Some Background on Industrial Hemp in a Western Oregon Context

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As industrial hemp has not been grown in Oregon in over 70 years (a USDA Agricultural Research Service program located in Corvallis was transferred to Wisconsin in 1937) and data records from that earlier research period are sketchy, this document represents a compilation of information from scientific sources in parts of the world where hemp is being grown. We have used standard analytical procedures to apply this available data to known Oregon conditions.

What is it? Industrial hemp is a variety of *Cannabis sativa L.* and is of the same plant species as marijuana (Johnson, 2013). Hemp, however, has lower levels of the psychoactive compound THC (tetrahydracannabinol); < 0.3%, while marijuana has approximately 17% (Johnson, 2013).

How is it used? Hemp has a long history for non-drug use, particularly in the fiber industry. There are global estimates that the hemp market consists of more than 25,000 products (Johnson, 2013). Hemp can be grown as a fiber crop for many products - fabrics and textiles, yarns and raw or processed spun fibers, paper, carpeting, home furnishings, construction and insulation materials, auto parts, and composites. The stalk has two different fibers; hurd, the interior of the stalk and the bast, the outer fibers. The hurd is used for animal bedding, raw material inputs, low-quality papers, and composites while the bast is among the strongest and most durable natural fibers (Brook, 2008). Oil and "milk" from crushed hemp seed (called a nut) are ingredients in a number of body care products, nutritional supplements, cosmetics, pharmaceuticals, and food products (Johnson, 2013).

http://tinyurl.com/khxdud7

What is the potential market? Precise data are not available on the size of the U.S. market for hemp-based products; however, current industry estimates report that U.S. retail sales of all hemp-based products may be nearly $500 million per year (Johnson, 2013). By comparison, wheat in Oregon had a farm gate value of $503M in 2011 and all of Oregon agricultural and fisheries commodities had an aggregate value of $5.4B 2011 (Oregon Department of Agriculture; 2012 Oregon Agripedia - http://www.oregon.gov/ODA/pages/pub_agripedia.aspx)

What are the regulations governing production? Under the current U.S. drug policy, all cannabis varieties, including hemp, are considered Schedule I controlled substances under the Controlled Substances Act (CSA, 21 U.S.C. §§801 et seq.; Title 21 CFR Part 1308.11). Thus, all production and uses are controlled and regulated by the U.S. Drug Enforcement Administration (DEA; Johnson, 2013). Although the CSA does not make growing hemp illegal, it places strict controls on its production and enforces standards governing the security conditions for crop production. It is illegal to grow without a DEA permit. Currently, cannabis varieties may be legally grown for research purposes only. Among the concerns over changing current policies is how to allow for hemp production without undermining the agency's drug enforcement efforts and regulation of the production and distribution of marijuana (Johnson, 2013). Adaptation of hemp production practices used in Canada would seem possible.

Production Considerations:

Although nearly anything is possible when growing a crop on a small scale, the following contextual points are made in relation to the potential for large-scale, commercial production in western Oregon. If a large-scale fiber or seed industry is envisioned, then these production constraints will need to be addressed in some practical manner.

Climate Factors

- Temperature
  - The base temperature for growth of hemp is 1-2 °C (Bosca and Karus, 1998)
    - Wheat and the commonly grown grasses of western Oregon have a 0°C base temperature so they can grow at slightly colder temperatures.
    - Recent year Corvallis weather records show that a 1°C (34 °F) seed zone soil temperature is obtainable year-round (Hyslop Weather Station; NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/).
  - Seed germination is better at temperatures between 6-10 °C (43-50 °F) than at 1°C (Freisen, 2006, Baxter and Scheifele, 2000)
    - Corvallis weather records for recent years show that a 6 °C (43 °F) seed zone soil temperature is typically reached by mid-Jan (Hyslop Weather Station; 5 cm (2-inch) soil reading, simple min/max average).
    - Grain crops (wheat and oats) have been planted successfully in western Oregon in Jan-Feb when field conditions allow. An increase in notill production in the last decade has allowed for increased, but not reliable, field access in these months.
  - Using a base air temperature of 1 °C, European fiber-hemp varieties require 1,900-2,000 Growing Degree Days (GDD_C - see calculation explanation at the end of this document) to develop to the typical fiber crop harvest maturity stage (male flower maturity) and 2,700 – 3,000 GDD_C to reach seed crop maturity (Bosca and Karus, 1998)
    - If a growing degree day model is run using a 30-yr Corvallis data record (1981-2010; Western Regional Climate Center – daily tabular data; http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?or1862) then this planting date by maturity matrix can be generated:

Planting date	Fiber - 1900 GDD_C	Seed - 2700 GDD_C
Jan 15	Jul 20	Sept 1
Feb 15	Jul 27	Sept 9
Mar 15	Aug 6	Sept 21
Apr 15	Aug 19	Oct 9
May 15	Sept 6	Nov 11

  - Optimal growth temperatures are between 19 and 25 °C (66-77 °F; Bosca and Karus, 1998)
    - Average temperature in western Oregon is above 19 °C (66 °F) for the period July 12 to Aug 23 (Corvallis OR, 30-yr weather record).
  - After the fourth or fifth pair of leaves has developed, hemp can survive at temperatures as low as -5 °C (23 °F); however, this low temperature can disrupt the physiology of the plant

and stunt growth (Bosca and Karus, 1998). Western Oregon seldom has temperatures that are this cold.

- As a comparison, a typical northern-type, "100-day" US yellow dent corn might require 2400 GDD_F to reach harvestable maturity. Corn has a GDD_F base temperature of 50 °F. Average 2-inch soil temperature in western Oregon does not reach 50 °F until early April. Using average air temperature, a 50 °F base temperature, and a start date of April 1, 2400 GDD_F would be reached on Oct 23 using a 30-yr Corvallis weather record. Formulas similar to those shown at the end of this handout were used for this calculation but with Fahrenheit temperatures and a 50 °F base temperature.

- Light
  - Hemp is a short day plant – it begins to flower as days shorten after the summer solstice (June 21). Winter wheats, clovers, and grasses are long-day plants and flower as days lengthen toward the solstice, typically in Apr – May.
  - There are considerable differences in flowering times among hemp varieties. Flowering time is a key factor in determining hemp yield and quality for different locations (Weightman and Kindred, 2005; Bosca and Karus, 1998).
- Precipitation and irrigation
  - 20 - 28 inches of precipitation is necessary over the growing season with 10 -14 inches of water needed during the vegetative period (Baxter and Scheifele, 2000).
  - In the Jan 15 – Jul 20 vegetative growth period (as identified above), 20.1 inches of rainfall is accumulated (30-yr Corvallis weather record). This would seem adequate but 18 inches of this 20.1 has been accumulated by May 27. May-Jun and Jun-Jul rainfall would likely be inadequate to meet crop need assuming 1.75 inch need per month (10 inches for vegetation/6 months in Jan – Jul period). Soil-stored moisture will not be adequate to carry the crop to seed crop maturity. It is highly likely that irrigation will be needed to successfully grow hemp commercially.
  - In an Apr 15 – Aug 19 vegetative growth period (as identified above), 6.0 inches of rainfall is accumulated (30-yr Corvallis weather record). Irrigation will be needed to successfully grow hemp to fiber or seed crop maturity with an April planting date.
  - In the 30-yr weather average, 0.25 inch of accumulative rain was received in each three-day period beginning Oct 12; 0.10 inch per day on Oct 17; 0.20 inch per day on Nov 9 through Jan 18. Rainfall complicates harvest of fiber or seed crops.

Soil Factors

- Soil texture and drainage
  - Hemp grows best in well-drained soils. Heavy clay soils should be avoided.
    - Research has shown that the higher the clay content of a soil, the lower the yield of hemp fiber or seed produced. Clay soils are easily compacted and hemp is very sensitive to soil compaction (Baxter and Scheifele, 2000).
    - Given these soil constraints, hemp is likely to grow best on western Oregon soils that grow legumes, wheat or horticultural crops, not the more poorly drained or high clay content soils on which grass seed crops are commonly grown.

        - Young plants are sensitive to wet soils or flooding during the first 3 weeks or until growth reaches the fourth internode (about 12 inches). Water-damaged plants will remain stunted, resulting in poor stands (Baxter and Scheifele, 2000).
- pH
    - Hemp requires a near-neutral pH for optimal growth. A pH of 7.0 – 7.5 is preferred, with a lower limit of 6.0 (Bosca and Karus, 1998; Baxter and Scheifele, 2000). Many of the soils in western Oregon are acidic, but can be kept in a pH range of 5.5-6.5 through liming; the primary consideration is cost of liming materials.
- Nutrient requirements and fertilization
    - Hemp requires approximately the same fertility as a crop of wheat (Baxter and Scheifele, 2000).
    - Recommended fertilization rates for fiber hemp are N - 70 – 100 lbs/acre; P - 0 – 45 lbs/acre; K - 45 – 178 lbs/acre (Ivonyi, Izsoki, and Vaneder Werf, 1997).
    - The effect of nitrogen (N) on stem yield was reported to be positive up to 215 lbs/acre but above 85 lbs/acre, the bast fiber yield and quality decreased (Ivonyi, Izsoki, and Van der Werf, 1997).

Harvest Timing and Yield Potential

- Hemp fiber maturity has been determined to occur at the male plant flowering development stage (approximately 3,400 GDD but variety-dependent; Brook, 2008).
- Industrial hemp yields approximately 700 lbs grain/acre, which can be pressed into about 50 gallons of oil and 530 lbs of meal (Johnson, 2013).
    - Hemp seed price was reported in a 2000 study (Baxter and Scheifele, 2000) at $0.30 /lb; thus, seed value would be $210 with a 700 lb/a yield. The Canadian Hemp Trade Alliance reports prices of $0.45 to $0.60 per lb or $315 to $420 per acre (http://www.hemptrade.ca/grow_hemp.php; accessed Nov 7, 2013). A typical wheat yield in western Oregon is 100 bu/a at a price of @$7/bu = $700/acre (http://www.ams.usda.gov/mnreports/jo_gr110.txt).
- Straw production averages 5,300 lb/acre and 1300 lb fiber/ acre (Johnson, 2013). At a price of $0.014 per pound of straw (Baxter and Scheifele, 2000) straw would add an additional $74.20 in per acre value.
- Hemp fiber yields in Ontario Canada have been reported to be 2,000 to 11,000 lb/acre of dry retted stalks at 12% moisture (Baxter and Scheifele, 2000).

Harvesting Equipment

- Harvesting methods for industrial hemp vary depending on whether the cultivar is for seed, fiber, or both.
- Canada and the European Union (EU) use different harvest methods
    - The EU uses dual purpose cultivars that are direct combined - combine cuts, threshes, and cleans seed and binds and/or spreads remaining stems.
    - In Canada, the harvest is a two-step process; combining, followed by stalk cutting (Brook, 2008.

Pest Issues

- The Canadian Hemp Alliance reports that there are no pesticides currently registered for use on hemp in Canada (Canadian Hemp Trade Alliance; http://www.hemptrade.ca/grow_hemp.php, accessed November 2013). The average time to register a new pesticide with a full use, regular label is typically nine years (Buckenham, 2007). However, based on experience with other minor crops, it is possible that hemp could be added to an existing crop label with a limited amount of crop tolerance and efficacy trial work. This would make label acquisition time considerably shorter.
- Diseases
    - Hemp can be affected by over 100 diseases. The two primary diseases are *Sclerotinia sclerotiorum* (Hemp Canker) and *Botytis cinerea* (grey mold; Brook, 2008).
    - Sclerotinia and grey mold are common diseases in western Oregon (http://pnwhandbooks.org/plantdisease/).
- Insects
    - Bertha Army Worms (*Mamestra configurata*) and Painted Lady Butterflies (*Vanessa cardui*) have affected hemp crops, among other insects (Brook, 2008).
    - Both are commonly found in western Oregon (PNW Insect Management Handbook; http://pnwhandbooks.org/insect/).
- Weeds
    - Although there are no herbicides currently registered for use on hemp in the US, it may be possible to have hemp assigned to an EPA crop group (No. 20 – oilseeds?) and if so, to secure US labels with a limited amount of tolerance and efficacy testing work.
    - If the crop grows well throughout its life cycle, the quick growth and dense canopy of hemp tends to limit the need for herbicides (Baxter and Scheifele, 2000). Later plantings, when seed germination is better and crop growth enhanced, will facilitate weed suppression but could delay crop maturation.

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Addendums

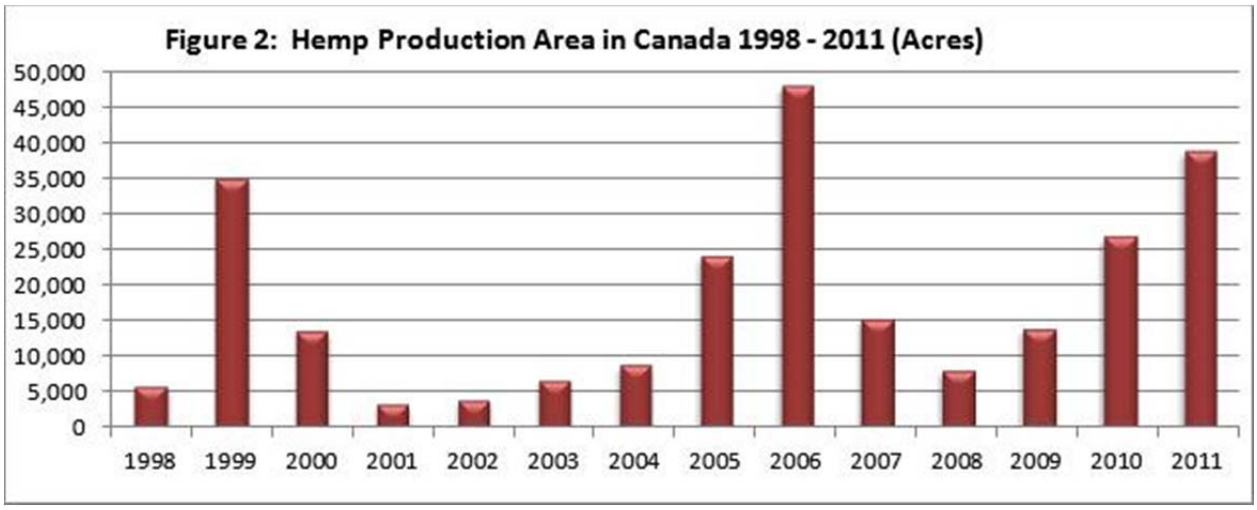

Figure taken directly from http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/econ9631 - article projected 100K acres in 2014

Calculating GDD with a base temperature of 1°C

Daily average temp (°C) = (daily max temp °C + daily min temp °C) / 2
Hemp GDD_C (1°C base) = daily average temperature °C - 1°C
A constraint on minimum temperature is used to eliminate the effect of low temperature that could retard growth. If the daily min temp < 1°C, it's set equal to 1°C

Example 1:
Given: daily maximum temperature = 10°C and daily minimum temperature = 2°C
Then: daily average temperature = (10°C + 2°C) / 2 = 6°C; daily temp GDD_C = 6°C - 1°C = 5 GDD_C

Example 2:
Given: daily maximum temperature = 8°C and daily minimum temperature = 0.5°C
In this case: daily minimum temperature of 0.5°C is replaced with 1°C
Then: daily average temperature = (8°C + 1°C) / 2 = 4.5°C
Daily hemp GDD_C = 4.5°C - 1°C = 3.5 GDD_C