AN INTRODUCTION TO Conservation Tillage for Vegetable Production

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Introduction

Conservation tillage is a term that describes a number of nonconventional tillage practices, which conserve at least 30% of the previous crop residue on the surface. Conservation tillage has been used successfully in agronomic cropping systems (e.g., cotton, corn, soybeans, etc.) in Georgia, and has several benefits—most notably minimizing soil erosion. Other benefits include increasing soil organic matter, maintaining a healthy rhizosphere (root zone soil), reducing riparian and waterway pollution, and conserving water, to name a few.

Some examples of conservation tillage practices include no till, ridge till, and strip till. No–till production involves no tillage of field soils and leaves all of the previous crop residue on the soil surface. Ridge–till production involves building a ridge during cultivation, then scalping the ridge and sowing seed. The scalping process moves most of the previous–crop residue to the row middles, leaving a clean row for sowing. Strip–till production is when a narrow strip is tilled for each row that will be planted, leaving the row middles intact with the previous–crop residue. Strip–tillage may reduce yields if weeds in the untilled area are not killed, as these weeds will compete with the crop for water and nutrients. Although the planted row is free of previous crop residue, it may be advantageous to kill the cover crop to prevent it from competing for nutrients and water with the vegetable crop.

Conservation tillage has not been used widely in vegetable production in Georgia, and it may not be feasible with some vegetables. This publication is an introduction to this type of production. For those wishing to implement conservation tillage practices with their vegetables, we strongly urge growers to begin on an experimental basis as results will vary based on previous crop, soil type, weed pressure, etc.

Vegetables that probably would not do well in conservation tillage include any small–seeded, direct–sown crops, such as onions, carrots, and many of the brassicas that are not transplanted. Vining crops such as pumpkins and fast–growing crops such as sweet corn tend to perform well in conservation–tillage systems.

Equipment

Equipment used for conservation tillage with agronomic crops has been available for many years (Figure 1). Generally, such equipment requires the use of greater horsepower tractors capable of pulling the equipment through the previous–crop residue. No–till planters are available for both drilling and precision planting. No–till drills (Figure 2) are used to plant cover crops into previous crop residue. Precision planters are used where a specific in–row spacing is needed, as with vegetable crops. The singulation with such equipment is handled by various plates, belts, or vacuum plates based on equipment design. All such planters require coulters or double wheels to rip through previous crop residue and open a furrow where seed is to be planted.

Figure 1. No-till equipment for planting sweet corn and other large-seeded crops.

Figure 2. The no-till drill on the left has two hoppers so it can sow two cover crops at once (e.g., grass and a legume). In the photo on the right, note the coulters that are capable of opening a furrow.

Conservation tillage transplanters (Figure 3) also are available. These transplanters are used to plant small seedlings that have been greenhouse–grown. There are both finger and carousel transplanters available. This equipment is designed and built with coulters or double wheels to open a furrow for transplanting.

As with any planting equipment, it is important to inspect, clean, and repair before using to ensure proper seed or transplant placement. This includes adjusting and calibrating for both the in–row spacing and the proper depth. The press wheels must also be adjusted, either so that seeds make good contact with the soil, or to firm the soil around transplants without damaging the seedlings.

Cover Crop

There are a number of cover crop choices when considering conservation tillage, as well as no cover crop at all. With no cover crop, the new season's crop is planted directly into the stubble of last year's crop. The previous crop residue may need to be mowed or roller–crimped (Figure 4) prior to planting to facilitate the operation of planting equipment.

Generally, one of three groups of plants—or a combination of these—can be used as a cover crop. One group is the grasses or grains. Examples include wheat, rye, or oats. Legumes are another group that would include plants such as clover, vetch, sunhemp, and Austrian winter pea. Finally, several of the brassicas also are used as cover crops. These include mustard, rapeseed, and daikon radish. Cover crop mixtures, using a combination of two or more of these groups, also can be used.

Figure 3. Single row no-till transplanter. Note this is a carousel-type transplanter.

Figure 4. Roller-crimper mounted on the front of a tractor. Note the chevron design, which helps it ride more smoothly over the ground.

Each cover crop has its particular benefits and drawbacks. Grains can produce a great deal of biomass and are able to scavenge nutrients, especially nitrogen, from deeper in the soil. Drawbacks of grains include reducing soil moisture and having a high carbon–to–nitrogen ratio that may tie up nitrogen as they break down. Legumes also can contribute a substantial amount of biomass and have the ability to pull nitrogen from the air into the soil. Generally, legumes will have a lower carbon–to–nitrogen ratio compared to grains, so they tend to break down faster. With legumes, nitrogen may be released so quickly that it may be leached from the root zone. Brassicas are relatively fast–growing and they produce compounds that have fumigant properties that can help control soil diseases, insects, and weeds. A drawback of brassicas is that they require additional fertilizer, particularly nitrogen. If you intend to rely on the prior cover–crop residue as your primary method of weed control, you may need to increase seeding rates of the cover crop in order to supply greater biomass and mulch after termination.

For a complete overview of cover crops and their selection, performance, and use, consult *Managing Cover Crops Profitably* (see the references section for this and other links). Additional information on using cover crops in vegetable production can be found at the Southern Cover Crop Council website.

Fertilization and Liming

Soil testing should be done each year. Your local county Extension agent can help you with this and can supply soil test bags and instructions on how to collect samples. Soil pH should be between 6.0 and 6.5, because nutrients are most available in this pH range. Most soils in Georgia are acid–forming, so liming may be required to ensure proper soil pH.

Soils tend to be cool in the spring, and because phosphorus is relatively unavailable under cool soil conditions, a *pop–up* (high phosphorus) fertilizer usually is recommended. This is even more important with conservation tillage because soils tend to be even cooler with conservation tillage systems.

Additional nitrogen may be required when the previous cover crop has a high carbon–to–nitrogen ratio, such as with winter rye. The straw from such plants is slow to decompose and may tie up nitrogen in the process. In contrast, leguminous cover crops can provide nitrogen to the subsequent crop. An estimate of the amount of nitrogen tied up or released during cover–crop decomposition can be obtained using the *Cover Crop Nitrogen Availability Calculator* from the University of Georgia. This calculator was successfully tested during 3 years at UGA's Horticulture Research Farm and at two private organic farms (Gaskin et al., 2019). To get full advantage of the calculator, the cover crop should be sampled and sent to UGA's Agricultural and Environmental Services Laboratories for quality analysis. Information on how to sample a cover crop can be found in the UGA Extension circular *Cover Crop Biomass Sampling* (Gaskin et al., 2015).

Planting Date

Soil temperatures under conservation tillage can be considerably cooler at a 2–in. depth compared to conventional tillage. This may require postponing planting for 1 to 2 weeks to allow soils to warm in spring. In addition, with direct–seeded crops, the seeding rate may have to be increased by 10–15%.

Weed Control

Weed control is a critically important step in successful conservation tillage. Cover crops can be an important component for weed control. High–residue, evenly distributed cover crops can help suppress weed growth. Certain crops such as rye can have allelopathic effects that can inhibit weed growth, usually affecting small–seeded weeds. Large–seeded crops such as corn or beans generally are not affected because of their size and their deeper planting depth. Previous crop residue and cover crops can be flail–mowed prior to herbicide application. Flail mowing is recommended over rotary mowing because it breaks up the material into finer particles, making it easier to operate the seeder or transplanter. A roller–crimper (Figure 4) also can be used for cover crops. This

implement rolls the cover crop down and crimps the plant stems, aiding in desiccating and killing the plants. Herbicides still may be required when using a roller–crimper.

Previous crop residue and cover crops need to be killed with a general–purpose herbicide such as glyphosate or paraquat. Glyphosate will take a week to 10 days to kill plants completely. Cover crops should be killed prior to seed–set to be completely effective. Follow label directions for application rates and all safety information. We suggest using the highest recommended rate, particularly if the field has a history of hard–to–control weeds. Making two passes over the field with the roller–crimper and herbicide application will ensure good weed control.

Preemergent herbicides are recommended and should be applied according to label directions. Water–activated herbicides may require more irrigation or rain to ensure all the herbicide reaches the soil and is activated. Misapplication of preemergent herbicides can result in stand reduction, so be sure to precisely follow label directions as to crop, application rate, and other cultural practices.

Postemergent herbicides may be limited based on the selected vegetable. Care should be taken when selecting the proper herbicide, its application timing, recommended rate, and safety recommendations. Carefully read herbicide labels prior to application and consult your local county Extension agent if you have any doubts or questions.

Insect and Disease Control

Insect and disease control may be more difficult in conservation tillage systems because deep turning of previous crop residue is sometimes recommended to reduce disease incidence. In conservation tillage, this method is not used, and therefore some diseases may be more prevalent. This means that crop rotation becomes even more important to help reduce the impact of crop–specific soilborne diseases. Crop rotation should be done across plant families to help reduce soilborne diseases and improve soil fertility.

Some insects may be attracted to a killed cover crop. Carefully scout the area for damaging insects before and after planting. Growers may need to apply a suitable insecticide to prevent crop damage, particularly early in a crop's life cycle.

Crop and Variety Selection

Several vegetables are not suitable for conservation tillage because of their planting method or because of population size; examples include carrots and onions. Because of the small seed size, neither is recommended for direct–seeding in conservation tillage. Onion transplants have not been evaluated for conservation tillage systems. Carrots, onions, and other direct–sown small–seeded vegetables may be more suited to strip–till production, where narrow strips of plowed soil are prepared and then the seed is sown.

Table 1 lists several vegetables that are good candidates either for direct–seeding or transplanting in conservation tillage. Probably the best candidates for growers first attempting conservation tillage include sweet corn or beans. Field corn has been grown successfully with conservation tillage and sweet corn could be grown with similar planting methods, fertility, and pest control. Beans are another good candidate because they are very similar to soybeans (another agronomic crop), which have been grown successfully with conservation tillage methods. Other vegetables that have been grown successfully with conservation tillage include pumpkins, tomatoes, squash, and cabbage.

Table 1. Select vegetables' potential for conservation tillage production.

	Planting method[y]	
Vegetable	Direct seeded	Transplanted
Beans	High	NA
Broccoli, cabbage, cauliflower, collards	NR	High
Cantaloupe, cucumber	High	High
Eggplant	NR	High
Peppers	NR	High
Potato	Low	NA
Southern peas	High	NA
Summer squash[x]	High	High
Sweet corn	High	NA
Sweet potato	NA	Low
Tomato	NR	High
Watermelon	NR	High

[x]Also includes winter squash, pumpkins, zucchini squash, and related vegetables.
[y]High=well–established basis for success; Low=limited or no data of success; NA=not applicable; NR=not recommended.
Adapted from "No-till vegetable production—its time is now," by R. D. Morse, 1999, *HortTechnology*, *9*(3), p. 377 (https://doi.org/10.21273/HORTTECH.9.3.373). Copyright 1999 by the American Society for Horticultural Science.

Transplants should be disease–free, of good size, and hardened before planting. Take care to ensure transplants coming from the greenhouse are free of diseases. This will help prevent problems from arising later. The transplant size can be critical depending on the transplanting equipment used. Carousel transplanters use a carousel of cups into which the transplants are dropped. The cups open and drop the transplant into the planting mechanism at the desired spacing. Transplants that are too large can get caught in the mechanism. Other transplanters in which the operator places the transplants directly into the soil will not have as much difficulty with transplant size. Workers may follow the transplanter to ensure that the transplants are properly planted.

Variety selection should first address market needs and buyers' preferences, and look for disease resistance when available. The *Southeastern U.S. Vegetable Crop Handbook* (Kemble, 2022) has lists of recommended varieties for Georgia. These lists also will indicate which varieties have disease resistance and to what diseases.

Organic Production and Conservation Tillage

Organic growers are particularly interested in conservation tillage because of the benefits mentioned in the introduction. There are a limited number of herbicides that organic growers may use, and these do not work as well as herbicides used in conventional production. Because of this limitation, organic growers generally rely on mechanical methods to kill a cover crop, such as flail mowing and using a roller crimper. Flail mowers use hammers to cut cover crop material into smaller pieces than what rotary mowers produce. This covers the ground more evenly and the smaller pieces break down more quickly. Roller crimpers kill the cover crop by laying the cover crop on the ground and crimping the stems. Mowing or using a roller crimper may not kill the cover crop completely, which may result in a difficult–to–control weed problem. It is more difficult to achieve success using conservation tillage in organic production, and factors such as weed species, weed population, time of year, soil conditions, etc. will impact its success. Organic growers in particular should proceed with caution and try conservation tillage on a limited basis.

References

Clark, A. (Ed.) 2007. *Managing Cover Crops Profitably* (3rd ed.). Sustainable Agriculture Research and Education, U.S. Department of Agriculture. https://www.sare.org/resources/managing-cover-crops-profitably-3rd-edition/

Gaskin, J. W., Cabrera, M. L., Kissel, D. E., & Hitchcock, R. (2019). Using the cover crop N calculator for adaptive nitrogen fertilizer management: A proof of concept. *Renewable Agriculture and Food Systems, 35*(5), 550-560. https://doi.org/10.1017/S1742170519000152

Gaskin, J. W., Hancock, D., Saha, U., & Chatam, K. (2015). *Cover Crop Biomass Sampling.* University of Georgia Cooperative Extension. https://extension.uga.edu/publications/detail.html?number=C1077

Kemble, J. M. (Ed.). (2022). *Southeastern U.S. Vegetable Crop Handbook*. Southeastern Vegetable Extension Workers Group; Great American Media. http://www.vegcrophandbook.com

Morse, R. D. (1999). No-till vegetable production—its time is now. *HortTechnology, 9*(3), 373–379. https://doi.org/10.21273/HORTTECH.9.3.373

Southern Cover Crop Council. https://southerncovercrops.org/

University of Georgia Agricultural & Environmental Services Laboratories. *Cover Crop Nitrogen Availability Calculator.* https://aesl.ces.uga.edu/mineralization

extension.uga.edu

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