Fact sheet

U.S. Dairy Forage Research Center
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Perennial forages benefit soils, other crops, and water quality in important ways

Alfalfa is the most widely grown perennial forage species in the U.S., with the greatest acreage in the upper Midwest and West. But alfalfa acreage has been declining steadily for the past 50 years, while the acreage of soybeans and, more recently, corn has been increasing.

There are costs associated with the displacement of perennial forage acreage. As we enter a period with heightened public scrutiny of agriculture's environmental 'footprint' (water and air quality, greenhouse gas production, and energy use), farmers need to consider the ***total*** value of adding perennial forages to their crop rotations. This Fact Sheet covers: a) the direct benefits of perennial forages used in rotation or as a cover crop; and b) the more far-reaching benefits of perennial forages in terms of improved soil and water quality.

One of the reasons for the increase in corn acreage, and decrease in alfalfa acreage, is that the amount of corn silage fed to U.S. dairy herds has increased significantly in the past 20 years for a variety of reasons, according to Randy Shaver, University of Wisconsin dairy scientist. These include: higher yield and energy per acre from corn silage, improvement of corn silage hybrids, problems with winterkill of alfalfa, high rumen degradability of alfalfa protein, and better opportunities for manure management.

There are, however, a number of economic and environmental benefits from production of alfalfa and other perennial forages that are sometimes overlooked when comparing them to silage corn. One of the most important economic reasons to incorporate perennial forages into a rotation is the nitrogen (N) credit for the crop following the forage. Nitrogen released from decomposing alfalfa tissue and from newly accumulated soil organic matter can supply most or the entire N requirement of a following corn crop (Fig. 1).

Estimates of fertilizer N credit vary depending on the forage species, the quality of the stand (Fig. 2), and the amount of regrowth. For example, University of Wisconsin recommends an additional first-year N credit of 40 lb/acre when 8 inches or more regrowth is incorporated. In addition, first-year corn grown after alfalfa may have 10 to 15% higher yield potential due to factors other than N supply ("rotation effect" in Fig. 1), including improved soil tilth and fewer pest problems. Because of lower insect pressure, additional savings can be had in seed or insecticide with corn rotated after a perennial forage.

A major concern with corn silage production is the increased risk of soil erosion when there is little residue to protect the soil surface. Erosion can be greatly reduced by incorporating alfalfa into the rotation. An

Figure 1. Yield response to fertilizer nitrogen for continuous corn and corn following alfalfa (first and second year). Note maximum return to N arrows at the bottom of figure and rotation effect at upper right. Mallarino & Pecinovsky, 2006.

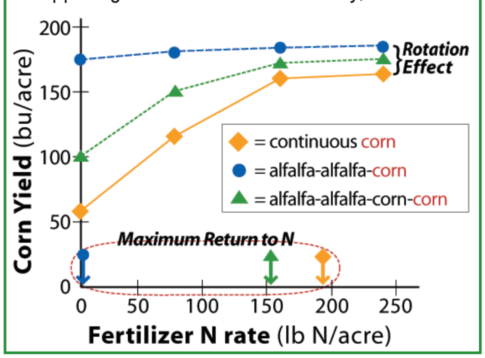

Figure 2. Value of fertilizer nitrogen credits when alfalfa is grown the previous year.

Stand Density	N Credits (lb/acre)	Value* of N Credits $/acre
Good	130	$104
Fair	100	$80
Poor	70	$56

*With nitrogen at $0.80/lb.

example from southern Wisconsin shows that soil erosion can be reduced to 3 tons/acre soil loss in a corn silage-alfalfa rotation, compared to 10 tons/acre with continuous corn silage (Fig. 3). Erosion also can be reduced with a winter cover crop after corn silage, but not as much as with a perennial crop.

Decreasing soil erosion helps protect surface water from sediment, one of the most frequently cited impairments of water quality. In addition, most phosphorus (P) lost in surface runoff from row crop systems is associated with eroded sediment. Both sediment and P impair habitat for high-value fish species, and excessive P can increase algae growth, leading to water quality degradation and fish kills. Producers should be aware, however, that significant soil erosion and associated P loss can occur during establishment of perennial forages, and that dissolved P can be present in runoff from freeze-damaged forage. Quick tips: Reduce erosion during establishment by including a companion small grain or forage grass. Reduce runoff of dissolved P by removing regrowth in late fall.

Much of the benefit in controlling erosion is derived from the year-round vegetative cover perennial forages provide, but another important factor is increased accumulation of soil organic matter compared to annual cropping. Soil organic matter supports better water infiltration, water holding capacity, aeration, and soil aggregate stability. The composite effects on physical, chemical, and biological soil properties can be estimated by calculation of a soil quality index. One such index, the Soil Management Assessment Framework (SMAF), incorporates several soil characteristics, including bulk density, water-stable aggregates, organic matter, extractable P, pH, and microbial biomass carbon. Legume and grass forages improve the SMAF soil quality index, both as rotation crops (Fig. 4) and as companion crops or cover crops (Fig. 5), compared to continuous corn.

Another environmental concern is the leaching of nitrate into subsurface tile drains. Land seeded with alfalfa or Conservation Reserve Program vegetation in Minnesota had lower tile line discharge and negligible nitrate-N loss (less than 5 lb N/acre) compared to continuous corn or a corn-soybean rotation (30 to 80 lb N/acre). Nitrate losses also can be reduced by planting grass or alfalfa 'waterways' directly over tile lines.

And on top of all these benefits, nearly every economic analysis has concluded that alfalfa production is, on average, more profitable than corn. The fact that forages also can produce substantial direct and indirect economic returns should make the decision to include more forages in the rotation an easy one.

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Figure 3. Cropping system effect on soil loss. Rotation is 2-year corn and 3-year alfalfa. Estimates by Brian Hillers, USDA-NRCS, were based on the RUSLE2 equation for a Miami silt loam soil, 5% slope in Dodge County, WI.

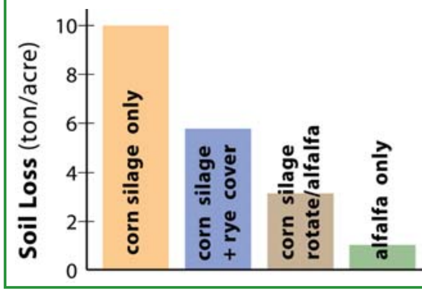

Figure 4. Rotation effects on soil quality index (SMAF). 30-year average, Lancaster, WI. Karlen et al., 2006.
sb=soybean
alf/rc =alfalfa/red clover

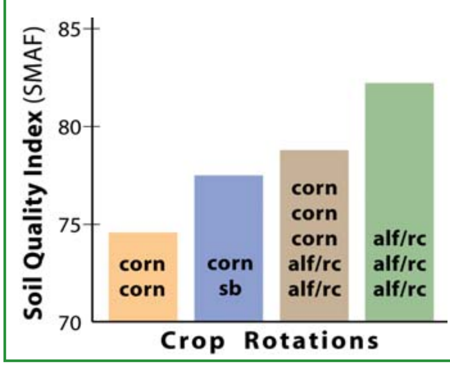

Figure 5. Forage cover crop effects on soil quality index (SMAF) in silage corn. 4-year average, liquid manure applied annually, Prairie du Sac, WI.