Frost Injection of Manure at Table Rock Farm: A Case Study

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Fig. 1 Frost injection of manure at Table Rock Farms (photo by E. Jacobs)

Each spring, on farms all over the Northeast, the race is on to accomplish a large amount of field work in a very limited amount of time. Manure needs to be spread, crops need to be planted, and, before you know it, hay is ready to be harvested. Western New York's unpredictable spring weather can further reduce the window of opportunity for optimal timing. Frost manure injection is one procedure that Table Rock Farm has implemented to redistribute the spring workload while maintaining good environmental stewardship.

Table Rock Farm is a dairy operation located in Wyoming County, New York. The farm has 850 lactating cows, 115 dry cows, and 636 heifers and calves for a total of 1719 animal units. The farm produces approximately 10,300,000 gallons of waste and 1600 tons of manure. There is a total of 1200 acres of cropland. Table Rock Farm has two 5000-gallon tractor-drawn tankers with injectors (Fig. 1). Additionally, there are four truck spreaders with 4500-gallon tanks to transport the waste to the field spreaders.

One of the reasons that the farm purchased injectors is to increase the amount of the manure's nitrogen available for the crops. Six years ago a 15 row, 15-inch corn planter was purchased. This has increased corn production and eliminated the ability to side dress nitrogen. The last three years' corn silage yield has averaged 24 tons per acre at 30% DM. At this average yield, one hundred eighty pounds of nitrogen is needed to meet

the crop requirements. Based on the average spring manure sample, the total nitrogen is 24 pounds per 1000 gallons, 12 pounds organic N and 12 pounds of ammonia. Spring injection increases the value of nitrogen two fold. If 8000 gallons of manure is surface applied and not worked in within three days, approximately 48 pounds will be available to the crop (50 percent of the organic nitrogen). If spring injected, approximately 110 pounds will be available. Other positives associated with injection are limiting the risk of nutrient runoff and reducing odor. Good environmental stewardship is not only a governmental requirement, but one of the farm's primary missions. Converting to injection reduced odor problems, and neighbor complaints have been eliminated.

The challenge on this farm, as well as many other dairy farms, is to accomplish the large spring workload in a timely manner, within the guidelines of a Comprehensive Nutrient Management Plan. Each spring, approximately five million gallons of manure need to be hauled to the fields and spread, and 200 acres of alfalfa seedings and 650 acres of corn need to be planted. Timeliness is critical. To make a profit, the clearly defined goals of the farm's staff is to have the seedings planted by April 20th, corn planted by May 10th and first cutting harvested by the end of May, while dealing with the unpredictability of Western New York weather. To accomplish the goal of harvesting the new seedings three times, early planting is a must and, according to Cornell research, corn that is planted by the end of April or early May has a 10 percent yield advantage over corn planted in mid May (May 25 is 20 percent).

In good weather, it takes Table Rock Farm 20 days to haul out and apply 5,000,000 gallons of manure, 5 days to till, fit and drill the seeding, and 10 days to plant the corn. Weather, breakdowns, and labor problems can certainly throw a monkey wrench into the best laid plans. If one task is delayed, a domino effect can alter the timeliness needed for planting or harvesting.

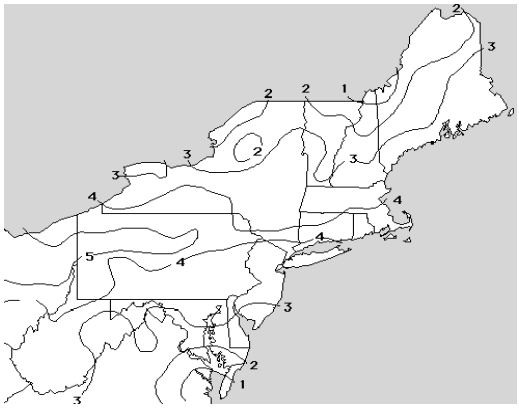
Frost Tillage

Frost tillage can be performed when the upper surface is frozen and the subsurface is still unfrozen (see also What's Cropping Up Vol 6, No4, and Vol 3, No 1). Northeast tillage is seldom done in winter or early spring because soil is either saturated or frozen. However, during a freeze cycle in late winter or early spring, the soil will have a few days when the frost is shallow (4 inches or less) which provides the opportunity for frost tillage and manure injection.

Redistribution of the moisture in the soil creates the conditions for frost tillage. When frost sets into unfrozen soil, the subsoil water is drawn up into the frozen surface layer, leaving the subsurface dry enough to till, at least as long as the frost depth is less than 4 inches. Using the reliable climatic data from the U.S. National Weather Service network of volunteer observers a model was developed to estimate frost penetration depth. Based on this analysis, Table Rock Farm has an average of 4 days per year with conditions that allow for frost tillage (Fig. 2). In general, after an initial thaw, soil that experiences two to three days of good freezing temperatures (daily minimum temperatures below 15 degrees F and maximum temperatures below freezing) would produce conditions

favorable for frost tillage that may persist for a few days. If snow coverage follows immediately, the window may extend for several more days.

Figure 2. Average number of frost tillage days per winter



Before applying frost tillage, a "ball test" is recommended by digging through the frozen layer with a shovel and attempting to squeeze a sample of the unfrozen soil into a ball. If the soil molds and forms a ball, it is too wet to till. If the soil crumbles the conditions are favorable for frost tillage.

Frost Manure Injection on Farm

Based on our frost tillage research, the concept emerged to use injectors to simultaneously till the soil and inject manure into the frozen soil profile, which was presented to the Table Rock Farm staff. They were receptive to the idea, and in the late winter of 1999 approximately 1,000,000 gallons of manure were injected into the soil. In early March the following year, approximately 1,500,000 gallons were injected into about 150 acres of land. Five days worth of manure spreading was done in 2000 prior to the spring thaw. With the high precipitation of spring and summer 2000, this helped ease the burden by spreading the workload out and allowing the farm to stay within its time schedule. The staff observed that a rye cover crop, planted originally for soil conservation, seemed to help promote a shallower frozen subsurface allowing a much wider time window for frost injection.

In addition to easing the spring workload, frost injection also reduced soil compaction. A 220 horse power tractor pulling a tanker load of manure combines to weigh 40 tons. Especially in the spring, serious compaction damage may occur with this much weight. Using frost injection, the frozen zone supports the equipment with no compaction damage to the soil. Despite the advantages, there are also drawbacks to the system. It takes approximately 20 percent more power to inject into frozen soil than normal soil conditions. The wear and tear on equipment will increase as well, and, fields that vary in topography make injection difficult. Some areas will have favorable conditions while other areas within the same field will not. Knolls are more likely to have a deeper frost zone than valleys and have caused damage to the injectors when the frozen depth was too deep.

Conclusion

Frost injection or incorporation provides an environmentally safe means for farmers to shift some workload from the spring to the winter. Fields that could possibly be a concern for runoff with normal winter spreading, can safely be spread using this best management practice. Emerging EPA and NRCS guidelines may disallow winter spreading on frozen ground with the potential for waste runoff. In some states, like Vermont, a law has been passed that prohibits all winter spreading on frozen ground. Laws and standards should give special consideration for frost manure injection/incorporation as an environmentally sound practice.

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