Residue and Tillage Management, Reduced Tillage *NH-345*

Successful No-till for New Hampshire Dairy Farmers

Although there are basic rules that apply to all no-till systems, no two farms will approach no-till in exactly the same way. Cultural, financial, and logistical challenges vary from farm to farm. Below are some ideas to help farmers make progress as they adopt no-till.

Planting Techniques

> GOOD – Spray and Wait	**>> BETTER** – Planting Green	**>>> BEST** – Cover Crop Roller
Traditional no-till. Terminate the cover crop prior to planting. Cover crop biomass is low, which reduces organic matter and nutrient uptake. Creates problems managing dead cover crop residue.	Plant directly into living cover crops. Cover crops are allowed to grow larger, increasing organic matter and nutrient uptake. Soils are mellow due to living roots and residue is succulent.	Allow cover crops to reach critical biomass before rolling and no-till planting. Requires specialized equipment (available to rent). Provides all benefits of planting green, plus better weed control.
		

Manure Management

> GOOD – Surface Application	**>> BETTER** – Surface + Testing	**>>> BEST** – Injection
Surface apply manure onto living cover crops. Application MUST be even. Apply at low enough rates to not smother cover crops. Spring manure supplies the bulk of N to the crop, which may reduce yield.	Surface apply manure, then perform in-season testing (PSNT or chlorophyll meter) to determine additional N need. Sidedress N as necessary. Adjust manure rates and cover crops to better manage.	Inject manure to avoid N loss, nutrient runoff, and odor. Use low disturbance injection systems. Injection will reduce sidedress needs due to lower losses. Continue to use in-season N testing.
		

MAKE PROGRESS

Cover Crop Species

> GOOD – Cereal Grain	**>> BETTER** – Grain + Brassicas	**>>> BEST** – Diverse Mixes
Plant cereal grains, such as rye or wheat, immediately after corn silage harvest. Grains grow quickly, are winter hardy, and can be harvested as forage. Prone to nutrient tie-up if terminated late.	Brassicas, such as radish, turnip, and rapeseed, compliment cereal grains. They have deeper taproots, extract more N, and quickly cover the soil. Most winterkill and return nutrients in spring.	Mixes, including multiple grains, grasses, brassicas, clovers, and other legumes provide rapid fall cover with manageable spring biomass. They also act as a N source and reduce nutrient tie-up.
		

Cover Crop Establishment

> GOOD – Broadcast	**>> BETTER** – Aerial	**>>> BEST** – Drill
Broadcast seed on the soil surface after harvest. Works with winter rye, but germination rates will be low and stands uneven. Use a roller or cultipacker to achieve better seed-soil contact.	Use aircraft to seed cover crops into growing corn prior to harvest. Allows earlier establishment and enhanced fall growth. Can have similar establishment problems as typical broadcast. Expensive.	No-till drill seed immediately after corn harvest. Produces the most consistent results at lower seeding rates, which saves money. Can be slow with a small drill. Drills can also be used for forage seedings.
		

PLAN. PLANT. OBSERVE.

Successful no-till corn silage requires careful planning before you plant. Use the schedule below to help prioritize all the moving parts of your no-till system. Individual farmers will find unique solutions to no-till challenges, but all farmers must consider the same basic principles: (1) proper seed placement, (2) manure management, (3) effective weed control, and (4) timely cover crop establishment.

WINTER	December	**ORDER – Buy seed and fertilizer for next season** Look for corn hybrids with good early vigor and strong cold germination. Seek hybrids with shorter relative maturity balanced with good yield potential.
	January	**PLAN – Look at all parts of your no-till system** Examine your planter, nutrient and pest management programs. Talk through changes with your agronomist, Cooperative Extension, and NRCS staff.
	February	**UPGRADE – Perform planter maintenance and install no-till upgrades (p. 5)** Install row cleaners, down pressure springs, closing wheels, and fertilizer systems. Calibrate seed meters. Keep your planter in good working order.
SPRING	March	**ASSESS – Monitor cover crop growth and species composition (pp. 7-8)** Tall cover crops are easier to manage in no-till. Planters with rollers can be rented. Study burndown herbicide options for cover crop mixes with legumes.
	April	**SPREAD – Surface apply or inject manure into growing cover crops (p. 9)** Wait till cover crops green-up and soils dry before spreading manure. Do not plant corn into soils saturated with manure. Allow enough time for drying.
	May	**PLANT – Delay planting until soil temperatures are consistently >50° F (p. 8)** No-till soils warm slower than tilled soils. Consider planting green and killing the cover crop after planting, which will improve biomass and weed control.
SUMMER	June	**SIDEDRESS – Use PSNT or chlorophyll meter to determine nitrogen need (pp. 9-10)** Nitrogen cycles slower in no-till systems and these methods are key to reducing yield drag. Cooler spring soils can delay mineralization from manure.
	July	**SCOUT – Monitor fields for increased weed and insect pest pressure (p. 8 & p.11)** Armyworm and black cutworm can be more common in no-till systems. Early identification is key to effective control. Spray according to IPM pest thresholds.
	August	**PREPARE – Get ready to harvest corn silage and quickly establish cover crops (p. 6)** Early establishment is critical to cover crop success. Make sure all seed, labor, and equipment is ready. Cover crops are important, so treat them that way!
FALL	September	**HARVEST & SEED – Harvest corn silage and immediately seed cover crops (p. 6)** Use cover crop mixes to balance robust fall growth with manageable spring cover. Use a grain drill for the best germination and reduced seeding rates.
	October	**SPREAD – Surface apply or inject manure on growing cover crops (p. 9)** Wait till cover crops are several inches tall. Nitrogen volatization is minimized in cool, damp conditions. Do not apply manure to frozen or saturated soils.
	November	**INCENTIVES – Contact the local NRCS field office to discuss financial incentives** Payments are available for no-till, cover crops, nutrient management, crop rotation, and forage seedings. Plan now for next growing season.

MAKING NO-TILL WORK FOR YOU

Dairy farms growing corn silage are a great candidate for no-till agriculture. A well-managed no-till system is efficient, which saves time, fuel, and labor expenses. It also builds healthy soils that moderate extreme weather events. Moving away from tillage also poses some unique challenges that must be understood and managed. Adopting no-till isn't a simple change in planting technique, it's a top to bottom change in how you grow corn. The more you understand how successful no-till works as a system, the better no-till farmer and manager you'll become.

Some common questions and answers are presented below to help interested dairy farmers successfully adopt no-till on their farms.

>>> CROP YIELD

Q: Will I have reduced yields?

A: No, but it entirely depends on your management. The transition from tillage to no-till production requires some major management changes and many subtle tweaks. Successfully adapting to these changes is the key to maintaining or improving yields.

Dairy cows require consistent, high-quality feed, so it's common sense that yield is a top priority for dairy farmers. First, no-till itself does not cause yield reductions. In fact, well-established no-till systems consistently equal or win national yield competitions against tilled systems. Still, yield losses, or yield drag, are a legitimate concern and can be a problem for some when adopting no-till. Just like any major management change, no-till requires a period of adjustment both for you as a farm manager and for your soil. With careful planning, monitoring, and record keeping, you can avoid yield drag.

No-till soils resist compaction due to improved physical structure, which is helpful in high-traffic silage corn systems.

No-till can save time and money, but the cropping system requires careful management to realize those goals. No-till also requires dedication to work through the transition period, which might not meet unrealistic expectations. As a farm manager, you'll need to be sure your equipment is ready, you select the right corn hybrids, and you manage pests and nutrients effectively. Cover crops should be integrated into the system to maximize the benefits of no-till. Your soil will also go through a process of physical, chemical, and most importantly, biological change. No-till soils rely on healthy soil microbes (bacteria, fungi, protists, and nematodes) and macrofauna, like earthworms, to cycle nutrients, build stable soil aggregates, and break-down surface residue. Over time, the improved soil structure and organic matter content leads to better drainage and improved water-holding capacity, reducing your vulnerability during periods of extreme weather.

>>> PLANTING EQUIPMENT

Q: Do I need to buy new equipment?

A: Probably not. Often, existing corn planters can be effectively modified to work well for no-till planting.

There is a thriving aftermarket industry devoted to converting and customizing all types of corn planters so they will perform well under no-till conditions. For example, a well-maintained and upgraded John Deere 7000 planter from the mid-1970's can become a capable no-till tool. As with all equipment, proper maintenance is essential and sometimes new equipment may be the best choice.

With no-till, the planter often becomes the most important implement on the farm. It must do all the work to cut into the soil, place the seed, and cover the seed trench without any prior tillage to prepare the seedbed. It must perform those steps precisely, with minimal variation in depth and spacing, across the entire field. Most corn planters are not designed to do this effectively from the factory and fewer still after years of use and abuse. In all cases, the planter must be properly setup to match the conditions on the farm. Reducing variables to promote even stand emergence, which starts with proper seed placement and consistent depth, is the key predictor of corn silage yield.

Spiked closing wheels help fracture sidewall compaction and assure the seed trench is fully closed in challenging soil conditions.

Typical corn planter maintenance and upgrades required for no-till include:

- Bushings in worn parallel linkages, gauge wheel arms, and tailpieces
- Heavy-duty and/or adjustable down pressure springs on row units
- Sharp, properly adjusted double-disc openers
- Walking gauge wheels
- T-handle style closing wheel tailpieces -- easily adjustable down pressure
- Spiked, notched, or spoked closing wheels
- Seed firmers (Keaton), covers (Shaffert Rebounder) or firming wheels (Monosem Pro Wheel, Great Plains Seed-Lok)
- Liquid pop-up and/or starter nitrogen fertilizer systems
- Foam row markers or GPS row guidance

As farmers experience success with no-till, many may also want to upgrade manure spreaders, look toward manure injection, and purchase seed drills for cover cropping. These tools help improve efficiency and uniformity of coverage, but are often not needed immediately.

>>> COVER CROPING

Q: Do I still need to plant cover crops?

A: Yes, you'll experience greater success and faster results when cover crops and no-till are applied together as a cropping system.

Cover crops and no-till perfectly complement each other when applied together as a system. Cover crops help "jump start" the physical and biological changes in the soil that are important for successful no-till. Soils with cover crops are mellower, retain excess nutrients, and dry faster in the spring, all of which make no-till perform better. In fact, many of the benefits of no-till, such as increased organic matter, cannot be fully realized without cover cropping.

Root exudates from cover crops feed soil microbes, which in turn make nutrients available to plants and form stable soil aggregates (individual soil particles glued together into larger, stable clumps). These aggregates form soil channels that improve water infiltration, allow air flow, and trap soil organic matter. Cover crop roots can also alleviate compaction caused by wheel traffic during silage harvest. When managed for greater biomass, cover crops reduce weed pressure, moderate soil temperature in the summer, and help retain water during droughts. Over time, cover crop residues contribute to soil organic matter.

Q: How do I plant cover crops without tillage?

A: There are several options for seeding cover crops without tillage, such as a 1) no-till grain drill, 2) surface broadcast, 3) aerial application, and 4) manure slurry.

Grain drills provide the most consistent cover crop stand at the lowest seeding rate.

Grain drills provide the best seed soil contact, germination rate, evenness of stand, and overall consistency. Seeding rates can be reduced when compared to broadcast methods, which reduces seed cost. Grain drills may be the only option for large seeded cover crops, such as beans and peas, which require a 1-2" seeding depth to germinate. Seeding with a drill is slower than broadcast methods and large drills are both expensive and difficult to transport. In the long term, a grain drill may be a wise investment for the farm as it can also be used for hay and forage seeding. You can also check with your local conservation district to find a drill to rent.

The most basic application method is simply to broadcast the cover crop seed onto the soil surface and use rain to help germinate the seed. This can work fairly well for some species, like winter rye, but does not guarantee an even stand or plant population. Crop residue on the soil surface and dry weather can

also hinder germination. Better seed soil contact can be achieved by rolling after seeding, most often with a cultipacker with the tines raised to avoid soil disturbance. Higher seeding rates are required versus drilled cover crops due to reduced germination rates.

Aerial seeding is also a broadcast method, but has several advantages. First, seeding and germination happen prior to corn harvest, so the cover crop has more time to become established and produce biomass in the fall. Second, aerial seeding cuts down on farmer labor during harvest and ensures timely seeding. Every day counts in the fall when seeding cover crops. Like surface broadcast, success is extremely weather dependent. Dry weather can lead to delayed germination or crop failure. Some seed will also become trapped in the corn leaves during the seeding process, which reduces overall stand density. Seeding rates are higher to compensate for trapped seed. Farmers using aerial seeding should also plan to harvest their corn crop 2-3 weeks after seeding. Longer periods will stress the cover crop and increase injury during harvest. Especially thick corn stands, such as high populations, double-row, or narrow-row corn, can also reduce aerial seeding success. Although convenient, the added cost of flying on the seed tends to make aerial the most expensive method.

Cereal grains and legume cover crops can be mixed into the manure slurry at spreading and applied with the manure spreader. Although this might sound appealing because it reduces a pass across the field, it also takes time to fill the spreader and agitate the mixture. This method can work, but also tends to yield spotty and inconsistent results. Using this method successfully will take determination and experimentation.

Planting cover crops is always a balance of time, money, and consistency. The best predictor of cover crop success is planting date. Simply said, get your cover crops planted as early as possible to maximize their impact. Second, choose a seeding method that will yield the most consistent results. You'll enjoy the greatest benefit from the time and money spent seeding if the results are consistent across the field. Reducing variability of your cover crops will reduce variability of your corn crop. If you're planning to use the cover crop for weed control, then dense, even stands are important to suppress weed germination and compete with any germinated weed plants.

Q: How do I terminate my cover crops without tillage?

A: Cover crops can be terminated with burndown herbicides. Include residual herbicides in the tank mix to have a one-pass herbicide program.

Most no-till farmers choose to terminate their cover crops with burndown herbicides either several weeks prior to planting or immediately before/after planting. Early termination is often termed "spray and wait". The exact time it takes for the cover crop to die will depend on what product you use, and is further affected by surfactants/adjuvants, water chemistry, weather, and growth stage. Timing is critical and must be taken into account when selecting an application date and a subsequent planting date. Planting into living cover crops is called "planting green" (see below) and can make seeding easier,

although there are drawbacks to consider. In some cases, it may also be practical to plant a winterkilled cover crop that dies due to cold temperatures. This eliminates the need for herbicide burndown, but does not provide a living root system in the spring, which reduces the overall effectiveness of the cover crop.

Seek the advice of UNH Extension or your crop advisor for the best choice of herbicide rate and product for your unique situation.

Q: What is "Planting Green"?

A: Planting Green is planting technique where corn is planted directly into a living cover crop. The cover crop is terminated IMEDIATELY after corn planting.

Planting green into a winter rye cover crop using a no-till planter with integrated cover crop rollers.

Although it may seem strange to plant corn into a living cover crop, it has distinct advantages and is becoming very popular with no-till farmers. First, green covers are succulent and the planter can easily cut through the living plant material. Alternately, cover crops that are killed before to planting become tough and can be driven into the seed trench by the planter double-disc openers. This problem, called hairpinning, reduces seed/soil contact, germination rates, and stand density. Planting green also allows you to maximize the amount of time your cover crop is accumulating biomass, scavenging nutrients, and protecting the soil surface. Maintaining living roots in the soil that overlap with cash crop germination maximizes soil organic carbon, microbiological activity, and nutrient cycling. In short, you will maximize the benefit of your cover crop.

However, the technique requires careful management of the cover crop biomass. If cover crops grow too tall, they can shade new seedlings and delay early season corn growth. Using a crop roller can help lay the cover crop flat prior to termination (herbicide application) and avoid shading. If the cover becomes over mature (cereal grains that have headed out), there is a risk for nitrogen tie-up as the cover crop residue decomposes. Be sure to monitor for nitrogen deficiencies in the corn crop and side dress as necessary. Legume cover crops in a mix with cereal grains can also help avoid nitrogen tie-up. Cover crop residues may increase the likelihood of injury from some pests, such as black cutworm or true armyworm, which can "bridge" from the dying cover crop into the growing corn crop. This is not a common problem, but requires extra care to scout for pests and treat promptly when it's appropriate. Some Bt traited corn hybrids can also prevent pest outbreaks, but effectiveness varies based on the exact hybrid and traits.

>>> MANURE & NUTRIENT MANAGEMENT

Q: Don't I need to incorporate my manure?

A: Although getting manure into the soil is best, that can be a challenge in a no-till system. Fortunately, when combined with cover crops, many of the concerns related to surface manure application can be avoided.

For years, farmers were given good advice that they should incorporate manure to reduce nutrient runoff and capture volatile ammonium (NH4+) nitrogen. While this strategy makes sense in tillage based systems, it's simply not feasible in no-till systems where the goal is to eliminate soil disturbance from tillage, including the incorporation of fall applied manure. If fall tillage continues, you never get the full benefit of a no-till system, while having to cope with the transition period year after year.

Manure surface applied in the fall onto an actively growing cover crop will have lower nitrogen loss and reduced environmental risk.

Roughly half of the nitrogen in dairy manure is in an organic form that is stable and not readily lost to the environment. The remaining half is ammonium (NH4+), which can be rapidly lost to the atmosphere as ammonia gas, especially when conditions are hot and dry. To avoid this loss in no-till, there are two options: careful surface broadcast and manure injection. First, surface broadcast can be utilized much like it is for hayland, where cover crops absorb and retain the nutrients applied. When manure is spread on growing cover crops, ammonia nitrogen losses are reduced by over 20 percent. Applying during cool weather and/or with a soaking rain reduces losses further, likely conserving 60-70 percent of the total nitrogen in the manure. This is comparable to manure incorporated one day after spreading. When possible, application timing should be adjusted to avoid warm days and dry weather in the fall. Broadcast is the only option for semi-solid or bed pack manure. In all cases, it's critical manure is spread evenly to avoid zones of nutrient deficit and excess, which will impact crop yield. Also, be sure there are no large clumps to plug the corn planter. Manure should not be spread on saturated or frozen soils or before an intense rainstorm. In these cases, manure will likely runoff the field, reduce crop available nitrogen, and pollute surface waters.

Second, manure can be injected into the soil, either passively using an aerator prior to spreading (set to 0 degrees offset to minimize disturbance) or actively using disc/shank injection. Manure injection will greatly reduce ammonia losses, typically by 90 percent for shank injection. Manure injection equipment can be costly to own and may be hard to schedule with custom applicators. Care should also be taken to avoid injection into frozen soils that will heave, leaving the ground rough and difficult for no-till planting.

MAKING NO-TILL WORK FOR YOU

Q Will no-till change my nutrient management program?

A: Yes, no-till will require rethinking the timing and flow of nutrients through your cropping system. Specifically, adequate nitrogen must be made available early in the growing season.

Dairy farms typically rely on manure for the bulk of their crop nutrient needs and supplement with broadcast or banded fertilizer when required. This nutrient management strategy relies on spring tillage to warm and aerate the soil, which causes the rapid decomposition of organic matter and a flush of available nitrogen. Although this depletes the soil organic matter reserve, which can have detrimental effects later in the growing season, it does provide suitable amounts of nitrogen to young crops early in the season. Tilling under green cover crops and manure in the spring provides an additional nitrogen boost. No-till does not benefit from this effect of tillage and extra early-season nitrogen may be required. This is especially true for soils that have not fully transitioned to no-till and are not cycling nutrients efficiently. Additional nitrogen can be added through various fertilizer options, such as liquid pop-up (in-furrow at low rates), banded (liquid or dry), or broadcast (dry).

Extra nitrogen may also be needed if a cereal grain cover crop has headed out before termination. Grains killed at this stage require extra soil nitrogen to break down, which robs plants of nitrogen for growth. Eventually, the nitrogen is returned to the soil as the bacteria and fungi that decompose the cover crop die and are mineralized, but this may occur too late in the season and can cause yield drag. In these cases, extra nitrogen applied at the time of planting can make up for this temporary nitrogen depression. Care should be taken to avoid nitrogen application directly onto the decaying cover crop residue as there is a greater chance this nitrogen will be consumed by soil microbes before it reaches the plant roots. Adding a legume to the cover crop mix can help avoid nitrogen depression by altering the overall carbon to nitrogen ratio of the cover crop biomass. The nitrogen provided by the decaying legume roots offsets the nitrogen consumed by bacteria and fungi. Mid-season testing with pre-sidedress nitrate tests, chlorophyll meters, or the Adapt-N model is especially useful in determining nitrogen needs

Diverse cover crop mixes, with legumes and brassicas, can help improve nitrogen availability in the spring.

There is concern among some farmers and agronomists that continual surface applied nutrients will result in stratification, where immobile nutrients such as phosphorus and potassium will become concentrated in the upper layers of the soil. Stratification does occur in no-till, but has not been shown to impact yields or plant health. Impacts are offset by greater earthworm populations that continually mix the soil and by abundant mycorrhizal fungi that increase root uptake of nutrients. Before adopting no-till, bring your soil pH and fertility to adequate levels, then maintain those levels through additional lime, fertilizer, and manure either surface broadcast or injected/banded.

>>> HERBICIDE CONSIDERATIONS

Q: Do I need to change my herbicide program?
A: Many farms will find that their existing herbicide programs are equally effective for no-till, or that they may only need some relatively minor modification.

Most pre-emergent, post-emergent, and burndown herbicides will work the same way in no-till as they do in conventional tillage systems.

The combination of cover crops with no-till requires the use of burndown herbicides to terminate vegetation prior to or at planting. Also, verify that any pre- or post-emergence herbicides you use won't interfere with the growth of whatever cover crop species you plan to sow after harvest. Most grasses, including cereal grains, don't pose any problems, but small-seeded legumes (e.g. clovers, vetch) and brassicas can be sensitive to certain products. This is especially true when herbicide activation may be delayed to due dry weather and carryover to cover crop emergence. When double cropping, check the product label to make sure that harvesting for feed is allowed.

Some changes may be required under high-residue cover crop systems that leave a mulch mat on the soil surface. The residue can prevent pre-emergent herbicides from reaching the soil. In these cases, it's likely the mulch mat will help suppress weed germination and can partially offset the decreased effectiveness of the herbicide. Research has shown decreased weed populations and overall weed size when residue levels are high, which can help make herbicides more effective. Some trial and error may be necessary when using high-residue cover crops. Ultimately, post-emergent or burndown herbicides may prove more effective.

A rolled cover crop mulch mat provides effective weed control if the cover crop biomass is sufficient.

In general, no-till systems see reduced weed pressure early in the transition process because the seeds of annual weeds, which thrive under the disturbance caused by tillage, are no longer brought to the surface to germinate. Eventually, perennial weeds species that would otherwise be eliminated by tillage will grow more common under long-term no-till. This change may require switching herbicide products, techniques, and timing.

>>> NON-GMO CORN HYBRIDS

Q: Does No-till Work with Non-GMO Corn Hybrids?

A: Yes, no-till can work very well with non-GMO corn hybrids and should perform very similar to tillage systems.

The lack of genetic traits means choices in weed control are more limited and potentially more challenging, but there are still plenty of options available. Likewise, without traited protection from insect pests, scouting and well timed insecticide applications become more critical. These may be acceptable tradeoffs for reduced seed cost, milk price bonuses, and greater public acceptance.

The timing of spray applications, especially for cover crop termination, is the most important difference with non-GMO's due to the lack of "clean-up" spray options after crop emergence. Spraying early and waiting for the cover crop to die is the safest way to plant, but it does reduce cover crop biomass and potential for weed control. If you plant green and apply your own herbicides, be sure to burndown the cover crop before crop emergence. Aim to spray the same or next day if at all possible. If you're choosing to plant green and use a custom applicator, it may be wise to wait until the cover crop is sprayed before planting. Although this may delay planting in some cases, if the crop happens to emerge before the custom applicator gets to your farm, killing the cover crop will be more difficult and will almost surely decrease yield. The benefit of planting green with non-GMO corn is that increased cover crop biomass will help suppress weed germination and make killing weeds easier.