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Water Erosion Prediction Project (WEPP) – Building Industrial Hemp Management Systems

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Background

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WEPP Basics

- WEPP is a hillslope sheet and rill erosion prediction tool
- WEPP is a process-based model (7 subprocesses)
- Two other presentations at ASABE cover WEPP use and Conservation Resources – Land Management Operations Database (CRLMOD) more completely
- WEPP for NRCS hosted by ARS on website: http://brenton.nserl.purdue.edu/rest/weppcrtest/
- Used as supplemental planning tool by NRCS
- Extensive vegetation and operation library exists for conservation planners

WEPP Basics (continued)

- **Popularity of industrial hemp created vegetation and operation need:**
  - Hemp, industrial, CBX
  - Hemp, Industrial, fiber
  - Hemp, industrial, grain
- **Vegetation files built using multiple resources:**
  - WEPP technical documentation
  - ARS and university input
  - Conservation planner field observations
- **New operations and vegetations shared with partners and public**

WEPP Basics (continued)

- **Vegetation construction heaviest workload and focus of presentation**
- **Two new harvest operations also added:**
  - Harvest, biomass fiber
  - Harvest, biomass manual
- **Harvest operations simple to parameterize**
  - Little ground disturbance
  - Similar to existing harvest biomass operations

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Vegetation Parameterization Workflow

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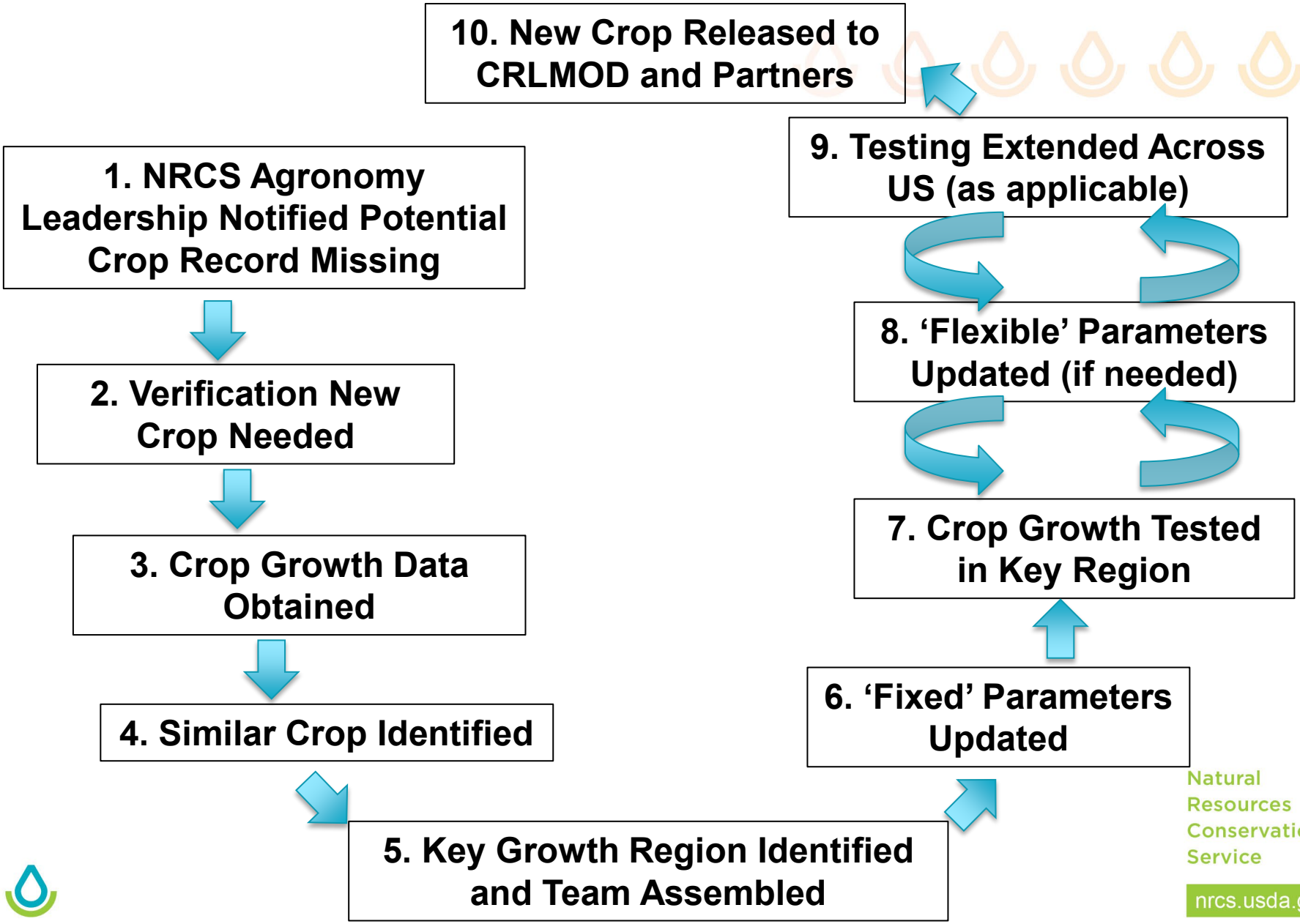
Vegetation File Creation Workflow



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Crop Record - Notification and Need

- **Recommendations made by planners and partners**
- **NRCS State Agronomists, Regional Agronomists, and National Agronomist primary points of contact**
- **Key Questions:**
  - Does a similar vegetation file exist?
  - If so, does it grow properly and have similar canopy cover, stature, population and residue properties?
  - If not, how widespread is the vegetation use?
  - What is the model erosion output being used for?

Obtaining Crop Growth Data

- Land Grant University (LGU) publications (both formal and informal)
- ARS publications
- NRCS Plant Material Center (PMC) publications
- LGU, PMC, and ARS Agronomists' correspondence
- Photos and tabular growth data from NRCS conservation planners
- Personal interviews with agronomists and hemp specialists

Similar Existing Crop Identification

Grain Sorghum and No-Till Soybeans

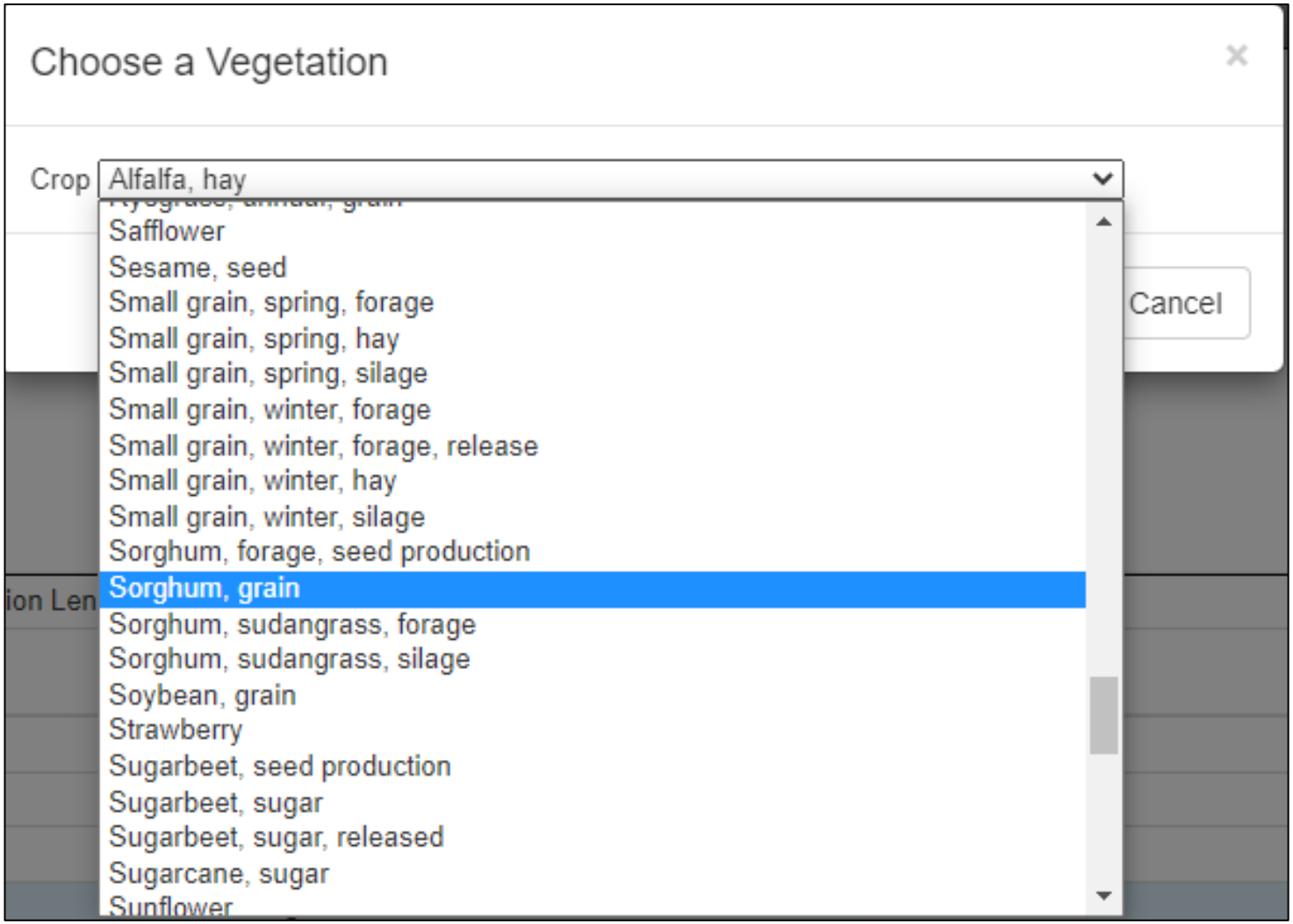
Similar Existing Crop Identification

Industrial Hemp – Seed Production – Photo Courtesy of Mike Kucera

Similar Existing Crop Identification

Industrial Hemp – CBD Oil Production – Photo Courtesy of Mike Kucera

Similar Existing Crop Identification



Parameterization Priorities

Interface Variable	Units	Definition	Notes
BB	---	Canopy Cover Coefficient	
BBB	---	Canopy Height Coefficient	
BEINP	---	Biomass Energy Ratio	biomass
BTEMP	C°	Base Daily Air Temp.	Lower temperature at which plants no longer generate biomass
CF	m^2/kg	Flat Residue Coefficient	Cover provided by plant residue per unit of residue weight
CUTHGT	m	Cut Height	Typical above ground cutting (or harvest) height. Impacts post-harvest standing vs. flat residue.
DIAM	m	Stem Diameter	
HI	---	Harvest Index	
HMAX	m	Max Height	
PLTSP	m	In-row Plant Spacing	Space between plants within a crop row
RDMAX	m	Maximum Root Depth	Impacts root density partitioning by depth range
RSR	---	Root-to-shoot ratio	Root biomass/above ground biomass
SPRIOD	Days	Period for Senescence	Period of leaf drop and beginning of conversion of live biomass to flat residue before harvest; impacts % canopy cover

Step 2: Adjust Remaining Parameters

Step 1: Establish Fixed Parameters

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Adjusting Remaining Parameters

WEPP NRCS 11/26/2021. | Project | Results Analysis | History | Map | Managements | Help

Documentation

This is a draft User Guides for the NRCS WEPP web application: Draft WEPP NRCS User Guide (PDF)

Options

- [x] Show all WEPP detail parameters in management help.
- [x] Always keep menu bar visible.

Database version to use: Latest

Calibration length (years): 15 Calibration Yield Tolerance (%): 10

- [ ] When using PRISM climate adjust wet day probabilities.

Click here to set and debug vegetation parameters ...

Canopy Cover Coef., Canopy Height Coef., and Biomass Energy Ratio Adjustments


```
{
    "crops" : [
        { "name" : "Hemp, industrial, fiber", "bb" : 5, "bbb" : 3, "beinp" : 35, "btemp" : 4, "cf" : 1.97, "cuthgt" : 0.1524, "diam" : 0.0127, "hi" : 0.9, "hmax" : 3, "pltsp" : 0.02, "rdmax" : 2, "rsr" : 0.25, "spriod" : 5}
    ]
}
```

Identified Hemp Harvest System

- Comments: Annual, broadleaf, fiber. Suggest harvest ops: Mow, swath, windrow, followed by Harvest fiber/biomass, kill crop. Target Yield calibration: YES

Num		Date	Crop Intv.	Operation	Crop
1		4/15/22	☐	Drill or air seeder, double disk	Hemp, industrial, fiber
2		7/15/22	☐	Mow, swath, windrow crop	
3		7/25/22	☑	Harvest, biomass fiber	

User comment description: Placeholder, for mowing/windrow operation, used to capture STIR and fuel use. Used for annual crops for uniform dry down prior to a grain harvest operation from the windrow material or prior to baling or other forage harvest operation. This operation must be followed by; Harvest, grain from windrows; baling; or forage harvest operation as appropriate. Does not kill crops.

User comment description: Harvest operation, cut and remove fraction of above ground biomass, for any type of biomass-fiber crop such as industrial hemp, sun hemp, kenaf or other biomass-fiber crops. Annual crops are killed.

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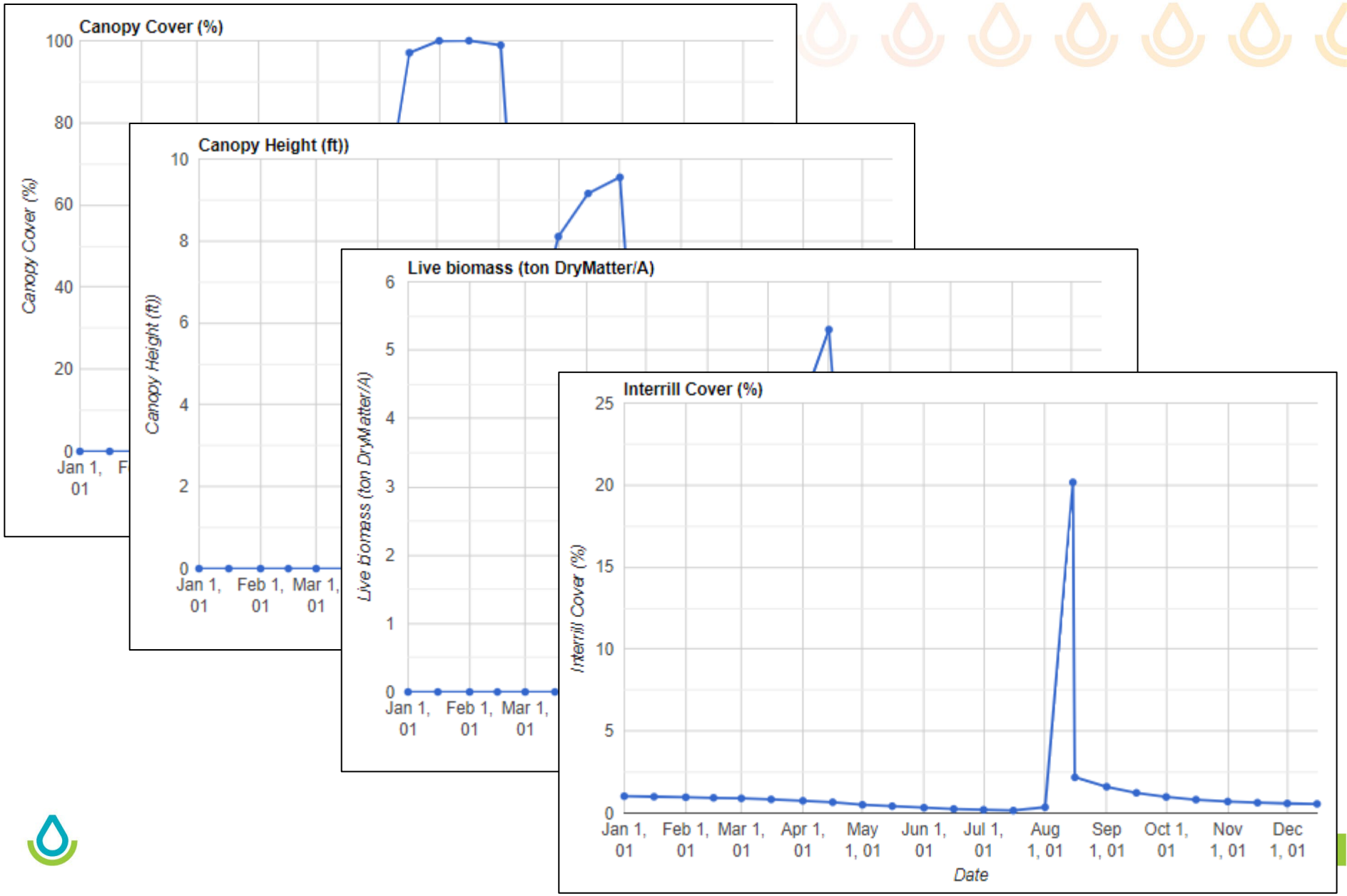
Simple Hemp Fiber Management



Identified Hemp Harvest Systems

Table 2. Industrial Hemp Harvest Systems Commonly Used in the US.

New Vegetation File Name	Recommended Paired Harvest Operation(s)	Notes
Hemp, industrial, fiber	Mow, swath, windrow crop + Harvest biomass fiber OR Harvest biomass fiber (alone)	Mow, swath, windrow crop is used to capture Soil Tillage Intensity Rating (STIR) only. Harvest biomass fiber mechanically removes all vegetation down to the cut height, leaving only 15.24 cm (6") of standing residue.
Hemp, industrial, grain	Harvest, killing crop XXpct standing stubble + Harvest, biomass fiber OR Harvest, killing crop XXpct standing stubble (alone)	Hemp grain is removed from the field, leaving 200 cm (78.74") of standing residue. Standing stalks may be removed post-grain harvest.
Hemp, industrial, CBX oil	Harvest, biomass manual	Plants are hand-harvested down to the cut height, leaving only 15.24 cm (6") of standing residue.

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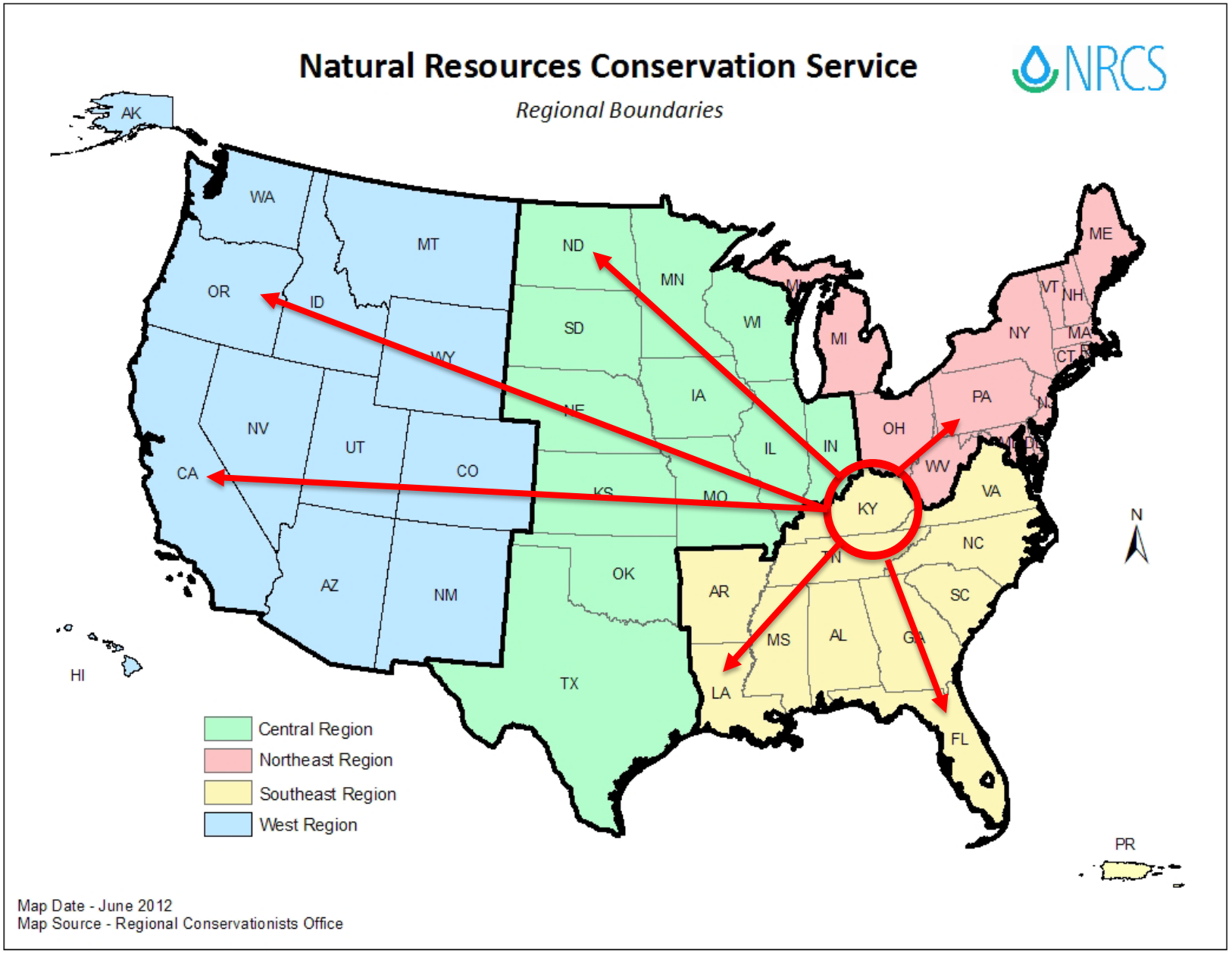
Testing Industrial Hemp Management Systems



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Questions?

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Reference Section – Energy to Biomass

8.2.1 Potential Growth

Interception of photosynthetic active radiation (*PAR*) is estimated with Beer's law (Monsi and Saeki, 1953):

$$PAR_i = 0.02092\ (RA)_i\ (\ 1.0 - e^{-0.65\ LAI}\ )_i \qquad [8.2.3]$$

where *PAR* is photosynthetic active radiation ($MJ \cdot m^{-2}$), *RA* is solar radiation (*Ly*), *LAI* is leaf area index, and subscript *i* is the day of the year. Potential biomass production per day is estimated with the equation (Montieth, 1977):

$$\Delta B_{p,i} = 0.0001\ BE_j\ (PAR)_i \qquad [8.2.4]$$

where $\Delta B_{p,i}$ is the potential increase in total biomass on day *i* ($kg \cdot m^{-2}$), and BE_j is the crop parameter for converting energy to biomass for crop *j* ($kg \cdot MJ^{-1}$). The potential increase in total biomass is adjusted daily according to the growth constraints. The adjusted daily total biomass production (ΔB_i) is accumulated through the growing season (B_m).

$$B_m = \sum_{i=1}^{ndays} \Delta B_i \qquad [8.2.5]$$

Table 8.2.1. Parameter values used in the cropland growth submodel.†

Symbol	Variable	Corn	Soybeans	Sorghum	Cotton	Winter Wheat	Spring Wheat	Oats
β_c	BB	3.60	14.00	3.60	5.89	5.20	5.20	5.20
β_k	BBB	3.00	3.00	3.00	3.50	3.00	3.00	3.00
BE_j*	BEINP ($kg \cdot MJ^{-1}$)	18/28/35	20/23/25	12/17/25	17.5	25/30/35	25/30/35	17/20/23

Reference Section – Canopy Cover

8.2.2 Canopy Cover and Height

Canopy cover and height for annual and perennial crops are calculated as functions of vegetative biomass:

$$C_c = 1 - e^{-\beta_c B_m} \quad [8.2.6]$$

where C_c is canopy cover (0-1). The variable β_c is defined as:

$$\beta_c = \frac{-\beta_1}{\ln\left[1 - \frac{R_w}{\beta_2}\right]} \quad [8.2.7]$$

where R_w is the row width (m), β_1 is a plant-dependent constant, and β_2 is the maximum canopy width at physiological maturity. β_c is an input parameter (BB). For crops not grown in rows, R_w is set equal to the plant spacing (P_s).

$$H_c = \left(1 - e^{-\beta_h B_m}\right) H_{cm} \quad [8.2.8]$$

where H_c is the canopy height (m), H_{cm} is the maximum canopy height (m), and β_h is a plant-dependent constant.

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