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A Tool for Selecting Cover Crops for Row Crop Rotations in the Southeast

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Cover photo: cotton plants growing out of the residue of a cereal rye cover crop in Georgia.

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Preface

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Plant Materials Program has been involved in the collection, evaluation, selection, increase, and release of conservation plants for more than 75 years. The purpose of this document is to give NRCS staff and landowners in the Southeast practical cover crop alternatives to address natural resource concerns while meeting landowner goals. The NRCS Nine-Step Planning process provides a framework for developing solutions to resource problems. This technical note and selector tool provides customized information based on landowner's crop rotation, time of planting, production practices, and production concerns for specific fields.

For additional information on particular species of plants mentioned in this publication, please see the USDA PLANTS database or contact the nearest Plant Materials Center or plant materials specialist and/or State Land Grant Universities. The USDA NRCS soils website and National Plant Materials Program web site also provide additional information about conservation practices and vegetative technology to support soil health.

Southeast Plant Materials Region

Selecting a Cover Crop for Row Crop Rotations in the Southeast

The Southeastern United States produces a diverse array of row (i.e., commodity or cash) crops, including cotton, corn, peanuts, soybeans, and wheat (USDA NASS, 2015; see Appendix A for scientific names of crops and cover crops mentioned in this publication). The predominance of these crops and their rotations make the Southeast unique from other regions such as the Mid-West or Great Plains. Cultural production practices for these crops commonly include conventional tillage methods (i.e., the seedbed is disturbed with tillage equipment in the fall or spring to reduce plant residue in or on top of soil, firm soil, and disrupt weed growth).

Cover crops provide cropland with seasonal vegetative cover, resulting in many possible conservation benefits. Cover crops are planted to provide benefits to the farm other than direct sale of marketable seed, grain, or vegetative material (Clark, 2007). A cover crop can be any adapted plant species, including grasses, legumes, and forbs. Cover crops are typically grown after harvest and before planting of commodity crops. The cover crop may be planted during the warm or cool season of the year, depending on the window of time available between cash crops. This tool focuses on traditional row crop production; most cover crop species recommended grow in the cool season after the harvest of corn, soybean, and peanuts.

Planting cover crops is a conservation practice used by NRCS to address a wide range of resource concerns on cropland. Cover crops can reduce soil erosion, add organic matter, improve soil biological health, protect water quality by cycling nutrients, suppress weeds, conserve soil moisture, and alleviate soil compaction (Chen and Weil, 2010; Clark, 2007; Munawar et al., 1990; Reicosky and Forcella, 1998). Promoting effective water infiltration, better soil drainage, and better overall soil health may lead to enhanced production of commodity crops, reduced production costs, and a multitude of environmental benefits (Clark, 2007; Ingles et al., 1994; Snapp et al, 2005). Selecting the most efficient cover crop species adapted to the production rotation, resource concerns present, and landowner goals is crucial. Since cover crops are not harvested or sold, landowners must wisely invest in the costs and labor associated with cultivating cover crops. Challenges landowners commonly face in growing a cover crop involve: lack of landowner experience and a lack of regional information on crop production using cover crops. Use of cover crops requires additional planning, labor, management, seed costs, and may require the purchase or retrofitting of farm equipment. Due to these factors, there is a need for a simple selection tool to help landowners organize their goals, resource concerns, and current production practices. By using the cover crop selection tool as part of the NRCS Nine-Step Planning Process, (Table 1), landowners can easily identify cover crop species that function within given constraints.

Table 1: The nine steps of the formal NRCS planning process.

1. Identify problems	4. Analyze resource data	7. Make selections
2. Determine objectives	5. Formulate alternatives	8. Implement plan
3. Inventory resources	6. Evaluate alternatives	9. Evaluate plan

The cover crop selection tool supports planning steps 4, 5, and 6 by facilitating the collection of information essential in determining adapted cover crop species. Essential information is divided into user-friendly questions with different options and can be used by planners, landowners, or both. The basic process for using this tool includes:

1. Select goals and identify resource concerns to address, such as:
    i. Increasing nitrogen production for cash crop (legume crops)
    ii. Suppressing weeds and/or crop pests
    iii. Reducing soil compaction
    iv. Improving water Infiltration into soil
    v. Increasing soil organic matter
    vi. Retaining existing mobile nutrients that have been applied to cash crops
    vii. Providing high quality forage for livestock grazing
2. Inventory existing landowner crop rotation and current production practices, such as:
    i. Current and future cash crops
    ii. Tillage regime
    iii. Herbicide use
    iv. Existing equipment use for planting, managing, and terminating cover crops
3. Develop a list of alternative cover crop species from the selection tool output and evaluate their pros and cons with resource management specialists for final seeding design and implementation.

Figure 1: Click to open the Excel-based tool.

How to Use the Cover Crop Selection Tool

The Cover Crop Selection Tool provides a first step for NRCS field staff and landowners to begin a discussion on the feasibility of planting cover crops (see your state FOTG for CPS 340, Cover Crop). Information on commodity crop rotation, the timeframe available for growing cover crops, and the selection of resource concerns to address are incorporated into the tool. The tool allows the commodity crop and planting times to be changed to accommodate fluctuations in commodity crop prices, weather, or development of new resource concerns. Planning for several scenarios ahead of time gives landowners maximum flexibility to plant cover crops between commodity crops, terminate the cover crop effectively, and ensure successful commodity crop planting after cover crop termination.

This tool **will not** design the complete conservation practice. The tool's output provides information for use with state planning procedures and will provide only basic options for designing a seeding plan for landowners (see example output Fig. 4). Seeding rates, seeding dates, equipment the landowner has available to plant and terminate the cover crop, and seed vendor sources are not part of this tool. Species identified in tool outputs must be evaluated according to landowner capabilities. Specific tool output recommendations **should not be listed** in the contract line item scenarios for Farm Bill contract development, as the tool is only for planning purposes. A full seeding plan should include detailed instructions about seedbed preparation, specific planting and termination methods and dates, and monitoring instructions. Detailed information is available from local NRCS offices and sources listed in Appendix A.

This EXCEL Workbook is open source and may be adapted for specific regions. Please contact the corresponding author if you would like to adapt the workbook.

Information required for using the tool:

- Landowner's name, farm, and field name or number.
- The following questions are in the Cover Crop Selection Tool to collect general production information:
  - What is your cash crop now?
  - What is your normal planting date?
  - What is your normal harvest date?
  - What is next cash crop you anticipate planting (i.e., what is your rotation)?
  - When will you plant the next commodity crop in your rotation?
  - What is your tillage regime?
  - When do you prepare cash crop seedbed for planting? (If limited-till, when do you burndown, i.e., spray chemicals to terminate winter weed growth, before planting?)

Directions for inputting information into the tool:

Select the appropriate answer from the dropdown menu for each question (Figure 1).

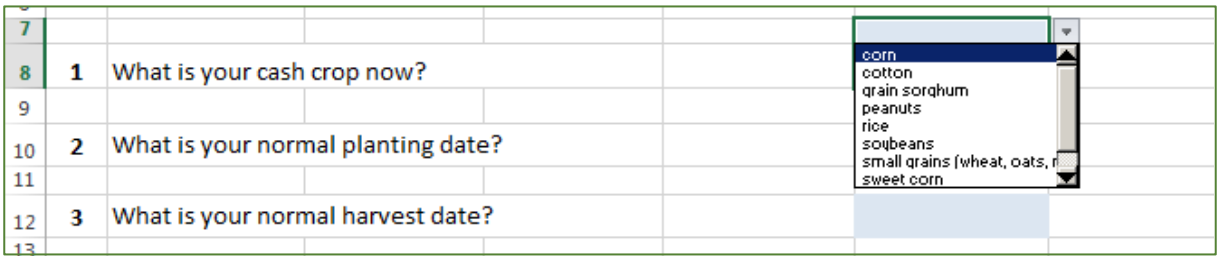

Figure 2: Screen shot of options to questions in the tool.

Some answers or combinations of answer will generate additional guidance or warnings (Figure 2).

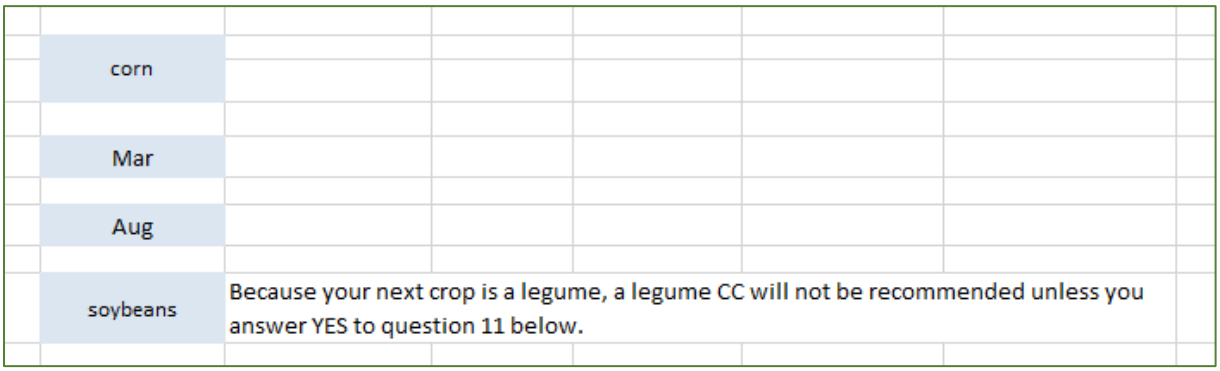

Figure 3: The tool displays additional information based on selections.

Resource concerns are grouped into a list of landowner problems (Table 2) and addressed in the following questions for the landowner:

- What is your most serious problem you think cover crops will help with?
- What is your second most serious problem you think cover crops will help with?

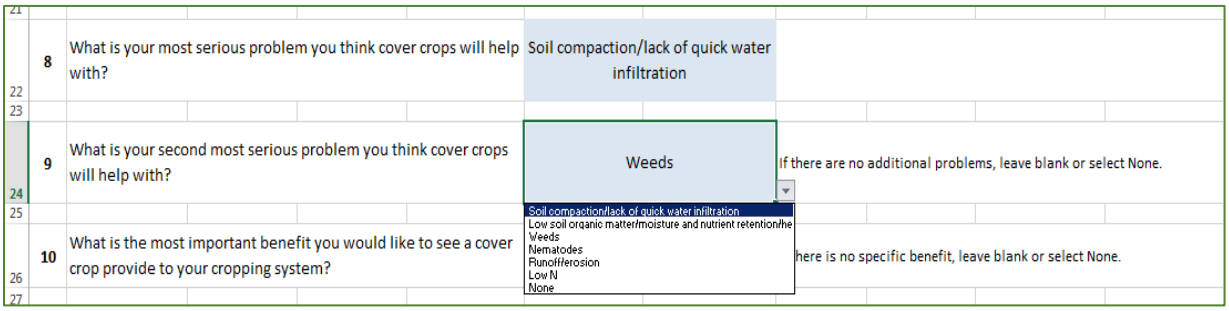

Figure 4: Problems listed in the tool correlate with NRCS resource concerns.

Table 2: Resource problems listed in the tool

Landowner Problem	Resource Concern(s)	Assessment
Soil compaction/lack of quick water infiltration	Soil Quality Degradation – Compaction Insufficient Water - Inefficient Moisture Management or Inefficient Use of Irrigation Water	determined by landowner's visual observation and/or soil penetrometer
Low soil organic matter, low soil moisture-holding capacity, low herbicide efficacy	Soil Quality Degradation - Organic Matter Depletion Insufficient Water - Inefficient Moisture Management or Inefficient Use of Irrigation Water	determined by recent soil test, undesirable SCI, and/or landowner observations
Weeds	Degraded Plant Condition - Undesirable Plant Productivity and Health and/or Excessive Plant Pest Pressure	determined by landowner observations and/or NRCS visual assessment
Nematodes	Degraded Plant Condition - Undesirable Plant Productivity and Health and/or Excessive Plant Pest Pressure	determined by landowner observations, extension lab results, and/or NRCS visual assessment
Runoff/erosion	Soil Erosion - Sheet and Rill Erosion and Ephemeral Gully Erosion	determined by NRCS and landowner observations of ephemeral gullies in fields, evidence of sheet and rill erosion
Low N	Degraded Plant Condition - Undesirable Plant Productivity and Health	determined by landowner observations, recent soil test, and/or NRCS visual assessment

At least one landowner problem must be selected. A secondary problem may also be selected. If there is no secondary problem, select "none".

In addition to solving problems, users may select a benefit they expect from a cover crop by answering the following question (dropdown options and Resource Concerns addressed for this question are shown in the table below; Table 3):

- What is the most important benefit you would like to see a cover crop provide to your cropping system?

Table 3: Additional cover crop benefits listed in the tool.

Additional Benefit	Resource Concern(s)
Provide N	Degraded Plant Condition - Undesirable Plant Productivity and Health and/or Excessive Plant Pest Pressure
Scavenge N	Water Quality Degradation - Nutrients in Surface Water and/or Nutrients in Groundwater
Scavenge P and K	Water Quality Degradation - Nutrients in Surface Water and/or Nutrients in Groundwater
Attract beneficial insects/pollinators	Degraded Plant Condition - Undesirable Plant Productivity and Health and/or Excessive Plant Pest Pressure
High forage quality	Livestock Production Limitation - Inadequate Feed and Forage

Another important question for the landowner:

- Would you like to plant a cover crop mix?

This is a "Yes" or "No" answer. A "Yes" answer is required to provide a legume cover crop species recommendation prior to planting a legume commodity crop (such as soybeans).

The final questions are field-specific information:

- What is your pH?
- Does your field have poor drainage?
- Have you applied any soil residual herbicides?

If the answer to the soil residual herbicide question is "Yes", be sure to discuss with the landowner past application of soil residual herbicides. The presence of residual herbicides may result in cover crop failure. If residual herbicides were applied, consult with the local cooperative extension agent to discuss safe rotation intervals.

The questions and dropdown options in the tool are available in Appendix B to accommodate information collection in the field

Finding the Right Cover Crop

Producer Name:	Jane Farmer	Current Cash Crop:	corn	Next Planned Crop:	soybeans
Farm:	Home Farm	Current Crop Planting Date:	Mar	Planting Date for Next Crop:	Mar
Field No:	10	Current Crop Harvest Date:	Aug	pH:	6 to 7
		Normal Seedbed Preparation Date or CC Burn Down:	Feb		
		Potential Residule Herbicide Problem:	Consult with cooperative extension for appropriate rotation interval before selecting a cover crop.		

Potential growing season:	Cool Season
What CC to use based on next cash crop:	All types (functional groups) can be used.

Note: For mixtures, plant at least one species from each of the cover crop color groups shown below.

How does each recommended cover crop rank for your specific issues?

Possible cover crop	Most Serious Issue or Problem: Low N – Provide N		2nd most Serious Issue: Weeds – Residue Persistence	Weeds – Weed Supression	Most Important Benefit: High forage quality	Relative seed cost	Drainage: The field has no drainage issues	Links to Information:	
Mustards			Fair	Very Good	Good	$		SARE	Plant Materials
Radish			Fair	Excellent	Good	$$		SARE	Plant Materials
Rapeseed			Good	Very Good	Good	$		SARE	
Oats			Good	Excellent	Very Good	$$		SARE	
Rye/Triticale			Excellent	Excellent	Good	$$		SARE	Plant Materials
Wheat			Very Good	Very Good	Very Good	$		SARE	
Crimson Clover	Good/Very Good		Good	Very Good	Excellent	$$		SARE	Plant Materials
Red Clover*	Good/Very Good		Fair	Very Good	Excellent	$$		SARE	
White Clover*	Good/Very Good		Fair	Very Good	Excellent	$		SARE	
Winter Peas	Good/Very Good		Fair	Good	Very Good	$$$		SARE	Plant Materials

*This is a perennial species that may not be suited to certain cropping situations. Consult local extension recommendations.

Figure 5: Example tool output

Using Tool Outputs

Individual cover crop species suggestions are based on answers to the questions. The resource concern(s) determines whether the landowner plants one or a mixture of species. To maximize soil microbial activity, the cover crop mix should be diverse and contain representative(s) from three functional plant groups (i.e., a grass such as rye, a legume such as crimson clover, and a broadleaf such as radish). Some commodity crops will not require the use of all three functional groups (e.g., if the landowner is in continuous soybeans, there is no need to plant a legume for additional N, no grass species recommended if the current crop is rice due to the large amount of residual grass, etc.). It is important to note that some cover crop species may act as alternate hosts for crop pests. Please consult university cooperative extension agents for more information.

Seed mixes –Recommendations for seed mixes are not provided. The landowner and NRCS field staff develop seed mixes together. Sample mixes to address specific resource concerns are included in Appendix C.

Planting dates –Consult state electronic Field Office Technical Guide (eFOTG) for recommended planting dates for specific areas. The tool may recommend species that are not included in NRCS specifications for your state if the crop harvest date is later than the recommended planting window for that cover crop species in that area. Landowners may work around this problem by aerial seed application before the crop is harvested, or by planting cover crops the same day the commodity crop is harvested. Consult the local state agronomist for detailed advice.

Termination dates –Consult state eFOTG and USDA-Risk Management Agency guidelines. In general, terminate earlier on dryland than on irrigated fields as cover crops may dry out the soil. In some cases, termination dates may be based the emergence date of weeds. Avoid terminating cover crops more than 3 weeks before planting because some cover crop species, like daikon radish, may decompose and allow captured soil nitrogen to leach from the soil profile before the commodity crop is capable of using it. For crop insurance/Risk Management Guidelines see http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167871.pdf

Frequently Asked Questions (FAQs)

1. **My landowner has selected cover crop species based on the output. How do I determine seeding rates?**
   See Appendix C for sample mixes. Think about the primary resource concern and the quality of the cover crop biomass. Adjust the proportions of functional groups (grass, legume, broadleaf) after looking up the full seeding rates. Consult plant materials staff or area or state agronomists for more information.
2. **My landowner does not have a primary or secondary resource concern; he/she just wants to plant a cover crop for general soil health. What should I do?**

Maintaining or improving soil health is a purpose for the NRCS Cover Crop, Code 340, standard. Soil health is not a specific NRCS resource concern, but maintaining or improving organic matter (OM) is a big component of soil health; selecting low OM as a resource concern will address most issues with soil health. Planting cover crops require increased costs and labor, so careful planning is essential.

3. **The commodity crop will be harvested too late to plant the cover crop species I want by the optimum planting date—what do I do?**

   If the cover crop species is recommended by your state land grant university, ask the landowner if he/she is willing to aerially seed (airplane or highboy tractor, etc.) cover crop into the standing commodity crop before harvest. For example, aerially broadcasting (i.e. interseeding) cover crop seed in a soybean field prior to leaf drop can provide the needed cover crop growing season length. If the landowner is not willing to interseed, he/she needs to choose a cover crop species with an appropriate planting date. Planting cover crops species outside recommended timeframes is risky and may produce poor cover crop growth, wasted financial resources, and leave the targeted resource concerns unaddressed.

4. **Does the landowner have to plant all the species in the output?**

   If the landowner did not want to plant a mixture (answered "No" to the mixture question), the answer is no. Each species in the output meets all criteria and could be planted alone.

   If landowner wants a mixture (answered "Yes" to the mixture question), the answer is still "no", but the landowner needs to plant at least one cover crop species from at least two of the functional plant groups (grass, legume, and broadleaf) addressing both primary and secondary resource concerns. In the example output (Figure 4), this means the mixture would contain a legume and grass (two functional groups) or a legume and forb (also two functional groups). A forb and grass mixture will not address the Low N concern. For the greatest improvement in overall soil health, landowners should select a representative cover crop species from all three functional plant groups.

   It is important to consider the possibility of cover crops harboring or contributing pests and/or pathogens to the commodity crop. Contact cooperative extension agents for more information.

5. **My landowner is only concerned with planting legumes to fix nitrogen that will be available for the commodity crop. Can he or she plant only legumes?**

   If they want to, yes, but generally, it is not recommended to plant just legume species. Mixing in a species that establishes quickly such as wheat or radish can be beneficial. Why? Legumes are slower to establish compared to wheat or radish, leaving the soil bare for critical weeks after commodity crop harvest. In addition, slow establishment limits

the amount of nutrients (mostly N) captured by the cover crop. Nitrate nitrogen is mobile in soil and valuable fertilizer may be lost if cover crop roots are not established quickly. Planting a legume and quickly establishing non-legume cover crop species could result in both scavenged and fixed N being available for the commodity crop. For example, landowners practicing no-till corn production may have large amounts of surface residue to insulate the soil from rain and erosion while legumes are establishing; however, mobile nitrate-N leaches out of corn residue quickly if not reabsorbed by actively growing cover crops. In addition, N production is maximized by allowing legumes to reach the bloom period and nodulate (fix N). If the landowner plans to kill the cover crop early (to plant corn, for example), it may not be effective to purchase legumes for a cover crop. That landowner would be better off selecting a quickly establishing species such as cereal rye to catch leftover N from the previous crop.

6. **My landowner has never planted cover crops before and by using the tool we have found that his/her concerns can be addressed with a single cover crop species or a mixture of cover crop species. Which should they choose?**

   Planting mixtures is advisable for soil health, nutrient scavenging, rapid cover, etc., but mixtures can be more expensive and more difficult to manage and/or terminate. If a single cover crop species will address the resource concerns identified by a landowner who has never used cover crops before, “success” with a single species might be the best way to get started. Interested landowners will learn from a single species and may want to try mixtures as a next step.

References

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Ingels C, Horn M, Bugg R, Miller P. 1994. Selecting the right cover crop gives multiple benefits. Calif Agr 48(5):43-48. DOI: 10.3733/ca.v048n05p43.

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Snapp, S. S., S. M. Swinton, R. Labarta, D. Mutch, J. R. Black, R. Leep, J. Nyiraneza, and K. O'Neil. 2005. Evaluating Cover Crops for Benefits, Costs and Performance within Cropping System Niches. Agron. J. 97:322-332. doi:10.2134/agronj2005.032

Appendix A. Cover crop species names and references.

Common Name	Scientific Name	Cover Crop References
Black Oats	*Avena strigosa*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Appendix-B http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1255314&ext=pdf
Browntop Millet	*Urochloa ramosa*	http://www.caes.uga.edu/commodities/fieldcrops/forages/species/BrowntopMillet.html http://plants.usda.gov/plantguide/pdf/pg_urra.pdf
Buckwheat	*Fagopyrum esculentum*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Nonlegume-Cover-Crops/Buckwheat
Corn	*Zea mays*	n/a: used as a cash crop
Cotton	*Gossypium hirsutum*	n/a: used as a cash crop
Cowpea	*Vigna unguiculata*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Legume-Cover-Crops/Cowpeas http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/njpmcpg11930.pdf
Crimson Clover	*Trifolum incarnatum*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Legume-Cover-Crops/Crimson-Clover http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/orpmcpg11726.pdf
Hairy Vetch	*Vicia villosa*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Legume-Cover-Crops/Hairy-Vetch
Lupine	*Lupinus* spp.	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Appendix-B
Mustards	*Brassica* spp.	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Nonlegume-Cover-Crops/Brassicas-and-Mustards http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/orpmcpg11337.pdf
Oats	*Avena sativa*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Nonlegume-Cover-Crops/Oats
Peanut	*Arachis hypogea*	n/a: used as a cash crop
Radish	*Raphanus sativus*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Nonlegume-Cover-Crops/Brassicas-and-Mustards http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/arpmcpg11828.pdf
Rapeseed	*Brassica napus*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Nonlegume-Cover-Crops/Brassicas-and-Mustards
Red Clover	*Trifolium pratense*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Legume-Cover-Crops/Red-Clover
Rye	*Secale cereale*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Nonlegume-Cover-Crops/Cereal-Rye http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mopmcpg11784.pdf
Soybean	*Glycine max*	n/a: used as a cash crop
Sorghum-Sudangrass	*Sorghum bicolor* X	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Nonlegume-Cover-Crops/Sorghum-Sudangrass
Sunn Hemp	*Crotalaria juncea*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Appendix-B http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053283.pdf

Common Name	Scientific Name	Cover Crop References
Triticale	× *Triticosecale [Secale x Triticum]*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Nonlegume-Cover-Crops/Cereal-Rye http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mopmcpg11784.pdf
Wheat	*Triticum aestivum*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Nonlegume-Cover-Crops/Winter-Wheat
White Clover	*Trifolium repens*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Legume-Cover-Crops/White-Clover
Winter Peas	*Pisum sativum* spp. *arvense*	http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Legume-Cover-Crops/Field-Peas http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/wapmcpg11190.pdf

Appendix B. Cover crop selection tool inventory questions.

Resource Inventory Questions: Cover Crop Selection Tool

Covers these planning steps: 1) Identify problems, 2) Determine objectives, 3) Inventory resources

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Landowner name: _____
Field: _____
Farm/tract number: _____
Date: _____

1) What is your cash crop now? (species)

2) When is your normal cash crop planting date? (month)

3) When is your normal cash crop harvest date? (month)

4) What is the next cash crop you anticipate planting (i.e., what is your crop rotation?) (species)

5) When will you plant the next cash crop in your rotation? (month)

6) What is your tillage regime? (no-till, conventional till, limited till, etc.)

7) When do you prepare your seedbed for planting? (month)

8) What are the two most serious problems you think cover crops can help with? (select one)
    a. Soil compaction/lack of quick water infiltration
    b. Low soil organic matter/soil moisture retention/nutrient retention/herbicide efficacy (CEC)
    c. Lack of adequate control of weeds or nematodes
    d. Runoff/erosion at edge of field or on beds, etc.
    e. Low N

9) What is the second most serious problem you think cover crops will help with? (select one from list above or none)
    a. Soil compaction/lack of quick water infiltration
    b. Low soil organic matter/soil moisture retention/nutrient retention/herbicide efficacy (CEC)
    c. Lack of adequate control of weeds or nematodes
    d. Runoff/erosion at edge of field or on beds, etc.
    e. Low N

10) What is the most important benefit you would like to see a cover crop provide to your cropping system? (select one or none)
    a. Provide N
    b. Scavenge N
    c. Scavenge P & K
    d. Attract beneficial insects/pollinators
    e. Provide high-quality forage for grazing

11) Would you like to plant a mix of cover crop species? (yes or no; if no, species still may be mixed, but all three plant functional groups may not be represented)
12) What is your soil pH? (select one)
    a. <5
    b. 5-6
    c. 6-7
    d. 7-8
    e. >8

13) Does your field have poor soil drainage most of the time between cash crops? (yes or no)

14) Have you applied any soil residual herbicides? (yes or no; if yes, consult cooperative extension agents for appropriate rotation interval restrictions before discussing cover crop planting)

15) Have you planted wildlife food crops in the past or present? (yes or no; if yes, species that worked well in current crop rotation may be excellent choices for cover crops)

Appendix C. Using tool output recommendations to design cover crop seeding mixtures to solve targeted resource concerns.

A full seeding plan should include detailed instructions about seedbed preparation, specific planting and termination methods and dates, and monitoring instructions. Detailed information is available from local NRCS offices and sources listed in Appendix A. Caution: full seeding rates differ by state. You must check recommendations on the state eFOTG first before designing mixes or seeding rates.

Table 4: Example seeding rates for continuous soybean rotation (based on tool output)

	Soil compaction[1]			Low soil organic matter[2]			Nematodes[3]		
Plant species	**% of seed mix**	**Full seeding rate (lb/ac)**	**Potential seeding rate (lb/ac)**	**% of seed mix**	**Full seeding rate (lb/ac)**	**Potential seeding rate (lb/ac)**	**% of seed mix**	**Full seeding rate (lb/ac)**	**Potential seeding rate (lb/ac)**
Daikon radish	40%	10	4	15%	10	1.5	20%	10	2
Cereal rye	60%	100	60	75%	100	75	-	-	-
Black oats	-	-	-	-	-	-	80%	120	96

Example mixes from tool outputs (only the primary resource concern is changed; Figure 5). **Continuous soybean, no-till/limited tillage, burndown in March prior to planting.** Notice that the tool does not give any legume recommendations, as they may harbor similar pests that attack the cash crop.

Discussion of important points:

[1]Breaking up a compacted zone or plow pan is best done with a combination of root structures. The radish creates macropores for quick water infiltration, while the fibrous roots of cereal rye create micropores for root gas exchange and microbial habitat. Daikon radish is much more expensive than cereal rye, so the proportions are adjusted to 40% radish and 60% cereal rye and full seeding rates are adjusted accordingly.

[2]In general, grasses produce lots of biomass and can increase soil organic matter efficiently, so planting at 75% of the full rate is a good place to start. Mixing daikon radish at 15% gives you another functional group and also lowers the carbon to nitrogen (C:N) ratio of the biomass. One problem with too much grass is that the straw breaks down slowly and can tie up nitrogen for the cash crop (very high C:N ratio).

[3]Rye, radish and black oats are all rated well for discouraging nematode populations. One grass and one radish species may be used, depending on producer choice and/or price. Black oats (or cereal rye) at 80% and daikon radish at 20% of the full rates gives a robust mixture while keeping the C:N lower than a pure grass

1	What is your cash crop now?	soybeans
2	What is your normal planting date?	Apr
3	What is your normal harvest date?	Sep
4	What is the next cash crop you anticipate planting (i.e., what is your rotation?)	soybeans
5	When will you plant the next cash crop in your rotation?	Apr
6	What is your tillage regime?	no-till/strip till
7	When do you prepare cash crop seedbed for planting (if limited-till when do you burndown before planting)?	Mar
8	What is your most serious problem you think cover crops will help with?	Soil compaction/lack of quick water infiltration
9	What is your second most serious problem you think cover crops will help with?	None

Figure 6: Tool input selections for example scenario.