Curtis Stibb	**CITY OF COLUMBUS WATER QUALITY TRADING AGREEMENT**	Tax Parcel Numbers: 11018-1, 11018-2, 11018-9, 11018-9.B, 11018-8, 11018-7, 11018-18, 11024-654, 11024-655, 11018-5.01, 11018-6, 11018-13, 11018-12, 11018-3, 11030-546, 11030-547, 11030-545, 11018-16, 11018-17, 11018-15, 11018-10, 11018-11, 11018-39.03, 11024-654.A, 11024-657.04

[Above space reserved for recording information]

This Agreement is entered into as of the _____ day of _____ 2024, by and between the **City of Columbus ("City") and Curtis Stibb ("Owner").**

RECITALS

1. Background. The City is participating in a Water Quality Trading (WQT) program. The goal of WQT is for the City to receive credit for implementing agricultural conservation practices. The main pollutant of concern is total phosphorus (TP). A secondary pollutant of concern is total suspended solids (TSS). TSS is the main mechanism of transport for TP because of the fact that phosphorus attaches to solids. Benefits of WQT will also be improved soil health and water quality in other surface waters in the Upper and Lower Crawfish River Watersheds. The program was established in 2020 between the City and Curt Stibb and has been implemented through the County for the past 4 years. This agreement will be a new agreement to extend the WQT agreement for a 5-year period and incorporate changes learned, technological advancements and program changes in the first agreement.

2. Parties to Agreement. The parties to the Agreement are the City of Columbus and Curtis Stibb. This Agreement is a standalone Agreement between Parties. The County is acting pursuant to the Service Agreement between the City and County concerning implementation of the WQT agreement.

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the parties agree as follows:

AGREEMENT

3. Project Area. The project area for the Owner's land is shown in Appendix A. The map shows the approximate area for installation of management measures agreed to in this Agreement.

4. Agreement Practices and Lengths. The management measures to be implemented through this Agreement are described in accordance with National Resources Conservation Service's (NRCS) naming convention.

The Agreement duration agreed upon by the Parties is 5 years. The City and Owner agree to extend this agreement for an additional 5-year period upon mutual review and revision to this agreement. Nutrient Management Plans are not eligible for this Agreement. The NRCS practice names, practice code numbers, and practice acreages for the 5-year agreement are shown in Table 1 below. The Owner will be allowed to adjust which fields are in the cover crop program as necessary due to weather and other environmental conditions, given P credit reduction modeled in Snap Plus remains within 10% of the specified amount in the WQT plan, 210 P credits, and all fields remain within the watershed.

Existing buffer strips removed for crop rotation shall be done only as approved by County and should be done in conjunction with cover crop rotation to comply with the requirement to be within 10% of the specified amount in the WQT plan. When buffer strips are reestablished in areas used for a rotational crop, new buffer strip should be treated as a new installation and reimbursed by the City per this agreement.

Table 1 – Management Measure Practice Summary

NRCS Management Measure Name and Component	NRCS Code Number	Acres
Filter Strip	393	2
Filter Strip	393	2
Filter Strip	393	2
Filter Strip	393	5
Cover Crops	340	29
Cover Crops	340	19
Cover Crops	340	24
Cover Crops	340	73
Cover Crops	340	35
Cover Crops	340	18
Cover Crops	340	8
Cover Crops	340	12
Cover Crops	340	8
Cover Crops	340	20
Cover Crops	340	12
Cover Crops	340	33

*This is a list of potential fields for the cover crop program for the duration of the agreement. It is not intended that cover crop will be planted on every field listed every year of the agreement.

Cover crops:

Cover crops shall be installed as part of this agreement to obtain the total amount of 210 Phosphorous credit. Meeting the requirement of 210 credits is to be done through a combination of cover crops and buffer strips shown in Table 1 above for the fields shown in Appendix A map. The total acreage of cover crops is determined by the WQT Snap Plus model and may vary but is estimated to be approximately 100 acres annually. The fields suggested for cover crops in Table 1 above exceed the required area for cover crops and are intended to be used on a rotational basis as approved by the county to meet the required credits. Seeding rate and dates recommended in Table 1. of the NRCS Wisconsin 340 Cover Crop Guidance Document provided in Appendix C should be followed. If other installation methods are used, seeding rate and dates should be adjusted and approved by the County.

Methods for seeding cover crops shall be approved by the County and shall include but are not limited to:

- Broadcast
- Drill
- Aerial

5. Initial Practice Payment. The Owner and County will be responsible for working together to solicit bids and install all new practices agreed upon between the City and Owner that are not existing from previous agreements. The City will reimburse initial practice installation costs in full after the management measure construction has been successfully implemented, including cover crops. The City will pay the Initial Practice Payment within 60 days of County approval.

6. Annual Rental Payment for Land Taken Out of Production. In addition to the Initial Practice Payment, the City will pay Owner an additional annual payment for the following practices that take land out of production: Filter Strips, Grassed Waterways, and Cover Crops. In this case, the annual rental payment is $4,060 per year. This was determined by negotiating an increase to the rate provided by County guidance on rental rate by soil type. Details of the negotiated payment structure are given in Appendix B. The payment will be based off the first year payment and then adjusted annually in accordance with the consumer price index (CPI) for subsequent years of the agreements.

The annual rent payment for land taken out of production will be made by the City to Owner after the Annual Certification documentation is submitted by the County and the City confirms that the projects are continuing in a successful mode. City shall pay Owner within 30 days of confirmation.

7. Annual Operation and Maintenance Payment Per Year. An Operation and Maintenance (O&M) payment of $3,200 will be paid by City to Owner within 30 days of the end of each calendar year of the contract. Details of this payment structure are given in Appendix B. The payment will be based off the first year payment and then adjusted annually in accordance with the consumer price index (CPI) for subsequent years of the agreements.

8. Reimbursable Costs. Material costs are able to be reimbursed up to $3,000 dollars over the contract period for materials purchased for Operation and Maintenance purposes. The Owner will pay for costs for fertilizer related to the improvements. Details of this payment structure are given in Appendix B. Receipts for materials are to be submitted to City within 60 days of purchase. The City will acknowledge and either approve or reject the reimbursement request within 10 business days of receiving the request. The City will disburse funds for the reimbursable materials within 60 days of approval of the reimbursement request.

9. Annual Certification. Owner agrees to let a member of the County staff on its land at least once per year for all contract years for an inspection of the practices, after sufficient prior notice.

10. Operation and Maintenance. Practices must be operated and maintained in accordance with NRCS Technical Standards. Operation and Maintenance in accordance with NRCS –COA-1202 CPC Section 6 must be followed.

11. Termination and Survival. If the Owner fails to carry out the terms and conditions of this Agreement, the City may terminate this Agreement.

The City may terminate this Agreement without liability, if the City determines that continued operation of this Agreement will result in the violation of a statute or regulation, or if the City determines that termination would be in the public interest. Annual Payments will not be made by City to Owner from the termination date forward.

If termination of the Agreement occurs before the end of the term of Agreement, the Owner shall reimburse the City for the full value of the Initial Practice Payment unless at least three years have passed since the installation of the practice. After three years have passed from the date of installation, a prorated amount of the Initial Practice Payment would be refunded according to the following schedule (Table 2) and paid within 60 days of the transfer of ownership:

Table 2 – Initial Practice Payment Refund Schedule

	Percentage of Initial Practice Payment To Be Repaid if Owner Terminates Agreement Before X Years Are Completed.				
	1 Yrs	2 Yrs	3 Yrs	4 Yrs	5 Yrs
5-Year Agreement	100%	100%	100%	75%	65%

If the Owner wishes to sell or transfer ownership of a portion of the land that is included in the management practices, the Owner must approach the City to amend the Agreement. The City has the right to approve or reject based on the intent and objectives of the Agreement. The City will calculate the percentage of the original practice that is impacted, and the Owner will owe that percentage of the Initial Practice Payment, multiplied by the percentage listed in the above chart based on how long the practice was in place before the date of sale or transfer. For example:

A 20-acre parcel has a 5-year Agreement term with an Initial Practice Payment of $5,000. The Owner wants to amend the Agreement to sell 5 acres before the 4th year of the Agreement is completed:

5 Acre/20 Acres = 25% of the Initial Practice Area x $5000 x 75% = $937.50 repaid to the City within 60 days of transfer of ownership.

12. Confidentiality. The City and County will need accurate field-specific information to plan for, design, and construct selected practices. The Owner is expected to share farm operational information with the City and County so that Snap Plus modeling can be completed. This farm operational information includes but is not limited to: soil test data, soil types, crop rotation, topography, fertilizer application and animal units. The information will be shared with appropriate City personnel and appropriate County Land and Water Conservation staff only. The City will not share the information with the media or public unless required by law. The City will not disseminate any information that identifies the Owner's property, farming operations, or farming practices with any entity outside the project unless required by law.

13. General Understandings. Owner understands and agrees to the following:

a. That we are entering this agreement voluntarily.

b. That any changes we make on the property will be our choice and our responsibility and we will not hold the project or its implementers responsible for any impacts caused by these changes.

c. That the City will not release any information about the property, our farming practices or our farming operations unless required by law. However, the project will be allowed to display in an anonymous fashion, the list of changes, the estimated costs, the estimated phosphorus reductions, and the payments made resulting from our participation in the program.

14. Notices. All notices to either party to this Agreement shall be delivered in person or sent by regular mail, postage prepaid, return receipt requested, to the other party at that party's last known address. If the other party's address is not known to the party desiring to send a notice, the party sending the notice may use the address to which the other party's property tax bills are sent.

Notices shall be as follows:

Engineer:

Jason Lietha
Ruekert & Mielke, Inc.
W233 N2080 Ridgeview Parkway, Suite 300
Waukesha WI 53188-1020
262.953.4154
jlietha@ruekert-mielke.com

City:

Jacob Holbert
Columbus Utilities
105 North Dickason Blvd
Columbus WI 53925
920-623-5912
jholbert@columbusutilitieswi.com

Owner:

Curt Stibb
Stibb Farms LLC
N2151 County Road C
Rio, WI 53960
608-212-8364
Stibbfarms.cs@gmail.com

County:

Todd Rietmann
Columbia County
112 E. Edgewater Street
Portage, WI 53901
608.742.9670
Todd.Rietmann@columbiacountywi.gov

15. Severability. In the event that any one or more of the provisions, paragraphs, words, clauses, phrases or sentences contained in this Agreement, or the application thereof in any circumstance, is held invalid, illegal, or unenforceable in any respect for any reason, the validity, legality and enforceability of any such provision, paragraph, word, clause, phrase or sentence in every other respect and of the remaining provisions, paragraphs, words, clauses, phrases or sentences of this Agreement shall not be in any way impaired, it being the intention of the parties that this Agreement shall be enforceable to the fullest extent permitted by law.

16. Entire Agreement**.** This Agreement sets forth the entire understanding of the parties and shall be recorded at the Register of Deeds for Columbia County, Wisconsin. This Agreement may not be changed except by a written document duly executed and acknowledged by all parties hereto and properly recorded in the office of the Register of Deeds for Columbia County, Wisconsin.

17. Waiver. No delay or omission by any party in exercising any right or power arising out of any default under any of the terms or conditions herein shall be construed to be a waiver of such a right or power. A waiver by a party of any obligations of the other party shall not be construed to be a waiver of any breach or any other terms or conditions of this Agreement.

18. Enforcement. Enforcement of this Agreement may be by proceedings at law or in equity against any person, persons or entity violating or attempting to or threatening to violate any terms or conditions contained herein, either to restrain or prevent such a violation or to obtain any other available relief. If a suit is brought to enforce this Agreement, the prevailing party shall be entitled to recover its costs, including reasonable attorney's fees, from the non-prevailing party.

19. Not a Dedication. Nothing in this Agreement shall be deemed to be a gift or dedication of any portion of the property affected hereunder to the public or for any public purpose whatsoever.

20. Governing Law. This Agreement shall be governed by, and construed in accordance with, the internal laws of the State of Wisconsin.

Effective as of the last date set forth below:

IN WITNESS WHEREOF, the City of Columbus and Curtis Stibb have executed this Agreement as of the day and year first above written.

CITY OF COLUMBUS	Curtis Stibb
By: _____	By: _____
Name: _____	Name: _____
Title: _____	Title: _____Authorized Member _____
Date: _____	Date: _____

STATE OF WISCONSIN)

) SS

_____ COUNTY)

Personally came before me this _____ day of _____, 2024, the above named _____, the _____ to me known to be the persons who executed the foregoing instrument and acknowledged the same.

_____

Notary Public, Wisconsin

[SEAL]

My commission:_____

STATE OF WISCONSIN)

) SS

_____ COUNTY)

Personally came before me this _____ day of _____, 2024, the above named _____, the _____ to me known to be the persons who executed the foregoing instrument and acknowledged the same.

_____

Notary Public, Wisconsin

[SEAL]

My commission:_____

Appendix A: Stibb Farms Map

stibb

Farm: Stibb Grain and Livestock LLC, V18 Generated:12/21/2018, Crop year: 2019, Township Range Section:10N 10E s1

Appendix B: Cost Estimate

Stibb Farm Phosphorus Calculations					
Practices (listed on map)	**Location**	**Rental Rate for Soil Type***	**Acreage Taken Out of Production**	**Rental Amount per Year***	**Controlled Acreage**
M4 Buffer Strip	Field M4	$ 374	2	$ 748	18
M5 Buffer Strip	Field M5	$ 374	2	$ 748	8
M6 Buffer Strip	Field M6	$ 485	2	$ 969	6
M7 Buffer Strip	Field M7	$ 259	5	$ 1,593	11
Total Buffer Strips					43
Cover Crops	Field H1	N/A	0	N/A	29
Cover Crops	Field H1A	N/A	0	N/A	19
Cover Crops	Field H4	N/A	0	N/A	24
Cover Crops	Field M1	N/A	0	N/A	73
Cover Crops	Field M3	N/A	0	N/A	35
Cover Crops	Field D3	N/A	0	N/A	18
Cover Crops	Field D4	N/A	0	N/A	8
Cover Crops	Field D5	N/A	0	N/A	12
Cover Crops	Field R1	N/A	0	N/A	8
Cover Crops	Field R1A	N/A	0	N/A	20
Cover Crops	Field R4	N/A	0	N/A	12
Cover Crops	Field F1	N/A	0	N/A	33
Total Cover Crop Available					291

*The payment will be based off the first year payment and then adjusted annually in accordance with the consumer price index (CPI) for subsequent years of the agreements.

Stibb Farm Site Analysis Summary		
Total Acreage Used for Practices	302	acres
Total Acreage Taken Out of Production	11	acres
Project Duration (assumed)	5	years
Reimbursable Material Costs up to $3,000 (*provide receipt*)*	**$ 3,000.00**	**dollars**
Operation and Maintenance Payment Per Year (*inspections, mowing if needed*)*	**$ 3,200.00**	**dollars**
Rental Payment per Year*	**$ 4,060.00**	**dollars**

*The payment will be based off the first year payment and then adjusted annually in accordance with the consumer price index (CPI) for subsequent years of the agreements.

USDA United States Department of Agriculture

Wisconsin 340 Cover Crop
Guidance Document

Measuring the Benefits of the Cover Crop Practice

One of the goals of conservation planning is to consider the effects of conservation practices and systems on soil quality. A number of assessments tools exist to measure the impact of the Cover Crop practice.

Assessing Cover Crop Value as it relates to Soil Quality Benefits

1. The Revised Universal Soil Loss Equation (RUSLE2) and Wind Erosion Prediction System (WEPS) planning software is used to evaluate the impact of cover crop management decisions have on soil loss levels. In addition, RUSLE2 has the Soil Condition Index (SCI) that determines a relative value for anticipated Organic Matter based on management of the cover crop.
2. A soil health assessment is used to determine existing soil characteristics. Typical soil health assessments include soil organic matter levels, soil respiration rates, soil bulk density, soil penetrometer readings, soil infiltration rates and observation of soil cohesion utilizing the slake test.
3. Observable reduction in soil erosion (sheet, rill, ephemeral, and gully). Cover crops increase vegetative and residue cover during periods when erosion energy is high. The addition of cover crops to low residue cropping systems such as corn silage and vegetables can substantially decrease soil erosion.
4. Observable soil porosity improvements due to an increase of biomass, that when decomposed, increases soil organic matter content promoting increased microbial activity and aggregation of soil particles. As a result, soil porosity is increased and bulk density is decreased. **Caution**: avoid planting cover crops when soils are saturated to avoid compaction, or use alternative establishment methods such as aerial over seeding.
5. Observable soil aggregate stability which results in less soil crusting. Cover crops reduce soil crusting by protecting the soil surface from the direct impact of rain drops. The resulting increase of soil organic matter, improved infiltration, and increased aggregate stability will further reduce soil crusting and improve the uniformity of seed germination.
6. Adequate soil surface cover and the improved aggregate stability will reduce erosion and surface water run-off and increase water infiltration rates. Channels created by cover crop roots and earthworms form macropores that further improve infiltration. Cover crops, especially small grains, can effectively capture and utilize excess nitrogen to prevent infiltration below the crop root zone.
7. Cover crops reduce the volume of surface runoff resulting in reduced nutrient losses. Decomposition of cover crop or green manure biomass provides a slow release of nutrients to the root zone. Legume crops fix atmospheric nitrogen and provide nitrogen for the main crop. Legumes also capture more phosphorus than grass or small grains. Small grains are useful as catch crops to utilize end of season nitrogen, which reduces the potential for nitrogen leaching. Planting cover crops on continuous corn silage fields with a history of repeated manure applications during late summer is highly beneficial.
8. Nutrient Immobilization can be observed when decomposition releases available nitrogen to the next crop.

   The carbon-to-nitrogen (C:N) ratio is a relative estimate of the nitrogen necessary to decompose an organic matter (crop residue) source. A C:N ratio of 50:1 or higher will temporarily "immobilize" soil nitrogen. The immobilization is a result of microbes consuming readily available soil nitrogen during the decomposition of crop residue. The nitrogen will remain immobilized until the microbes deplete the crop residue or other organic matter sources.

   Young cereal rye plants have a 14:1 C:N ratio as compared to corn stalks with a 60:1 C:N ratio. The C:N ratio for most clover plants is generally 15:1, which allows nitrogen to quickly become available to the following crop.
9. Cover crops can reduce pesticide loss by reducing surface water runoff resulting in reduced pesticide losses. Increased organic matter increases soil biological activity that can increase the breakdown of pesticide residues.

10. Visible reduction in weed pressure is due to reduced light, seed/soil contact and soil temperatures. The release of chemical compounds by the cover crop (allelopathy) may also inhibit weed growth.

    The potential for a negative impact on the primary crop can be reduced by killing the cover crop two to three weeks prior to planting and ensuring good seed/soil contact during seed placement.

11. Soil moisture can be improved when cover crops and green manure crops remove excess moisture from wet soils, resulting in reduction of "waterlogging" in poorly drained soils.

Specie Selection and Seed Quality

- Select species that are adapted to soil, climatic, and ecological site conditions.
- Select species suited for the planned purpose and specific site conditions.
- Do not plant species identified as restricted or prohibited by law.
- Inoculate legumes with the proper Rhizobium bacteria.
- Non-commercial seed can be used, as long as the seed has been tested for germination.
- Seeding rates are based on certified obtained from commercial sources.

Seedbed Preparation and Seeding

Site preparation shall be adequate to assure weed suppression and to promote germination and growth of the species planted. Seedbed preparation and seeding methods are determined as a result of the following:

- Resource concern and/or objective for planting the cover crop
- Cover crop life cycle (overwintering)
- Current soil surface conditions, moisture levels, existing biomass (surface cover)
- Planned harvest date of the primary crop
- Estimated growing degrees units remaining prior to the average killing frost
- Availability of labor/time and equipment

Seeding Methods

Wisconsin NRCS Conservation Practice Standard 340 - Cover Crop, supports several seeding and planting options to establish cover crops. Successful cover crop plantings require seeding within the recommended dates, seeding methods that ensure adequate seed to soil contact and sufficient soil moisture to support seedling growth.

Cover crops may be drilled, no-tilled, slurry applied, broadcast inter-seeded, over-seeded or frost seeded with or without incorporation depending on field conditions. Incorporation of seed following planting by light shallow tillage, or use of a ring roller, culti-packer or similar tool to embed the seed will result in a more uniform seedling emergence. The following non-traditional establishment methods can be used to expand the settings where cover crops can be utilized.

Slurry Seeded Cover Crops - Slurry-enriched seeding is a process that combines low-disturbance tillage, manure application and the seeding of cover crops into one operation. This technique is efficient and effective in un-tilled crop fields. Cover crop seed is mixed directly with liquid manure in the manure tanker. Cover crop species best suited to plant with this system include; cereal rye, wheat, annual ryegrass, oil seed radish, red, ladino and crimson clover.

For additional details on slurry seeding refer to the following link: http://www.mccc.msu.edu/SlurrySeeding.html.

Frost Seeding is categorized as broadcast or aerial seeding occurring mid to late March through early April during the active freezing and thawing cycle. Warm daytime temperatures combined with low overnight temperatures cause the surface of the soil to freeze and crack. Frost seeding takes skill in determining the exact conditions that are favorable and in assuring the crop will not freeze after emergence.

Guidelines when frost seeding cover crops:

1. Seedbed conditions must favor good seed to soil contact: a) un-tilled winter wheat or soybean residue fields are ideal seedbed conditions, b) frost seeding SHALL NOT occur on un-disturbed heavy residue corn fields or similar conditions, c) when seedbed preparation is necessary to prepare a uniform seedbed in the fall prior to freeze-up and maintain 30-70% residue surface cover.
2. Frost seeding SHALL NOT occur on areas covered with solid ice or snow cover depth greater than 2 inches.
3. Frost seeding shall be completed before the end of the freeze and thaw cycle. Note: Ideal frost seeding conditions vary from year to year, and in certain years the window for seeding may amount to a few days.

CAUTION: Because the risk for failure is high, this practice requires a variance from the Area Resource Conservationist or State Agronomist except for the red clover inter-seeded into dormant winter wheat.

Refer to UW-Publication— "Frost Seeding Red Clover in Winter Wheat" for additional details: http://ipcm.wisc.edu/downloads/nutrient-managment/

Broadcast inter-seeding or over-seeding without incorporation may be used to establish a cover crop into a fully mature crop scheduled for harvest in the near future. The terms inter-seeding and over-seeding, are used interchangeably defining seeding techniques where the cover crop is seeded over the top of an un-harvested crop without incorporation into the soil.

When broadcasting cover crops, seed germination depends on the presence of adequate moisture at the soil surface or within the crop residue layer. Dry conditions will result in poor germination due to limited seed to soil contact. The following guidelines will reduce the risk of seeding failure, when cover crops are broadcasted.

Guidelines for broadcasting cover crops:

1. Assess site for one or more of the following conditions: a) moist, friable soil surface, b) 30% soil surface residue cover to conserve surface moisture for seed germination and c) high probability of rainfall after seeding.
2. Seeding as early as possible within the recommended seeding dates will improve stand density and vigor.
3. Select species known to have the highest germination rate may favor broadcast methods. Below are specie groupings in numeric order beginning with the highest probabilities of successfully germinating:
    - » Group 1: small grains
    - » Group 2: annual/perennial rye grass
    - » Group 3: small seed brassicas
    - » Group 4: small seed legumes

Note: Large legume seed crops are not recommended for aerial seeding.

Additional guidelines when broadcasting cover crops into standing crops:

1. Corn for grain: Do not over-seed cover crops when corn is immature or green. Cover crops should be over-seeded after the corn has begun to dry down, silks are brown and leaves are dried up to the ear and turned down. This timing will minimize the potential for seed to be trapped in leaf whorls and will allow sunlight to reach the ground between the rows.
2. Corn for silage: Cover crops should not be over-seeded into corn that will be harvested as silage, more than 21 days prior to the planned harvest date.
3. Soybeans: Over-seed cover crops into standing un-harvested soybeans when 50% of the leaves are yellow and/or prior to 50% leaf drop.
4. Red clover into winter wheat: Over-seed red clover into dormant winter wheat by frost seeding during the active freeze and thaw cycle (late February to mid-March).
5. Red clover into snap beans: Over-seed red clover during the last cultivation of snap beans.

Fertilization

Cover crops usually follow heavily fertilized crops and do not require fertilization. Fall-planted fibrous rooted grasses or small grains will scavenge leftover nitrogen from the previous crop. Legume cover crops will add nitrogen to the system for the following crop. For these reasons, fertilizer is not required unless the site condition warrants it.

Seed Mixtures for Cover Crops

The seeding mixture used will depend on the objective and identified resource concern. Cover crops can include a diverse mix of grass, non-legume broadleaf and legume plants. The seed mixture should create a balanced stand of above ground biomass and root structure to enhance soil building. Seed mixtures that develop a full canopy will maximize snow retention, soil surface coverage, reduce soil erosion and may be utilized for livestock forage. A mixture of grasses, non-legume broadleaf (brassicas, buckwheat, etc.) and legume plants will improve the soil's biological activity. A mixture of plant species will feed beneficial organisms, improve soil structure, reduce compaction, improve water infiltration/water holding capacity and increase the amount of available nutrient exchange sites in the soil.

Cover crop mixtures are often recommended when the goal is to address multiple objectives and resource concerns. When considering multiple species mixtures, consider the effects of; specie growth characteristics, anticipated growing conditions, nutrient needs, planned seeding rate and the termination method and date.

Use the following references to evaluate cover crop species for growth characteristics and conservation benefits: Table 2 "Identification and Comparison of Cover Crop Performance and Benefits by Species".

Table 3 "Morphology, Physiology and Growth Requirements". "Midwest Cover Crop Decision Tool" http://mccc.msu.edu/index.htm.

Single and Multiple Species Seeding Rate Calculation

When designing cover crop seed mixtures, the seeding rate recommendation is based on the seeding method selected. Cover crops that are drilled, no-

tilled, or broadcast and incorporated, the minimum recommended seeding rate or higher can be planned. Cover crop seeding methods such as broadcast over-seeding or inter-seeding, slurry seeded, frost seeded and other methods, where seed to soil contact is of concern, a higher recommended seeding rate is required. When designing multiple cover crop seed mixtures, multiply the minimum seeding rate for each selected plant species by the planned percentage of each species. The "planned percentage" represents a general proportion of the seed to be planted per species and is not a direct calculation of seeds per square foot or an estimate of canopy cover or plant dominance of a given species. Refer to Table 1 "Cover Crop Species Recommended for Planting in Wisconsin" for the recommended seeding rate per species.

A waiver from the State Agronomist or Area Resource Conservationist for NRCS is required when:

1. Less than **one pound** of seed per plant species is required when designing seed mixtures.
2. More than 4 species are included in the seed mixtures.
3. Cover crops are planted later than the recommended ending seeding date.

Calculating Seeding Rates and Mixes:

Minimum Table 1 seeding rate range or higher per species multiplied by the planned percentage of each species will determine the pounds of seed per plant species to be planted per acre.

Round up to the next full pound of seed if the seeding rate calculation results in a decimal of 0.5 or larger.

Example Seeding Mixture Calculation Results

Spring Mix—Cover crop will be drilled into soybean stubble. The landowner selected the seed mixture below:

40% oats…minimum seeding rate 30 lbs./ac. (Table 1)

40% oilseed radish 4 lbs./ac. (Table 1)

20% field pea 65 lbs./ac. (Table 1)

Actual seeding rates:

Oats= 30 lbs X 40% = 12 lbs for the mix per acre

Radish=4 lbs X 40%= 1.6 which rounded up is 2 lbs for the mix per acre

Pea=65 lbs X 20%=13 lbs for the mix per acre

Cover Crop Attributes

The following summary of cover crop attributes provides additional information (advantages and disadvantages) regarding the species listed in Table 1.

Refer to Table 2 for performance and roles of cover crops.

Alfalfa (Medicago sativa)

- Advantages: nitrogen fixer, crude protein: 14-22%, forms arbuscular mycorrhizal associations, attracts pollinators, good at scavenging nitrogen from the soil, and break up compaction.
- Disadvantages: produces autotoxcity and will not tolerate wet sites.

Annual Ryegrass (Lolium multiflorum)

- Advantages: quick-growing non-spreading bunchgrass, establishes quickly even in gravelly or wet soils, excellent for trapping nitrogen, dense shallow root system improves water infiltration and enhances tilth, improves early season weed control, attracts few insect pests and generally can help reduce insect pest level, can be over-seeded into corn or soybeans after leaves turn yellow, self-pollinating, and forms arbuscular mycorrhizal associations.
- Disadvantages: can host high densities of Penetrans Root-Lesion Nematode.

Barley, Spring/Winter (Hordeum vulgare)

- Advantages: produces a deep fibrous root system, produces more biomass than any other small grain crop, will scavenge significant amounts of nitrogen, releases allelopathic chemicals that help suppress weeds, drastically reduces root-knot nematode populations, has a higher nutritional value than oats or wheat, works well in cocktail mixtures, prefers mesic soil conditions.
- Disadvantages: fusarium head blight can be a problem when other small grains are planted within one year and disease problems (especially with tan spot) can be problematic, avoid planting barley after winter wheat.

Berseem Clover (Trifolium alexandrinum)

- Advantages: extremely vigorous tall annual white clover, tolerant of wet conditions, crude protein: 27-29%, excellent nitrogen fixer, forms arbuscular mycorrhizal associations, flowers attract bees, excellent weed suppressor.
- Disadvantages: none.

Buckwheat (Fagopyrum esculentum)

- Advantages: provides quick soil cover, excellent weed suppressor, provides nectar for pollinators and other beneficial insects, loosens topsoil, rejuvenates low fertility soils,

dense fibrous root cluster in the top 10 inches of soil providing an extensive root surface area for nutrient uptake, extracts soil phosphorus from the soil better than most grain-type cover crops, residue decomposes quickly releasing nutrients to the next crop, excellent choice to follow early vegetables, popular honey bee pollinator.

» Disadvantages: sets seed quickly, will reseed and may become a weed if flowers mature, frost sensitive, will not germinate/thrive in cold soils, and highly attractive to Japanese Beetles.

Canola/Rape (Brassica napus)

» Advantages: flowers attract pollinators, good at scavenging nitrogen from the soil, crude protein: hay 16%, grain 21%, silage 12%, pasture 17%.

» Disadvantages: susceptible to sclerotinia, host for Penetrans Root-Lesion Nematode.

Cereal Rye, Winter (Secale cereale)

» Advantages: tremendous biomass production, can be seeded later in the fall than other cover crops, germinate at temperatures as low as 34°F and produce vegetative growth at 38°F, reduces nitrate leaching, excellent weed suppressor, secrete compounds that will inhibit germination of weeds such as lambquarters, redroot pigweed, dandelions, and Canada thistle, few diseases affect rye as compared to other small grains, can be over-seeded in field crops, can be grown on a wide range of soils and will increase the concentration of exchangeable K near the surface by means of its fibrous root system, tolerates triazines herbicides, excellent for scavenging nitrogen, medium water use.

» Disadvantages: may become a weed when terminated too late, not recommended before corn in rotation, host for Penetrans Root-Lesion Nematode.

Chicory (Cichorium intybus)

» Advantages: rapid growth, excellent forage crop, crude protein: 20-32%, attracts pollinators, rooting depth 4 to 5 feet, forms arbuscular mycorrhizal associations, used in mixtures, grows well under droughty conditions.

» Disadvantages: none.

Cow pea (Vigna unguiculata)

» Advantages: provides 50 to 100 pounds of nitrogen, attracts pollinators, forms arbuscular mycorrhizal associations.

» Disadvantages: none.

Crimson Clover (Trifolium incarnatum)

» Advantages: grows well on poorly drained soils, use as a winter kill annual, utilize as hay, pasture, favored legume of organic farmers, attracts pollinators, grows well in extreme heat.

» Disadvantages: host for root knot nematode and Penetrans Root-Lesion Nematode.

Field Pea (Pisum satuvum)

» Advantages: residue breaks down and releases nitrogen quickly, provide nitrogen at a rate of 50 to 100 pounds per acre, mix well with oats and barley, excellent for soil building and water use is low.

» Disadvantages: can lead to aphanomyces problems when in rotations with alfalfa, susceptible to sclerotinia.

Forage/Oilseed Radish (Raphanus sativa)

» Advantages: deep root crop, excellent for compaction control, crude protein: 26-30%, good for scavenging nitrogen from the soil, flowers attract pollinators and excellent for grazing.

» Disadvantages: winter kills at 25°F, odor during decay, host for root knot nematode, Penetrans Root-Lesion Nematode, and sugarbeet cyst nematode.

Forage Turnips (Brassica rapa)

» Advantages: root crop, crude protein: leaf tops 16%, root 12-14%, forms arbuscular mycorrhizal associations, rated good for scavenging Nitrogen, flowers attract pollinators, excellent for grazing.

» Disadvantages: can become a serious weed if allowed to go to seed, host for root knot nematode, Penetrans Root-Lesion Nematode, and sugarbeet cyst nematode.

Hairy Vetch (Vicia villosa)

» Advantages: provides 60 to 120 pounds of nitrogen, attracts pollinators, used in a cocktail mixtures, only vetch species that can be fall seeded and reach maturity the next year, can withstand trampling from grazing animals during May and June, adapted to a wide range of soil types, but prefers loamy and sandy soils.

» Disadvantages: stems are weak and have a tendency to lodge, when seeded with a small grain, the weak stems are supported by the tangling of the tendrils with the small grain stalks, do not plant hairy vetch with a winter grain if you desire to harvest grain for feed or sale, fall seeded hairy vetch will winterkill with temperatures less than 15 degrees with no snow cover, certain species of nematodes increase with hairy vetch, Spring/summer seeding is less successful.

Japanese Millet (Echinochloa frumentacea)

» Advantages: fast growing annual grass, tolerates frequent clipping, makes excellent forage and hay, tolerate both droughty and wet soils, excellent feed source, good choice for converting land to vegetable production.

» Disadvantages: will not germinate/thrive in cold soil, host for Penetrans Root-Lesion Nematode.

Oats (Avena sativa)

» Advantages: provide quick weed suppressing biomass, naturally occurring compounds in roots and residue can hinder weed growth, excellent nutrient catch crop, improves productivity of legumes when planted in mixes, inexpensive to establish.

» Disadvantages: slow to release nitrogen to following crops, unless growth is terminated in mid-vegetative stage (12 to 18 inches), host for Penetrans Root- Lesion Nematode.

Pearl Millet (Pennisetum glaucum)

» Advantages: forms arbuscular mycorrihizal associations, excellent for grazing, low water use requirements, self-pollinator.

» Disadvantages: slower to establish than sorghum or sudangrass, will not germinate/ thrive in cold soil.

Red Clover (Trifolium pratense)

» Advantages: provides 70 to 120 pounds of nitrogen, crude protein: 15%, flowers attract bees and can be used in cocktail mixtures.

» Disadvantages: host for root knot nematode and Penetrans Root-Lesion Nematode.

Sunflower (Helianthus annuus)

» Advantages: deep rooted, effective in mining mobile nutrients deep in the soil profile, attracts pollinators, forms arbuscular mycorrhizal associations, can be used cocktail mixtures.

» Disadvantages: may increase sclerotinia inoculum.

Sorghum-Sudangrass Hybrids (Sorghum bicolor x S. bicolor var. Sudanese)

» Advantages: tall fast-growing heat-loving summer annual, suppress some nematodes species, seedling, shoots, leaves and roots secrete allelopathic compounds that suppress weeds, has an aggressive root system that relieves compaction, mowing stalks increases root mass 5 to 8 times compared with un-mowed stalks and forces the roots to penetrate deeper making the root system an excellent subsoil aerator, drought tolerant, will tolerate a pH range of 5 to 9, nutrient uptake increases on sandy soils, self-pollinator, medium water use required, forms arbuscular mycorrhizal associations.

» Disadvantages: requires fertile soils, mature plants terminated by frost-killed become quite woody.

Sudangrass (Sorghum bicolor)

» Advantages: tall fast-growing heat-loving summer annual, suppress some nematodes species, seedling/shoots/leaves and roots secrete allelopathic compounds that suppress weeds, has an aggressive root system that relieves compaction, mowing stalks increases root mass 5-8 times compared with un-mowed stalks and forces the roots to penetrate deeper, making the root system an excellent subsoil aerator, drought tolerant, will tolerate a pH range 5-9, nutrient uptake increases on sandy soils, self-pollinator, medium water use required, forms arbuscular mycorrhizal associations.

» Disadvantages: requires fertile soils, frost damaged plants can cause prussic acid poisoning in livestock, drought stressed plants can cause nitrate poisoning, host for Penetrans Root-Lesion Nematode.

White Clover (Trifolium repens)

» Advantages: crude protein 24-30%, forms arbuscular mycorrhizal associations, flowers attracts bees.

» Disadvantages: will not tolerate droughty soils and has a shallow root system.

Triticale, Winter (Triticum x Secale)

» Advantages: crude protein: hay 9-16%, grain 17%, self-pollinator, forms arbuscular mycorrhizal associations, excellent weed suppressor and excellent for grazing.

» Disadvantages: seed is more expensive than wheat or rye.

Wheat, Winter/Spring (Triticum aestivum)

» Advantages: excellent weed suppressing crop, can be over-seeded into corn or soybeans, produces a tremendous amount of biomass, excellent nitrogen scavenger.

» Disadvantages: host for Penetrans Root-Lesion Nematode, when planted in rotation with other small grains within a year there can be disease problems (especially with tan spot).

Termination of Cover Crops:

Cover crops will be terminated by frost, harvest or grazing for forage, roller crimping, tillage, and/or with proper herbicide selection. Timely termination of in season cover crops is required to reduce soil moisture depletion, nitrogen immobilization, allelopathy and to prevent unwanted re-seeding. Timing of cover crop termination must meet the purpose of the cover crop as specified in the conservation plan. Manage cover crop surface residue and biomass production to meet objectives specified in the conservation plan. In vineyards and small fruit operations, grow cover crop in aisles, mow as necessary for mulch cover and maintain as short stubble. Adjust nitrogen application rates for the subsequent crop based on nitrogen credits for specific cover crop species from University of Wisconsin nutrient guidelines.

(a) Herbicide Termination:

Herbicide selection for termination must be made by a Certified Pesticide Applicator, Certified Crop Advisor or qualified Extension Specialist following pesticide labeling and must be compatible with the following main crop to grown.

(b) Winter Kill Termination:

Insure that planned cover and biomass production levels can be achieved for the specific cover crop purpose from the conservation plan when using cover crop species that terminate by frost or winter kill. When the objective of the conservation plan is to allow fall manure applications to in high Nitrogen Leaching soils, winter kill termination is not an option and winter hardy cover crops must be used.

(c) Grazing/Haying Termination:

Cover crops grazed or harvested for forage as a termination method will have a specified amount of target residual biomass left in the field to meet the cover crop objective(s) outlined in the conservation plan. Employ additional termination methods as needed once grazing/haying has concluded and target biomass is achieved and documented. When cover crops are grazed, potential adverse reactions from cover crop consumption by grazing animals must be monitored at all times.

(d) Tillage Termination:

Use inversion type tillage implements that will adequately bury and kill the cover crop.

(e) Roller/Crimper Termination:

Rolling/crimping will take place at the proper cover crop growth stage to limit regrowth potential. For small grains this stage is at the boot or grain head stage, for legumes the flowering stage. Direction of rolling/crimping will coincide with planting direction when no-till planting the subsequent crop. Crimpers must break the plant stems in three or more places to be effective. Crimping must be done prior to seed set stage in order to prevent tillering or reseeding of the cover crop.

For additional NRCS cover crop termination criteria refer to: "NRCS Cover Crop Termination Guidelines". http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse/crops/

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Midwest Cover Crop Decision Tool: http://mcccdev.anr.msu.edu/

Planting Winter Cereal Rye after Corn Silage: http://www.soils.wisc.edu/extension/covercrop.php

NRCS Cover Crop Termination Guidelines: http://www.nrcs.usda.gov/wps/portal/nrcs/main/ national/landuse/crops/

National Agricultural Aviation Association website: http://www.agaviation.org/

UW Extension Publications: Cover Crop Termination, Forage Herbicide Quick Sheet – Cereal Rye Forage after Corn Silage, Forage Herbicides Quick Sheet – Spring-Seeded Forages after Corn and Herbicide Rotation Restrictions in Forage and Cover Cropping Systems located at the Wisconsin Crop Weed Science Website: http://wcws.cals.wisc.edu

Table 1: Cover Crop Species Recommended for Planting in Wisconsin

Species	[1] Minimum Seeding Rate in lbs. bu./ac. (incorporated seed)		[2] Minimum Seeding Rate in lbs. bu./ac. (non-incorporated seed)		Seeding Date (statewide)	Planting Depth (inches)
GRASSES	lbs.	bu.	lbs.	bu.		
Annual Ryegrass (Lolium multiflorum)	15	0.7	20	0.8	4/10-6/1, 8/1-9/1	¼ to ½
Barley, Spring (Hordeum vulgare)	50	1.0	63 to 75	1.3 to 1.6	4/10-6/15, 7/15-9/20	¾ to 1½
*Japanese Millet (Echinochloa frumentacea)	22	0.5	28	0.6	6/1-7/15	½ to ¾
*Sorghum Sudangrass (Sorghum bicolor x S. bicolor var. Sudanese)	28	0.6	33	0.7	6/1-7/15	½ to 1½
*Sudangrass (Sorghum biclor)	28	1.0	33	1.2	6/1-7/15	½ to 1
*Pearl Millet (Pennisetum glaucum)	22	0.5	28	0.6	6/1-7/15	½ to ¾
Wheat, Spring (Triticum aestivum)	50	0.8	70 to 90	1.2 to 1.5	4/10-6/15, 7/15-9/1	¾ to 1½
Barley, Winter (Hordeum vulgare)	50	1.0	63 to 75	1.3 to 1.6	8/15-9/15	¾ to 1½
Cereal Rye, Winter (Secale cereale)	55	1	55	1	7/15-10/15	¾ to 1½
Oats (Avena sativa)	30	0.9	45 to 60	1.4 to 1.9	4/10-9/1	½ to 1½
Wheat, Winter (Triticum aestivum)	50	0.8	70 to 90	1.2 to 1.5	8/1-10/1	¾ to 1½
Triticale, Winter (Triticum x Secale)	50	1.0	70 to 90	1.3 to 1.9	8/1-10/1	¾ to 1½
NON-LEGUMES BROADLEAF	lbs.	bu.	lbs.	bu.		
*Buckwheat (Fagopyrum esculentum)	20	0.4	35	0.7	5/15-8/1	½ to 1
**Oilseed Radish (Raphanus sativus)	4	--	12	--	4/10-6/15, 7/15-8/15	½ to ¾
*Sunflower (Helianthus annuus) (part of a mix)	1	--	2	--	6/1-7/15	1 to 1½
*Chicory (Cichorium intybus) (part of a mix)	1	--	2	--	4/10-6/1, 8/1-9/1	½ to ¾
Rapeseed/Canola (Brassica napus)	2	--	6	--	4/10-6/15, 8/1-8/15	½ to ¾
Forage Turnips (Brassica rapa)	1	--	5	--	4/10-6/15, 7/15-8/15	¼ to ½
LEGUMES	lbs.	bu.	lbs.	bu.		
Alfalfa (Medicago sativa)	13	--	16	--	4/15-6/1, 8/1-8/30	¼ to ½
Berseem Clover (Trifolium alexandrinum)	9	--	17	--	6/1-8/1	¼ to ½
*Cowpea (Vigna unguiculata)	55	0.9	99	1.7	6/1-7/15	1 to 1½
*Field Pea (Pisum satuvum)	65	2.6	100	4.0	4/10-6/15	1 to 1½
Hairy Vetch (Vicia villosa)	15	--	20	--	4/10-6/15, 7/15-9/15	1 to 1½
*Peas, Winter (Pisum sativum subsp. arvense)	65	2.6	100	4.0	8/1-9/1	1 to 1½
Red Clover (Trifolium pratense)	9	--	13	--	4/10-8/15	¼ to ½
White Clover (Trifolium repens)	7	--	9	--	4/15-6/1, 8/1-8/30	¼ to ½
Crimson Clover (Trifolium incarnatum)	11	--	17	--	6/1-8/1	¼ to ½

[1] Incorporated seed—Seeding methods used that provide good seed to soil contact (drilled, no-tilled, or broadcast and incorporated).

[2] Non-incorporated seed—Seeding methods used when broadcasting seed without mechanical incorporation (aerial, over-seeding/inter-seeding and frost seeding.

Cover crop seed mixture designs must include a minimum of 1 pound of seed per specie planted.

Note: lbs_bu/ac represent the numbers in sequence in the Table. For example: 15/0.7 refers to 15 lbs. or 0.7 bushel per acre.-

* Species with asterisk are not recommended for aerial seeding. Large seed legumes (cowpea, etc.) and summer annuals (Japanese millet, etc.) require adequate seed to soil contract.

** Spring seeding of oil seed radish must include the termination strategy to prevent the production of viable seed.

Table 2: Identification and Comparison of Cover Crop Performance and Benefits by Species

Species	Use [1]	N-Source	SoilBuilder	Erosion Fighter	Weed Fighter	Pest Fighter	N-Scavenger	Grazing	Quick Growth	Non-Fragile Residue	Pollinator	Deep Rooted
Alfalfa (Medicago sativa) [3]	C	4	3	3	3	1	2	3	3	1	3	4
Annual Ryegrass (Lolium multiflorum)	C	0	3	3	2	2	3	4	4	2	0	2
Barley, Spring (Hordeum vulgare)	C	0	3	3	3	1	3	3	3	4	0	2
Berseem Clover (Trifolium alexandrinum) [3]	C	4	2	2	2	1	1	4	2	1	3	1
Buckwheat (Fagopyrum esculentum)	C	0	2	3	3	1	3	1	4	0	4	4
Canola/Rapeseed (Brassica napus)	C	0	2	3	2	1	3	4	4	1	3	3
Cereal Rye, Winter (Secale cereale)	C	0	4	4	4	3	4	4	4	4	0	3
Chicory (Cichorium intybus)	E	0	2	2	2	0	2	3	2	1	2	3
Cowpea (Vigna unguiculata)	C	3	2	2	2	0	2	3	3	1	2	1
Crimson Clover (Trifolium incarnatum)	E	3	2	3	2	1	2	4	3	1	4	2
Field Pea (Pisum satuvum)	C	2	2	2	1	1	1	2	3	1	2	2
Forage Turnips (Brassica rapa)	C	0	1	3	2	0	3	4	3	1	1	1
Forage/Oilseed Radish (Raphanus sativus)	E	0	2	3	2	1	4	3	3	1	3	3
Hairy Vetch (Vicia villosa)	C	4	2	2	3	2	1	0	2	1	2	4
Japanese Millet (Echinochloa frumentacea)	C	0	3	3	3	3	3	3	4	4	1	3
Oats (Avena sativa)	C	0	3	3	3	2	3	4	4	2	0	2
Peas, Winter (Pisum sativum subsp. arvense)	C	2	2	2	1	1	1	2	3	1	2	2
Pearl Millet (Pennisetum glaucum)	C	0	3	3	4	2	3	4	4	4	1	2
Red Clover (Trifolium pratense)3	C	4	3	3	3	1	2	4	3	2	4	3
Sorghum-Sundangrass (Sorghum bicolor x S. bicolor var. Sudanese)	C	0	4	4	4	2	4	4	4	4	2	3
Sunangrass (Sorghum biclor)	C	0	4	3	4	3	4	4	4	4	2	3
Sunflower (Helianthus annuus)	E	0	2	2	2	1	3	1	3	3	3	4
Triticale, Winter (Triticum x Secale)	C	0	3	3	3	2	3	4	3	4	0	2
Wheat, Spring/Winter (Triticum aestivum)	C	0	3	3	3	2	3	4	3	4	0	2
White Clover (Trifolium repens) [3]	C	2	2	1	1	2	3	3	3	3	2	0

[1] Use: C=Common Use – Considerable state knowledge regarding species use.
E=Emerging Use – Limited state knowledge regarding species use.

[2] Attribute Ratings: 0=Poor, 1=Fair, 2=Good, 3=Very Good, 4=Excellent

[3] Legumes such as alfalfa and red clover may cause bloating of ruminant animals. Take necessary precautions to prevent bloat when grazing cover crops that contain these legumes.

Table 3: Morphology, Physiology and Growth Requirements

Species	Life Cycle	Growth Height	Preferred pH	Minimum Germination Temp	Heat Tolerance	Drought Tolerance	Shade Tolerance	Flood Tolerance	Low Fertility Tolerance	Winter Survival Dry Matter Production (lb/ac/yr)		Termination Information
GRASSES												
Annual Ryegrass (Lolium multiflorum)	winter annual	upright	5.5 - 7.0	40	good	good	very good	very good	good	seldom	1000 - 6000	freeze, tillage, chemical
Barley, Spring (Hordeum vulgare)	cool season annual	upright	6 to 8	38	fair	good	fair	good	very good	never	2000 - 5000	freeze, tillage, mow, chemical, roller crimper
Barley, Winter (Hordeum vulgare)	winter annual	upright	6.0 - 8.0	38	fair	good	fair	good	very good	expected	2000 - 5000	tillage, mow, chemical, roller crimper
Cereal Rye, Winter (Secale cereale)	cool season annual	upright	5.0 - 7.0	34	fair	very good	good	very good	excellent	expected	2500 - 6000	freeze, tillage, mow, chemical, roller crimper
Japanese Millet (Echinochloa frumentacea)	summer annual	upright	4.6 - 7.0	65	excellent	excellent	fair	fair	very good	never	1500 - 3500	freeze, tillage, chemical
Oats (Avena sativa)	cool season annual	upright	4.5 - 6.0	38	fair	good	good	very good	very good	never	2000 - 6000	freeze, mow, tillage, chemical
Pearl Millet (Pennisetum glaucum)	summer annual	upright	5.5 - 7.0	65	excellent	excellent	fair	fair	excellent	never	2000 - 6000	freeze, tillage, chemical
Sorghum-Sundangrass (Sorghum bicolor x S. bicolor var. Sudanese)	summer annual	upright	5.5 - 7.0	65	excellent	excellent	fair	good	good	never	3000 - 8000	freeze, tillage, chemical
Sunangrass (Sorghum biclor)	summer annual	upright	5.5 - 7.0	65	excellent	excellent	fair	good	good	never	3000 - 8000	freeze, tillage, chemical
Triticale, Winter (Triticum x Secale)	winter annual	upright	5.2 - 7.0	38	fair	good	fair	good	good	expected	2000 - 5000	tillage, mow, chemical, roller crimper
Wheat, Spring (Triticum aestivum)	cool season annual	upright	6.0 - 7.0	38	fair	good	fair	good	good	never	2000 - 5000	freeze, tillage, mow, chemical, crimper
Wheat, Winter (Triticum aestivum)	winter annual	upright	6.0 - 7.0	38	fair	good	good	good	good	expected	2000 - 5000	tillage, mow, chemical, roller crimper
NON-LEGUMES BROADLEAF												
Buckwheat (Fagopyrum esculentum)	summer annual	upright to semi-upright	5.0 - 7.0	50	excellent	good	fair	fair	very good	never	1500 - 2500	freeze, tillage, chemical, mow
Chicory (Cichorium intybus) (part of a mix)	short-lived perennial	upright	5.0 - 7.0	50	very good	very good	good	good	very good	expected	1500 - 2000	tillage chemical
Forage Turnips (Brassica rapa)	cool season annual	upright	5.3 - 6.0	45	good	fair	good	fair	good	seldom	1200 - 3000	freeze, tillage, chemical
Oilseed Radish (Raphanus sativus)	cool season annual	upright	6.0 - 7.0	45	good	very good	good	fair	good	seldom	1200 - 3000	freeze, tillage, chemical
Rapeseed/Canola (Brassica napus)	winter/cool season	upright	5.5 - 8.0	41	good	good	good	fair	good	seldom	1000 - 2500	freeze, tillage, chemical
Sunflower (Helianthus annuus) (part of a mix)	summer annual	upright	5.7 - 8.0	44	excellent	excellent	good	fair	very good	never	250 - 500	freeze, tillage, chemical, mow
LEGUMES												
Alfalfa (Medicago sativa)	cool season perennial	upright	6.5 - 7.0	42	good	good	fair	poor	poor	expected	3000 - 8000	tillage chemical
Berseem Clover (Trifolium alexandrinum)	summer annual	upright	5.0 - 7.0	42	very good	good	fair	fair	fair	never	1200 - 3000	freeze, tillage, chemical
Cowpea (Vigna unguiculata)	summer annual	semi-upright to climbing	5.5 - 6.0	58	excellent	very good	fair	very good	very good	never	2000 - 3600	freeze, tillage, chemical, mow
Crimson Clover (Trifolium incarnatum)	winter annual	upright to semi-upright	5.5 - 7.0	42	very good	good	fair	very good	very good	never	3500 - 5500	freeze, tillage, chemical
Field Pea (Pisum satuvum)	cool season annual	climbing	6.0 - 7.0	41	fair	fair	fair	fair	fair	seldom	1200 - 3000	tillage, mow, chemical
Hairy Vetch (Vicia villosa)	winter/cool season annual	climbing	5.5 - 7.0	60	fair	good	good	good	good	expected	1800 - 4000	tillage, chemical, roller crimper
Peas, Winter (Pisum sativum subsp. arvense)	winter annual	climbing	6.0 - 7.0	41	fair	fair	fair	fair	fair	seldom or expected	1200 - 3000	tillage, mow, chemical
Red Clover (Trifolium pratense)	short-lived perennial	upright	5.0 - 8.0	41	very good	good	very good	good	very good	expected	2000 - 5000	tillage chemical
White Clover (Trifolium repens)	cool season annual	upright	5.5 - 6.5	42	fair	fair	fair	good	fair	expected	600 - 1000	tillage chemical