

# INDUSTRIAL HEMP: RULES, REGULATIONS AND AGRONOMICS

BY

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# HEMP FARMING ACT 2018

- “H<sub>EMP</sub>.—THE TERM ‘HEMP’ MEANS THE PLANT *CANNABIS SATIVA* L. AND ANY PART OF THAT PLANT, INCLUDING THE SEEDS THEREOF AND ALL DERIVATIVES, EXTRACTS, CANNABINOIDS, ISOMERS, ACIDS, SALTS, AND SALTS OF ISOMERS, WHETHER GROWING OR NOT, WITH A DELTA-9 TETRAHYDROCANNABINOL CONCENTRATION OF NOT MORE THAN 0.3 PERCENT ON A DRY WEIGHT BASIS.”



# HEMP FARMING ACT 2018

- HEMP IS REMOVED FROM THE CONTROLLED SUBSTANCES ACT
- USDA MAINTAINS AUTHORITY OVER FEDERAL REGULATIONS AND GUIDELINES
- FDA MAINTAINS AUTHORITY OVER HEMP PRODUCTS
- ALLOWS FOR FEDERAL FUNDING FOR HEMP RESEARCH
- ALLOWS FOR FEDERAL CROP INSURANCE
- ALLOWS INTERSTATE COMMERCE (OF PRODUCTS <0.3% THC)



# HEMP PROGRAM – GETTING STARTED

- NEED TO ACQUIRE A LICENSE
  - GROWER LICENSE
  - PROCESSOR LICENSE
- NEED TO PASS A CRIMINAL BACKGROUND CHECK AND FINGER PRINTING
- PROVIDE MAPS AND GPS COORDINATES OF THE GROWING/PROCESSING LOCATION(S)
- PAY FEES
  - LICENSE FEE
  - APPLICATION FEE
  - TESTING FEE



# MORPHOLOGY

- DICOTYLEDONOUS PLANT
- PRIMARILY DIOECIOUS
  - SEPARATE MALE/FEMALE PLANTS
- SOMETIME MONECIOUS
  - MALE/FEMALE FLOWERS ON SAME PLANT
- GENDER CAN BE DETERMINED 4-6 WEEKS AFTER PLANTING
- REPRODUCTION OCCURS THROUGH POLLINATION
  - POLLEN SHED TYPICALLY LASTS 2-4 WEEKS
  - MALE PLANTS WILL DIE AFTER POLLINATION



Male Plant



Female Plant



# CLIMATE AND SOIL REQUIREMENTS

- **SOIL TYPE:** WELL-DRAINED SOILS ARE BEST (SANDY TO LOAMY)
  - HEAVY CLAY SOILS CAN REMAIN SATURATED AND COOLER
- **SOIL TEMPERATURES:** >45-50°F
- **OPTIMUM AIR TEMPERATURE:** 65-75°F
- **MOISTURE REQUIREMENT:** MINIMUM OF 10-15 INCHES
  - DOESN'T LIKE WET CONDITIONS BUT TENDS TO BE THIRSTY
- **SOIL FERTILITY:** AVOID MARGINAL SOILS WITH LOW FERTILITY
- **PHOTOPERIOD:** REQUIRES >10 HOURS DARKNESS TO INITIATE FLOWERING



# FIELD SELECTION

## GENERAL

- FIELDS THAT ARE MOST PRODUCTIVE
- FIELDS WITH LOWEST WEED PRESSURE
- FIELDS THAT ARE WELL-DRAINED
- AVOID FIELDS WITH COMPACTION
- AVOID FIELDS PRONE TO DISEASE
- ROTATION AFTER SOYBEANS
  - POTENTIAL FOR WHITE MOLD
- ROTATION AFTER CORN
  - INCREASED NITROGEN DEMAND

## ORGANIC

- ROTATIONS THAT PROVIDE NATURALLY LOW WEED PRESSURE
  - ROTATION AFTER LEGUME SOD CROPS (ALFALFA, CLOVER)
    - BEST WEED CONTROL
    - RESIDUAL NITROGEN
  - ROTATION AFTER WINTER RYE
    - TERMINATE 10-14 DAYS PRIOR TO PLANTING TO REDUCE POTENTIAL ALLELOPATHIC EFFECT
  - ROTATION AFTER CORN/SOYBEANS
    - HIGHER WEED POTENTIAL
- INCREASE PLANTING RATES



# FERTILITY

- NUTRIENT DEMAND INCREASES WITH PLANT AGE – GREATEST DEMAND IS AT FLOWERING
- **PH RANGE:** 6.0-7.5
- **NITROGEN** (ACTUAL): 125-150 POUNDS/ACRE (GRAIN); 50-150 POUNDS/ACRE (FIBER)
  - MAJORITY IS STORED IN THE STALK
  - EXCESS NITROGEN CAN CAUSE LODGING AND/OR DELAY MATURITY
  - NEED TO DETERMINE THE EFFECT ON FIBER QUALITY
- **PHOSPHORUS** (ACTUAL): 40-70 POUNDS/ACRE (GRAIN AND FIBER)
  - MAJORITY IS STORED IN THE SEED
- **POTASSIUM** (ACTUAL): 60-100 POUNDS/ACRE (GRAIN); 200-300 POUNDS/ACRE (FIBER)
  - MAJORITY STORED IN THE STALK
- **SULFUR** (ACTUAL): 15-25 POUNDS/ACRE



# NITROGEN



40 lbs/ac - Nitrogen  
Yield: ~500 lbs/ac



125 lbs/ac - Nitrogen  
Yield: ~1500 lbs/ac



# PLANTING

- FIRM, SHALLOW SEEDBED
  - ROLLING/PACKING FOR GOOD SEED-TO-SOIL CONTACT
- **PLANTING DEPTH:**  $\frac{1}{4}$  -  $\frac{3}{4}$  INCHES
  - **TARGET:**  $\frac{1}{2}$  INCH
- **PLANTING RATE:**
  - CBD: 1500-2000 PLANTS/ACRE (1 PLANT PER 4-6 FT)
  - FIBER: 40-60 POUNDS/ACRE (23-34 SEEDS/FT<sup>2</sup>)
  - GRAIN: 25-35 POUNDS/ACRE (14-20 SEEDS/FT<sup>2</sup>)
- **PLANTING METHOD:** GRAIN DRILL/AIR DRILL, BRILLION SEEDER, BROADCAST, CORN PLANTER (CBD, GRAIN), TRANSPLANTER (CBD)
- **PLANTING DATE:**
  - FIBER: APRIL TO MAY (>45°F SOIL TEMP) – SAME TIME AS **SMALL GRAINS**
  - GRAIN/CBD: MAY TO JUNE (>50°F SOIL TEMP) – SAME TIME AS **CORN**
- PLANT AFTER A RAIN, NOT BEFORE (EXCEPT IN ARID REGIONS)

Planting Depth  
is IMPORTANT!





# PESTS (WEEDS)

- ONE OF THE MOST SIGNIFICANT PESTS OF HEMP
- FIELD SELECTION IS CRITICAL
- AVOID WET WEATHER AFTER PLANTING
- WEED CONTROL DURING FIRST 30-DAYS IS CRITICAL
- FIND SITUATIONS THAT REDUCES WEED PRESSURE
  - PLANT AFTER LEGUME SOD CROPS (ALFALFA, CLOVER)
  - GOOD SOIL FERTILITY
  - PLANT AFTER A RAIN, NOT BEFORE
    - PLANT DURING A DRY PERIOD
  - WELL-DRAINED SOILS
  - USE OF SOIL AMENDMENTS (GYPSUM, LIME, COMPOST)
- POSSIBLE MECHANICAL CONTROL (ROTARY HOE, TINED-WEEDER, HARROW, CULTIVATOR)



Weeds during Slow Growth Phase



# PESTS (DISEASE)

- TWO SIGNIFICANT DISEASES:
  - WHITE MOLD (*SCLEROTINIA SCLEROTIORUM*)
  - GRAY MOLD (*BOTRYTIS CINEREA*)
- CONDITIONS FOR MOLD
  - COOL – MODERATE TEMPERATURES (<85°F)
  - HIGH HUMIDITY
  - DRIZZLE/FOGGY CONDITIONS (MARITIME-LIKE)
- REDUCE DISEASE PRESSURE
  - KNOW THE DISEASE HISTORY OF YOUR FIELDS
    - AVOID FIELDS PRONE TO WHITE MOLD OR GRAY MOLD
  - CONSIDER ROTATING AFTER CORN/WHEAT RATHER THAN SOYBEANS
  - REDUCE PLANT POPULATIONS AND WIDEN ROW SPACING (INCREASES AIRFLOW)



White Mold – Left, advanced stage; Right, beginning stage



# PESTS (INSECTS)

- GENERALLY, INSECT PEST ARE NOT ECONOMICALLY SIGNIFICANT IN GRAIN OR FIBER HEMP
- COMMON INSECT PESTS
  - JAPANESE BEETLES
  - CORN EARWORM
  - EUROPEAN CORN BORER
  - EURASIAN HEMP BORER
  - APHIDS
  - SEEDCORN MAGGOT
  - SPIDER MITES
  - STINKBUGS
  - GRASSHOPPERS



Seedcorn Maggot



Japanese Beetle



# TYPES OF HEMP

- CANNABIDIOL (CBD)
  - FIBER
  - GRAIN



# TYPES OF HEMP

## CBD HEMP

- SIMILAR TO GROWING PRODUCE OR TOBACCO
- **PLANTING STOCK:** SEEDS OR TRANSPLANTS (CLONES)
  - FEMALE PLANTS ONLY
- **PLANTING METHOD:** TYPICALLY BY HAND OR TRANS-PLANTER. CAN BE GROWN IN GREENHOUSE
- **PLANTING RATE:** 1500-2000 PLANTS/ACRE (<1 LB SEED)
- **HARVEST METHOD:** TYPICALLY BY HAND
- **POST-HARVEST:** PLANTS ARE HUNG TO DRY IN DRYING SHEDS OR WAREHOUSES; FLOWERS ARE STRIPPED FROM BRANCHES



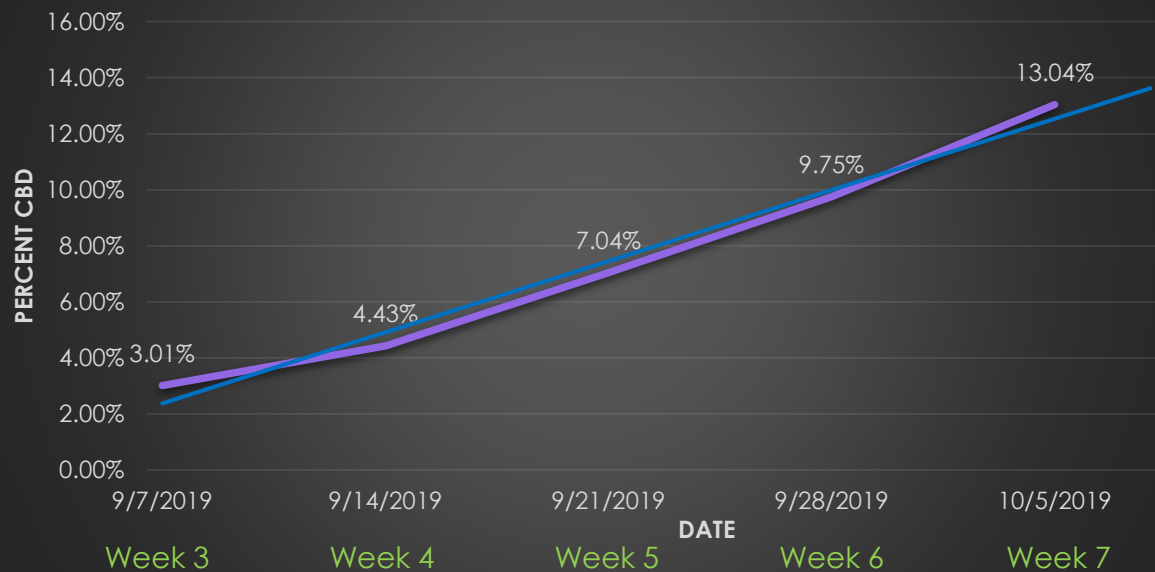


# COMPARISON OF CBD AND THC OVER TIME

CBD:THC  
Ratios Vary: 20:1 to 30:1

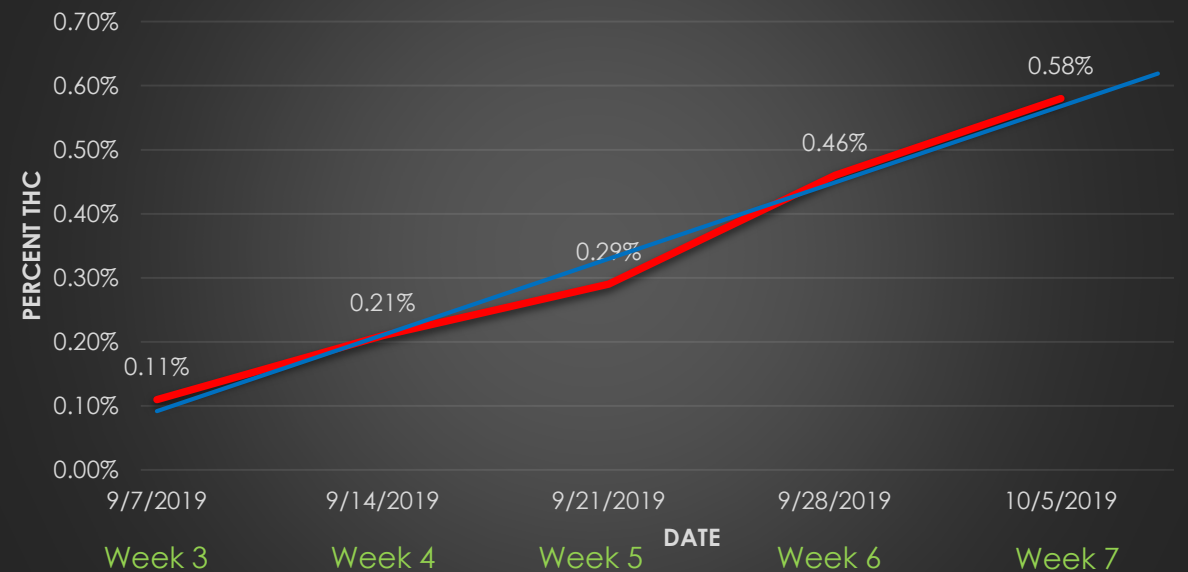
## CBD

### Total Potential CBD



## THC

### Total Potential THC





# POST HARVEST (CBD)

## STORAGE

- THIS IS ONE OF THE MOST OVERLOOKED AND UNDERESTIMATED PORTIONS OF GROWING CBD HEMP
- PLANT SIZE WILL DETERMINE HOW MUCH SPACE IS NEEDED TO HANG AND STORE THE CROP
  - ESTIMATES RANGE FROM 5 – 50 CUBIC FEET/PLANT
    - DEPENDS ON SIZE OF PLANTS: 6 FT (HEIGHT) X 3 FT (WIDTH) X 3 FT (DEPTH) = 54 CUBIC FEET PER PLANT
- SOME WILL HARVEST AND HANG ENTIRE PLANTS WHILE OTHERS WILL DE-BRANCH AT HARVEST



De-branched cannabis for drying



Whole plants of cannabis for drying



# POST HARVEST (CBD)

## DRYING

- HANGING PLANTS TO DRY IS THE MOST POPULAR AND COST EFFECTIVE WAY TO DRY
  - ABSOLUTELY ESSENTIAL TO HAVE ADEQUATE AIRFLOW
- CLIMATE CONTROLLED BUILDINGS ARE PREFERRED
  - DRY TIME: 7-21 DAYS TO DRY
  - TEMPERATURE: 65 – 70°F
  - HUMIDITY: 50 – 55%
    - DEHUMIDIFIERS ARE PREFERRED
- DRYING SHEDS CAN WORK BUT CANNOT CONTROL HUMIDITY
  - DRY TIME: 30-90 DAYS TO DRY – DEPENDS ON OUTSIDE HUMIDITY
  - RELATIVELY HIGH RISK OF MOLD WITHOUT CONTROLLING HUMIDITY
- DRYING CONTAINERS/STRUCTURES (10-30 DAYS TO DRY)
  - ALLOWS FOR BATCH DRYING AND CAN BE MOBILE
  - LOW HEAT WITH GOOD AIRFLOW IS ESSENTIAL



<https://twitter.com/hashtag/cbdcrew>

Whole plants in climate controlled building



Plants hang dry in a semi trailer



# COMMERCIAL CBD PRODUCTION (HIGH CBD GRAIN CULTIVARS)



<http://business.hemptrade.ca/list/member/power-zone-agricultural-center-4346>

The GrassHopper– FormationAg  
Chaff Collection



<https://www.pinterest.com/pin/57983913938792750/>

CleanCut Harvester – FormationAg



<https://formation-ag.com/products/harvesting/cleanstrip>

CleanStrip Harvester – FormationAg



# MARKETING/SALES (CBD)

- CONTACT SEVERAL PROCESSORS TO DETERMINE THEIR DEMAND AND SPECIFICATIONS
  - VERY FEW PROCESSORS BUYING BIOMASS
  - MOST PROCESSORS ARE DOING OIL SPLITS OR TOLL PROCESSING
    - PROCESSOR TURNS FARMER'S BIOMASS IN TO OIL AND TAKE HALF OF THE OIL AS PAYMENT
- MANY PROCESSORS HAVE A MINIMUM %CBD REQUIREMENT (MOST ARE >8%-10% CBD)
- CONTRACTING PRIOR TO PLANTING IS CRITICAL
  - ANALYSTS ESTIMATE 90% OF CBD CROP HAS NOT BEEN PROCESSED OR SOLD
- OVERSUPPLY
  - \* 2019: ~511,000 ACRES LICENSED; ~230,000 ACRES PLANTED; ~115,000 HARVESTED
  - \* 2018: ~78,000 ACRES GROWN
  - \* 2017: ~25,00 ACRES GROWN



# INDUSTRIAL HEMP

## - FIBER -





# TYPES OF FIBER HEMP

## FIBER HEMP

- **TWO TYPES:** TRUE FIBER TYPE vs. DUAL PURPOSE
- **PLANTING STOCK:** SEEDS
- **PLANTING METHOD:** GRAIN/AIR DRILL, BROADCAST
- **PLANTING RATE:** 40-60 LBS/AC vs 25-35 LBS/AC
- **HARVEST METHOD:** MOWING, RAKING (1-3x),  
BALING (ROUND OR SQUARE)
- ★ **HARVEST TIMING:** AT POLLINATION (JULY/AUG) vs  
AFTER COMBINING (OCTOBER/SPRING) ★



<http://www.hemptrade.ca/eguide/fibre-production/fibre-harvesting-equipment>

True Fiber Type

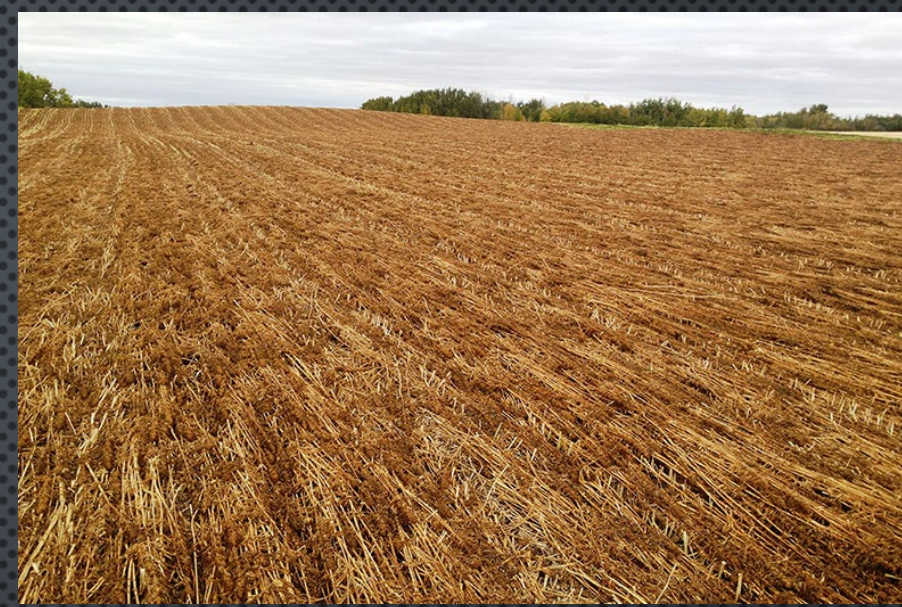


Dual Purpose



# HARVEST (FIBER)

- HARVEST TIMING:
  - MOWING:
    - FIRST 1-2 WEEKS OF POLLINATION (JULY/AUGUST)
    - LEAVE 4-6 INCHES OF STUBBLE TO REDUCE ASH CONTENT
  - RAKING:
    - RAKE WHEN STALKS TURN FROM GREEN TO PALE YELLOW
    - 1-3 TURNS MAY BE REQUIRED
- RETTING PERIOD: 2-6 WEEKS (DEPENDS ON ENVIRONMENT)
- BALING
  - BALE MOISTURE: <15%
  - LARGE SQUARE BALES ARE PREFERRED



<http://www.hemptrade.ca/eguide/fibre-production/storing-baled-hemp-fibre>

Retted Hemp Straw



<http://www.hemptrade.ca/eguide/fibre-production/salvaging-hemp-fibre>

Baling



# FIBER YIELDS

- TRUE FIBER-TYPE: 4 – 6 TONS/ACRE
- DUAL PURPOSE: 0.5 – 2.0 TONS/ACRE
- **HEIGHT OF PLANTS AND PLANT DENSITY GREATLY INFLUENCE YIELD**



# INDUSTRIAL HEMP

## - GRAIN -





# TYPES OF HEMP

## GRAIN HEMP

- SIMILAR TO GROWING SMALL GRAINS (WHEAT)
- **PLANTING STOCK:** SEEDS
- **PLANTING METHOD:** **GRAIN/AIR DRILL**, BROADCAST, CORN PLANTER
- **PLANTING RATE:** 25-35 POUNDS/ACRE
- **HARVEST METHOD:** COMBINE
- **POST-HARVEST:** GRAIN SHOULD BE CLEANED, THEN DRIED IN AERATION BINS IMMEDIATELY AFTER HARVEST







## ASSESSING MATURITY

- MATURATION BEGINS AT THE BOTTOM OF THE HEAD AND CONTINUES UPWARD
- SEED BRACTS WILL TURN BROWN AND SHRINK EXPOSING SEEDS
- **HARVEST TIME:**
  - 70-80% OF SEEDS MATURE (100-120 DAYS)
    - SEPTEMBER/OCTOBER
  - **WITHIN 2-4 DAYS OF A KILLING FROST**
  - SOME SEEDS WILL BE IMMATURE AT HARVEST
- **HARVEST MOISTURE: 12-18%**
- **STORAGE MOISTURE: 9%**





# HARVEST

- STRAIGHT CUT COMBINING IS RECOMMENDED
  - ROTARY WORKS BEST (SINGLE)
    - CONVENTIONAL WORKS FINE
  - DRAPER HEADERS ARE PREFERRED
- CUT GRAIN HEADS ONLY
  - REDUCES FIBER INTAKE IN THE COMBINE
  - CONSIDER LEAVING 5-15% OF THE LOWER HEADS IN UNEVEN STANDS
- REDUCE GROUND SPEED (2-3 MPH)
- SWATHING IS NOT RECOMMENDED
  - ALLOWS LARGE VOLUMES OF FIBER THROUGH THE COMBINE



Straight Cutting



<http://www.hemprade.ca/eguide/fibre-production/fibre-harvesting-equipment>

Swathing



# POST HARVEST

- HANDLE GRAIN WITH CARE
  - CONVEYORS ARE PREFERRED
  - RUN AUGERS FULL AND SLOW
- QUICK CLEANING IS RECOMMENDED PRIOR TO STORAGE
  - FINAL CLEANING CAN BE PERFORMED AFTER GRAIN IS DRY
- **GRAIN SHOULD BE DRIED IN AERATION BINS IMMEDIATELY AFTER HARVEST**
  - SPOILAGE CAN BEGIN WITHIN **4-6 HOURS** AFTER COMBINING
    - DO **NOT** LEAVE GRAIN SIT OVERNIGHT WITHOUT AIR
  - GRAIN MAY NEED TO BE ROTATED IN BINS TO REDUCE “HOT SPOTS”
  - MONITOR GRAIN REGULARLY
- **DRY MOISTURE: 9%**

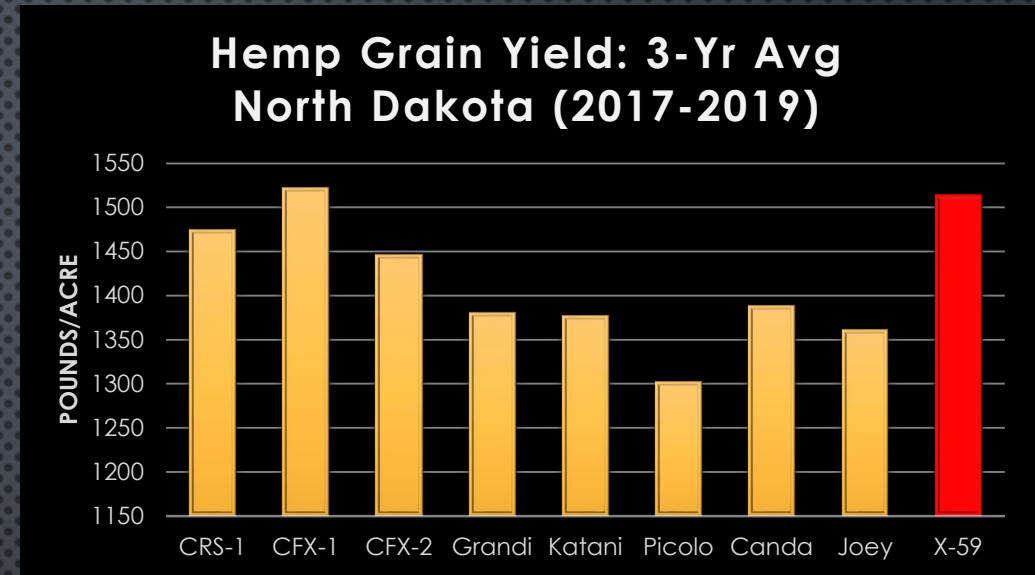


Cleaning grain before storage

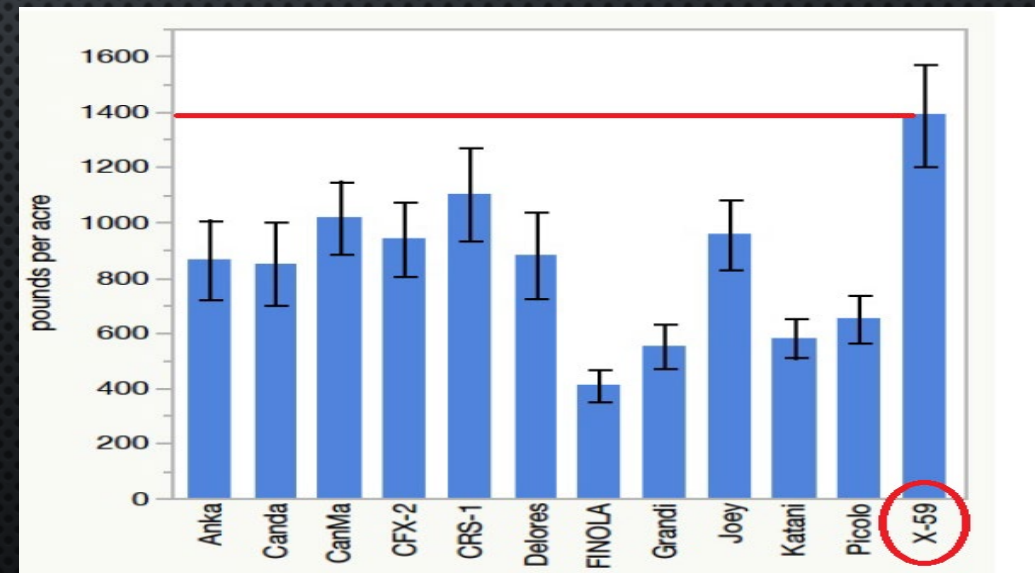


# GRAIN YIELD

- **YIELD**
  - **RANGE:** 600-2000 POUNDS/ACRE
  - **AVERAGE:**
    - CONVENTIONAL: 1200-1400 POUNDS/ACRE
    - ORGANIC: 600-800 POUNDS/ACRE
- KNOW WHICH FOOD-GRADE CULTIVARS BUYERS WANT



Industrial Hemp Variety Performance in North Dakota – NDSU



University of Minnesota Industrial Hemp Variety Trial - 2017



# FIBER HARVEST (DUAL PURPOSE)

- **AVERAGE YIELD:** 0.5-2.0 TONS/ACRE
- **HARVEST TIME:**
  - MOWING: 1-3 DAYS AFTER COMBINING
  - BALE: 14-30 DAYS AFTER MOWING (WHEN DRY)
  - **MOW AND BALE IN SPRING (PREFERRED)**
- **MOISTURE:** <15%
- **EQUIPMENT**
  - **MOWER:** DISK MOWER (WATCH FOR WRAPPING), SICKLE MOWER (PREFERRED), SWATHER
  - **BALER:** LARGE SQUARE BALER (PREFERRED), ROUND BALER



<https://www.nuntisunya.com/en/hemp-stem-faq-uses-benefits/>



# SUMMARY

- KNOW WHICH TYPE OF HEMP YOU WANT TO GROW (CBD, FIBER, GRAIN)
- BEST TO FIND A BUYER BEFORE GROWING A HEMP CROP
- KNOW WHAT QUALITY SPECIFICATIONS THE BUYER/PROCESSOR REQUIRES
  - CBD: MINIMUM CBD CONCENTRATION, HEAVY METALS
  - FIBER: TRUE FIBER TYPE VS. DUAL PURPOSE
  - GRAIN: FOOD-GRADE CULTIVARS, MICROBIAL CONCENTRATION
- FIELD SELECTION IS IMPORTANT FOR WEED CONTROL
- APPLY ADEQUATE NITROGEN
- UNDERSTAND HARVEST AND DRYING REQUIREMENTS TO AVOID SPOILAGE



# RESOURCES

- [CANADIAN HEMP TRADE ALLIANCE](#) (ONLINE)
- [WISCONSIN HEMP – UW-EXTENSION](#) (ONLINE)
- ALBERTA AGRICULTURE AND FORESTRY – INDUSTRIAL HEMP (ONLINE)
- GROWING INDUSTRIAL HEMP IN ONTARIO (ONLINE)
- INDUSTRIAL HEMP PRODUCTION AND MANAGEMENT – MANITOBA (ONLINE)
- HEMP PRODUCTION IN SASKATCHEWAN (ONLINE)
- HEMP DISEASES AND PESTS: MANAGEMENT AND BIOLOGICAL CONTROL (BOOK)
- THE CULTIVATION OF HEMP: BOTANY, VARIETIES, CULTIVATIONS AND HARVESTING (BOOK)
- MARIJUANA BOTANY: THE PROPAGATION AND BREEDING OF DISTINCTIVE CANNABIS (BOOK)



# QUESTIONS?

AGRONOMIST – LEGACY HEMP, LLC

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