

The past, present, and future of the cover crop industry

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HISTORICAL COVER CROP USE

The use of the crops we commonly refer to as cover crops can be traced back over the millennia. Ancient civilizations depended on their use to enhance the growth of crops they cultivated for food. Native Americans utilized a concept called “Three Sisters” where corn (*Zea mays* L.), edible beans, and squash were grown together as the benefits of diversity were realized. This strategy established a foundation of the effectiveness of the synergy of mixed species that is so prevalent in cover cropping today.

Cover crops were used nearly two hundred years before World War II. In fact, you could argue that the first US president, George Washington, who was also a well-known farmer by trade, was one of the foremost promoters in America for cover crops. His crop rotations were strategically listed to include “crops grown to eat and sell” and “crops grown to replenish the soil.” Clover, grass, and buckwheat (*Fagopyrum esculentum* Moench) were listed as those he incorporated into his cropping system (Mount Vernon Ladies’ Association 2015). Many farmers in the new frontier were farming the land for a dozen years or so only to observe the soil erode and become less productive and no longer profitable. It was easiest to just move west, obtain new land, and start over. This didn’t seem sustainable to an intelligent man such as George Washington, so he drew on the experience of Arthur Young, an English agronomist, to help him devise a way to maintain healthy and productive soils over the long term (White 2015). The use of crop rotation was also a tactic employed to obtain these benefits.

The nineteenth century brought extensive use of cover crops, which were commonly referred to as “green manure” in reference to the fertility properties that were desired and achieved. Hairy vetch (*Vicia villosa*) and peas were quite popular

in the northern United States to provide nitrogen (N) as a legume, and they sometimes did double duty as forage. Lupins (*Lupinus* sp.) were used quite extensively in the South in cotton (*Gossypium hirsutum*) and peanut (*Arachis hypogaea*) rotations. Legume cover crops were clearly used to add N to the soil, and grass covers were used for erosion control.

As World War II ended, the advent of synthetic N fertilizer softened the use of legume cover crops with its ease of timely application and affordability. Herbicides were also being introduced during this time and further suppressed cover crop usage. By the mid-1960s, cover crops were quickly becoming a distant memory of that generation.

Until the 1980s, cover cropping farmers were rare and considered “on the fringe.” Organic farmers depended on cover crops for many of the same reasons as farmers previous to World War II, but at this time this group represented a very small percentage of agriculture. As the 1990s began, more farmers started to dabble in cover crops in part due to the USDA forming the Sustainable Agriculture and Research Education (SARE) program. This program provided the opportunity for farmers and researchers to utilize funding to test “sustainable” ideas such as cover crops. Hundreds of grants met this need and successfully influenced the increased use of cover crops in many areas of the county. Cereal rye (*Secale cereale*) had previously been the most popular cover crop due to its winter hardiness and ability to be planted late in the season. However, SARE projects brought back a wide range of cover crop species into the agronomic picture.

The first decade of the twenty-first century marked a clear upswing in cover crop usage. Some of the credit has been assigned to brassicas, particularly radishes (*Raphanus sativus*), which have demonstrated tangible yield increases in subsequent cash crops. In fact, some have suggested that radishes were the “spark plug” of the recent increase use of cover crops in the last decade (figure 1). Environmental issues

have certainly increased cover crop usage as well. The Chesapeake Bay has been viewed as a pilot project for the rest of the nation in regards to reducing nutrient and sediment loads in bodies of water. Cover crops have addressed both of these issues by reducing soil erosion and keeping nitrate-nitrogen (NO₃-N) in the fields where it belongs. The cover crops appear to be working as levels of nutrients and sediment have dropped slightly, although not to targeted levels. Cover crop usage in the Chesapeake Bay Watershed now is at 18%, more than three times what it was in 2005 (USDA NRCS 2015).

COVER CROPS TODAY

According to the 2012 United States Agriculture Census, around 4 million ha (10 million ac) of cover crops were planted that year representing about 2% of American row crops (USDA NASS 2014). Many species of seed are readily available and reasonably priced. However, there are very real challenges that threaten to limit progress. Farmers frequently ask if cover crops pay or claim they do not have time to plant them. These are legitimate questions, and there are some solutions that address these concerns.

Cover cropping is a simple concept but can be very complex to implement successfully. It has been said that a farmer needs to treat cover crops like cash crops in order to profit. In other words, a farmer would be foolish not to plant corn the first day it’s fit to plant in the region. The equipment is ready, seed purchased, and the schedule firmly assigned to accomplish the task in a timely and efficient manner. This readiness has been honed through generations, but the mindset has lagged when applied to cover cropping. For example, even though a farmer may not know for sure that there is a cover crop planting window, a seed dealer should at least be notified of the possibility so a timely order can be fulfilled. Many times, a limitation is the lack of available personnel due to harvesting operations. This is certainly a challenge, but some farmers who have committed to cover cropping have hired retired farmers or give

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Figure 1

Tillage radish, a popular cover crop option in the past decade.



an opportunity to a younger family member to get some planting experience. Others have hired custom operators that specialize in cover crop planting. They usually supply seed, planting equipment, and a driver so the farmer can focus completely on harvest.

Interseeding. Innovative ways to establish cover crops and to expand planting windows are being birthed on farms and universities alike. The concept of interseeding, planting a cover crop into a growing cash crop such as corn (figure 2), has been tested for the past five years by Penn State University, Cornell University and the USDA Agricultural Research Service have also collaborated on this project (Roth and Curran 2014; Roth et al. 2015). Their research has shown this practice to have merit, and hence it has taken root among farmers in the northeastern United States as well as in Ontario and Quebec. In fact, in 2015 there may be as many as 4,047 ha (10,000 ac) of corn that have been interseeded in these areas. Cover crops are planted when corn is in the V4 to V6 stage of growth—around knee high. It has been found that getting the seed in the soil using a simple seeding unit is clearly better than just broadcasting on top of the ground. While spinning seed on the surface is easier and faster, the lack of consistency due to previous crop residue not allowing seed to

soil contact or dry surface conditions make it a risky practice for consistent establishment. Several drill type seeding units are now available to purchase, and some mechanically inclined farmers have designed their own machines. Most have 2 or 3 rows to seed covers between 76 cm (30 in) corn rows and range in size from 2 to 12 rows wide.

Results have shown there to be no yield drag associated with interseeding, much to the surprise of what would be expected of

having living plants growing at the same time in the cash crop. It is theorized that since the cover crops are planted later and essentially go dormant over the summer months they don't take up many nutrients or very much moisture. There also could be a synergistic effect that has been observed when mixed species are grown together. The key is to interseed the cover crop late enough that it doesn't become competitive with the corn but early enough that sufficient establishment is achieved to survive under the canopy through the summer. Once the corn starts drying down, sunlight reaches the lethargic cover crop and it begins to grow again. By harvest, the cover crop is actively growing and could be as much as three to four weeks ahead of a cover crop planted after harvest. That could make the difference between no cover crop at all or a cover crop that has significantly more time of growth in order to achieve the benefits that covers have to offer. The more common species that have shown to be most consistent are annual ryegrass (*Lolium multiflorum*), crimson clover (*Trifolium incarnatum*), and cover crop radish. However, hairy vetch has recently shown promise as well. Other species continue to be tested and, like cover crop use in other aspects of agriculture, geographical preference will undoubtedly develop.

Pre- and post-emergent herbicides have to be considered when utilizing this concept. In recent years, due to the use of

Figure 2

Cover crops interseeded into corn.



more residual herbicides to combat resistant weeds, the level of complexity has increased. Shorter residuals, like Verdict, are more desirable to allow the cover to establish. Many commonly used herbicides are currently being evaluated in the context of interseeding. One aspect that requires a different mindset is the observation of herbicide damage to the cover crop. Contrary to cash crops, a little herbicide damage may not be a negative aspect. All that needs to be achieved is that the cover crop survive until the corn starts to dry down in the fall. Some farmers have used a short residual and followed up with glyphosate where Roundup Ready corn was planted or Liberty in the case of LibertyLink genetics.

A few other concerns are to be noted. Interseeding a cover crop does not interfere with corn harvest. Stand establishment maybe more consistent than with aerial seeding since the seeds are placed in the soil rather than on top. Since the timing is close to side dressing time, some machines are designed to apply N in the same pass. Others have even added post-emergent sprayers to do a three-part operation in one pass. A nonresidual herbicide such as glyphosate can be applied at the same time, providing a herbicide-tolerant corn was used in the field. Interseeding establishment costs are minimal if done with side-dressing N and a post-spray application.

Interseeding soybeans (*Glycine max* [L.] Merr.), however, has not been consistent enough to recommend this practice. Even in 76 cm (30 in) soybeans, there is less light under the canopy than that of corn. Stand establishment of the cover crops has been achieved, but more often than not, the cover crop dies over the summer.

There are still some aspects of interseeding that need further research. We know that the farther north a farm is, the more attractive this concept becomes due to the fact that seeding cover crops after harvest is usually too late in the growing season. Based on current experience, interseeding is a viable option as far south as between the Interstate 70 and Interstate 80 corridor. Another question is how high corn yields can be for successful interseeded cover crops. To this point, 12,600 to 14,175 kg ha⁻¹ (200 to 225 bu ac⁻¹) corn has worked well in regards to cover crop summer sur-

vivability. However, it is not clear whether the dense canopy of high-yielding 15,750 or 18,900 kg ha⁻¹ (250 or 300 bu ac⁻¹) corn that may occur in some fields would limit the survivability of the interseeded cover crop. To date this has not been widely tested, but it may be a limitation.

Planting Green. Planting a cash crop into a living or green cover is gaining popularity in some areas. This has been driven by a desire to maximize the benefits cover crops have to offer and in some cases has been shown to reduce slug pressure. Most farmers are shy about this practice, and it's not for novices due to increased management and, to a certain extent, the risks associated with it. If spring conditions are dry and no rain is in sight, terminating the cover crop earlier is strongly recommended so as not to dry out the soil for the pending cash crop. However, this same concept can be used to dry out the soil during a wet spring. The cover crop soaks up excess moisture allowing for earlier or better planting conditions. Proper equipment is required to handle significantly more biomass than what a farmer may be used to. Some have even installed rollers on the planter to lay down the cover so the tall plants do not interfere with the early growth of corn or soybeans. Cereal rye or triticale (*Triticosecale*) is a grass cover of choice.

Short Season Genetics. Another tactic to widen the cover crop window is to plant shorter season genetics with either corn or soybeans. There is general consensus among seed dealers and farmers alike that these faster-maturing varieties and hybrids are much better yielders than 20 years ago. There are some strong yields coming from some 90 to 100 day corn and group 2 soybeans now. Strategically planting them first may allow for up to a three week earlier harvest with some generating similar yields as the commonly planted maturities in the area. This allows a cover crop to be planted much earlier in order to maximize all the attributes they have to offer. One day of growth in September may be the same as five or six days growth in October. Research has shown that cover crop biomass doubled when planted two and a half weeks earlier in the fall. Legumes are able to produce more N, allowing for less purchased nutrient application in the following spring for the cash crop. It also gives

brassicas and grasses more time to soak up left over nutrients—keeping them out of waterways where they are a pollutant and potentially saving some fertilizer the following year, which becomes a profit.

There are many other considerations for planting 5% to 10% of production land to shorter season cash crops. Some areas have a higher basis for cash grain prices, which tend to go down as harvest progresses. Faster maturity can beat late summer dryness, which could dampen yields of normal season genetics. Potential losses to storms and bad weather later in the fall may can be avoided with an earlier harvest. These hybrids and varieties need to be monitored closely as they may dry down faster than expected. By harvesting when ready, a farmer can potentially save some drying costs as well. Short season genetics should be chosen based on a knowledgeable seed dealer's advice and experience. The disease ratings should be appropriate for the area, and lower fertility fields should be targeted as these tend to be the ones that either dry out quicker or run out of fertility sooner, benefiting the shorter season concept.

The costs are the same for the cover crop seed and for the planting operation no matter when it is planted. However, when a cover crop is planted can make a huge difference. It gives farmers a magnified advantage of the many things cover crops have to offer by planting them earlier. Using shorter season genetics could be the difference between getting a cover crop planted or not, but at the very least it provides an opportunity for more growth in the fall. All the benefits that cover crops have to offer are increased, and more species can be utilized. Brassicas provide more nutrient scavenging, or legumes produce more N, which leads to less purchased inputs the following spring.

Manure and Cover Crops. Cover crops are excellent to use in a system that includes manure. Whether manure is applied in the fall or the spring, cover crops are excellent at holding and storing nutrients until the next cash crop can use them. Frequently, cover crop establishment and manure application dates are within days of each other. Ideally, manure is spread, and cover crops are planted as soon as possible. However, in some situations

where manure cannot be spread immediately, planting the cover crop in a timely manner is preferred. As long as the manure is not spread too heavy, a growing cover crop can withstand a light application.

Cover Crops as a Forage. A common dual purpose use of cover crops is to use them as forage in addition to the many other aspects as outlined above. For those who have animals, this presents an opportunity to further maximize cover crop benefits. Planting dates may need to be earlier if forage production is intended for the fall. Seeding rates need to be higher—typically double that of a cover crop rate. It is also important to make sure adequate fertility is present due to higher biomass production.

Cover Crop Seed Industry. The past 10 years have seen a plethora of seed companies jumping onto the cover crop seed band wagon. Some have been start-ups dealing primarily in cover crop species, but most recently, as the industry has established itself, more traditional grass seed companies have entered the market. Some of these companies have provided educational materials and associated research, but most are simply supplying seed to farmers who ask for it.

RESEARCH AND EDUCATION

Currently, there are enough seed providers that most any farmer can access cover crop seed if desired. The element that is lacking is education and research, and it costs money to generate meaningful data. Within the USDA, specifically the SARE Program and the Agricultural Research Service, much research has been done both through funding on-farm and academic research. This has provided guidance for specific cover crop use, but since farmers in general still view cover crops as an afterthought, has not impacted a majority of agriculture to this point. Some agriculture organizations have budgeted time, money and effort toward cover crop research, but they have been few and far between. What is most notable is that a majority of seed companies have not invested significant dollars into this important research. However, much marketing has been done and has been effective in promoting the use of cover crops. It is difficult for these companies to be competitive at the

retail level while at the same time investing in research that helps those not yet employing cover crop practices on their farms to buy in to the principle. As the cover crop industry matures, it would be expected that, little by little, more funding will be dedicated to enhancing the management of cover crops.

FUTURE

There are several issues that may be very soon influencing the increased adoption of cover cropping. Government regulations associated with water quality will undoubtedly increase. Since cover crops have proven to be very adept in keeping nutrients like NO_3 in farmers' fields, they are top candidates for mitigating this growing problem in our nation's waterways. Several large cities have taken steps to challenge upstream watersheds for allowing the runoff of NO_3 , which must be removed via expensive denitrification methods in order for the water to meet federal safe drinking water standards.

Other ideas that have been discussed are using cover crop incentives that are tied into qualification for subsidies or an offsetting tax that supports cost sharing of cover crops. The Risk Management Agency is considering certain crop insurance premium discounts to those who have proven to historically have lower risk due to cover crop use. Several large corporate food companies are also implementing "fertilizer optimization plans" that include responsible nutrient use. This will influence how their vendors grow the food they sell. Cover crops are actively a part of that discussion and may be a key component to activate these plans.

How are the current low grain prices affecting interest in cover crops? It appears that experienced cover croppers continue to use them—they realize the benefits. They don't question the expense, but see the long-term investment as a value to their cropping system. Education and research data are critical for newcomers to realize and maximize those benefits. There are various forms of cost share money available from some states and from the USDA Natural Resources Conservation Service. These programs are designed to incentivize farmers to get started in cover crops, but require some efforts in order to receive funds.

SUMMARY

Cover cropping is not analogous to finding a missing puzzle piece. Rather, it's more like rearranging the picture to accommodate the practice. Twenty-first century agriculture is proving to merge technology and biology, and cover crops are a part of that dynamic. Increased profitability is a result of a more resilient soil that can better handle weather extremes. It will take additional research to validate and to help strategically manage each farmer's cropping system, including cover crops. Agricultural pollution can be mitigated and public perception can be restored by the use of cover crops. We can "green" the planet one field at a time.

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