

Recoupling crops and livestock offers energy savings to Northeast dairy farmers

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Brian Gray, a former Penn State undergraduate research assistant, standing in a field of flowering canola at Penn State's Agronomy Research Farm in Rock Springs, Penn. The canola oil he is holding was pressed and filtered at the farm to fuel a tractor designed to run on straight vegetable oil (SVO). Credit: Heather Karsten, Penn State

For Pennsylvania dairy farmers, producing feed grain on-farm requires significantly less energy than importing it from the Midwest, according to Penn State researchers whose findings may help dairy farmers save energy and money in the face of rising feed costs.

Historically, it made economic sense for many dairy farmers in the Northeast to import feed from the Midwest, where yields are higher and subsidies contribute to a relatively cheap and abundant supply. However, this separation of cows—and their manure—from feed-crop production results in a regional nutrient imbalance with important energy implications. Grain prices can also be volatile, with much higher costs in some years.

"If you think about the Midwestern practices for growing feed crops, largely it's done with synthetic nitrogen fertilizers, which are extremely energy-intensive to produce," said Glenna Malcolm, former research associate in plant sciences now a lecturer in biology. "We wanted to understand the energy use that this approach requires compared to growing feed on-farm, where that fertilizer requirement can be met, in part, with manure and through diversifying crop rotations to include perennial legume crops that convert atmospheric nitrogen to a usable form for plants."

Malcolm and her colleagues compared the energy use of three farming

systems. On the low-import end was a dairy cropping systems designed to meet the forage, feed and fuel needs of a 65-cow, 240-acre dairy farm. Computer models simulated the milk production based on actual crop yields and quality analyses. The researchers reported their results in a recent issue of *Agriculture, Ecosystems and Environment*.



The dairy cropping-systems trial was designed as part of a larger multi-year study to evaluate strategies to meet the forage, feed, and fuel needs of a 65-cow, 240-acre dairy farm. Conducted at 1/20th scale, the cropping-systems trial is situated on 12 acres at Penn State's Agronomy Research Farm in Rock Springs, Penn. Credit: Heather Karsten, Penn State

Using farm-scale equipment and manure from a neighboring dairy farm, the researchers grew feed grains—corn and soybean—and forage crops—alfalfa, corn silage, rye silage, red clover and rye—on 12 acres, one 20th the scale of a 240-acre farm. They also grew canola, which they processed into fuel for the farm's vegetable-oil-powered tractor. They fed the canola meal by-product to the virtual dairy herd. They imported some diesel fuel for custom farm operations, as well as some grain to make up for a slight shortage in their on-farm production.

For comparison purposes, the researchers then simulated two additional farms that represent different Pennsylvania dairy farming approaches. Both simulated farms used the exact same rations for the same number of cows as the research farm's virtual dairy herd, and therefore produced the same amount of milk. Both used diesel fuel for all tractor operations, and were assumed to be practicing no-till agriculture. Both farms also used nitrogen from animal manure and alfalfa, and so had lower nitrogen fertilizer needs than Midwestern grain farms.

However, even though the Pennsylvania farms achieved the same yields per acre, they differed in their size and how much feed they imported. One grew only forage crops on 120 acres, importing all of its feed grain. The other grew all of its forage crops and the majority of its feed, including corn grain and soybeans, on 160 acres.

With this range of farms, the researchers quantified and compared how much fossil energy it took to produce the feed for the farms' cows. They used an open-source computer model, the Farm Energy Analysis Tool, developed by then-master's student, Gustavo Camargo. The researchers accounted for fertilizer, lime, seed, pesticides, on-farm diesel consumption, grain drying and off-farm diesel used to transport inputs to the farm and grains to an off-site storage facility.



The dairy cropping-systems trial uses injected manure to supply nitrogen to the forage, feed, and fuel crops raised on the farm. Credit: Robert Meinen, Penn State

"When we looked at the results, our most notable observation is that the smallest Pennsylvania farm—the one producing only forage and importing everything else—has a large fossil-energy input compared to the other two," Malcolm said. "Now, that's on a per Pennsylvania farm acre basis. When you consider the different sizes of the farms and adjust the results to a milk-produced basis, the difference is not as big, but you can still see that the two larger farms are using about 15 percent less fossil energy than the small farm to produce the same amount of milk."

The largest source of [fossil energy](#) inputs for the small forage-only farm was the production and shipping of Midwestern grain, followed by on-farm diesel and nitrogen fertilizer use. In fact, nitrogen inputs were four times greater for imported corn grain than for that grown on the trial farm, where injected animal manure and nitrogen-fixing legumes were used to meet a significant portion of the crop's nitrogen requirements.

Malcolm said that while growing the canola fuel crop on-farm may have other environmental benefits, it did not result in significant energy savings, considering tradeoffs like the additional land required to grow canola and the energy required to press and process it.

"In terms of energy use, the middle farm—which wasn't trying to grow fuel crops—is pretty similar to our farm, where we were growing a fuel crop," she said. "So, just growing your own feed on-farm makes a big difference."

In addition to revealing the energy savings that can come from growing more feed on-farm, these findings can have important economic implications, said Heather Karsten, associate professor of crop production and the director of the long-term cropping-systems trial.

"The reality is that in some years feed costs have gone up, especially in years with high fuel costs and demand for grains from the biofuel sector," she said. "One of the take-home messages from our study is that, in addition to saving energy, this strategy of growing more of your feed on-farm can reduce off-farm nutrient imports and the economic risk of fluctuating [feed](#) costs."

Provided by Pennsylvania State University

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