United States Department of Agriculture
Natural Resources Conservation Service

2011 Ranking Period 1

Soil Quality Enhancement Activity - SQL02 – Continuous cover crops

Enhancement Description
Growing continuous *seasonal* cover crops of grasses, legumes or forbs following all annual crops during all the non-crop production periods of the rotation. Continuous cover cropping is applicable to conventional, specialty and organic crop production systems.

Land Use Applicability
Cropland.

Benefits
Growing seasonal cover crops during all non-crop periods between annual crops reduces wind and water erosion. Cover crops also restore and maintain soil productivity and soil quality over a wide range of climates and crop species. They do so by increasing organic matter, improving soil fertility, breaking pest cycles and providing habitat for soil macro-fauna, such as earthworms.

Criteria
Implementation of this enhancement requires continuous cover crops during the non-crop production period of the rotation. The cover crops must meet 2 or more of the following criteria:

1. High bio-mass cover crops for erosion control and increased soil organic matter improvement.
    a. Plant a cover crop with a growth potential to produce a minimum of 2,000 lbs/acre (dry weight) above ground bio-mass when terminated by harvest, frost, mowing, tillage, crimping, and/or herbicides in preparation for the following crop.
2. Legume cover crops for biological nitrogen fixation.
    a. Plant a leguminous cover crop between two primary crops in the rotation, or plant a leguminous crop that replaces one of the primary crops. This enhancement does not apply to legumes that are normally part of the crop rotation. It shall be seeded at a rate recommended by the NRCS Field Office technical Guide. Estimate nitrogen credits from the leguminous crop and base any additional N applications according to the guidelines of the Land Grant University.
3. Non-leguminous cover crops to capture and recycle residual nitrogen.
    a. Plant a cover crop with a growth rate and rooting depth sufficient to scavenge excess nitrogen from the root zone of the previous crop. Seed the cover crop at the rate recommended by the NRCS Field Office Technical Guide. Reduce the nitrogen recommendation for the following crop by the amount of nitrogen estimated to have been scavenged and recycled by this cover crop.

This enhancement does not apply to the same acres on which a leguminous cover crop is applied.

4. Cover crops for weed suppression.
    a. Plant a cover crop with the chemical and physical characteristics necessary to suppress or compete with the identified target weed species. Leave cover crop residues on the soil surface to maximize the allelopathic (chemical) and mulching (physical) effects. Select cover crops as recommended in the NRCS Field Office Technical Guide or from the Land Grant University as appropriate.
5. Biodiversity improvement with cover crops.
    a. Plant cover crop species with the characteristics to attract beneficial insects such as pollinators and/or predator insects, serve as trap crops for damaging insects, and/or provide natural bio-fumigation for soil dwelling pests. Select cover crops to meet the planned objective as recommended in the NRCS Field Office Technical Guide or from the Land Grant University as appropriate.

Documentation Requirements

1. Crop rotation records, including rotation length in years, crops and cover crops planted.
2. Sequence and description of operations for each crop and cover crop including harvest, tillage, nutrient placement and planting/seeding

Michigan Supplement

Soil Quality Enhancement Activity – SQL02 - Continuous Cover Crops

Continuous Cover Crops
Cover crops include grasses, legumes and forbs that are planted for *seasonal* cover and other resource conservation purposes. Continuous cover crops are the use of *seasonal* cover cropping throughout the crop rotation in conjunction with the production crop or whenever the production crop is not present. Continuous cover cropping is applicable to conventional, specialty and organic crop production systems.

Continuous cover crops is most effective in a conservation management system when used in combination with a conservation crop rotation, residue management, nutrient and, pest management practices, conservation buffer practices and/or other conservation practices needed on a site-specific basis to address natural resource concerns and the landowner's objectives. The major objectives of continuous cover crops are reduced soil erosion from wind and water and increased soil organic matter content.

Benefits: A major risk of this practice is soil moisture depletion prior to establishment of a crop. A successful annual program may require the use of irrigation. Refer to NRCS eFOTG standards 442 - Sprinkler Irrigation System, 449 - Irrigation Water Management, or 441 - Micro-irrigation system 441.

A major benefit of cover crops is preventing wind and water erosion by providing surface cover that offers resistance to soil-particle detachment and transport (Langdale et al., 1991) and protection of aggregates from breakdown by raindrop impact. Indirect benefits occur from increased soil organic matter which helps prevent surface sealing and increases water storage capacity and soil macroporosity (Dabney, 1998).

Cover crops have potential to reduce pesticide applications for weed and insect control (Lal et al., 1991; Dabney et al., 2001; Kristensen et al., 2003; Worsham, 1991). Cover crops also control weeds through competition, allelopathy, and/or physical effects (Creamer et al., 1996; Liebman and Davis, 2000).

Cover crops can harbor both harmful and beneficial arthropods (Bugg 1991; Masiunas, 1998). Cover crops can also serve as a host for alternative prey for beneficial arthropods, provide a favorable habitat for arthropod predators, interfere with host-finding abilities of pest species and serve as a trap crop for pests as the primary crop.

Cover crops play a major role in the restoration and maintenance of soil productivity and soil quality over a wide range of climates and crop species; they do so by increasing organic matter and providing good habitat for soil macro-fauna, such as earthworms.

Continuous cover crops enhancement activities help agricultural producers and the environment as they can:

- Reduce erosion from wind and water
- Increase soil organic matter and soil humus content
- Capture, recycle and redistribution on nutrients
- Encourage Biological nitrogen fixation
- Increase biodiversity
- Suppress Weeds
- Encourage pollinators
- Control dust in the air
- Protect crops from wind damage.
- Suppress harmful nematodes

Criteria for Continuous Cover Crops

Acceptance of this enhancement requires a participant to be applying continuous cover crops during the non-crop production period of the rotation and meeting the general criteria, and additional criteria for wind, water erosion and improving soil condition in conservation practice standard Cover Crop 340. Additionally the participant must employ **two or more** of the following Continuous Cover Crops Enhancement Activities.

1. ☐ High bio-mass cover crops for erosion control and soil organic matter improvement.
2. ☐ Legume cover crops for biological nitrogen fixation.
3. ☐ Non-leguminous cover crops to capture and recycle residual nitrogen.
4. ☐ Cover crops for weed suppression.
5. ☐ Biodiversity improvement with cover crops.

All cover crops sown for the following purposes should follow the MI NRCS Cover Crop Standard 340 for seeding rate, method, date, and time of planting.

Activities Criteria

1. High Bio-Mass Cover Crops for Erosion Control and Soil Organic Matter Improvement

Activity: Maximize bio-mass produced for erosion control and soil organic matter.

Minimum Criteria: The cover crop selected shall have the growth potential to produce a minimum of 2,000 lbs/Acre above gound bio-mass. See Chart 2 Performance & Roles, from "Managing Cover Crops Profitably, 3rd Edition" or use NRCS MI RUSLE2 or WEPS Models to estimate bio-mass production.

2. Legume Cover Crops for Biological Nitrogen Fixation

Activity: Planting a leguminous cover crop that will replace part of the nitrogen required by the following crop.

Minimum Criteria: A leguminous cover crop will be planted as part of the crop rotation. This may be a leguminous cover crop that is planted between two primary crops in the rotation, or it may be a leguminous crop that replaces one of the primary crops. It may be a legume inter-seeded in the existing crop. It shall be seeded at a rate recommended by the NRCS Field Office technical Guide Cover Crop standard 340. Nitrogen credits from the leguminous crop will be estimated and applied according to the guidelines MSU or NRCS 590 or 340 Standard.

Table 1

Legume	Life cycle**	Nitrogen Value (lb/ac)	Seed rate (lb/ac)	Seed depth (inches)
Annual medic	SA	40-100	10-39	¼ -1/2
Berseem clover	SA	60-90	9-20	¼ -1/2
Crimson clover	SA	50-60	12-20	¼ -1/2
Field peas	SA	30-100	70-150	1-2
Hairy Vetch	WA	60-180	25-40	¼ -1/2
Mammoth red clover	B	60-70	8-15	¼ -1/2
Sweetclover	B	70-90	8-15	¼ -1/2
Alfalfa	P	50-150	9-25	¼ -1/2
Alsike clover	B/P	60-70	5-7	¼ -1/2
Birdsfoot trefoil	P	40-100	5-10	¼ -1/2
Medium red clover	P	60-70	10-15	¼ -1/2
60/40 or 80/20 mix*	B/P	60-90	8-15	¼ -1/2
White clover	P	60-100	10-15	¼ -1/2

*red clover and sweet clover mixture
** Life cycles: P – perennial; WA – winter annual: SA – summer annual; B- biennial

3. Non-Leguminous Cover Crops to Capture and Recycle Residual Nitrogen

Activity: Using a cover crop that will scavenge nitrogen left in the soil after the harvest of a primary crop in the rotation.

Minimum Criteria: The cover crop selected shall have the growth rate and rooting depth necessary to scavenge excess nitrogen from the root zone of the previous crop. It shall be seeded at a rate recommended by the NRCS Field Office Technical Guide 340 standard. Any species that has the ability to scavenge excess nitrogen is acceptable. The nitrogen recommendation for the following crop shall be reduced by the amount of nitrogen estimated to have been scavenged and recycled by this cover crop.

Table 2

Non-legumes	Life cycle**	Estimate Nitrogen Capture residual N***	Seed rate (lb/ac)	Seed depth (inches)
Buckwheat	SA	PSNT (lbs/ac) x 50%	36-60	¼ -1/2
Forage turnips	SA	PSNT (lbs/ac) x 50%	3-5	¼ -1/2
Oats	SA	PSNT (lbs/ac) x 50%	34-68	¼ -1/2
Oilseed radish	SA	PSNT (lbs/ac) x 50%	15 - 25	¼ -1/2
Rape	WA	PSNT (lbs/ac) x 50%	3 - 8	¼ -1/2
Annual ryegrass	WA	PSNT (lbs/ac) x 50%	15 - 25	¼ -1/2
Barley	WA	PSNT (lbs/ac) x 50%	48 - 96	1-2
Rye	WA	PSNT (lbs/ac) x 50%	28 - 115	½-1
Triticale	WA	PSNT (lbs/ac) x 50%	60 - 120	½-1
Wheat	WA	PSNT (lbs/ac) x 50%	60 - 120	½-1

*red clover and sweet clover mixture

** Life cycles: P – perennial; WA – winter annual: SA – summer annual; B- biennial

***PSNT – Use the Pre-Side-dress Nitrogen Test procedure for corn in the fall to estimate residual N available after cover crop is sown and before the cover crop emerges. Example Calculation: ((PSNT (ppm x 6) x 50%)) to estimate N credit from soil residual N captured.

This enhancement does not apply to the same acres on which a leguminous cover crop is applied.

4. Cover Crops for Weed Suppression

Activity: Planting and managing a cover crop species with chemical and physical characteristics to suppress or compete with weeds.

Minimum Criteria: The cover crop selected shall have the chemical and physical characteristics to suppress or compete with the identified target weed species. Cover crop residues will be left on the soil surface to maximize the allelopathic (chemical) and mulching (physical) effects. Cover crops selected shall be as recommended in the NRCS Field Office Technical Guide 340 standard or from MSU as appropriate.

Any of the cover crops listed above in Tables 1 or 2 will suppress the following Annual broadleaves based on MSUE research at Kellogg Biological Station:

- Common lambsquarters
- Common pigweed
- Common ragweed
- Nightshade
- Velvetleaf

Any of the cover crops listed above in Tables 1 or 2 will suppress the following Annual grasses based on MSUE research at Kellogg Biological Station:

- All foxtail species
- All crabgrass species
- Fall panicum
- Barnyardgrass

Any of the perennial legume cover crops listed in Table 1 and mowed and fertilized for one year as a hay crop in the crop rotation should suppress the following perennial weeds:

- Canada thistle
- Quackgrass
- Yellow nutsedge

*Source: MSUE Bulletin E2704 Michigan Field Crop Pest Ecology and Management 2000 Weed Ecology and Management chapter.

5. Biodiversity Improvement with Cover Crops

Activity: Planting and managing cover crops to attract beneficial insects (predators, pollinators, etc), serve as trap crops for damaging insects, and provide natural bio-fumigation for soil dwelling pests.

Minimum Criteria: Cover crop species will have the characteristics to meet the objectives (attraction, trap crop, bio-fumigant, etc.). Cover crops selected and the required management to meet the objective shall be as recommended in the NRCS Field Office Technical Guide 340 standard or from MSU.

1. Attract Pollinators Predators and trap crops: Any of the legumes in Table 1, buckwheat, oilseed radish, pacific gold oriental mustard and dwarf Essex rape.
2. Bio-fumigation:
   - Pacific Gold Mustard – root knot and lesion nematodes potatoes and orchards
   - Oilseed radish – Sugarbeet cyst nematode (Use only Adagio or Colonel varieties)

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Chart 2 **PERFORMANCE AND ROLES**

	Species	Legume N Source	Total N (lb./A)[1]	Dry Matter (lb./A/yr.)	N Scavenger[2]	Soil Builder[3]	Erosion Fighter[4]	Weed Fighter	Good Grazing[5]	Quick Growth
NONLEGUMES	Annual ryegrass *p. 74*			2,000–9,000	◕	◕	◕	◕	◕	◕
	Barley *p. 77*			2,000–10,000	◕	◕	●	◕	◕	◕
	Oats *p. 93*			2,000–10,000	◕	◑	◕	●	◑	●
	Rye *p. 98*			3,000–10,000	●	●	●	●	◑	●
	Wheat *p. 111*			3,000–8,000	◕	◕	◕	◕	◕	◕
	Buckwheat *p. 90*			2,000–4,000	○	◑	◔	●	○	●
	Sorghum–sudan. *p. 106*			8,000–10,000	●	●	●	◕	◕	●
BRASSICAS	Mustards *p.81*		30–120	3,000–9,000	◑	◕	◕	◕	◑	◕
	Radish *p. 81*		50–200	4,000–7,000	●	◕	◕	●	◑	◕
	Rapeseed *p. 81*		40–160	2,000–5,000	◕	◑	◕	◕	◑	◕
LEGUMES	Berseem clover *p. 118*	●	75–220	6,000–10,000	◕	◕	◕	●	●	●
	Cowpeas *p. 125*	●	100–150	2,500–4,500	◔	◑	●	●	◑	◕
	Crimson clover *p. 130*	◕	70–130	3,500–5,500	◑	◕	◕	◕	●	◑
	Field peas *p. 135*	●	90–150	4,000–5,000	◔	◑	◕	◑	◕	◕
	Hairy vetch *p. 142*	●	90–200	2,300–5,000	◔	◕	◑	◑	◑	◔
	Medics *p. 152*	◑	50–120	1,500–4,000	◔	◑	◑	◕	◕	●
	Red clover *p. 159*	◕	70–150	2,000–5,000	◑	◕	◑	◕	●	◔
	Subterranean clovers *p.164*	●	75–200	3,000–8,500	◔	◕	◕	●	◕	◑
	Sweetclovers *p. 171*	●	90–170	3,000–5,000	◔	●	◕	◕	◕	◑
	White clover *p. 179*	●	80–200	2,000–6,000	◔	◑	◕	◕	●	◔
	Woollypod vetch *p. 185*	●	100–250	4,000–8,000	◑	●	◑	●	◑	◕

[1]**Total N**—Total N from all plant. Grasses not considered N source. [2]**N Scavenger**—Ability to take up/store excess nitrogen.
[3]**Soil Builder**—Organic matter yield and soil structure improvement. [4]**Erosion Fighter**—Soil-holding ability of roots and total plant.
[5]**Good Grazing**—Production, nutritional quality and palatability. Feeding pure legumes can cause bloat.

○ =Poor; ◔ =Fair; ◑ =Good; ◕ =Very Good; ● =Excellent

Chart 2 **PERFORMANCE AND ROLES** continued

	Species	Lasting Residue[1]	Duration[2]	Harvest Value[3] F*	Harvest Value[3] S*	Cash Crop Interseed[4]	Comments
NONLEGUMES	Annual ryegrass	◕	◕	◑	◔	●	Heavy N and H_20 user; cutting boosts dry matter significantly.
NONLEGUMES	Barley	●	◑	◕	◑	◕	Tolerates moderately alkaline conditions but does poorly in acid soil < pH 6.0.
NONLEGUMES	Oats	◑	◔	◑	◑	●	Prone to lodging in N-rich soil.
NONLEGUMES	Rye	●	◕	◔	◔	◕	Tolerates triazine herbicides.
NONLEGUMES	Wheat	◕	◕	◑	◕	◔	Heavy N and H_20 user in spring.
NONLEGUMES	Buckwheat	○	◔	○	◔	◕	Summer smother crop; breaks down quickly.
NONLEGUMES	Sorghum–sudangrass	◕	●	●	○	○	Mid-season cutting increases yield & root penetration.
BRASSICAS	Mustards	◔	◑	○	◔	○	Suppresses nematodes and weeds.
BRASSICAS	Radish	◔	◑	◕	◔	◔	Good N scavenging and weed control; N released rapidly.
BRASSICAS	Rapeseed	◑	◕	◔	●	○	Suppresses *Rhizoctonia.*
LEGUMES	Berseem clover	◑	●	●	◕	◑	Very flexible cover crop, green manure, forage.
LEGUMES	Cowpeas	◔	●	◑	◑	◑	Season length, habit vary by cultivar.
LEGUMES	Crimson clover	◑	◔	●	◕	●	Established easily, grows quickly if planted early in fall; matures early in spring.
LEGUMES	Field peas	◔	◑	●	◕	●	Biomass breaks down quickly.
LEGUMES	Hairy vetch	◔	◕	◔	◕	◑	Bi-culture with small grain expands seasonal adaptability.
LEGUMES	Medics	◑	◕	◑	◑	◑	Use annual medics for interseeding.
LEGUMES	Red clover	◔	◑	●	◕	●	Excellent forage, easily established; widely adapted.
LEGUMES	Subterranean clover	◕	◕	◕	○	●	Strong seedlings, quick to nodulate.
LEGUMES	Sweetclovers	◕	◕	◕	◑	◑	Tall stalks, deep roots in second year.
LEGUMES	White clover	◔	●	◕	◑	◕	Persistent after first year.
LEGUMES	Woollypod vetch	◔	◕	◔	◕	◑	Reseeds poorly if mowed within 2 months of seeddrop; overgrazing can be toxic.

[1]**Lasting Residue**—Rates how long the killed residue remains on the surface. [2]**Duration**—Length of vegetative stage.
[3]**Harvest Value**—Economic value as a forage (F) or as seed (S) or grain. [4]**Cash Crop Interseed**—Rates how well the cover crop will perform with an appropriate companion crop.

○ =Poor; ◔ =Fair; ◑ =Good; ◕ =Very Good; ● =Excellent