Saying "Yes" to Raising Organic Soybeans

A Decision Case Study

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Steve had raised many different crops and livestock during his organic years. He knew how to grow purple corn, oats, barley, field pea, hay, cover crops, beef cattle, and laying hens organically. But one thing he stayed away from was soybeans. Soybean pests like aphids can make soybean production difficult even for the most experienced organic growers. But recently, Steve was approached with a lucrative opportunity to grow soybeans, and it could open up further opportunities within his rotation—but is the high premium worth the risk?

Steve Judson's* grandparents bought their east central Minnesota farm in the early 1940s. He was a fixture at the farm most summers while growing up. During those summers, Steve learned to appreciate agriculture and the outdoors. It wasn't much of a surprise when not long after school, Steve moved to Wisconsin and began farming. Steve and his business partner raised dairy cows and crops throughout the 1980s, but eventually the family farm drew Steve back to Minnesota.

For the first ten or so years that Steve farmed the family land, he did not practice organic agriculture and farmed conventionally. During those years, glyphosate resistant crop technology (Roundup Ready crops) became an option for soybeans. The technology and claims around glyphosate-resistant soybeans intrigued Steve. Genetic engineering had allowed researchers to develop a soybean breeding line that was resistant to the herbicide glyphosate; the soybeans and weeds in a field could be sprayed with glyphosate, but only the weeds would be affected.

Steve decided to give glyphosate a try. However, not long after Steve's first foray into genetically engineered soybeans, he made the decision to stop growing genetically engineered crops completely. He wanted to get back to growing 'real food' on his farm and started extending his rotation beyond just corn and soybeans. He was also concerned about the increasing use of synthetic chemicals in grain crop agriculture. Much of his management plan for the next five years adhered to the requirements for organic certification. Furthermore, Steve was genuinely concerned about health issues he was experiencing and decided to make further changes to his farm management plan. Soon after, Steve had his farm certified as organic.

New Opportunities, New Risks

About eight years after Steve's farm became certified organic, one of the seed companies

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

from which Steve regularly bought told him they would be willing to pay a premium to farmers who would contract to grow soybean seed for them. Steve had thus far avoided growing soybeans organically, as he was concerned about soybean pests, such as soybean aphid, brown stem rot, soybean rust, and weed pressure – all of which can make soybeans especially difficult to manage in an organic system (*see EXHIBIT A: Common Soybean Pests*). Plus, Steve hadn't thought that the market prices were quite good enough to warrant the risk. His concern was that a difficult year with soybean pests might reduce the yields so much that even organic premiums wouldn't be enough to offset the losses.

However, the good price offered by the seed company had Steve's attention. The soybean option also made him reconsider his current rotation. If he included soybeans in his rotation, it would open up an opportunity to plant a cover crop after the soybean harvest. Cover crops are good at decreasing soil erosion, particularly during winter and early spring. The cover crop, if it included a grass, could help increase soil organic matter. And, if the cover crop included legumes, it could provide nitrogen for the next cash crop. Not to mention the fact that soybeans themselves are legumes and do not require added nitrogen and even provide some for the next cash crop. Soil organic matter and nitrogen are important considerations for organic farmers. With these ideas in mind, Steve overcame his concerns about producing soybeans. He signed a contract with the seed company and began growing certified organic soybeans.

Controlling Soybean Aphid

Steve had grown soybeans prior to his organic certification and he had experience with organic pest management in other crops. He prepared to grow soybeans again by making planting, tillage, and weed management decisions that would contribute to soybean pest and weed control. These included such things as managing early-emerging weeds and having a solid weed cultivation plan. Steve's farm also already had natural areas and perennial crops that could attract beneficial insects to the farm. He knew, though, that there would be a very good chance that each time he grew soybeans he'd be battling soybean aphid. Soybean aphids are found in every county of Minnesota. They overwinter on common buckthorn, which is an invasive shrub from Asia found throughout the state. Aphids feed on the plant's sugars, which stresses the soybean plants and may result in reduced yields due to poor plant growth and/or pod set. In addition, plant damage from soybean aphids can aid in transmitting diseases, which also can decrease yield.

Soybean growers need to scout their fields regularly for soybean aphid infestations. The economic threshold (the number of aphids per plant that a soybean field can manage without significant decrease in yield) for non-organic soybean growers is 250 aphids per plant on 80% of the field. Non-organic farmers can then spray a synthetic insecticide to kill the soybean aphids if infestations exceed this level. While organic growers are prohibited from spraying insecticides, they do have options for managing soybean aphids, including planting resistant varieties, exploiting biological controls, and applying

organic-approved insecticides. Most organic producers utilize pest-resistant varieties when available. However, in northern areas like Minnesota, there are very few aphid-resistant varieties available. Additionally, producers who grow soybeans under contract do not get to choose which variety is grown.

Another management option is to use biological controls that include naturally-occurring or introduced predators of the soybean aphids. Any natural or perennial areas of a farm may act as host to these beneficial predatory insects such as the lacewing or lady beetle (*see EXHIBIT B: Soybean Aphid Predators and Parasites*). Asian lady beetles that target soybean aphids are available commercially, although there is some concern about their effectiveness at a field scale. A soybean field, for instance, would require a large amount of lady beetles and proper distribution may be difficult. Researchers are working on breeding parasitic wasps, a biological control of aphids in Asia, for commercial use, but none are currently available to producers.

A third pest management option is the use of insecticidal sprays that are approved for organic soybean growers. These include compost teas, insecticidal soaps, and naturally-derived insecticides. These sprays, however, are not as effective as conventional products and have shown varying results on-farm (*see EXHIBIT C: Organic Research for Soybean Aphid Management*). Waiting until the aphid infestation reaches 250 aphids per plant (the non-organic recommendation) has often resulted in no suppression, and some have suggested a threshold of 100 aphids per plant to compensate for the differences in effectiveness of organic products. Unfortunately, naturally-derived insecticides can affect not only the target pest insect, but also beneficial insects.

Clearly, soybean aphid management options are available to organic soybean producers, but none of them have thus far provided consistent aphid control or suppression. However, there are many organic farmers in the region that successfully produce soybeans with profitable yields.

It came as no surprise to Steve when there was a summer day during his first year of growing soybeans organically that he saw aphids in his field. Unfortunately, the soybeans he was growing for the seed company were not a variety that was resistant to aphids. The infestation level was low at that point, but Steve knew he had to make a decision quickly regarding what management method to use. If he waited and the soybean aphid population didn't increase, he might be able to get by with doing nothing. But, if the aphid population increased, yields and revenue might suffer significantly (*see EXHIBIT D: Financial Impact of Yield Losses due to Soybean Aphid*). Should he go with one of the approved insecticidal sprays? He'd had experience with some of them, but was never very impressed with their effectiveness, and would it be cost effective if he had to do more than one spray application? Should he try a biological control? He had used lady beetles some years earlier on a similar infestation in his alfalfa, but could he get enough of them for an entire field? He needed to weigh their effectiveness against their cost. An organic insecticidal spray such as Pyganic would cost up about $4,000 for two rounds of application, while the lady beetles would cost around $400. The aphid population could explode quickly; a decision needed to be made now! What should Steve do?

Exhibit A. Common Soybean Pests

Whether organic or non-organic, farmers have the same pests to deal with when growing soybeans. Some of the most common soybean pests include soybean aphid and cutworm. There are many additional common soybean pests, and organic producers must use numerous techniques to manage them.

Soybean Aphids
Description: Insect that is green/yellow in color and less than 1/16 inch in length at maturity. Pear-shaped. Both winged and wingless.
Damage: Feeds on plant sugars / sap which can reduce yield and quality. Can also lead to diseases and viral infection.

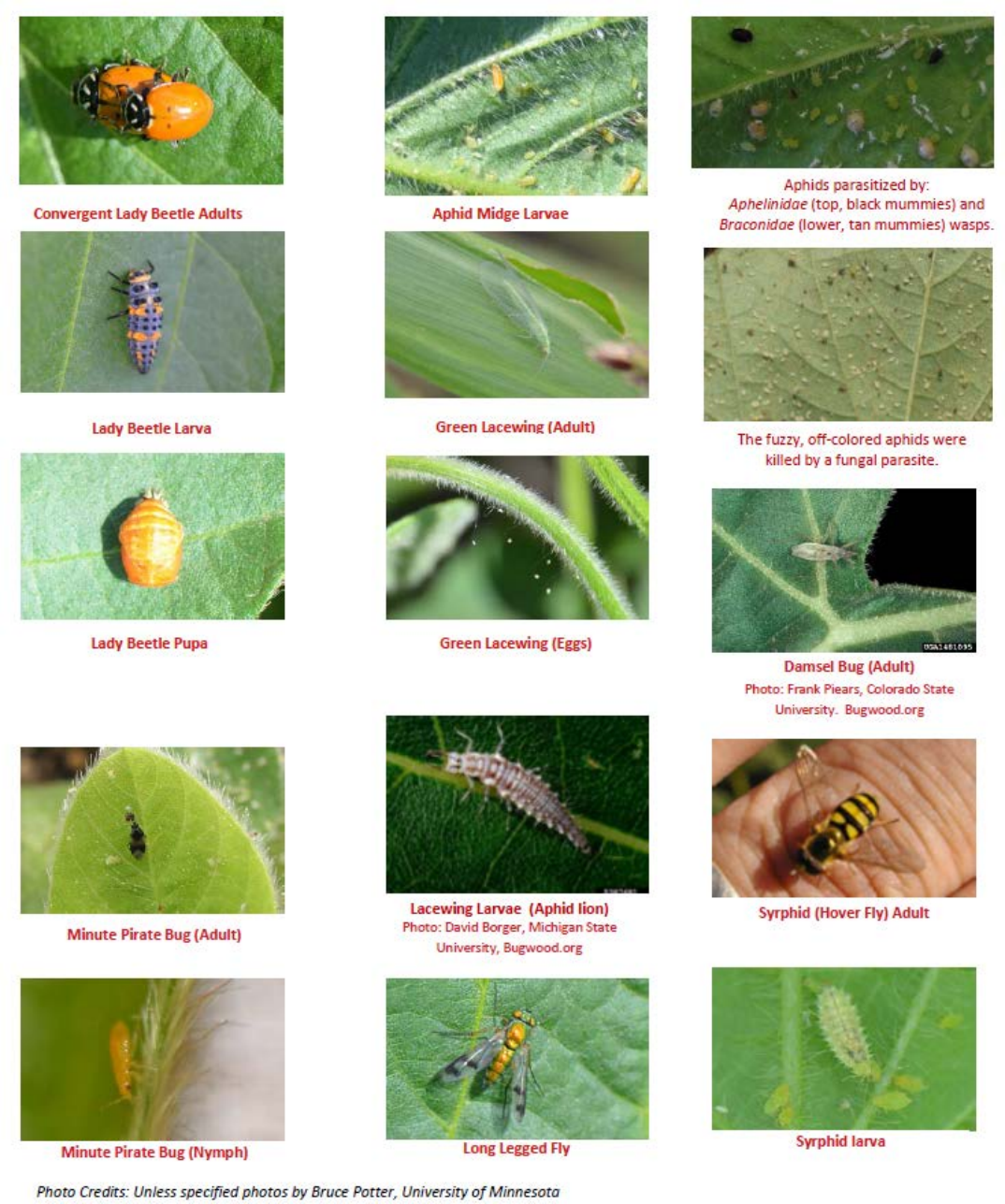
Black Cutworm

Description: Larvae are 0.2-1.5 inches in length and gray to black in color. Adult moths have a 1-2 inch wingspan and are grayish-black in color. Adult moths migrate to Minnesota and lay eggs that hatch within 5-10 days.
Damage: Larvae will feed on leaf tissue, cotyledons, and stems. They may completely sever the soybean seedling or eat enough of the plant to cause wilting or for the seedling to fall.

Soybean Cyst Nematode
Description: Roundworm that is about 1/40 inch in length and shaped like a lemon. Start out white to yellow in color and can be seen on roots but eventually turn brown which makes a visual difficult.
Damage: Feeds on soybean roots which damage them and hinders nutrient and water uptake. Can lead to significant yield loss (greater than 30%).

Source: Coulter, J., Moncada, K., and Sheaffer, C. 2010. Chapter 10: Soybean production. In: K. Moncada and C. Sheaffer, eds., *Risk Management Guide for Organic Producers.* University of Minnesota. (http://organicriskmanagement.umn.edu)

Exhibit B. Soybean Aphid Predators and Parasites



Source: Koch, R. and Potter, B. 2015. Scouting for soybean aphid. University of Minnesota Extension. (https://extension.umn.edu/pest-management/soybean-aphid)

Exhibit C. Organic Research for Soybean Aphid Management

MN has an estimated 26,000+ acres of organic soybean. Organic soybean growers are faced with risk of aphid infestation and significant yield loss annually. Having an effective "responsive control" is desirable to prevent economic loss, especially in outbreak years when 40 to 50% yield losses were documented. In 2006 through 2012, Phillip Glogoza and his team evaluated several organically-approved treatments against soybean aphids on Minnesota organic farms. Table 1 provides an overview of their results. The products tested included:

- Neem oil – a naturally-occurring insecticide produced from seeds from the neem tree. It repels and kills insects by interfering with their feeding. Neem is not thought to be toxic to birds, mammals and plants.
- Insecticidal soap – potassium fatty acids that damage the cuticles of soft-bodied insects, such as aphids, causing them to dehydrate and die. Insecticidal soap is not toxic to birds and mammals.
- Pyrethrum – a naturally-occurring insecticide extracted from the chrysanthemum plant. It kills most insects on contact. It has low toxicity to mammals.

Table 1. An overview of field trials conducted on organic treatments for soybean aphid, 2006-2012.

Trial	Year	Outcome
Neem	2006	Failed to control soybean aphids
Neem, insecticidal soap and pyrethrum	2007	Pyrethrum suppressed aphids when applied at a lower threshold
Neem, insecticidal soap and pyrethrum	2008 - 2010	Pyrethrum impacted aphids more with reconfigured sprayer that provided wider coverage
Insecticidal soap as preventative	2010 - 2011	Failed to prevent soybean aphids

In conclusion, this research found:

- Natural pyrethrum was the best product evaluated, but only provided suppression of soybean aphid by 50 – 60%
- Multiple applications in outbreaks are likely, but still dependent on timing of infestation (e.g., July vs. August)
- Delaying until 250 aphids/plant was too late for "responsive control" with organic insecticides. An Action Threshold of 100 aphids/plant proved better, but there is no guarantee infestations would reach numbers reliably associated with economic losses
- Coverage is critical, particularly when aphid colonies are on lower leaves and stems

For more information on this work, please visit the following:
https://extension.umn.edu/

Exhibit D. Financial Impact of Yield Losses due to Soybean Aphids

Table 2. Average yield and price data from 55 organic soybean enterprises, 2011-2015.

Yield: 25 bu/acre	10% Loss	20% Loss	30% Loss	40% Loss
# bushels/acre	2.5	5.0	7.5	10.0
Price per bushel	23.60	23.60	23.60	23.60
# Acres	50	50	50	50
Loss per acre ($)	59	118	177	236
Total crop loss ($)	2,950	5,900	8,850	11,800

Source: Center for Farm Financial Management's FINBIN database.

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. What are some reasons that Mr. Judson hadn't grown soybeans since becoming certified organic?

2. How does soybean aphid management for organic soybean producers vary from non-organic producers?

3. What are some of the different management options for soybean aphids that Mr. Judson could use? Are all the options equally effective?

4. What are some of the pros and cons of using these different organic soybean aphid management options?

5. Does the use of organic-approved insecticidal sprays adhere to the principles of organic agriculture? Why or why not?

6. What are some of the barriers to using biological controls on a wide scale?

7. Which management option would you use for a soybean aphid infestation?