

Finding Fertility without Livestock

A Decision Case Study

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Organic farming principles revolve around using natural nutrient cycles to maintain soil fertility, relying on plant and animal activities to mobilize nutrients. But what happens when the current economic climate precludes the animal part of the nutrient cycle? This was the problem the Mathews family faced on their organic row crop farm when swine production became economically unviable. But by giving up the pigs, were they giving up organic production altogether?

Craig Mathews* grew up on a farm in west central Minnesota in the 1940s and 1950s, but left farming to pursue a teaching degree. He met his wife Stephanie, started teaching and then moved back to his hometown to continue teaching. On the day he was supposed to report to graduate school, Craig went into town and purchased the farmland where he farms today. He had been eyeing it for months for many reasons, but perhaps most importantly, because it was conveniently located near his father's farm. When it came to deciding between teaching and farming, Craig chose farming.

Nearly from the moment they purchased the farm, the Mathews knew that they wanted to be good stewards of the land. In the early 1970s, Craig and Stephanie chose to farm organically partly because they didn't have the start-up money and resources to pay for the seed and inputs required to farm conventionally. Craig witnessed farming practices in his childhood that didn't require chemical inputs, so he knew it could be done. Craig and Stephanie were also aware of the

** While these cases describe actual situations, names have been changed to protect the identity of participants.*

ecological impact their decisions had on their farm's land and natural resources and this is another big reason why they had chosen to use organic farming practices.

The Mathews' farm grew to be a diverse enterprise of 300 acres that included commodity grain crops and a 300-head farrow-to-finishing indoor hog operation. Stephanie worked full-time off the farm and, with Craig, raised four children who assisted in the farm operations, including managing the livestock, picking rocks, pulling weeds and other manual labor required in organic production systems.

The Mathews became officially certified as organic in the mid-1990s. Compared to many growers who faced a challenging transition; the switch to organic standards was relatively easy because they had been following organic practices for many years. Craig paid close attention to soil conservation and maintained a regular rotation of corn-soybean-small grain with red clover underseeded in the small grain. This rotation, he found, worked well within his organic system. It improved the soil, captured nutrients, added nitrogen and suppressed weeds and pests. In addition, small grains provided marketing flexibility—

Craig would vary the small grain he planted depending on what grain was commanding the best price. Some years, he underseeded the small grains with alfalfa instead of red clover (e.g., corn-soybean-small grain/alfalfa-alfalfa) to harvest a hay crop, and on occasion he experimented with field peas and dry beans to also fix nitrogen and provide a source of green manure.

Craig's operation ran for several decades as a system that maximized the nutrients available within his operation. The hog manure provided needed nutrients for his field crops and he raised a portion of his field crops to be fed back to the livestock. At the same time, a percentage of both his livestock and crops were marketed. To produce competitive yields in corn, farmers need to replace the nitrogen that the crop removed from the soil. Conventional farmers have an arsenal of synthetic fertilizers to choose from, but certified organic farmers do not. Eventually, Craig found his system produced crops that had "county competitive yields," meaning, his organic crops were yielding comparably to his conventional counterparts. This was important to Craig's farming philosophy and his bottom line.

Organic Farming is Always Evolving

In the late nineties, Craig and Stephanie's last child left the farm for college. Around the same time, the market prices for hogs were depressed and were forcing operators to scale up toward larger and larger production, with operations ranging around 3000-5000 head. It was becoming increasingly difficult for small-to-midsize hog operations like Craig's to make a profit. Craig knew it was important to have livestock for many reasons. The manure produced by hogs was an ideal source of added nutrients for his organic field

crops because it had no added cost, it was approved by organic certifiers, readily available, and easy to spread. Also, hogs provided diversity to his operations so he wasn't reliant solely on his commodity grains for farm income.

After many discussions with Craig's brother and his nephew, both of whom had farm operations near Craig, the men decided they would consolidate their hog operations. Craig's brother would manage the breeding stock, his nephew would manage the farrowing (birthing) operations and Craig would manage the finishing. In this new business arrangement, the farmers retained the livestock and manure, but spread out the costs and the labor.

Craig and his family ran the swine operation in this way for about fifteen years, but the market prices and operation size never stabilized enough for the Mathews' operation to be sustainable. Craig and his family came to realize they did not have the resources to expand their operation to raise the hog numbers needed to be viable in the pork industry. Finally, the hard decision to cease livestock operations was made.

The decision to cease livestock production had almost immediate ramifications on Craig's crop production. The first year without manure inputs from his farm, Craig's noticed his corn was slower to germinate and lacked the vigor it needed early in the season to compete with weeds. Craig knew, through years of experience, that his corn crop would continue to show a decrease in yield without additional N inputs. The next year, Craig's rotation happened to allow him to leave corn out, but he knew he was at a critical crossroads at his farm. Nitrogen was an immediate concern, but phosphorus was a

long-term concern. Alfalfa was important to the rotation for the N, but because he harvested and sold it, he knew the alfalfa would deplete his soil of phosphorus in the long-term. This would have a detrimental effect on soybean yield. This was the year he needed to formulate a new plan for nitrogen and phosphorous inputs. Where would Craig get the nutrients he needed to grow competitive yields? (See *EXHIBIT A: Livestock and Plant-based Nutrient Inputs for Organic Systems*.)

Craig also looked at alternative, organic-approved inputs, such as composted pelletized turkey litter. The pellets provided a source of nitrogen and phosphorus and would fall within the requirements for organic certification. However, Craig found that he would need a considerable amount of litter to replace the nutrient needs in his soil, because the pellets have a low nutrient concentration. The pellet fertilizer was labeled as 5-5-5 (NPK) meaning that it contained only 5% of nitrogen, phosphorus (P₂O₅), and potassium (K₂O). He also found the pellets were frustrating to manage. He had to find a way to have them transported to his farm and then he didn't have the equipment to accurately or effectively spread the pellets on his fields. Inputs such as this were an added expense, with prices ranging up to \$125/ton and between two to three tons/acre might be needed. Would the hassle and expense provide the results Craig needed to continue to grow corn and soybeans?

Another option Craig considered was buying manure. He knew that there were no organic livestock operators near enough, but maybe there was a conventional neighbor with manure to sell. Organic certification does not require the farmer to have an organic source for manure. Craig was familiar with the

National Organic Program (NOP) standards on manure because of his use of his own manure through the years. Manure is considered a restricted input and therefore has requirements for application. Manure may only be used in conjunction with other soil-building practices and application rates must be less than or equal to the requirements of the crop. In addition, the organic farmer must have the manure tested to ensure that it does not contain non-approved synthetic additives. All of this information was tracked and reported to his certifier every year. This paperwork is also required if manure is purchased or brought onto the farm from non-organic source (see *EXHIBIT B: Requirements for Manure inputs in organic systems*). Craig was concerned that the added cost of buying, hauling and applying the manure would outweigh the return from the corn crop. It was important to have a source close enough to have cost effective hauling costs. The cost of manure would be about \$90/acre if he could find a nearby source, but manure from a farther source would be significantly more (see *Exhibit C: Cost Analysis of Manure Procurement and Application*).

Craig knew that this was the year to make critical decisions about his organic operation. He estimated his corn yield would be reduced by 50 bushels/acre (from 160 to 110 bushels/acre) without the use of manure or a commercial fertilizer. If he couldn't find an effective solution for managing the fertility and nutrients in his soil for competitive organic yields, there was a real chance that Craig would have to accept a significant decline in farm revenue or, even more drastically, have to discontinue farming organically. Should Craig buy manure? Should he invest in animal production again? Or should he quit certified organic production altogether?

Exhibit A. Livestock and Plant-Based Nutrient Inputs for Organic Systems

Organic certification prohibits the use of synthetic inputs within organic production. As a result, organic producers often rely on livestock manure to supplement their nutrient input. Organic certification does not require manure to be certified organic, but there are requirements regarding the composition of the manure and how it is applied. (Manure applications must be done in accordance with National Organic Practices [NOP] 205.203 C.1-3).

When properly managed, manure application can recycle nutrients to crops, improve soil quality, and even protect water quality. It is used most effectively in combination with thoughtful crop rotation, green manures and, where available, cover cropping. As outlined below, different manures have different levels of nutrients. In addition, manures range in nutrient density depending on animal feed, grazing, the age of the manure, amount and type of bedding, and other factors.

Table 1. Typical nutrient contents of manure.

	% Dry Matter	Ammonium-N	Organic N	P ₂ O ₅	K ₂ O
Slurry Manure	----- lb of nutrient per 1,000 gal manure -----				
Dairy	8	12	13	25	40
Beef	29	5	9	9	13
Swine	9	42	17	40	24
Layers	11	37	20	51	33
Solid Manure	----- lb of nutrient per ton manure -----				
Dairy	46	3	14	11	16
Beef	67	2	22	23	30
Swine	57	4	13	20	–
Layer	40	18	19	55	31
Turkey	70			15	30

Adapted from Koelsch and Shapiro, 2006.

Source: Koelsch, R. and Shapiro, S. 2006. Determining crop available nutrients from manure. University of Nebraska-Lincoln Extension, Institute of Agriculture and Natural Resources. (https://efotg.sc.egov.usda.gov/references/public/NE/G1335_Determining_Crop_Available_Nutrients_from_Manure.pdf)

Exhibit A, cont'd.

Table 2. The amount of nitrogen from alfalfa and red clover crops available to subsequent crops. Much of the nitrogen will be available in the first year, but a smaller amount is available in the second year. These crops do not add phosphorus and potassium like manure.

Legume Crop	Nitrogen Available	
	First Year	Second Year
	----- lb/acre -----	
Harvested Alfalfa	150	75
Red Clover	75	35

Adapted from: Lamb, J., Sheaffer, C., and Moncada, K. 2010. Risk Management Guide for Organic Producers.

(https://organicriskmanagement.umn.edu/sites/organicriskmanagement.umn.edu/files/soil_fertility.pdf)

Exhibit B. Organic Certification Requirements for Manure Use in Organic Production

Per the National Organic Program (NOP) standards, organic farmers can import manure from conventional farms for use within their organic systems. There are, however, application restrictions and testing requirements.

The NOP regulation (§205.203(c)(1)) on manures specifies the following for commodity row crop organic farmers:

- Accurate records of manure and compost application and production must be kept by all farmers using these types of soil amendments. Farmers must accurately record the application date of any untreated or composted soil amendment of animal origin.
- Manure may only be used in conjunction with other soil-building practices and be stored in a way that prevents contamination of surface or groundwater.
- If the amendment came from a third-party source, documentation is required that the amendment has undergone a scientifically valid process to meet requirements for a treated amendment, and that it has been stored in a manner that prevents contamination of surrounding areas and water supplies.
- Manure application must not exceed “agronomic application rates”, which means the amount applied must be less than or equal to the requirements of the crop.
- Manure cannot be applied when the ground is frozen, snow-covered, or saturated.
- "Raw" fresh, aerated, anaerobic, or "sheet composted" manures may only be applied on perennials or crops not for human consumption
- Biosolids, sewage sludge, and other human wastes are prohibited. Septic wastes are prohibited, as well as anything containing human waste.

Sources: Rittenhouse, T. 2015. Tipsheet: manure in organic production systems. USDA-ATTRA. (https://www.ams.usda.gov/sites/default/files/media/Manure%20in%20Organic%20Production%20Systems_FINAL.pdf), and

Wander, M. 2015. Managing manure fertilizers in organic systems. USDA-NIFA eXtension. (<http://articles.extension.org/pages/18628/managing-manure-fertilizers-in-organic-systems#2>)



Exhibit C. Cost Analysis of Manure Procurement and Application

Commodity grain organic farmers often rely on livestock manure for providing important nutrients in their soils. Ideally, having ready access to manure through on-farm production or close proximity to a livestock producer is the least expensive, most convenient scenario for the farmer. However, for some farmers, access is a real concern and the farmer must thoroughly review the procurement, transportation, hauling, and application costs before committing to purchasing manure from a third-party.

There are tools available for farmers to make these calculations to understand the cost per acre and the value of applying manure to their fields.

Use this calculator developed by the University of Minnesota to quickly estimate the value of specific manure types: <http://www.extension.umn.edu/agriculture/manure-management-and-air-quality/manure-application/calculator/>

Step 2: How much Fertilizer Can You Replace With Manure?

10.	Manure Species	Beef <input type="text"/>
11.	Liquid or Solid	Liquid <input type="text"/>
12.	Acres Available for Manure	<input type="text"/> acres Required
13.	Volume of Manure Available to be Applied	<input type="text"/> gals Required
14.	Nutrients Typical in this Manure, lb (N- P₂O₅ - K₂O)	(29 - 18 - 26)/1000 gal
15.	Use the Above Default Nutrient Values?	Yes <input type="text"/>
	If No, Enter Your Nutrient Test Results Here:	
16.	N, lb	29 <input type="text"/> /1000 gal
17.	P ₂ O ₅ , lb	18 <input type="text"/> /1000 gal
18.	K ₂ O, lb	26 <input type="text"/> /1000 gal
19.	Manure Application Method	Broadcast - Incorporate <12 Hours <input type="text"/>

Discussion Questions:

Below are examples of the kinds of questions the decision case study facilitator can use to stimulate discussion of the issues in this case. Participants may discuss some of these questions in groups of two to four and some questions as a large group. The questions used can vary depending on your time limit and the issues you wish to discuss. Other questions may be added as needed and appropriate to the situation.

1. Why is livestock manure important for Craig's organic operation?
2. What are some challenges of managing livestock within a crop production operation (i.e., managing an "integrated" organic operation)?
3. What types of information must organic farmers maintain and consider when using manure in their operations?
4. How does nutrient input vary for different organic fertilizers (e.g., beef vs. layer, manure vs. alfalfa, etc.)?
5. How does the consistency of the manure affect management and spreading? Which types of manures are easier to manage? How does manure management compare with incorporating a legume into the organic rotation?
6. What are some options Craig considered for providing nitrogen? Are there combinations he didn't consider that you think might be worth exploring?
7. What would you do if you were in Craig's shoes? Why?