Saskatchewan
Soil Conservation
Association

Soil Facts

Forages in Rotation

Including forages in the crop rotation is one of the simplest ways to improve soil quality. Forages provide environmental benefits such as increased carbon sequestration, retrieval of deeply leached nutrients, and critical habitat for wildlife. Diversity is a key to sustainable agriculture. Forages are one way to extend crop rotations, reducing input costs and lowering financial risk.

The benefit of nitrogen fixing plants in agriculture has long been recognized. Virgil (70-19 B.C.) made reference to the nitrogen fixing capability of alder:

"What was designated of old as the dense 'fat shadows' beneath which the green grass and the tender herb continued to flourish."

Perennial forages like alfalfa improve soil quality and sequester soil carbon.

Historically forages, and legumes in particular, played an important role in weed control and nitrogen (N) supply for an upcoming crop. Over the last 50 years, producers have begun to rely more heavily on the use of pesticides to control weed, insect and disease outbreaks and fertilizers to nurture growing crops. These products usually do a good job. But as farmers have come to rely more and more on these commercial crop inputs, the cost of growing a crop has skyrocketed which means lower net returns for producers. Many of the good husbandry or best management practices (BMP) that could be incorporated into crop rotations have been neglected.

The inclusion of alfalfa or legume/grass mixtures in crop rotations has many benefits, including increased soil organic matter. This perk will take on even greater importance now that Canada has ratified Kyoto. In addition, the root structure of forages is finer, so they break down more easily allowing air and water to enter the soil with ease. As forages break down, they produce binding products that act like glue to hold the soil together. The result is larger and more stable soil aggregates that are better able to resist wind and water erosion.

A survey of 253 producers in 1992 in Manitoba and Saskatchewan indicated that producers recognized the yield benefits from forages, but few producers were managing forage stands for maximum rotational benefit. Producers tended to maximize forage stand length, reestablishing only when the existing stand had lost productivity. However research has shown that it takes only two to three years to obtain maximum N accumulation and weed suppression benefits from an alfalfa stand.

Direct seeding and the use of herbicides to terminate forage stands serve to overcome many establishment and termination problems. Adopting these tools enables producers to cycle forages through their rotations more frequently.

Establishment

Forages can take longer to germinate and establish compared to crops such as cereals or pulses. As with any small seeded crop, the key to forage establishment is to seed shallow (1.25 cm or ½ inch deep) into a firm, moist seedbed to ensure good seed-to-soil contact. Direct seeding is therefore an ideal way of ensuring success.

Dormant seeding or seeding in October is another method. This method takes advantage of early season moisture and cooler temperatures that minimizes drying out of the seedbed. However research in Manitoba has found dormant seeding to be successful only about 50% of the time.

Weed control to ensure establishment is also another important issue. Weeds should be controlled prior to

seeding with a pre-seeding burn-off, and an in-crop herbicide or by cutting the volunteers to reduce competition to the young seedlings.

Companion crops, although commonly used in the establishment of forages, reduce stand development. It is, therefore, not recommended to use a companion or cover crop. Direct seeding into standing stubble provides the young seedlings with protection from the wind and a cooler, moister seedbed. Without cover crops, it may be possible to take a cut of forage in the first year. In some instances a second cut may be possible.

Alfalfa established using a field pea companion crop. While companion crops are commonly used to establish forages they reduce stand development and are not recommended.

Termination

The second most common reason producers tend not to use forages in their rotations is the problem of terminating a forage stand. Terminating forage stands using tillage is expensive, time intensive, uses large amounts of fossil fuel, dries the soil and reduces many of the soil improvement benefits of the forage. Herbicides are usually less expensive.

Glyphosate applied at a rate of 1.5 to 2 litres/acre tank mixed with 2-4,D or Banvel is used to terminate forage stands. It works best if the forage crop is actively growing. Grasses should have 3 to 4 leaves per stem and legumes should be in the bud to bloom stage.

Research has found that spraying out forage in the year before seeding is more successful than spraying in the spring. It allows time for soil moisture to be replenished. The forage root system has time to decompose making the seedbed more mellow. The phytotoxic effect of decaying forage plants is also reduced.

In arid regions of the prairies, available moisture must be given significant consideration. There may not be enough moisture to justify forages in the rotation. And if there is enough moisture to grow the forage profitably, a producer may require a fallow period after termination to recharge moisture reserves. However preliminary findings by Jefferson et al. (2003) suggest

Table 1: Wheat yields as influenced by previous crop type (adapted from M. Entz, University of Manitoba).

Crop Rotation*	Grain Yield of Wheat (bu/ac)	Nitrogen Uptake by Wheat (lbs/ac)
1.W-P-B-W-W-W	15.8	29.2
2. W-P-B-W-P-W	20.2	43.0
3. A-A-W-W-W-W	24.0	43.7
4. A-A-W-W-P-W	37.5	74.8
5. A-A-A-W-W-W	25.1	41.5
6. A-A-A-A-W-W	33.7	51.4
7. A-A-A-A-A-W	46.1	82.5

Note: no nitrogen fertilizer added to any of these rotations over the six-year study period.

* W-Wheat; P-Field Pea; B-Barley; A-Alfalfa.

that the type of forage is what may be important. Using short-lived grasses such Dahurian wildrye (DWR) or slender wheatgrass (SWG) in crop rotations rather than using longer-lived species like intermediate wheatgrass improves yield of subsequent annual crops. By including alfalfa with DWR or SWG, forage yields can be improved and following termination, annual production can also benefit.

Most crops have been grown successfully after forage termination. However the key is to select a crop that is competitive and has in-crop herbicide options to control forage regrowth. Cereals typically have cheaper herbicide options than canola. Peas have no in-crop herbicide options to control the regrowth of legumes such as alfalfa.

Perennial forages are very competitive and can play an important role in an Integrated Weed Management plan to suppress weeds.

Weed Suppression

One of the unique features of forages is their ability to suppress weeds. The competitive nature of forages for light and nutrients, and the frequent cutting as hay reduces the vigour of weeds and their ability to produce seed. For example, Dr. Martin Entz at the University of Manitoba reported that the wild oat numbers in a wheat crop grown after alfalfa had been reduced to the same level as a wheat field that had received a wild oat herbicide.

Research has shown that the weed suppression capabilities of forages are similar between a three year stand and a six year stand. Therefore, the best way to achieve the rotational benefits of forages is to cycle the forages through the rotation more quickly over more acres. As well, by shortening forage stands to 3 or 4 years, the invasion of dandelion can be kept in check.

Forages impact various weed populations differently. Forages greatly reduce the populations of wild oats and green foxtail. However small-seeded broadleaf weeds such as lamb's quarters and red root pigweed are much less affected and in some instances, will increase. Canada thistle can be controlled by alfalfa as the frequent cutting and competition from the forage reduce the Canada thistle shoot density. Weed reductions from cycling forages through the rotation can be enhanced through direct seeding. Tillage encourages germination of weeds while weed seeds left on the surface through low disturbance seeding are subject to desiccation and consumption by beetles and other small creatures.

Forages offer an excellent method of dealing with **herbicide resistant weeds,** particularly wild oat. Including forages in the crop rotation minimizes the use of the herbicide group that has shown resistance. Cutting the forage for hay prevents herbicide resistant volunteers from setting seed.

Nitrogen Benefits

Forage legumes have a unique ability to fix their own nitrogen significantly reducing our reliance on nonrenewable energy to produce nitrogen fertilizer. Research shows yield benefits from forages can last up to a decade after termination. Not only do grain crops yield more after forages, but also the rotational benefit from field peas is greater where alfalfa has been included previously in the crop rotation (Table 1).

When tillage is used to terminate a forage stand, a great amount of N can be released during the first season. Under warm wet soil conditions, N can be lost as nitrous oxide (N_2O), a serious greenhouse gas, through denitrification. Tillage can also cause an increase in the nitrate levels below the root zone through leaching, particularly in lighter soils. When herbicides are used to terminate a forage stand, the release of N is considerably slower which benefits more than just the first crop after termination. Mohr (1996) found the slower release of N is more like a split N application for subsequent crops. The late season N can build higher protein levels in cereal

Forages in rotation can provide flexibility to adjust the land in hay and pasture to meet an individual producer's needs.

crops grown the following year. It also improves N use efficiency.

While forage legumes increase the N levels of soils, they can also deplete other nutrients such as Phosphorus, Potassium, and Sulphur. Therefore, it is good planning to soil test after terminating forages to meet the next crop's nutrient requirements. Crop failures after terminating forages can be linked to nutrient deficiencies and not just moisture depletion.

Disease Management

Adding forages to rotations helps break disease cycles. Diseases cannot be eliminated but crop rotation is the best way to minimize the amount of disease residue and soil-borne pathogens. Disease pressures change with changing environmental conditions. Thus crop rotation, in conjunction with direct seeding and fungicides, is the most effective method of disease control.

Grazing

Forage based rotations that include grazing deplete fewer nutrients than hay systems. By grazing these acres, nutrients are recycled to the soil. As well, pastures and grain crops can be rotated on the same piece of land. In some cases, marginal lands under zero till could support both annual crops and forage crops as soil erosion and salinity problems are minimized and rocks are left in the ground.

Even on a farm where there are no livestock, forages are beneficial in zero till rotations. Forages can be marketed and the soil and nutrient benefits for the subsequent annual crops are significant.

Conclusion

Incorporating forages into a crop rotation requires extra management but the rewards are many. Enhanced soil nutrient status, less reliance on herbicides for weed control and managing disease are just a few of the many benefits to including forages in an annual crop rotation.

Sources

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