

Frost-Seeding - an Effective Forage Establishment Practice for Michigan

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Frost-seeding is the practice of overseeding forage or cover crop seed in late winter for the purpose of adding new species components to grasslands or row crops, or renovating existing grasslands. It is an inexpensive and effective method for improving productivity and forage quality of grasslands without having to completely start over, and has the advantage of keeping pastures and hayfields in productive use throughout the improvement process. Because establishment is often uneven with this method, frost-seeding is not recommended for primary establishment of new fields.



Honey-combed soil and coated red clover seed (pink) the day after frost-seeding. Photo: Kim Cassida.

Successful frost-seeding depends on the freeze-thaw cycle that occurs in early spring when the surface of exposed soil freezes at night and thaws in the daytime. When this occurs in fine-textured soils, ice crystals in the soil form an elevated honeycomb structure at night that collapses during the daytime thaw. In this freeze/thaw process, seed that was deposited on the

soil surface is buried, establishing the soil-seed contact that is needed for germination.

Both research and farmer experience have shown frost-seeding with legumes to be a simple and inexpensive method of pasture improvement. Field demonstrations conducted with red and white clover by MSUE show that an investment in seed, inoculant, and starter fertilizer at \$35 to \$45 per acre can increase the yield of unimproved pastures by 0.8 to 1.5 tons per acre dry hay equivalent for a \$12 to \$15 per acre annual cost (assuming three-year clover longevity). Numerous livestock producers in Michigan have reported good success with frost-seeding pastures and continue this practice.

Like any other management practice, frost-seeding success can be improved by good planning and execution. Planning for frost-seeding should occur the year before the planting is to be done to ensure adequate time for site preparation.

Step 1. Select a suitable site.

Frost-seeding is especially effective on sites where use of larger planting equipment is not possible, such as steep slopes, rocky surfaces, or under trees. It can be used on large fields or spot-applied to damaged areas such as winter feeding lots. Sites suitable for frost-seeding have fine textured soil such as clay, silt, or sandy loam. These soils are capable of forming the desired honeycomb ice structures and also hold more moisture to aid survival of the newly emerged seedlings. Frost-seeding is not recommended on sandy soils because they exhibit little freeze/thaw activity and dry out too early. On sandy soils, it is better to direct drill with a no till drill or even a conventional grain drill seed as soon as the tractor can get across the field without excessive wheel track damage.

The effectiveness of frost-seeding depends on the timing of snow melt. The freeze/thaw cycle cannot help bury seed if the ground is snow-covered during the period when temperatures are still dependably freezing at night. Therefore, the usefulness of frost-seeding may be limited in the Upper Peninsula where snow cover may not disappear until May, long after the freeze/thaw period is over.

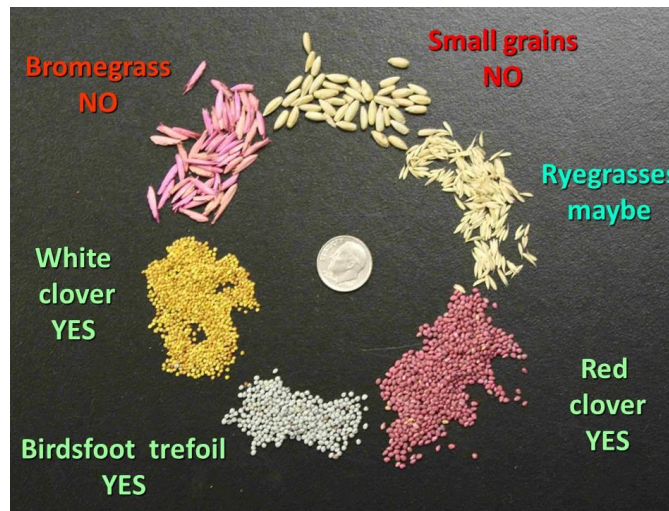
Pastures that consist of bunchgrasses like orchardgrass, timothy, or fescue are the best candidates for frost-seeding with legumes because there are spaces between plants where legume seedlings can establish. Sod-forming grasses such as bluegrass are likely to have a thatch layer that will impede soil-seed contact, and pastures containing more than 50% quackgrass are likely to be too competitive.

Another proven use for frost-seeding is establishing a red clover cover crop into winter wheat. The shade-tolerant clover bides its time under the wheat canopy, grows after grain harvest, and can provide a late summer forage cutting or simply provide ground cover and green manure for the subsequent crop. Many row crop producers in the southern Michigan, Saginaw Valley and Thumb area of Michigan use this practice.

Step 2. Select a suitable forage species and variety.

Frost-seeding is most often used to add legumes to grass pastures. This is useful because legumes often do not persist as long as grasses when seeded together, and frost-seeding is an effective way to maintain the legume proportion without needing to re-establish the entire pasture. To minimize the risk of bloat, the proportion of legume in a pasture should be held at 40% or below on a dry matter yield basis. Birdsfoot trefoil is an exception to this rule because it does not cause bloat.

Frost-seeding is most effective with small, dense, round, slick seeds that readily drop into the honeycomb structures and that can germinate and survive at low soil and air temperatures in early spring. Small-seeded legumes such as red clover, white clover (including ladino types), alsike clover, and birdsfoot trefoil are ideal. Alsike clover is toxic to



Small, round, smooth seeds are better suited for frost-seeding than large or irregularly shaped seeds. Photo: Kim Cassida.

horses and should not be frost-seeded into pastures of hayfields intended for horses. Frost-seeding is not a reliable planting method for alfalfa because it does not germinate well in cold soils, and this method is not recommended for alfalfa in Michigan.

Make sure legume seed is properly inoculated before planting, especially if that species has not been grown on the site for three years or more. Bacterial inoculant enables the legume seedlings to fix their own nitrogen, and without it, they will lack competitiveness with older plants. Most modern coated legume seed already contains inoculant, but if seed is more than six months old or has been held at temperatures over 70°F for several weeks, the inoculant may have died. It is cheap insurance to purchase extra inoculant and inoculate the seed again.

Frost-seeding is less reliable with grasses than with legumes because irregularly shaped, lightweight, and fluffy seeds are difficult to broadcast evenly and do not work into the soil as effectively during the freeze/thaw cycle. Nevertheless, success is possible with annual and Italian ryegrasses, perennial ryegrass, and orchardgrass. Based on Wisconsin research, success is unlikely with timothy or reed canarygrass. Some seed companies add coatings to grass seeds to increase seed weight for better spread under frost-seeding.

To be successful in a frost-seeding situation, seedlings need superlative vigor. Weak seedlings are unlikely to survive in a competitive environment. For that reason, success rates are better when using improved forage varieties bred for better seedling vigor and survival rather than VNS (variety not stated) or bin-run seed.

Step 3. Adjust soil pH and fertility.

If a forage stand faded because of low soil pH or poor fertility, frost-seeding is unlikely to improve the situation. Soil pH in hayfields and pastures should be 5.5 or above. Both red clover and birdsfoot trefoil tolerate acid soils, however, they will grow *better* at a soil pH above 6.0. Lime should be broadcast the fall before frost-seeding because it takes at least six months for soil reaction to occur and increase the pH. Growers should also pay close attention to phosphorus test because it is essential for good seedling root growth and establishment. If needed, P and K can also be broadcast in the fall.

Step 4. Control residue the fall before planting.

This step should also be completed in the fall before planting. Good seed-soil contact is essential for successful frost-seeding, and this means that seed must fall onto bare soil. Winter snows will mat any existing forage residue onto the soil surface, so heavy residues can prevent soil-seed contact when broadcast, and it is likely the soil will be too wet at frost-seeding time in Michigan to take any corrective action. For pastures, residue should be controlled by grazing harder than usual in late fall. The goal here is to *stress* the pasture by leaving a short grazing residual of two inches. This is much shorter than recommended for good grazing management, but preparation for frost-seeding is one of the few times when deliberate overgrazing can be useful. In addition to reducing residue so seed can reach the soil surface, it suppresses the existing plants so they grow less aggressively in spring and thus compete less with seedlings.

If pastures are already in excellent condition, a dense sod may not leave enough space for seeds to reach the ground even with hard grazing. In this case, a light fall disking or harrowing to scratch the surface and expose about 10% of the soil can help prepare the site for frost-seeding. Be aware that this practice can open the

sod for invasion of wind-dispersed weed seeds such as thistle, so do so with caution. For hayfields a late fall cutting from fields where frost-seeding is planned will reduce surface residue and improve soil-seed contact in the spring.

Step 5. Seed at the correct time of year.

For frost-seeding to work effectively, seed must be planted at a time to take advantage of the freeze/thaw cycle and soil moisture must be present. The more freeze/thaw cycles the seed is exposed to, the better the chance of seed germination. Broadcast seed in the early spring when temperatures are reliably freezing at night and thawing in the daytime. This usually occurs from late February to March in Southern Michigan and from March to early April in Northern Michigan and the Upper Peninsula. This timing is about 45 days before grass will typically break dormancy and begin to green up. In the event of a spring drought, frost seeding becomes extremely risky in any location because soil moisture is needed to germinate the seeds in a timely manner.

Overseeding into light snow cover makes it easier to see the spread pattern and can be successful as long as the snow is gone before the freeze/thaw window is over. Seed should not be broadcast into deep snow (more than 8 inches) because it risks being washed away in rapid snowmelt events.

A cyclone seeder, horn seeder, or seeder attachment on the back of a tractor or all-terrain vehicle will work well. Pay close attention to safety and manufacturer's precautions when using all-terrain vehicles.

Step 6. Harvest to encourage seedling survival.

If the older forages are allowed to grow tall and rank in the spring, new seedlings may be unable to compete for water, nutrients, and light. Suppression of the older plants is necessary to allow seedlings to compete and survive. For this reason, frost-seeding is often more effective in pastures than hayfields because pastures can be grazed much earlier in the spring to help reduce shading of the seedlings. Protection of seedlings in a pasture is easiest when using a rotational stocking system. Put livestock on the frost-seeded pasture when the older plant canopy is 8 to 10 inches tall in May and remove livestock at a stubble

height (grazing residual) of 3 to 4 inches. If a pasture cannot be grazed in a timely manner, top-clipping can be used to control competition. Pastures should be managed to reduce competition for seedlings throughout the first year after frost-seeding.

Hayfields are typically not harvested until much later than first turnout on pastures, at which point it may be too late for the seedlings. Therefore, the first cut from a frost-seeded hayfield should be taken as early as possible, and a vigorous cutting schedule should be maintained thereafter.

Step 7. Management after establishment.

Do not fertilize the frost-seeded field with nitrogen in spring after planting because it will create too much grass competition for the clover seedlings. If needed, P and K should be applied by May according to soil test.

Rainfall in May and June is critical to the survival of the new seedlings because they do not yet have deep roots that can compete with older plants for moisture. If water becomes limiting, the seedlings will be the

first plants to die. If available, irrigation can alleviate this risk.

Many of the species ideal for frost-seeding are short-lived and therefore will need to be reseeded frequently. Short-lived species like red clover will need to be reseeded every other year to maintain up to 40% in the stand. Birdsfoot trefoil should become thicker during the second and third years after frost seeding because these seedlings are less competitive than red clover. Some seeds may not germinate the first year, but this can be used to advantage because a regular program of frost-seeding helps build the seed bank in soil. This bank of seed saved in the soil provides a storehouse that can germinate whenever conditions are favorable.

Frost-seeding offers producers an inexpensive method of improving pastures. However, frost seeding is more risky than other methods because a dry spring and excessive competition from existing plants will reduce the establishment potential of frost seeding. The relatively low cost of this method is probably the greatest incentive for producers to utilize frost-seeding. With good management, the system has worked quite well on many Michigan farms.

Table 1. Recommended species and seeding rates for frost-seeding pastures and hayfields in Michigan.

Species	Uses	Planting rate (lb PLS*/acre)	Stand Duration
Red clover	Pasture, haylage, cover crop	6 - 8	2-3 years
White or ladino clover	Pasture, haylage	2 - 3	2-4 years
Alsike clover	Pasture (not for horses)	1 - 2	2 years
Birdsfoot trefoil	Pasture, hay	6 - 12	3 or more
Annual & Italian ryegrass	Pasture, haylage, cover crop	8 - 20	1 year
Perennial ryegrass	Pasture, haylage	8 - 14	1-3 years

*PLS – Pure live seed.

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