date. Planting early allows the plants to grow large enough to create a cool, healthy microclimate for their root zones, which they need to continue growing during the extreme heat of July and August. As hemp is a new crop for the Southwest, information is sparse on optimal growing conditions. New growers should try successful varieties from similar climates/growing conditions. Hemp seeds are never 100% guaranteed to be female. Growers who want sinsemilla must monitor their crop and remove male plants and/or those exhibiting rhodelization (when female plants develop pollen sacs due to external stressors).

A number of growers in the Southwest have produced several hemp varieties successfully, despite the fact that hemp is not a desert-adapted plant. While varieties are tested and promoted by growers in the Southwest, there is not much research to support these claims. The most popular varieties include Berry Blossom and Cherry Wine, though we cannot yet vouch for their success. Extension is conducting variety trials to provide growers with data on hemp growing in the dry, hot conditions of Las Vegas.

Before planting, growers should test their soil, or send samples to a lab. The more soil samples, the better, as a larger sample size will better capture the true composition of the whole plot in which one desires to plant hemp. Hemp grows best in soft, sandy, well-draining loam with a pH between 6 and 6.5. It does not grow well on wet soils or heavy, clay soils, and it is sensitive to soil crusting and soil compaction (PennState Extension, n.d.). Growers desiring more organic matter may amend their soil with compost or soil amendments, such as worm castings. Sulfur may be used over an approximately two-year period to condition alkaline soil to be more acidic.

Hemp thrives in sunny summer days, (greater than 14 hours), but requires shorter (approximately 12-hour days) to produce mature flowers or seed. Summer day high temperatures from 80 to 90 degrees Fahrenheit are optimal for healthy hemp growth. Nighttime temperatures should be about 10 to 15 degrees lower. In the winter, daytime temperatures of 65 F to 75 F and nighttime temperature above 60 F are adequate. The plant will continue to grow until it flowers, which naturally happens as days get shorter.Hemp thrives in abundant sunlight, but the high heat of Southwestern summers can stress the plant. During the hottest days growers, can start watering at sunrise and repeat every four to six hours through the afternoon to keep the root zone cool. Ideally, the top ¾ inch of soil should dry before watering again (J. McCoy, personal communication, Aug. 17, 2020). When plants are seedlings, or if planting in poor draining soils, growers must be careful not to overwater. The roots need a good supply of oxygen, and drowning seedlings do not grow!

Growers who are interested in small, boutique hemp gardens may hand water, but irrigation systems are a helpful tool for hemp cultivation. There are many types of irrigation systems, but ground-level drip irrigation works well for cannabinoid cultivation. Overhead and center-pivot watering systems can get water into hemp flowers, which can lead to mold or unwanted bacteria to develop that could damage plant health.

Avoiding pests, injury, and pathogens is necessary for healthy hemp production. *Cannabis* plants do not require insects or mites for pollination, so these organisms mostly act as parasites, causing injury that can lead to infection and disease. We encourage growers to practice Integrated Pest Management (IPM). IPM means prevention, not just reaction, and it saves growers money in the long term. We encourage growers to research IPM and develop their own practices best suited to their growing conditions. A common IPM practice is to purchase ladybugs and/or green lacewing larvae, which will organically help control pest populations. Removal of dead or diseased plant material will also reduce undesired pathogens.

Common pests include aphids, thrips, caterpillars of various species and spider mites, all of which can infest indoor grow houses (McPartland et al., 2000). In Arizona, white flies, flea beetles, spiders, beet armyworm, corn earworm and the beet leafhopper are other common pests.

Beet leafhopper is a vector for beet curly top virus (BCTV), a common disease (Masson, 2020). BCTV. Is a common pathogen in the Southwest, mainly due to the endemic nature of the insect in the desert Southwest. BCTV symptoms include vein swirling, leaf curling, yellowing of leaves, and stunting. Growers should also look out for powdery mildew. Plant samples may be sent to state plant pathologists for diagnosis. In Nevada, send samples to:

Shouhua Wang, Ph.D.
Plant Pathology and Diagnostic Laboratory
Plant Industry Division
Nevada Department of Agriculture
405 South 21st St.
Sparks, Nevada 89431
phone: 775-353-3765
email: shwang@agri.nv.gov

Lastly, hemp growers should note that large hemp plots can give off an odor that some may find unpleasant, and some growers often deal with complaints of “weed smells” from neighbors. A buffer crop may be planted around hemp fields to offset the odor. A cover/companion crop can be planted to integrate IPM tactics, create a dual crop use of the land, and to offset odors of *Cannabis* growth.

The Many Uses of Hemp

Some of the most coveted products of hemp are the cannabinoids. Cannabinoids are compounds found in all *Cannabis* plants, the most known of which is tetrahydrocannabinol (THC), but hemp plants have been cultivated to have lower THC levels and higher cannabidiol (CBD) levels. There are more than 130 known cannabinoids, but the hemp cannabinoids with the highest consumer demand are CBD and Cannabigerol (CBG).

Cannabinoids have been used for years to help people sleep, deal with pain and movement disorders, cope with anxiety, and improve cognition. More recently they have been used to treat a number of diseases, such as inflammatory bowel disease, glaucoma, bladder dysfunctions, Huntington’s disease, bacterial infections, colon cancer and appetite loss. However, clinical research on cannabinoids is still insufficient, and thus we cannot conclusively state that it is effective for these conditions and purposes.

Though many people know hemp for the products of its derived compounds, the rest of the plant can be used in various beneficial ways. Hemp has been grown for its fiber for centuries throughout the world, and was once grown on a large scale in the U.S. for this purpose. The decortication process for hemp mechanically removes the tough woody interior (the hurd material), from the softer, fibrous exterior of the stalk. The bast and hurd of the stalks are extracted to use for a number of commercial products. Hemp fiber is durable and keeps its shape, making it an ideal material for clothing (Vivek, 2020). Hemp fiber contains cellulose which can be made into a biodegradable bioplastic, unlike the petroplastics. The Ford Motor Company constructed a hemp plastic car in 1941 and claimed the hemp plastic panels were stronger than steel.

Hemp stalks hold much market potential, but in the U.S., the commercial processing infrastructure for hemp stalk-use is lacking. Hopefully, this will change in the near future, and hemp's full potential may be unleashed. Hand-decortication requires much labor time and is not cost-effective enough for most hemp growers.

Hemp's market potential is also seen in the animal feed industry, which has expressed interest in utilizing hemp as an animal feed ingredient due to its fiber content, and omega-3 fatty acid and protein profile. However, due to its recent entrance into U.S. production, there is little research available to support the safety of consumption for animals or humans, nor is there a valid definition of ingredients. The Association of American Feed Control Officials (AAFCO), one of the regulating agencies of hemp as an animal feed ingredient, has asked the hemp industry to come forward with research establishing definitions for animal feed ingredients from industrial hemp for scientific review (AAFCO, 2020). The Food and Drug Administration (FDA) has prohibited the use of CBD in any potential animal feed product, as CBD falls within the scheduled drug category, therefore limiting the parts of the hemp plant deemed suitable as a feed additive (AAFCO, 2020).

However, hemp seed oil, hemp seed meal and whole hemp seed have been deemed suitable as potential feed additives and are currently being researched. While hemp is not legal for use in animal feed, hemp seeds, hemp milk and hemp oil are sold in many grocery stores for human consumption. Research has demonstrated that hemp oil can help treat acne, eczema and psoriasis (Callaway et al., 2005; Oláh et al., 2014; Millsop et al., 2014). Hemp oil can even be used to power vehicles, as it can be transformed into a biodiesel through the process of transesterification.

Beyond the uses of its derived products, hemp has major potential for use in bioremediation of tainted soils. An experiment in Chernobyl has shown hemp's remarkable ability to remove radioactive elements from soil (Charkowski, 1998). Due to hemp's superb ability to remove pollutants from the soil, we emphasize the importance of multi-testing your entire plot before planting. We hope to see or conduct experiments with hemp's phytoremediation abilities in the Southwest.

Hemp's Performance in the Marketplace

To date, production costs for hemp are typically higher than profits. Like other agricultural commodities, the industry structure will evolve as hemp markets develop (Mark et al., 2020). As the demand for hemp plants, CBD and hemp products have increased since the implementation of the 2018 Farm Bill, the markets have been flooded with industry newcomers, as well as international imports as various other countries legalize hemp production. This increase in supply may prove to be detrimental to young companies, as the demand has decreased due to saturation. However, it is difficult to predict how the market will react. While the USDA requires all hemp growers to report acreage planted and production information, it does not require reports on pricing and sales data, causing a lack of pricing transparency for the overall market.

Due to this lack of reliable information, those wishing to enter the market will have to rely on speculative decision-making for pricing and marketing their product (Mark et al., 2020). Based on available information, the prices of CBD raw biomass, dried CBD flower, crude hemp oil, refined hemp oil and CBD isolates have all dropped since 2019. However, the global hemp fiber market size is expected to grow in the forecast period of 2020 to 2025, with a compound annual growth rate (CAGR) of 4.9%, and is expected to reach $264 million by 2025, from $218.2 million in 2019 (Marketquest, 2020).

The current state of the hemp market has caused most hemp growers to lose money. Those who are successful find buyers before they start growing, consult attorneys when they create or sign contracts, have existing farm equipment and processing facilities they can use, are vertically integrated, and focus on a specialized market. There are newsletters available from several companies with information about market trends.

Further Research and Necessities for the Future of Hemp

Horticultural research on hemp in the Southwest is needed, and Extensions are stepping up to fill this void. We encourage growers to reach out to their local Extension office about emerging hemp research. Hemp has much potential beyond its derived products, and further research on its phytoremediation abilities is needed, and could prove beneficial for areas with polluted soils in the Southwest and beyond. Much support can be offered from Extension offices, and Extensions are interested in collaborative research projects with farmers.

More clinical research on the health impacts of hemp consumption is needed to dispel myths. We encourage all stakeholders to regard emerging research with scientific skepticism, paying attention to the methods and sources of funding. Additionally, hemp grown for cannabinoid consumption should be cultivated with the utmost cleanliness, and we endorse organic practices to minimize potentially dangerous chemical content.

Needs Assessment Results

A survey was conducted of 123 people from eight states concerning their interest in a training for growing hemp. Responses from 118 people indicated that they had previous experience in growing hemp. The responses to the hemp needs assessment also indicated that most people would prefer an online certificate program. Respondents would prefer two-hour weekday classes, once per week, which could be a mix of live and recorded sessions. They were eager to see our course cover the topics of hemp horticulture, soil and soil amending, IPM, irrigation, and marketing. There was also interest in navigating regulations, desert growing and weed control. Extension will assess all of our needs assessment data as we create our curriculum to address the needs of growers in the Southwest and beyond. We encourage interested parties to reach out to Extension with any hemp questions. Further needs assessments will explore the problems growers have faced.

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Appendix

State regulatory information

- Nevada
    - Nevada Department of Agriculture website: http://agri.nv.gov/Plant/Seed_Certification/Industrial_Hemp/Producer_Information/
    - Contact: ablondfield@agri.nv.gov or 775-353-3675.
    - Those who wish to grow, produce or otherwise handle industrial hemp in the state of Nevada must register through the Nevada Department of Agriculture, as well as check with other local governing agencies.

- Arizona
    - Arizona Department of Agriculture website: https://agriculture.az.gov/plantsproduce/industrial-hemp-program/industrial-hemp-license-applications
    - Contact: azhemp@azda.gov or 602-542-0955.
    - Those who wish to produce, harvest, transport and process industrial hemp must register through the Arizona Department of Agriculture prior to taking possession of any hemp seeds or propagative materials. All documentation and instructions can be found on the ADA website.

- California
    - California Department of Food and Agriculture website: http://www.cdfa.ca.gov/plant/industrialhemp/
    - Contact: industrialhemp@cdfa.ca.gov or 916-654-0435.
    - The state of California requires those who wish to cultivate industrial hemp to register with their local county agricultural commissioner, as regulations vary from county to county. Applications and further instruction can be found on the CDFA website. The provided FAQ pages on the website are helpful in navigating through the application process.

- New Mexico
    - New Mexico Department of Agriculture website: https://www.nmda.nmsu.edu/hemp-registration/
    - Contact: hemp@nmda.nmsu.edu or 575-646-3207.
    - New Mexico Environment Department website: https://www.env.nm.gov/hempprogram/applications/
    - Contact: hemp.program@state.nm.us
    - Those wishing to produce hemp must acquire a license through the New Mexico Department of Agriculture. Those wishing to process hemp following harvest, such as extraction, distillation and manufacturing, must register through the New Mexico Environment Department. Further instructions and application documents can be found on the given websites.

- Utah
    - Utah Department of Agriculture and Food website: https://ag.utah.gov/industrialhempprogram/
    - Contact: udaf-commissioner@utah.gov or 801-982-2375.
    - Those who wish to cultivate, process or market industrial hemp or its products must be registered through the state. Applications and requirements can be found on the Utah Department of Agriculture website.

- Tribal laws
    - As tribal reservations possess their own governing agencies, each reservation must determine their own regulations for growing hemp. As of the time of this publication, there is growing interest within the tribes located in Nevada, but set regulations are still developing.
    - According to the Arizona Department of Agriculture, when applying for a state license to grow hemp, if the applicant is a member of an Indian tribe or is a tenant on Indian tribal lands, the applicant must provide a resolution from the tribe that authorizes the licensee to grow hemp.

Additional resources

- Hemp farming timeline and budget planner from Hemp Farming Academy https://s3.amazonaws.com/kajabi-storefronts-production/sites/51692/downloads/prr8q7lsR1Kf4Y1VvZx9_Hemp_Farming_Infographic.pdf

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Zoom Gardens [@zoom_gardens]. 2021, April 3. ✿ A lone purple trichome 🏵 with a rather beautiful secretory cell configuration. A recent diagram I was studying referred to the secretory cells at the base of the gland as a “ rosette of gland cells “ something I’ve never heard before..seems fitting. [Instagram photo].

Zoom Gardens [@zoom_gardens]. 2021, August 31. ▯ it’s a stigma. [Instagram photo].

Zoom Gardens [@zoom_gardens]. 2020, December 11. 🌱 Stem slide of a fresh clone rooted shown are cystolithic trichomes running down the middle red cuticle cells and bulbous trichome on the top and bottom 🌱. [Instagram photo].

Zoom Gardens [@zoom_gardens]. 2021, April 28. ❄ Sugar leaf. [Instagram photo].

Effects of increasing amounts of hempseed cake in the diet of dairy cows on the production and composition of milk

Article *in* animal · November 2010

DOI: 10.1017/S1751731110001254 · Source: PubMed

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Animal (2010), **4:11**, pp 1854–1860 © The Animal Consortium 2010
doi:10.1017/S1751731110001254

Effects of increasing amounts of hempseed cake in the diet of dairy cows on the production and composition of milk

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(Received 12 January 2010; Accepted 11 May 2010; First published online 10 June 2010)

*This study explored the potential for using seed cake from hemp (*Cannabis sativa *L.) as a protein feed for dairy cows. The aim was to evaluate the effects of increasing the proportion of hempseed cake (HC) in the diet on milk production and milk composition. Forty Swedish Red dairy cows were involved in a 5-week dose–response feeding trial. The cows were allocated randomly to one of four experimental diets containing on average 494 g/kg of grass silage and 506 g/kg of concentrate on a dry matter (DM) basis. Diets containing 0 g (HC0), 143 g (HC14), 233 g (HC23) or 318 g (HC32) HC/kg DM were achieved by replacing an increasing proportion of compound pellets with cold-pressed HC. Increasing the proportion of HC resulted in dietary crude protein (CP) concentrations ranging from 126 for HC0 to 195 g CP/kg DM for HC32. Further effects on the composition of the diet with increasing proportions of HC were higher fat and NDF and lower starch concentrations. There were no linear or quadratic effects on DM intake, but increasing the proportion of HC in the diet resulted in linear increases in fat and NDF intake, as well as CP intake (*$P < 0.001$*), and a linear decrease in starch intake (*$P < 0.001$*). The proportion of HC had significant quadratic effects on the yields of milk, energy-corrected milk (ECM) and milk protein, fat and lactose. The curvilinear response of all yield parameters indicated maximum production from cows fed diet HC14. Increasing the proportion of HC resulted in linear decreases in both milk protein and milk fat concentration (*$P = 0.005$* and *$P = 0.017$*, respectively), a linear increase in milk urea (*$P < 0.001$*), and a linear decrease in CP efficiency (milk protein/CP intake;* $P < 0.001$*). In conclusion, the HC14 diet, corresponding to a dietary CP concentration of 157 g/kg DM, resulted in the maximum yields of milk and ECM by dairy cows in this study.*

Keywords: *Cannabis sativa*, protein feed, crude protein, milk yield, N efficiency

Implications

This study evaluated the use of hempseed cake (HC) in dairy cow diets and its effects on milk production and milk composition. The results indicate that it is possible to use HC as a protein supplement for dairy cows and that including a moderate proportion in the diet gives the best results for milk production. Since hemp can be cultivated at high latitudes (above 60°N), HC is a viable source of protein suited to local production in northern regions of Europe.

Introduction

Dairy production in Scandinavia uses large quantities of imported protein supplements (e.g. soyabean meal). However, during recent decades, there has been increasing interest in alternative protein feeds that can be locally produced, as well as a growing concern over the environmental impacts of production techniques. Over-feeding of protein is costly for dairy producers and it also results in losses of N to the environment. Maintaining high milk production based on locally produced diets in Scandinavia requires protein crops that can be cultivated at high latitudes. Furthermore, protein supplements with a high content of digestible rumen undegradable protein (RUP) are preferred (NRC, 2001). This is particularly important for high producing cows, for which the forage is provided by high-quality grasses and legumes, as is often the case in Scandinavia. In these situations, the basal diet often contains sufficient amounts of rumen degradable protein, but is deficient in RUP (NRC, 2001). Common protein feeds grown in Scandinavia, like peas and rapeseed, often contain protein that is easily degradable in the rumen and they can also be difficult to cultivate in the northern parts of Scandinavia.

Since 2003, growing hemp (*Cannabis sativa* L.) varieties with a low concentration of the psychoactive substance

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delta-9-tetrahydrocannabinol has been permitted within the European Union (Council of the European Communities, 1993). Hemp is an annual herbaceous plant cultivated for its fibre and oil. The early-blooming variety Finola can be grown at high latitudes, giving seed yields around 1700 kg/ha (Callaway, 2002). Hempseed typically contains over 300 g oil/kg, about 250 g protein/kg and considerable amounts of dietary fibre, vitamins and minerals (Callaway, 2004). After extracting the oil, the remaining hempseed cake (HC) can be used as a protein feed for ruminants. The crude protein (CP) concentration in cold-pressed HC can vary, but values between 319 and 385 g/kg dry matter (DM) have been reported (Hessle *et al.*, 2008; Karlsson *et al.*, 2009). Furthermore, hempseed may be a good source of RUP. An *in vitro* study by Karlsson *et al.* (2009) showed that HC had a low effective CP degradability (EPD; Ørskov and McDonald, 1979) of 0.33. Mustafa *et al.* (1999) reported, in an *in situ* study, that hempseed meal was comparable with heat-treated canola meal in its rumen degradability characteristics, with an EPD value of 0.39.

Although HC seems to be a promising alternative protein feed for ruminants, there have only been a few studies published (Mustafa *et al.*, 1999; Gibb *et al.*, 2005; Hessle *et al.*, 2008) and none of them include dairy cows. Hence, there is a need to explore the possibilities of how to best utilise HC in dairy cow feeding. Increasing dietary CP often gives a curvilinear response with respect to milk production (e.g. Ipharraguerre and Clark, 2005) and a linear decrease in N efficiency (e.g. Olmos Colmenero and Broderick, 2006; Huhtanen and Hristov, 2009). Our hypothesis was that an increased proportion of HC in the diet would produce a similar response. However, increasing the amount of HC would result not only in a higher dietary CP concentration, but would also affect the concentrations of other nutrients in the diet. Therefore, the aim of this study was to evaluate the effects on milk production and milk composition of increasing the proportion of HC in the diet of dairy cows.

Table 1 *Mean chemical composition (g/kg DM if not otherwise stated) of silage and concentrates*

	Grass silage	Compound pellets[a]	Hempseed cake
DM (g/kg)	300	887	937
CP	127	123	344
Fat[b]	20	26	124
Ash	75	64	67
NDF	480	201	393
ADF	310	103	321
Starch[b]	41	428	10
BSN (g/kg N)	542	213	180
NPN (g/kg N)	511	150	103
ADIN (g/kg N)	33	44	78
ME[c] (MJ/kg DM)	11.5	11.9	9.5
iNDF (g/kg NDF)			845
Lactic acid	53		
Acetic acid	13		
Propionic acid	2.4		
Butyric acid	0.2		
Ethanol	13		
NH_3-N (g/kg N)	62		
pH	4.0		

DM = dry matter; BSN = buffer soluble N; NPN = non protein N; ADIN = acid detergent insoluble N; ME = metabolisable energy; iNDF = indigestible NDF.
[a]Containing 700 g barley, 100 g oats, 90 g sugar beet pulp, 50 g wheat bran and 20 g molasses/kg. Including added vitamins and minerals to provide 7.0 g of Ca, 4.5 g of P, 3.0 g of Mg, 6.6 g of K, 2.7 g of Na, 0.4 mg of Se, 4000 IU of vitamin A, 2000 IU of vitamin D and 40 mg of vitamin E/kg.
[b]Value for grass silage is standard from Feed Tables for Ruminants (Spörndly, 2003).
[c]Calculated values, for the silage according to Lindgren (1983) and for the concentrates according to Axelsson (1941).

Material and methods

Animals, diets and experimental design

Forty Swedish Red dairy cows (primiparous and multiparous) were used in a continuous dose–response feeding trial conducted at The Swedish University of Agricultural Sciences (Umeå, Sweden). The animals had an average parity of 2.5 (s.d. 1.0) and live weight (LW) of 627 (s.d. 58) kg. They were in milk for 154 (s.d. 82) days and produced 30.6 (s.d. 4.8) kg milk/day at the start of the trial. The cows were divided into 10 blocks according to parity and energy-corrected milk (ECM) yield and were allotted randomly within blocks to four different treatments, in order to evaluate the effects of HC as a protein supplement in the diet.

Four diets were formulated to contain increasing concentrations of HC: 0 g (HC0), 143 g (HC14), 233 g (HC23) or 318 g (HC32) HC/kg DM. They were balanced for a target production of 35 kg ECM. The ingredients and their chemical composition are presented in Table 1, while the experimental diets are described in Table 2. Grass silage was made from a mixed lay of Timothy (*Phleum pratense* L.*)* and Meadow fescue (*Festuca pratensis* Huds.) harvested in 2007 in Umeå. The herbage was cut using a disc mower with conditioner (Kverneland TA339, Kverneland group, Kverneland, Norway), precision chopped and stored in a bunker silo. The crop was treated with the acid additive PROENS[TR] (Perstorp Speciality Chemicals AB, Perstorp, Sweden), a mixture of formic acid (600 to 660 g/kg) and propionic acid (230 to 290 g/kg), at a concentration of 4 l acid/Mg fresh matter. The compound pellets including added vitamins and minerals were bought from a commercial feed company (Lantmännen, Holmsund, Sweden). The hempseeds (*Cannabis sativa* L., cv. Finola) were cold-pressed with a Täbypress Type 90 (Skepsta Maskiner AB, Örebro, Sweden) by a commercial oil producer (Vegolia AB, Falkenberg, Sweden).

The cows were housed in a loose housing system where diets were offered *ad libitum* as total mixed rations in Roughage Intake Control[TM] feeders (Insentec B.V., Marknesse, The Netherlands), with intake recorded individually at each visit. The ration levels in each feed bunk were adjusted daily to keep the availability of the diets *ad libitum*, following inspection of the residual feed between fillings. The residual feed was removed from the feed bunks once a day before one of the three daily fillings with fresh feed.

Table 2 *Ingredients and chemical composition of experimental diets (g/kg DM if not otherwise stated) containing different proportions of HC*

	Diets			
	HC0	HC14	HC23	HC32
Ingredient				
Grass silage	499	495	493	490
Compound pellets	501	362	274	192
HC	0	143	233	318
Chemical composition				
DM (g/kg)	451	455	457	459
CP	126	157	177	195
Fat	23	37	46	54
Ash	70	70	70	71
NDF	346	371	386	401
ADF	210	240	258	276
Starch	228	172	136	103
BSN (g/kg N)	383	339	319	305
NPN (g/kg N)	337	281	255	236
ADIN (g/kg N)	41	52	57	60
ME[a] (MJ/kg DM)	11.7	11.4	11.2	11.0

HC = hempseed cake; DM = dry matter; BSN = buffer soluble N; NPN = non-protein N; ADIN = acid detergent insoluble N; ME = metabolisable energy.
[a]Calculated values, for the silage according to Lindgren (1983) and for the concentrates according to Axelsson (1941).

The LW of the cows was automatically recorded in a weighing station (Insentec B.V.) after the morning milkings.

The experiment lasted for 5 weeks, following a 1-week pre-experimental period when all cows were given a diet with increasing amounts of HC and a mean composition corresponding to the average of diets HC14 and HC23. By this, the cows that were allotted to an experimental diet including HC could get used to the new feedstuff and yet all cows were offered the same pre-experimental diet. The first week of the proper experiment was considered to be a period of adaptation to the diets; hence, intake and production data from only the last 4 weeks were used for statistical analyses.

Feed sampling and analyses

Samples of the grass silage were taken daily, stored at −20°C and pooled to form one sample/week. Samples of HC and compound pellets were taken weekly and stored at room temperature. All feed analyses were performed at Kungsängen Research Centre, Swedish University of Agricultural Sciences (Uppsala, Sweden). The feed samples were pre-dried at 60°C for 20 h and ground through a 1-mm screen in a hammer mill (Slagy 200; Kamas Kvarnmaskiner AB, Malmö, Sweden). The DM of the concentrates was determined by drying at 103°C for 16 h, while the DM of the silage samples was determined by drying at 60°C for 16 h and corrected for volatile losses according to the NorFor Nordic Feed Evaluation System (2007) (Corrected DM (g/kg) = 0.99 × uncorrected DM (g/kg) + 10). The ash content of the feeds was determined by combustion at 550°C for 3 h. The CP content was determined as Kjeldahl $N \times 6.25$ (Nordic Committee on Food Analysis, 1976) using a 2020 Digestor and a 2400 Kjeltec Analyser Unit (FOSS Analytical A/S, Hillerød, Denmark). The NDF, excluding ash, was analysed using 100% neutral detergent solution, with the addition of amylase and sulphite 1 h before filtration (Chai and Udén, 1998). The ADF, including ash, was determined according to AOAC (1990; method no. 973.18) and the residue was analysed for acid-detergent insoluble N (ADIN; Licitra *et al.*, 1996). Non-protein N (NPN) was determined after protein precipitation with trichloroacetic acid (Licitra *et al.*, 1996), and buffer-soluble N (BSN) was determined using a borate-phosphate buffer (Hedqvist and Udén, 2006). Crude fat in the concentrates was determined according to the Official Journal of the European Community L 015 (18/01/1984; method B), using a 1047 Hydrolysing Unit and a Soxtec System HT 1043 Extraction Unit (FOSS Analytic A/S, Hillerød, Denmark), and starch, including maltodextrin, was determined enzymatically (Larsson and Bengtsson, 1983).

The fermentation characteristics of the silage were determined from the silage fluid. Volatile fatty acids and ethanol were determined using a HPLC-system with a Hewlett Packard Series 1050 pump and an autosampler (Andersson and Hedlund, 1983). Ammonia-N was determined by flow injection analysis, as described by Karlsson *et al.* (2009). The pH of the silage was determined with a pH electrode (654 pH-meter Methrom AG, Herisau, Switzerland). Metabolisable energy (ME) of the silage was calculated from *in vitro* organic matter digestibility (Lindgren, 1979 and 1983), while ME of the concentrates was calculated according to Axelsson (1941).

The indigestible NDF (iNDF) in HC was determined *in sacco* according to the NorFor Nordic Feed Evaluation System (Eriksson *et al.*, 2007). Duplicate samples of 2 g were weighed into bags and placed in each of two rumen-fistulated non-lactating dairy cows for 288 h. The iNDF values were calculated from mean weights of the sample residues and NDF analyses of pooled residues from the two bags in each cow.

Milk sampling and analyses

The cows were milked twice daily at 0600 and 1500 h and individual production (kg of milk) was recorded on each visit to the parlour by automatic milk recorders (Insentec B.V.). Milk samples were collected weekly during four consecutive milkings and pooled to produce one morning and one evening milk sample/cow/week. The samples were analysed for fat, protein, lactose and urea concentrations at Eurofins Steins Laboratorium AB (Jönköping, Sweden), using a CombiFoss 5000 MilkoScan infrared technique (FOSS Analytic A/S, Hillerød, Denmark). The yield of ECM was calculated according to Sjaunja *et al.* (1990): ECM (kg/day) = milk yield (kg/day) × ((383 × milk fat (%) + 242 × milk protein (%) + 783.2)/3140)).

Statistical analysis

Feed intake and milk production results were analysed using the MIXED procedure in SAS (Littell *et al.*, 2006), with a model including the fixed effects of diet, block and covariate. For all parameters analysed, the respective means from the pre-experimental week for each cow were used as a covariate. Efficiency parameters (ECM yield/DM intake and milk protein yield/CP intake, respectively) were based on the covariate-corrected values of intake and production and were analysed excluding the covariate in the model. The linear and quadratic effects of HC in the diet were examined by replacing the qualitative variable diet in the model with the quantitative variable proportion of HC. The relationship between milk production (kg ECM) and HC in the diet (g/kg DM) was analysed by polynomial regression.

Two of the cows fed HC14, one of the cows fed HC23 and three of the cows fed HC32 had to be taken out of the experiment, due to illness unrelated to the experiment; data from these cows were not included in the statistical analyses.

Results

Diet composition and feed intake

The CP concentrations in the diets ranged from 126 to 195 g/kg DM (Table 1). Replacing the compound pellets with HC resulted, in addition to higher dietary CP, in higher concentrations of fat, NDF, ADF and ADIN and lower concentrations of starch, BSN and NPN (Table 2). Increasing the proportion of HC had no linear or quadratic effects on DM intake, but there were linear increases in CP, fat and NDF intake ($P < 0.001$) and a linear decrease in starch intake ($P < 0.001$; Table 3).

Milk yield and composition

Increasing dietary HC resulted in significant effects on the yields of milk and ECM, described by a quadratic model, as well as on the yields of milk protein, milk fat and lactose (Table 3). The curvilinear response indicated maximum production from cows fed diet HC14. Including greater amounts than HC14 in the diet resulted in decreased production. The relationship between yield of ECM and dietary HC concentration is described by a polynomial regression in Figure 1.

Increasing the proportion of HC produced linear decreases in both milk protein and milk fat concentration ($P = 0.005$ and $P = 0.017$, respectively; Table 3). Furthermore, there was a linear increase in milk urea concentrations ($P < 0.001$) and a linear decrease in CP efficiency (milk protein/CP intake; $P < 0.001$).

Discussion

Diet composition and feed intake

The different proportions of HC in the diets were chosen to provide a wide range of dietary CP concentrations and to explore the dose–response effect. Two issues need to be raised. First, it is possible that the diets containing high HC concentrations contained insufficient amounts of degradable carbohydrates to allow utilisation of the available CP for synthesis of microbial protein. The *in sacco* incubations of HC showed a very low rumen degradability of the NDF (Table 1). As a consequence of the large amounts of iNDF, the calculated ME value of HC was rather low (Table 1). The high fat content contributed greatly to the ME value and dietary fat does not provide fermentable energy for microbial growth (Stern *et al*., 1994). Calculating the non-fibrous carbohydrates (NFC; NRC, 2001) as 1000 − g/kg DM of (NDF + CP + fat + ash), the diets in this

Table 3 *Effects of diets containing different proportions of HC on intake, milk yield, milk composition and nutrient efficiency of dairy cows*

Trait	Diets				s.e.[a]	Significances (*P*)		
	HC0	HC14	HC23	HC32		Diet	L	Q
Intake (kg/day)								
DM	23.3	26.4	23.9	26.4	0.8	0.022	ns	ns
CP	2.89	4.15	4.23	5.02	0.13	<0.001	<0.001	ns
Fat	0.51	0.98	1.10	1.39	0.03	<0.001	<0.001	ns
NDF	8.02	9.80	9.22	10.49	0.27	<0.001	<0.001	ns
Starch	5.40	4.54	3.22	2.90	0.13	<0.001	<0.001	ns
Yield (kg/day)								
Milk	25.2	28.7	26.8	26.8	0.7	0.022	ns	0.023
ECM	26.0	29.8	27.3	26.1	0.7	0.008	ns	0.003
Milk protein	0.91	1.04	0.97	0.96	0.14	0.011	ns	0.012
Milk fat	1.07	1.22	1.13	1.07	0.03	0.012	ns	0.002
Milk lactose	1.14	1.36	1.31	1.27	0.05	0.031	ns	0.024
Milk composition (%)								
Protein	3.63	3.61	3.49	3.40	0.06	0.028	0.005	ns
Fat	4.31	4.21	4.07	3.89	0.12	ns	0.017	ns
Lactose	4.65	4.69	4.77	4.38	0.07	0.016	ns	0.018
Urea (mmol/l)	2.7	3.7	4.4	5.1	0.2	<0.001	<0.001	ns
Efficiency (yield/intake)								
ECM/DM	1.12	1.13	1.12	1.03	0.04	ns	ns	ns
Milk protein/CP	0.29	0.26	0.22	0.22	0.02	0.009	<0.001	ns
Live weight (kg)	647	637	637	639	5	ns	ns	ns

HC = hempseed cake; L = linear effect of HC proportion; Q = quadratic effect of HC proportion; DM = dry matter; ECM = energy corrected milk; ns = non-significant.
[a]Average s.e. of the least square means for the four treatments.

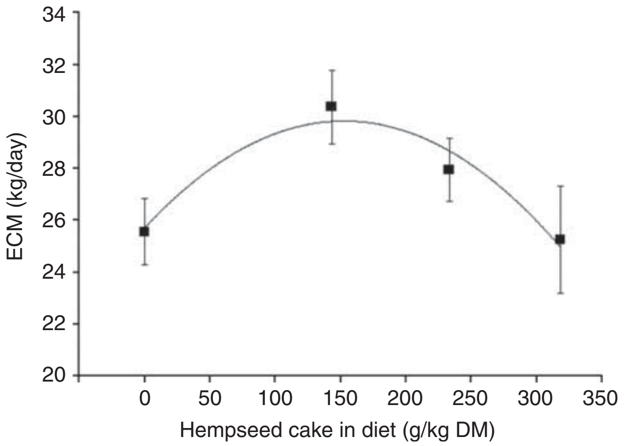

Figure 1 Relationship between yield of energy-corrected milk (ECM, kg/day) and hempseed cake (HC) in the diet (g/kg DM). ECM $= -0.0002$ HC$^2 + 0.054$ HC $+ 25.67$ ($R^2 = 0.94$ for treatment means). Bars indicate s.e.

study ranged from 435 to 279 g NFC/kg DM as the HC concentration increased from 0 to 318 g/kg DM. Therefore, CP intake probably does not reflect well the true protein supply, but limited data on HC precluded us from determining a metabolisable protein supply.

Second, replacing an increasing proportion of the compound feed in the diets with HC resulted in further changes in chemical composition of the diets such as increased fat and decreased starch concentrations. The diets were not reformulated to be equivalent in nutrient composition in order to demonstrate possible production responses when simply replacing compound feed by HC on a commercial farm.

The differences in DM intake do not have any clear explanation. However, the high DM intake of cows fed HC32 indicates that HC had a high intake potential and that the higher NDF and fat content did not limit feed intake.

Milk yield and composition

In this study, including more HC than in diet HC14 yielded no benefits in terms of milk yield as this diet corresponded to a CP concentration of 157 g/kg DM. These results are consistent with the findings in other studies that have shown that there is no further improvement in milk yield when increasing the dietary CP from 167 to 184 g/kg DM (Broderick, 2003), from 165 to 194 g/kg DM (Olmos Colmenero and Broderick, 2006) or from 157 to 192 g/kg DM (Groff and Wu, 2005). Wang *et al*. (2007) reported a similar response: increasing dietary metabolisable protein up to 97 g/kg DM resulted in higher yields of milk and protein, but the effects diminished after further increases. In this study, it is not possible to evaluate the effects of CP in isolation but our hypothesis that the positive effects on milk production of including HC would diminish with higher concentrations was confirmed. However, the strong negative effect on all production parameters at high HC concentrations was unexpected. The drop in milk production may be related to the decrease in dietary ME concentration (Table 2) resulting from increased HC. However, the estimated ME intakes from all diets (data not shown) should have satisfied the requirements for cows to produce at least 35 kg ECM/day.

Even though quadratic responses with reduced benefits from increased dietary CP are usual, the optima for maximising milk and protein yields vary between studies. The optimal HC inclusion observed in this study (Figure 1) had a CP concentration that was similar to the 165 g/kg DM resulting in maximum yields of milk (38.3 kg/day) and milk protein (1.18 kg/day) in a study by Olmos Colmenero and Broderick (2006). A meta-analysis by Ipharraguerre and Clark (2005) shows a significant curvilinear relationship ($R^2 = 0.19$) between milk yield and the CP concentration in the diet (ranging from 121 to 258 g/kg DM), but they reported the highest milk yield at a much higher CP concentration of 230 g/kg DM.

After reviewing the available data, Walker *et al*. (2004) concluded that there was no consistent effect of CP intake on milk protein concentration, except for extremely low CP intakes resulting in reduced milk protein concentrations. Feeding protein in excess has shown both positive and negative effects, but generally it increases the milk protein yield (Walker *et al*., 2004). This finding is in disagreement with the results in this study. It is possible that the CP in the HC had a high RUP content that was not digested in the small intestine, although Mustafa *et al*. (1999) reported a high value of the intestinally available CP in hempseed meal (654 g/kg CP) determined *in situ/in vitro*. The relatively high value of ADIN in HC (Table 1) indicates that some of the N passed through the cows without being digested. Another possible explanation is that the amino acid (AA) composition was not balanced for milk protein synthesis. However, Wang *et al*. (2008) reported a good AA profile of hempseed protein, with a significantly higher proportion of essential AA to total AA, compared to soya protein. Concerning the two AA that often are considered to be most limiting for milk production (NRC, 2001), Wang *et al*. (2008) found a higher content of methionine, but a lower content of lysine, in hempseed protein compared to soya protein. The content of histidine, found to be the first limiting AA in grass silage-based diets (Vanhatalo *et al*., 1999), was the same in the two protein sources (Wang *et al*., 2008). In addition, as previously mentioned, the low provision of degradable carbohydrates with high HC inclusion may have restricted synthesis of microbial protein and, therefore, real protein supply to the cows.

An increased dietary fat concentration, one result of the HC inclusion, has been associated with decreased milk protein concentrations (Wu and Huber, 1994). However, it has also been associated with an increase in milk yield, which was not observed in this study. The maximum average dietary fat concentration of 54 g/kg DM was not exceptionally high. However, the fat in HC is high in polyunsaturated fatty acids (PUFA; Callaway, 2004), and it is possible that the increased intake of such fat had some impact on milk fat synthesis. Lipid supplements rich in PUFA can have an antimicrobial effect, resulting in reduced fibre digestion, a reduced acetate:propionate ratio and depressed milk fat synthesis (Fredeen, 1996).

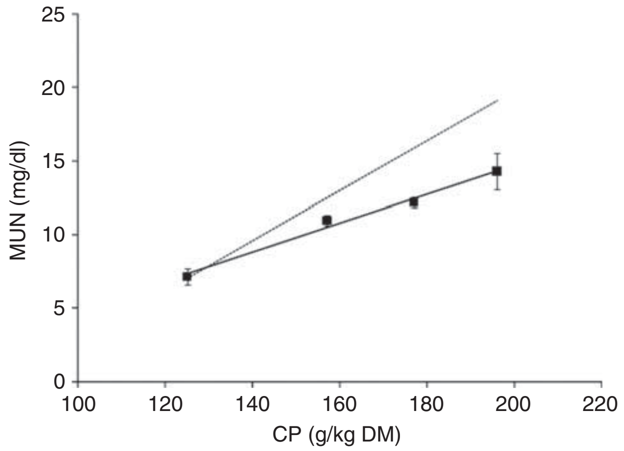

Figure 2 Comparison of the relationship between milk urea N (MUN, mg/dl) (■) and diet crude protein concentration (CP, g/kg DM) in this study (MUN = 0.10 CP − 4.9, $R^2 = 0.99$ for treatment means) and the relationship determined by Nousiainen *et al.* (2004) (- - -) (MUN = 0.17 CP − 14.2, $R^2 = 0.78$). Bars indicate s.e.

N efficiency

It is well known that feeding excess CP will result in increased environmental N emission. Measuring milk urea N (MUN) concentration has been shown to be an adequate method for estimating the N emission from milk production (e.g. Jonker *et al.*, 1998). Nousiainen *et al.* (2004) used a large data set to determine the relationship between dietary CP and MUN (MUN (mg/dl) = 0.17 × CP (g/kg DM) − 14.2). As expected, the milk urea in this study increased with increasing dietary proportion of HC, but did not reach a concentration greater than 5.1 mmol/l. Recalculating the urea values to MUN for the different dietary CP concentrations gives a relationship corresponding to that of Nousiainen *et al.* (2004), with MUN = 0.10 × CP − 4.9 (Figure 2). The shallower gradient indicates that there was less excess N from the HC diets, compared with the reference regression line. This would support earlier findings indicating the low rumen degradability of HC or meal (Mustafa *et al.*, 1999; Karlsson *et al.*, 2009).

The decrease in efficiency of converting dietary CP into milk protein was in agreement with the N efficiency decrease reported by Olmos Colmenero and Broderick (2006) from 0.37 at 135 g CP/kg DM to 0.25 at 194 g CP/kg DM. However, the cows in this study had generally a lower N efficiency at the corresponding dietary CP concentration.

Conclusions

Increasing the proportion of HC in four dairy cow diets from 0 to 318 g/kg DM resulted in curvilinear responses with respect to yields of milk, ECM, milk protein, milk fat and lactose. The maximum yields were recorded for the diet including 143 g HC/kg DM (corresponding to a CP concentration of 157 g/kg DM). Increasing the proportion of HC caused a linear decrease in the concentrations of milk protein and milk fat, a linear increase in milk urea, and a linear decrease in the efficiency of converting dietary CP into milk protein.

Acknowledgements

The authors acknowledge The Swedish Farmers Foundation for Agricultural Research for financial support of the project. We also thank the staff at the research barn, the Master's student Johanna Berg for assistance during the experiment, Börje Ericson for help with the feed analyses, Ulf Olsson for statistical support and Mårten Hetta and Pekka Huhtanen for comments on the manuscript.

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