Livestock & Cover Crops

Cover Crop Feed Value

Depending on the needs of the farmer and livestock, cover crops may be grazed in the fall, over the winter, or in the spring. Fall grazing takes advantage of cover crops that will winterkill, such as oats and many brassicas. Other covers may be carefully grazed in the fall and will regrow in the spring, such as rye.

- Aerial-seed grasses and some legumes at cash crop maturity: black layer in corn, or leaf yellowing in soybeans. Try and seed soon before a rainfall, to increase seed-soil contact.
- Interseed nearly any species near crop maturity with a highboy or other interseeder.
- Drill nearly any species after cash crop harvest.

Fall grazing: seed fast-growing species to graze in late fall or early winter. Allow 30-45 days of growth.

- Oats establish and grow quickly, but will winterkill.
- Rye will not winterkill, but avoid overgrazing in fall if spring grazing is also desired.
- Legume species are unlikely to establish or grow enough for fall grazing.
- Brassicas take up excess fertilizer N and so should not be fed alone. Brassicas will winterkill, but can be grazed after frost.
- There is no effect on crop insurance eligibility with winterkilled species.
- Be sure to leave enough surface residue to capture snow and protect the soil from wind erosion!
- Little to no compaction risk when grazing in the fall.

Spring grazing: seed winter-hardy species in the fall. Grazing to remove up to 40% is possible in the fall, but excessive forage removal will impair regrowth.

- Winter rye and triticale are popular; barley and wheat work as well.
- Some legumes, particularly winter pea and hairy vetch, can establish well enough to provide spring feed.
- Brassicas will not survive most Iowa winters, but do help to break up hardpans and scavenge nutrients.
- Harvesting (haying, ensiling, or grazing) cover crop forage in the spring will not affect crop insurance, so long as certain conditions are met:
    - The cover crop is still fully terminated at or near crop planting (zone-dependent).
    - Sufficient biomass remains to fulfill the conservation purpose of the cover crop.
    - The cover crop is not harvested for grain (i.e. is in vegetative, not reproductive, stage).
- For best results, cut by boot stage: once the forage shifts to the reproductive stage, its water usage increases greatly (which may harm the following cash crop) and forage quality decreases.
- Compaction may be an issue. Avoid grazing when pastures are wet – remove animals if pugging is evident. Move waterers and mineral feeders frequently to discourage loafing areas, or strip-grazing fields.

What are common rates and combinations?

As mentioned earlier, seeding rate will depend on the species being seeded and the producer's goals. Lower rates are often employed for conservation purposes, while those desiring forage may seed more. In addition, the method of planting will affect target seeding rate. Aerial or broadcast seeding rates should be about 50% greater than the drilled rate, to try and achieve the same final biomass. When in a mix, utilize a bit less than the normal recommended pure stand rate.

- Grasses: 1-2 bushels for conservation, 3+ for grazing
- Legumes: 3-20 for clovers, 20-100 for larger seeds like peas
- Brassicas: 5-10 lb/ac

What does it cost?

The cost of putting cover crops in on a farm varies by the method of seeding, species being seeded, and seeding rate. General values are listed below.

- Seeding cost
    - Aerial seeding: $13-18/ac
    - Drilling: $14-16/ac
- Seed cost (according to Green Cover Seed)
    - Grasses are generally less expensive than other species ($0.25-0.80/lb)
    - Legumes are slightly more expensive ($0.40-2/lb)
    - Brassicas are often the most expensive ($1-4/lb)

How much feed will be produced?

Total cover crop biomass depends on a number of factors, including seeding date, rate, and of course, weather. In general, the earlier a cover crop is seeded (i.e. aerial or highboy seeding into standing crops), the better it will yield. The better seed-to-soil contact (i.e. drilling instead of broadcast or aerial), the better it will yield. Cover crops for conservation purposes are generally seeded at a lower rate than cover crops seeded to provide livestock feed. Given a decent fall and moderate spring, 1-2 tons of forage is reasonable. The table below provides some Iowa data.

What is the feed quality like?

Forage quality depends strongly on forage type and maturity. Grasses tend to have greater fiber concentration (which decreases digestibility) and less protein. Legumes and brassicas are high in protein and often highly digestible. Within a given forage type, less mature forages are more digestible and higher in crude protein. In general, once forage reaches the reproductive stage, digestibility and protein concentration drops. Cover crop forages are nearly always harvested before the reproductive stage, for quantity/quality purposes, and because the cash crop needs to be planted (eligible for crop insurance).

In general, cover crop forage meets or exceeds the needs of maintaining, growing, or even lactating animals. Gurus such as Gabe Brown and David Brandt report gains of over 3 lb/d on stocker steers grazing cover crops.

Forage testing will provide all relevant information regarding the nutrient content of a forage. A more simple analysis of total nitrogen provides the crude protein concentration (%N x 6.25) but gives no indication of the digestibility or fiber content, or other values such as TDN or RFQ.

Cover crop yield and feed value: Farmer experiences and research-based recommendations

Data from PFI cover crop research trials yields the following approximate values. Cover crops were all fall-seeded and sampled in the spring, and the days between the two dates are provided when possible.

	Species	Seeding method	Days from seeding to sampling	Spring biomass (lb/ac)	Crude protein (%)
Grasses	Winter rye	overall	208	1265	19
		drilled	196	782	20
		aerial	227	1117	18
		no-till	184	435	28
		broadcast	218	672	19
		unknown	216	1671	16
	Winter wheat	--	218	1262	20
	Triticale	--	205	1611	19
	Annual ryegrass	--	200	1267	--
	Oats	--	136	51	29
	Barley	--	217	881	23
Legumes	Austrian winter pea	--	221	156	--
	Hairy vetch	--	221	100	--
	Red clover	--	221	29	--
Brassicas	Turnips	--	--	450	--
Mixtures	Hairy vetch, radish, rapeseed	--	210	344	23
	Hairy vetch, winter rye	--	--	11,034	--
	Rye, clover	--	--	3518	--
	Vetches	--	--	720	24

Hansen et al. 2013 (SD): cover crop monocultures and mixtures were planted in mid- to late-August and tested throughout the late fall and early winter. Forage yield tended to be greatest between late October and early November; after this point, many species began reproductive growth, bolted, or started to die off. Quality was greatest early in the season; crude protein concentration declined and ADF (indigestible fiber) increased over time, as the plants matured.

	DM yield, lb/ac				Crude Protein, %			
	late Sept - early Oct	late Oct - early Nov	late Nov - early Dec	Mean	late Sept - early Oct	late Oct - early Nov	late Nov - early Dec	Mean
oats	1590	3103	3194	2629	16.1	9.7	8.5	11.5
foxtail millet	2404	2357	1899	2220	12.4	10.1	10.8	11.1
lentil	779	2436	2109	1775	21.8	20.7	19.7	20.7
radish	3263	2445	1711	1700	19.2	16.1	13.1	16.2
mix	1509	2479	1900	2037	14.5	10.8	10.6	12.0
mean	1331	2585	2008		17.1	13.7	12.7	

	ADF, %				NDF, %			
	late Sept - early Oct	late Oct - early Nov	late Nov - early Dec	Mean	late Sept - early Oct	late Oct - early Nov	late Nov - early Dec	Mean
oats	23	16	20	21	41	39	38	40
foxtail millet	28	29	30	29	33	37	35	35
lentil	21	23	21	22	31	33	34	33
radish	18	18	21	19	24	27	30	27
mix	22	25	25	24	37	42	42	40
mean	22	22	23		35	37	38	

PFI members and other farmers have utilized cover crops extensively on their farms for crop and livestock systems.

- Winter annuals – wheat, rye, or triticale – can be seeded in the fall into cash crop acres. Some farmers graze the cover crops and stalks during the fall and winter; others use them as calving pastures in the spring. One farmer estimates that oats in cornstalks increased the grazing days by 30-50%. Another estimates that he can keep a cow-calf pair for a month or so on about ½-3/4 acre of rye or wheat cover crops.
- Silage and hay harvest are difficult early in the season due to often wet or muddy spring conditions. Waiting until later in May or June to harvest improves yield (though quality is reduced after forages hit boot stage) and makes dry-down easier. Planting a shorter-season corn or soybean variety still allows cash crop income off of those acres.
- Warm-season annual crops, such as BMR sorghum-sudangrass or millet, are planted in some fields or thin pastures to provide forage during the "summer slump," even eliminating the need for hay feeding during recent drought years.
- Cocktail mixtures of cover crops increase the likelihood that something will grow, no matter the weather or moisture level, and provide a more balanced nutrient profile than monocultures. Combinations of grasses and legumes or brassicas provide biomass and greater crude protein.
    - Oats and brassicas seeded into cash crops will provide late fall/early winter forage.
    - Rye, triticale, or wheat and winter peas or hairy vetch will yield some tonnage in the fall but will provide plenty of forage in the spring.
    - Oats, rye, and a brassica would give some fall and some spring grazing, if managed properly.

Cover crops are an excellent way for livestock and cash crop farmers to improve their nutrient management and provide extra fodder for livestock. Whether through fall or spring grazing, many species can provide 1-2 tons of dry matter per acre.

Mature beef cows in mid-gestation consume approximately 3% of their body weight per day as forage dry matter (more for finishing or lactating animals). With most grazing management practices, cattle consume approximately 50% of the available forage matter. The table below shows the number of grazing days per acre expected for different forage yields and animal body weights.

Aboveground forage DM yield (lb/ac)	Animal bodyweight (lb)				
	1000	1100	1200	1300	1400
500	8.3	7.6	6.9	6.4	6.0
1000	16.7	15.2	13.9	12.8	11.9
1500	25.0	22.7	20.8	19.2	17.9
2000	33.3	30.3	27.8	25.6	23.8
3000	50.0	45.5	41.7	38.5	35.7

With some assumptions, values can be attached to the above cover crops in terms of forage for livestock. The table below was constructed assuming around 25% loss of standing forage DM when haying and about 15% loss when ensiling; hay price was established at $120/ton; and the value of a cow grazing-day is $1/cow/day.

Aboveground forage DM yield (lb/ac)	Hay DM yield (tons/ac)	Hay yield (tons/ac)	Hay value @ $120/ton	Silage DM yield (tons/ac)	Silage yield (tons/ac)	Custom grazing return @ $1/cow/day (1200-lb cows)	Custom grazing return @ $1/cow/day (1400-lb cows)
500	0.19	0.22	26.47	0.21	0.33	6.94	5.95
1000	0.38	0.44	52.94	0.43	0.65	13.89	11.90
1500	0.56	0.66	79.41	0.64	0.98	20.83	17.86
2000	0.75	0.88	105.88	0.85	1.31	27.78	23.81
3000	1.13	1.32	158.82	1.28	1.96	41.67	35.71

Cover Crops and Soil Quality

Cover crops provide more than protection against erosion and runoff. A growing cover crop accumulates biomass, which contributes to soil organic matter after termination and decomposition. Living, growing roots in the soil during periods when fields are usually bare means that the soil is covered (protection against erosion) and that runoff or leaching of nutrients and soil is less likely. Cover crops also accumulate nitrogen by fixation, if a legume, or by scavenging soil N, if a grass or brassica. After termination, these nutrients are released at varying rates for the following cash crop. Alternatively, topgrowth of cover crops can be harvested by grazing, haying, or ensiling for livestock feed. The amount of nutrients a cover crop will take up – and thus return to the soil or go to livestock – depends on the fertility status of the soil (particularly for nutrient scavengers) and ultimately the biomass of cover crop that is produced.

The physical presence of cover crops and nutrient uptake they require means that manure application can take place at times and in amounts that may not normally be advisable. Cover crops will utilize the nutrients and hold the manure in place. Additionally, adding seeds to manure slurries is a seeding alternative on some acres.

Cover crops and manure: Farmer experiences and research-based recommendations

Practical Farmers members were asked about their experiences with manure on cover crops. Most reported no issues – often injecting liquid swine manure, they said that the observable loss of cover crops was due to being hit with the knife more than smothering or burn.

- One farmer seeded rye after injecting 4000 gal/ac of liquid swine manure, and reported that the cover crops growing where the manure ran out were thin and pale, compared to robust stands where adequate manure was applied.
- Another farmer injected liquid swine manure with a disc tiller into 1" tall already-established rye. While some plants were lost due to physical damage, the stand was fine.
- Similarly, yet another farmer applied 3000 gal/ac of swine manure on established rye, and the next spring reported that it was over knee high.
- Other research trials suggest that manure rates between 5000-7000 gal/ac of very liquid (<10% solids) manure work best for applying to cover crop land (Stute et al. 2010).
- Singer et al. (2008) injected liquid swine manure into an existing cover crop in the fall, then looked at cover crop performance in the fall and following spring. Manured cover crops did not take up any more N and put on a bit less biomass than non-manured cover crops in the fall, but in the spring the manured cover crops had greater biomass and N uptake. Cover crops did not affect late-spring soil nitrate test results or affect corn yield. Corn yield was greater in plots that had received manure, even though all plots were sidedressed with fertilizer to ensure non-limiting N.
- Eigenberg et al. (2002) spring applied beef manure (approx. 25,000 lb/ac) or composted manure (approx. 39,000 lb/ac) before planting silage corn, following cover crops or fallow, for seven years. Cover crops reduced soil nitrate levels compared to no cover crop treatments, particularly in the periods after corn silage harvest and before planting the next year. Corn silage yield was the same or greater following manure application than fertilizer alone.
- Beckwith et al. (1998) made monthly manure applications to cropground with established cover crops. Solid farmyard manure, broiler litter, or hog slurry was applied to deposit about 178 lb N/ac, and applications were made from September through January. Well-established cover crops reduced manure runoff, but high-N slurries and broiler litter were still risky to apply and would runoff with excess precipitation. Slurries increased cover crop yield, but monthly applications of more solid manure smothered cover crops.

To reduce the number of times machinery has to go over the field, researchers and farmers have experimented with mixing seed in with the manure and doing a one-pass manure application and seeding.

- Harrigan et al. (2006) seeded oilseed radish and oriental mustard in a manure slurry (5000-6000 gal/ac), and while plant density was a bit lower for the slurry-seeded cover crops, overall biomass did not differ.

- An Iowa farmer pre-wets the seeds before adding it to the slurry to ensure the seed stays in suspension during application.

Cover crop nutrient uptake and cycling

While many cover crops are used to capture excess fertilizer nutrients and prevent runoff and leaching losses, they may also help hold manure nutrients and solids. Fall application of manure is common on swine and dairy farms, but particularly with slurries, nutrient losses can be significant (Beckwith et al. 1998). Cover crops have the potential to keep the manure on the soil, benefitting growth of the cover crop itself and thus returning the nutrients to the soil in the spring for the following cash crop.

Study	State	CC type	CC yield (lb/ac)	N uptake (lb/ac)	P_2O_5 uptake (lb/ac)	K_2O uptake (lb/ac)
Singer et al. (2008)	IA	rye (seeded Sept, tested April)	328	8.9	3.1	7.8
			243	8.0	2.5	5.7
			1052	31.3	2.9	6.4
			1230	52.9	2.7	6.7
Stute et al. (2010)	WI	rye (boot stage)	4740	121.0	42.0	178.0

Breakdown of the cover crops is dependent on the carbon and nitrogen concentrations in the forage, as well as the activity of soil microbes. In a healthy soil, decomposition is rapid – in a more degraded, heavily-tilled soil, it will not be as quick.

For soil and fertilizer purposes, generally, 50% or less of cover crop N is plant-available the following season. The more legumes in a stand, the closer to 50% plant-available N; the more grass, the less plant-available N that will be available (Wagger and Mengel 1988). Whether cover crop biomass N will be made plant-available upon decomposition (through the process of mineralization) or unavailable (through immobilization) is dependent on the ratio of biomass carbon to nitrogen. Grasses typically have the highest C:N ratio and break down most slowly; legumes have a low C:N ratio and break down more quickly; brassicas are intermediate to the two. C:N ratio increases as a forage matures. When the C:N ratio is greater than 30:1, net immobilization (making N unavailable) is likely; mineralization (making N plant-available) is more likely when C:N is less than 30:1 (Ranells and Wagger 1996).

- PFI research found C:N ratios between 7-15 for fall-seeded winter annual cover crops.
- Rannells and Wagger (1996, in North Carolina) reported values of 11-17 for legumes, 18-26 for mixtures, and 40 for winter rye.
- Kuo et al. (1997, in Washington) planted cover crops in October and sampled the next April or May. Aboveground biomass had values of 10-18.5 for legumes, 25.5 for brassicas, and 34.5-50.5 for grasses. Belowground biomass C:N ratios were generally greater than aboveground.

Final Summary

Cover crops represent an opportunity to combine environmental stewardship and economic goals. While additional time and money are required to establish cover crops, the multiple benefits make them worth the cost.

- Nutrient management
    - Cover crops hold soil and soil nutrients in place, while contributing organic matter and nitrogen, in the case of legumes.
    - Manure applications to cover crops improve manure nutrient utilization and may increase cover crop biomass yield.
- Grazing and forage value
    - Either in the fall or spring, cover crops may be grazed to reduce the need for stored forages and rest pastures.
    - Cover crops may yield over 1 ton per acre, particularly if harvested in the spring, which may be grazed or harvested as hay or silage.
    - Compaction is unlikely from fall or early spring grazing. Following freeze-thaw, farmers can reduce the risk of compaction by strip grazing, removing cattle from fields when the soil is too wet, and moving mineral feeders and waterers frequently.
    - Cover crops may be hayed or ensiled; however, this may affect crop insurance payout. Consult RMA guidelines before mechanically harvesting cover crop forage.

Resources and Literature Cited

Beckwith, C. P, J. Cooper, K. A. Smith, and M. A. Shepherd. 1998. Nitrate leaching loss following application of organic manures to sandy soils in arable cropping. I. Effects of application time, manure type, overwinter cover crop and nitrification inhibition. *Soil Use and Management* 14:123-130.

Clark, A. J., A. M. Decker, and J. J. Meisinger. 1994. Seeding rate and kill date effects on hairy vetch-cereal rye cover crop mixtures for corn production. *Agronomy Journal* 86:1065-1070.

Collins, M. and V. N. Owens. Preservation of forage as hay and silage. *In* R. F. Barnes, ed. 2003. Forages. *Iowa State Press*, Ames, IA. www.agron.iastate.edu/Courses/agron515/Chapter19.pdf

Eigenberg, R. A., J. W. Doran, J. A. Nienaber, R. B. Ferguson, and B. L. Woodbury. 2002. Electrical conductivity monitoring of soil condition and available N with animal manure and a cover crop. *Agriculture, Ecosystems, and Environment* 88:183-193.

Hansen, M. J., V. N. Owens, D. Beck, and P. Sexton. 2013. Suitability of cover crop monocultures for late-season forage in South Dakota. *Canadian Journal of Plant Science* 93:589-597.

Harrigan, T. M., D. R. Mutch, and S. S. Snapp. 2006. Manure slurry-enriched micro-site seeding of biosuppressive covers. *Applied Engineering in Agriculture* 22:827-834.

Hively, W. D., M. Lang, G. W. McCarty, J. Keppler, A. Sadeghi, and L. L. McConnell. 2009. Using satellite remote sensing to estimate winter cover crop nutrient uptake strategy. *Journal of Soil and Water Conservation* 64:303-313.

Hoorman, J. J., R. Islam, and A. Sundermeier. 2009. Sustainable crop rotations with cover crops. *The Ohio State University*. http://ohioline.osu.edu/sag-fact/pdf/0009.pdf

Hudson, D., D. R. Mutch, T. E. Martin, W. Everman, J. Knorek, and M. Staton. Using red clover as a cover crop in wheat. *Michigan State University*. http://www.mccc.msu.edu/extension_material.html

Myers, D. K. and J. F. Underwood. Forage legumes for temporary soil cover. *The Ohio State University*. http://ohioline.osu.edu/agf-fact/0007.html

Sawyer, J. 2009. What are average manure nutrient analysis values? *Iowa State University*. http://www.agronext.iastate.edu/soilfertility/currenttopics/WhatAreAverageManureNutrientAnalysisValues_1-24-09.pdf

Singer, J. W., C. A. Cambardella, and T. B. Moorman. 2008. Enhancing nutrient cycling by coupling cover crops with manure injection. *Agronomy Journal* 100:1735-1739.

Stute, J., K. Shelley, D. Mueller, and T. Wood. 2010. Planting winter rye after corn silage: Managing for forage. *University of Wisconsin-Madison*. http://ipcm.wisc.edu/downloads/

Wagger, M. G. and D. B. Mengel. 1988. The role of nonleguminous cover crops in the efficient use of water and nitrogen. *Cropping Strategies for Efficient Use of Water and Nitrogen*, Special Publication no. 51:115-127.

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