This appendix contains technical information about managing a cover crop. Interagency cover crop termination guidelines for crop insurance, especially for non-irrigated cropland, may be found in the attached September 2014 NRCS Cover Crop Termination Guidelines [http://efotg.sc.egov.usda.gov/toc.aspx?CatID=2918].

Benefits of planting cover crops
A small grain cover crop, such as rye, and crimson clover, a legume that produces its own nitrogen, are common components of a conservation tillage system in the Southeast. Planting cover crops results in higher crop yields due to improved control of diseases and pests, especially weeds; increased soil organic matter and the efficiency of the use of soil water; improved soil physical properties and nutrient availability; and reduced soil erosion (Reeves, 1994). However, the increased yield of crops produced in conservation tillage systems, compared to a winter fallow system, is most frequently attributed to more effective weed control than to the other benefits of planting a cover crop (Price et al., 2006; Price et al., 2007).

Biomass goals
It is important to select the correct cover crop species and provide the conditions to obtain a sufficient amount of plant residue to cover the soil surface for effective weed control and to accomplish other goals. Approximately 4,000 lbs./ac. of dry biomass is the default for the production of many cover crops in the RUSLE2 soil erosion software. However, the amount of residue actually required for weed control ranges from 6,500-10,000 lbs./ac. according to local experts. Furthermore, according to a UGA Extension weed scientist, weed control is more difficult with 4,000 lbs./ac. of residue than without almost no cover remaining in the field at seeding.

See Table 1 below for the mean biomass cover in the three regions Southeast reported in the literature. For example, cereal rye is frequently grown throughout the state as a cover because of the high biomass potential, low cost seed and vigorous growth. Wheat is also another cereal grain cover to consider. Although cereal rye and wheat biomass production is approximately 6,000 lbs./ac. in the Piedmont, production in the Coastal Plain by both of these cereals averages only approximately 4,000 and 1,500 lbs./ac., respectively. It is likely the reduced capacity of the sandy soils of the Coastal Plain to retain rainfall and residual nutrients compared to the Piedmont is responsible for the difference in the productivity of these cover crops in those areas of the state.

Another major factor that determines the productivity of a cover crop is the time of planting. Plant cover crops during the recommended time frame to obtain an adequate stand and biomass to achieve the purpose of using a cover crop. See the Georgia NRCS Cover Crop (Code 340) Standard Appendix I for planting dates and other production information [http://efotg.sc.egov.usda.gov/toc.aspx?CatID=2918].
Also, it is likely that the amount of residual nitrogen in the soil may not be adequate to produce a cover crop with the biomass needed to control weeds. Apply 30-70 lbs. of nitrogen/acre to rye, unless the goal is to scavenge nitrogen (Balkcom et al., 2007 and Reiter et al., 2008). Apply 20 lbs. of nitrogen/acre to a mixture of legumes and small grains.

**Nitrogen availability**
The nitrogen scavenging potential of cover crops has been rated by Clark (2007):

- **Excellent** – rye, sorghum-sudangrass, forage radish
- **Very good** – barley, oats, wheat, rapeseed, berseem clover

Other cover crops recommended by UGA for this purpose include arrow leaf and crimson clovers, as well as black oat. Clover has the capacity to use available nitrogen and fix nitrogen from the atmosphere depending upon conditions in the field.

Determine the amount of nitrogen provided to the cash crop by the cover crop (or cover crop mixes) using UGA’s Nitrogen Cover Crop Availability Calculator [http://aesl.ces.uga.edu/mineralization/](http://aesl.ces.uga.edu/mineralization/), or current laboratory analysis. The NIRS analysis required for the calculator is available from UGA. Other laboratories certified for the NIRS method by the National Forage Testing Association in 2015 may also provide this service ([http://www.foragetesting.org/files/2015_Certified_Labs.pdf](http://www.foragetesting.org/files/2015_Certified_Labs.pdf)). Data needs to be normalized by the laboratory.

Assistance collecting a representative biomass sample of the cover crop with a rectangular quadrant for laboratory analysis is available through local UGA County Extension Offices. They will also accept samples and producer information.

**Termination guidelines**
In general, high yields of biomass from cereal grain and crimson clover, and probably other cover crop species, should be obtained as a result of a long growing period (Saini et al., 2006). However, the results of other experiments provide more specific information regarding the effects of stage of growth on biomass production by cover crops. For example, maximum biomass production by cereal grains occurs between flowering and the soft dough stage, depending upon the species (Ashford and Reeves, 2003). Also, the stage of growth for terminating a cover crop depends upon many factors in addition to biomass production (Schomberg and Balkcom, 2009). Vegetable producers may want to terminate a cover crop early in the season in order to increase the rate of soil warming in the spring.

A general recommendation for termination is 3-4 weeks before planting the cash crop because the allelopathic effects which are caused by chemicals produced by the decomposition of the cover crop that affect the growth of the subsequent crop. These effects occur primarily during seed germination and seedling growth. Allelopathy is a particular issue following black oat. The time period between terminating the cover crop and planting the cash crop is extremely important when planting small-seeded vegetables into cover residue (Morse, 1999). Large-seeded crops and vegetable transplants are affected by allelopathy to a lesser degree than small-seeded crops.
Terminate a legume cover that is grown alone when 10% of the flowers have bloomed. A 3-4 week decomposition period for below ground cover crop residue is recommended when cotton is preceded by a legume, such as crimson clover. This waiting period is also recommended before planting cash crops following other winter cover crops.

Two other important management factors for reducing stand losses and poor growth of the cash crop following cover crops are terminating the cover 2-3 weeks before seeding the cash crop to allow the cover residue to dry and obtain good seed/soil contact by controlling the depth of seed placement (Reeves, 1994). Managing planting equipment to remove the dry residue from the zone of seed placement will result in decreased residue that results in improved seed/soil contact, less allelopathic effects of the decomposing residue on the developing seedling and increased soil temperature that will enhance germination and growth.

There are several advantages of a terminating the cover crop closer to the anticipated planting date of the cash crop. A longer growth period for the cover crop results in increased biomass production and residue for soil and water conservation from the cover crop, greater weed control from allelopathic compounds and the mulch effect, and more nitrogen contributed from legumes that grow for a longer period of time.

The application of a nonselective burndown herbicide, such as glyphosate, is a common component of many conservation tillage systems because herbicides can be applied to kill the cover crop at any time or at any growth stage the crop is actively growing. However, herbicides may be expensive or not an option for some producers. Also, biomass production, the percent kill of cereal grains and the soil moisture are likely to be similar when using chemicals alone, chemicals applied at the 50% rate + rolling with a crimper-roller or a system using the crimper-roller alone, when these practices are applied at the soft dough or the early milk stages of growth (Ashford and Reeves, 2003). Using a roller-crimper also creates a thick residue mat covering the soil by bending the plants in one direction that promote enhanced emergence of the cash crop due to improved seed-soil contact and easier planting.

Organic producers and others who choose not to use herbicides can also terminate the small grain cover crop fairly successfully after flowering with roller-crimper alone (Ashford and Reeves, 2003 and Price et al., 2009). Although the percent kill with the roller-crimper alone may not be as high as desired, a significant reduction in soil moisture by the live plants remaining in the field should not be expected because of reduced loss of water by evaporation from the soil as a result of presence of the mat of cover crop residue on the soil surface created by the roller-crimper. However, the efficiency of killing cereal cover crops and maintaining soil moisture content by using only a roller-crimper before flowering may be low compared to terminating this cereal by applying herbicides with or without the use of the roller-crimper.

**Other information**
The effectiveness of some deep-rooted crops to reduce soil compaction is (Clarke, 2007, Sullivan, 2003 and Newman et al., 2014):
A. Good – rye (Gene Hardee. 2009. Personal communication.), hairy vetch, barley, wheat, rapeseed
B. Very good – red clover, alfalfa, bahiagrass
C. Excellent – Sorghum-sudangrass, forage radish, turnips

Summary
It is important to apply conservation practices such as cover crops, conservation tillage and nutrient management, together, rather than independently. Also, deep tillage under the row in the fall is an essential component of a conservation tillage system in soils subject to compaction (Schwab et al, 2002). Some of the recommendations for producing cover crops, especially in agronomic crop production systems include:

• Select a cover crop with the potential for producing the amount of biomass that is consistent with the purpose of the practice and time of year
• Consider the positive effects of planting legumes, brassicas, and buckwheat on populations of pollinators and soil life forms
• Seed cover crops at the recommended rates within the recommended planting windows
• Apply 30-70 lbs./ac. of nitrogen fertilizer to rye and other small grain cover crops to obtain maximum biomass
• The stage of growth for obtaining high yields of biomass of rye has been established. However, many factors other than the length of the growing season of the cover may be considered when deciding when to terminate a cover crop.
• Terminate small grain cover crops with a roller-crimper with or without the application of herbicides
• Seed the cash crop 3-4 weeks after terminating the cover crop. This time period is very critical to avoid allelopathic effects in small-seeded cash crops, cotton following a legume and all cash crops following black oat.
• Allow the cover residue to dry before planting the cash crop and obtain good seed/soil contact by controlling the depth of seed placement
• Nutrient management is essential throughout all stages of the production of the cover and cash crops. Producers should also consider the amount of residual nitrogen available to the cash crop following cover crops.
• Matching the termination date of the cover crop with the planting date of the cash crop is also essential in fall vegetable crop production systems. A summer annual, such as cowpea or sorghum sudangrass, is frequently planted to provide cover and/or nitrogen for fall vegetable crops and prevent soil erosion (Treadwell, et al., 2012).

References Cited
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