COVER CROPS

Cover crops may be considered an integral part of any cropping system that seeks to become more sustainable and supportive of conservation agriculture. Cover crops are grown in most cropping systems to provide environmental and soil productivity benefits. Thus, integrating cover crops into a crop production system should be considered a long-term investment for conserving and/or improving soil and water resources. The benefits arise from:

- Providing soil cover to prevent erosion in the off-season;
- Increasing water infiltration into the soil;
- Providing plant residues to increase soil organic matter;
- Reducing nutrient loss and leaching from the soil profile and/or lowering residual soil nitrogen (N);
- Reducing herbicide runoff in a corn–soybean rotation;
- Suppressing or reducing early-season weeds and weed biomass; and
- In the case of legumes, increasing N supply for the following summer grain crop.

For row crop producers in the Midsouth, the major categories of winter cover crops to consider are either grasses (wheat, rye, oats), legumes (vetches, peas, clovers), or a mixture of the two, and brassicas (See table 4 at end of article). The grasses will generally require N fertilizer to produce the desired biomass. The legumes will not require any fertilization since they have the ability to "fix" N; however, they may require the appropriate N-fixing bacteria. Some of the N that is "fixed" by the legumes will be available to the following summer crop, and this makes planting a legume cover crop more economical.

A cover crop can consist of a single species or a mixture of species. Current dogma is that successful establishment of a non-volunteer cover crop is best accomplished with the seeding of a mixture of diverse species, specifically grasses and legumes. However, this approach will create potential seeding and management problems because of the diversity of species in the mixture.

The CTIC published results from a cover crops survey that was conducted during early 2015 in the Midwest. Even though the results from this survey likely are not applicable to Midsouth producers, they do give some insight into practices that can be considered by producers in the southern US.

An excellent source for cover crop information for the entire US is Managing Cover Crops Profitably--SARE. Important sections and their page numbers are listed in Table 1. The charts on pages 66-72 are especially useful.

Table 1. Managing Cover Crops Profitably, Sustainable Agriculture Network, Handbook Series 9, June 2012	
Subject	**Page no.**
Plant Hardiness Zones	2
Benefits of Cover Crops	9
Selecting the Best Cover Crops	12
N Fertilizer Savings from a Cover Crop	22
Tables and Charts Introduction	62
Top Regional Cover Crops Species	66
Hardiness Zones of Cover Crop Species (Midsouth is Zone 7)	69
Planting and Seed Costs of Cover Crop Species	70
Properties of Cover Crops by Species	74-194

Grass and legume species that provided a high biomass yield and legume species that provided biomass with a high N content in Louisiana are highlighted in Table 2.

Table 2. Biomass and N production from selected cover crops in Louisiana; average of four years and six locations.

	Aboveground biomass yield			Average
	Average	**Low**	**High**	**N content**
Species	------------------------------lb/acre------------------------------			
Hairy vetch	**4347**	**2946**	**8699**	**144**
Common vetch	4054	0*	4592	122
Crimson clover	**5827**	**4286**	**8254**	**147**
Burseem clover	**5489**	**2843**	**9498**	**137**
Sub clover	4290	2733	5567	122
Austrian winter pea	3866	1904	7088	88
Wheat	**4835**	**2103**	**6738**	**54**
Ryegrass	3856	851	7285	46

Adapted from Boquet. *Winter killed in some years.
Cereal rye not included in above work.

Basic management information for 5 cover crop species that should be considered by Midsouth producers is shown in Table 3. The information is general and should be supplemented with the more detailed information in the linked article in Table 1 and the linked sources in the footnotes.

Table 3. Management details for five selected cover crop species for the Midsouth.

Cover crop	Date of Planting	Seeding Rate	Cost of seed*	Fall N requirement	Kill stage
		lb/acre	*$/lb*	*lb/acre*	
Hairy vetch	30-45 days before frost**	15-20	1.90-2.10	Inoculate#	Full bloom
Crimson clover	6-8 wks before frost**	15-20	1.50-1.70	Inoculate#	Full bloom
Berseem clover	Aug. 30–Oct. 15	10-12	2.15-2.20	Inoculate#	Full bloom
Wheat	Sept. 15–Oct. 15	75–90	0.25	None	soft dough
Cereal rye	late summer–early fall	65-80	0.25-0.35	None	flowering

*Estimated from Center Seeds and Green Cover Seed.
**Average frost date for a location. See article for Mississippi locations.
Use inoculant specific for species or class.

Planting date is critical for the success of winter cover crops. Cover crops should be planted early enough to:

- Establish adequate stands, achieve ground cover, and attain some growth before the onset of low temperatures;
- Achieve the desired growth for biomass production;
- Achieve adequate growth for significant nitrogen fixation (legumes); and
- Achieve growth that is sufficient to suppress winter weeds.

Cover crops may be planted preceding harvest (overseeding or interseeding) or immediately following harvest of a summer crop. It is projected that interseeding some cover crop species before harvest can result in the production of more dry matter in the fall than those planted after harvest. For instance, overseeding cereal rye into soybeans at leaf drop will result in more biomass yield than if seeding is delayed until after harvest.

Gandy has several types of seeders that attach to the head of a grain harvester so that seeding is done with the harvest operation. An article in No-Till Farmer describes other equipment that has been built or modified to spread cover crop seed.

Seeding rate will vary for planting method (drilled or broadcast—see below Table 4) and whether or not each species is planted alone or in a mixture; e.g. grass and legume mix.

Seed prices represent a major portion of the costs associated with establishing legume cover crops. However, the above-mentioned N contribution of the legume cover crop to a following grain crop will somewhat offset the high cost of the seed.

N requirement (fall-applied) of wheat and cereal rye will depend on whether or not they follow a legume (e.g. soybeans) or grain crop (e.g. corn, grain sorghum) and the desired fall growth. Also, when grass cover crop species are planted in a mix with legume species, fall-applied N may not be necessary.

Kill date or stage will vary if preceding an early-planted summer crop such as corn since the cover crop should be killed at least 2 weeks prior to planting the summer crop. Also, the kill date should match the desired N contribution with maximum growth and the manageable residue amount from the cover crop, and should be 2 weeks prior to planting the intended summer crop (See following section on timing of cover crop termination).

Cover crops usually are destroyed by tillage or herbicides prior to planting of a following summer row crop. They can also be destroyed mechanically by a crimper/roller designed for this purpose. See the video with rolling of the cover crop and planting of the summer crop in one operation and the video of various kinds of crimper/rollers. An implement that is commonly referred to as a pulverizer or cultipacker made by Brillion may also be used. The best results are likely achieved when the crimping/rolling and planting are done in one operation as shown in the first video because this dictates that the planter drill is running parallel to the downed cover crop.

Important points to consider when using herbicides to terminate cover crops can be found here, with more detail presented in a publication from Purdue University.

The following are traits or properties associated with the 5 species in Table 3.

Cereal rye

- Winter hardy.
- Relatively inexpensive seed.
- Excellent scavenger of unused/residual soil N to prevent N leaching.
- Can serve as an overwintering cover crop after corn or before or after soybeans.
- Can be overseeded into maturing corn and soybeans.
- Produces relatively high amount of biomass/residue.
- Taller and quicker growing than wheat.
- Rapid resumption of spring growth.
- Out-competes many weeds.
- Works well with companion legume cover crops such as hairy vetch.
- Spring weed suppression through N deprivation to weeds that lasts 5-6 weeks.
- Mineralization of N from decomposing residue very slow.
- Planted following soybean harvest can result in as much post-planting residue cover as a crop of corn.

- Environmental benefits of a killed winter rye cover crop do not impact corn or soybean yields.

Winter Wheat

- Seed are less expensive than cereal rye seed.
- Slower to mature than cereal rye, and thus easier to manage.
- Excellent scavenger of unused or residual soil N to prevent N leaching.
- Works well with companion legume cover crops such as crimson clover or hairy vetch.
- Rapid spring growth aids in suppressing weeds, especially when grown with a legume.
- Produces less but easier-to-manage residue than cereal rye.
- Can use bin-run seed for planting.
- Provides the option of harvesting for grain if summer crop plans change.
- May not be as adapted to wet soils as cereal rye.
- Should be seeded in a mix with legumes on low-N soils.
- Seed at higher rate than shown in table if overseeding into soybeans.

Hairy vetch

- A top producer of biomass.
- Heavy contributor of N that is readily available to the following summer crop.
- Slow fall growth and vigorous spring growth that smothers spring weeds.
- Decomposition of residue leads to ineffective weed suppression after 3-4 weeks.
- Killed vetch left on the soil surface conserves soil moisture.
- May provide enough N for low-N-requiring crops such as grain sorghum.
- Relatively drought tolerant.
- Excellent scavenger of soil P.
- Most widely used of the winter annual legumes because of its high N production, vigorous growth, tolerance of a wide range of soil conditions, low fertility needs, and winter hardiness.
- Works well in a hairy vetch/cereal rye mixture.
- Provides high N contribution even in no-till systems.
- Mechanical killing much quicker and more thorough using a roller with a chevron design--video.
- Better adapted to sandy soils than crimson clover.

Crimson clover

- Rapid fall growth.
- Provides adequate N for grain sorghum production.
- Fixes large amounts of N and produces large amounts of biomass.
- Grows well in mixtures with cereal grains.
- May not be suited for clay soils.
- Requires adequate P and K and soil pH above 5.5 for adequate N fixation.
- Planting too early will result in fall seed production and delayed regrowth from seed in the spring.
- May be managed to reseed for later-planted summer crops.
- Works well with no-tilling into killed residue that is left on the surface.
- Easy to kill mechanically, especially if at

early to full bloom.

Berseem clover

- Fixes large amounts of N and produces large amounts of biomass.
- Adapted to silt and clay textured soils.
- One of most expensive legume seeds.
- May be subject to winterkill if temperatures fall below 20 deg. F for several days.
- May not be effectively killed with rolling/crimping.
- Is susceptible to root-knot nematode.

Cover Crop Mixtures

- Mixture of grasses and legumes provides both biomass and N production.
- May improve winter survival of a companion species.
- Mixing grass and legume species may extend weed control effects of mulches.
- Provides greater control of winter annual weeds.
- Produces longer-lasting residues.
- Provides insurance against survival failure of a particular single species planting.
- Higher seed cost than planting only grasses.
- May provide too much residue to manage effectively.
- Grass/legume cover crop mix adjusts to amount of available soil N: if there is an abundance of N, the grass dominates; if there is not much available soil N, the legume will tend to dominate.
- Adding grasses to fall-seeded legumes improves soil coverage in the fall and winter.
- May complicate killing in the spring by having to compromise on which component(s) of the mix to choose for the proper time or stage to kill.

There are other cover crop species that may be appropriate for the Midsouth. Thus, the above list is not intended to recommend the five in the list to the exclusion of others that may be suitable.

Cover Crops in Soybean and Corn Production Systems

Cover crops can suppress early-season weeds for the first 3 to 5 weeks after soybean planting.

Cover crops planted in the fall and killed with herbicides before soybean planting the following spring favor soybean emergence and growth over that of weeds.

A grass winter cover crop can result in lower corn yield because of the depletion of soil nitrate levels by cover crop decomposition that is not overcome by post-emergence broadcast application of N to the corn crop.

The decreased N requirement from added fertilizer (and thus lower N fertilizer expense) for corn following a legume cover crop will somewhat offset the higher estimated cost for establishment of the legume cover crop compared to that for a cereal cover crop.

The preponderance of research results indicates that using cover crops in a soybean or corn system does not result in increased yield of either soybean or corn. Thus, net returns may be lower when cover crops are part of a soybean or corn production system because their use results in an added expense with no increased return.

Using cover crops is an environmentally sustainable practice, but likely is not an economically sustainable one in traditional or non-organic soybean and corn production systems. This must be weighed against the long-term soil health improvements that are expected.

Cover crops can be used in a production system that includes corn to increase farm profits by allowing a greater amount of corn residue to be harvested for sale as a cellulosic ethanol feedstock. Click here for a summary of this concept and here for a Purdue University article that describes the concept in detail.

Results from a 12-year study conducted in southern Illinois and published in "Long-Term Effects of Cover Crops on Crop Yields, Soil Organic Carbon Stocks and Sequestration" in the August 2014 issue (online) of the Open Journal of Soil Science provide evidence to support the above claims. The results from that work are:

- Average annual corn and soybean yields were statistically the same for no-till (NT), chisel-plow (CP), and moldboard-plow (MP) tillage treatments with and without hairy vetch and cereal rye cover crops.
- At the end of the study, cover crop treatments had more soil organic carbon (SOC) than those without cover crops for the same soil layer and tillage treatment.
- All tillage treatments with cover crops sequestered SOC in the 0-30 in. root zone.
- All tillage treatments without cover crops had a 20 to 30% greater soil loss over the 12 years of the study.
- Cover crops did not reduce soil loss from the tilled treatments (CP and MP) below the tolerance level of 3.75 ton/acre.
- For the tilled treatments (CP and MP), cover crops helped reduce the rate of SOC stock loss.

Allelopathy–Cover Crops

Cover crops have long been recognized for their potential to provide soil cover that will curtail erosion between crop growing seasons, and to provide residue that is available to increase soil organic matter.

With the increasing occurrence of herbicide-resistant (HR) weeds, cover crops are now being evaluated for their allelopathic potential to control weeds.

Current thought is that cover crops and their residues may provide weed suppression through their physical presence on the soil surface and/or by the release of allelochemicals that may inhibit weed seed germination and/or early seedling development. Thus, allelopathic potential of cover crops for weed suppression is touted. Until this is proven, cover crop management strategies should be directed towards practices that ensure maximum cover crop development in the fall to ensure maximum physical weed-suppression activity the following spring.

Cereal cover crops oftentimes will produce more biomass than will legume cover crops. This increased physical barrier, coupled with the slower degradation of residues from cereals compared to that of legumes, should result in more and longer-lasting weed control/suppression from using cereal cover crops.

There are four important points regarding the use of cover crops for weed control either by physical suppression or by allelopathy.

- Differentiating between allelopathy and the mulching effect of cover crops is difficult. As stated above, it is accepted that increased cover crop biomass on the soil surface can suppress weeds, but to what extent and with what resulting value in a soybean production system is not known.
- The variability in allelopathic effects from plant residues presently negates their consideration as a stand-alone weed control option in large-scale crop production systems.
- A likely system will be using cover crops that are proven to physically or allelopathically suppress weeds to offset some herbicide use.
- The additional cost associated with using cover crops in a crop production system must be considered. In other words, the additional cost of using cover crops for potential weed control must be compensated for by increased soybean yield and/or reduced herbicide usage/cost. Otherwise, producers will be reluctant to insert cover crops into soybean production systems for any reason.

Terminating Cover Crops

A Jan. 2016 article published in Crop, Forage, & Turfgrass Management (PMN) authored by Balkcom, Duzy, Kornecki, and Price at the USDA-ARS National Soil Dynamics Lab at Auburn, AL and entitled "Timing of Cover Crop Termination: Management Considerations for the Southeast", gives a concise summary of points that should be considered for the timing of cover crop termination in the Southeastern US.

Warmer winters in the Southeast extend the cover crop growing season, thus allowing greater biomass production compared to more northerly regions of the US. This results in potential risks associated with increased biomass production that can be reduced with proper timing of cover crop termination.

Planting a cover crop as early as practical in relation to the summer crop's maturity is essential to maximize cover crop biomass production. This in turn will affect its resulting growth and the decision of when to terminate in the spring.

- Planting cover crops on a particular date and then terminating them preceding an early-planted crop such as corn will result in less biomass than will result from their termination at a later date preceding a later-planted crop such as soybeans or cotton. In fact, terminating a cover crop preceding an early-planted corn crop may result in a level of biomass that fails to meet the standard for a high-residue cover crop.

For nonirrigated summer crop production, a cover crop should be terminated early enough to allow soil moisture replenishment before the intended planting date of the summer crop. If the cover crop is still actively growing or has been terminated just prior to planting the summer crop, rainfall before planting may not be sufficient to ensure optimum germination and early growing conditions for the summer crop. Also, residue remaining from a cover crop that is terminated sufficiently ahead of summer crop planting will improve infiltration and storage of rain water that is received after its termination and before planting the summer crop.

The climate of the Southeast shortens the persistence of surface residues remaining after cover crop termination. This is especially so for residues of leguminous cover crop species vs. residues of cereal cover crops. Thus, termination of the cover crop ahead of summer crop planting should consider whether or not the cover crops are predominately legumes or cereals. In essence, termination of legume cover crops can occur later than termination of cereal cover crops in relation to an intended planting date of the summer crop.

Nitrogen (N) management should be considered when timing cover crop termination.

- Residues from legume cover crops that have a low C:N ratio (<24:1) release or "mineralize" N quickly as they decompose and thus limit the time that these residues remain on the soil surface. This results in reduced benefits from the rapidly decomposing surface residue. If the summer crop is not actively growing to capture the mineralized N, then this N will be lost.

- Delaying termination of legume cover crops as long as possible will result in increased biomass production, and will improve the likelihood that cover crop N release and uptake of N by the summer crop will coincide.

- Residue from high-biomass cereal cover crops have a high C:N ratio (>24:1), and the small amount of N that is mineralized during their slower decomposition likely will be immobilized or consumed during the decomposition process. However, these residues with a high C:N ratio will persist longer than those with a low C:N ratio, and thus surface residue benefits will be enhanced.

- Delaying termination of cereal cover crops will result in increased biomass production, and increase the likelihood that resulting residues will be sufficient to provide the soil quality benefits derived from their persistence. However, the immobilization of N during cereal cover crop decomposition may necessitate that additional early-season N be applied to a following non-legume summer crop.

Cover crop residues act as a mulch, and this mulch and the possible allelopathic compounds that are released during their decomposition may inhibit weed seed germination and subsequent weed growth. In general, the more the cover crop biomass/residue, the more likely its negative effect against weeds. To realize the optimum benefit from the potential allelopathic effect of cover crops against weeds, their termination should be timed to allow for maximum production of biomass while also allowing sufficient time for rainfall to occur before planting the summer crop.

Cover crop termination should occur sufficiently ahead of planting the summer crop to allow for the residue to become completely dry and brittle. This will allow planting equipment to cut through the residue and prevent "hairpinning" that can result in insufficient seed-soil contact for optimum emergence of the summer crop.

Final Thoughts

Additional information about cover crops has been produced by Pioneer. The USDA-ARS Conservation Systems Research Team at Auburn, AL has produced fact sheets, publications, slide presentations, and videos that provide complete details on most aspects of cover crop use and management specifically for the southeastern US. Center Seeds of Minster Ohio has a publication that provides details about the various cover crop species that may be used in diverse situations.

The USDA-ARS laboratory in Mandan ND has produced a Cover Crop Chart that is designed to assist producers with decisions on the use of cover crops in cropping systems. The chart can be used as a guide to select individual cover crop species and as a source of information on how they will mesh with a particular crop production system.

Drs. Delaney, Iversen, Balkcom, and Caylor of Auburn University and USDA-ARS compiled an article entitled "Cover Crops for Alabama" that was published in Feb. 2014. Table 4 below from that publication provides details about and traits attributed to several cover crop species.

A 2015 Ph.D. Dissertation entitled "Effect of fall-seeded cereal cover crops for use in soybeans for control of Palmer amaranth in Mississippi" by Dr. Ryan Edwards (MSPB Bufkin Fellow—Project No. 51-2014) provides the following results that essentially confirm above points and results from previous cover crops research.

- Cereal rye cover provided the most effective impediment to weed emergence.
- Cover crops alone did not provide sufficient control of emerging summer weeds in soybeans.
- Cover crops did not improve weed control in soybeans above that of herbicides alone.
- High costs associated with using cover crops may prevent widespread adoption of their use in conjunction with residual herbicides.

- The presence of cover crops had no effect on soybean yield.

The information in this article is composited from many sources. It is meant to serve as a general guide to the major components of cover crop use and management in the Midsouth. The linked references will provide more detail on subject matter areas that will address a specific producer's production system and environment.

Composed by Larry G. Heatherly, Rev. Feb. 2016, larryheatherly@bellsouth.com

Table 4.

Cover Crop	Seeding Rate (lb/A)		Reduce Compaction	Residue Persistence	Erosion Control	Weed Control	Nematode Control	Attract Beneficials	Scavenge N	Scavenge P&K	Forage Quality
	Drilled	**Broadcast**									
Legumes											
Austrian Winter Pea (W)	60–90	90–100	F	F	VG	G	G	VG	F	F	VG
Crimson Clover (W)	15–18	22–30	F	G	VG	VG	F	VG	G	G	E
Red Clover (P)	10	10	VG	F	G	VG	F	VG	G	VG	E
White Clover (P)	5–9	7–14	F	F	VG	VG	P	G	F	F	E
Hairy Vetch (W)	15–20	25–40	F	F	G	G	F	E	F	G	G
Iron Clay Cowpea (S)	40–50	80–100	G	F	E	E	G	VG	F	G	G
Lupin (W)	70–120	—	G	F	G	G	E	E	F	G	F
Sunn Hemp (S)	20–40	—	E	G	VG	E	E	F	F	F	G
Velvet Bean (S)	20–40	—	G	G	VG	VG	E	F	G	G	G
Cereals											
Black Oat (W)	50–70	—	F	G	VG	E	E	P	VG	F	G
Rye (W)	60–120	90–160	G	E	E	E	G	F	E	VG	G
Sorghum-sudangrass (S)	30–40	40–50	E	VG	E	VG	VG	G	E	G	VG
Winter Wheat (W)	60–120	60–150	G	VG	VG	VG	F	F	VG	VG	VG
Brassicas											
Canola/Rapeseed (W)	5–10	8–14	G	G	VG	VG	VG	G	VG	F	G
Mustards (W)	5–12	10–15	G	F	VG	VG	VG	G	G	VG	G
Radish (W)	8–10	12–14	VG	F	VG	E	VG	F	E	VG	G
Other											
Buckwheat (S)	50–60	90–100	F	P	F	E	F	E	P	E	P

E = Excellent; VG = Very Good; G = Good; F = Fair; P = Poor/None (W) = Winter annual; (S) = Summer annual; (P) = Perennial.

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Dennis P. Delaney, *Extension Specialist*, Crop, Soils and Environmental Sciences; **Kirk V. Iversen**, Soil Scientist, Crop, Soils and Environmental Sciences; **Kipling S. Balkcom**, Research Agronomist, USDA Agricultural Research Service; **Arnold W. Caylor**, Director, North Alabama Horticulture Research Center

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