Will Changing the Rotation Change it All?

A Decision Case Study

By Jill Sackett Eberhart
Formerly of Agriculture Production Systems,
University of Minnesota Extension, Mankato, MN

This decision case study was produced under the *Principles for Transitioning to Organic Farming: e-Learning Materials and Decision Case Studies for Educators* project

Edited by Steve Simmons, Kristine Moncada, Craig Sheaffer,
Gigi DiGiacomo and Nicole Tautges;
University of Minnesota, St. Paul, MN

This work is supported by the **Organic Transitions Program (grant no. 2013-51106-21005)** *from the* **USDA National Institute of Food and Agriculture.**

Will Changing the Rotation Change it All?

Chris Feely recently discovered that adding winter wheat into his organic grain rotation increased soil cover and reduced labor and tillage requirements. However, adding in winter wheat has displaced alfalfa and red clover in the rotation, a practice which he has noticed has resulted in increased Canada thistle pressure in the rotation. Chris still wants to keep winter wheat in the rotation, but can his rotation survive the weed pressure while remaining organic?*

Chris and Sarah Feely have been farming in west central Minnesota for over 40 years. More than just a job, farming was a career and a calling for Chris. The Feelys felt strongly that it was important to be good stewards of the land, and were well aware of the impact their decisions had on their farm's natural resources. These values motivated their choice to utilize organic farming practices.

The farm soil was predominantly clay-loam and the average yearly precipitation was slightly less than 25 inches per year. With roughly 300 acres of land to make a living from, Chris paid close attention to soil conservation and chose a rotation that reflected his desire to improve the soil.

Chris planted a three-year rotation of corn-soybean-small grain, but would sometimes add a year or two of alfalfa after the small grain. Chris included multiple kinds of spring-planted small grains in his rotation over the years, from oats to barley to spring wheat. These he would no-till drill into soybean stubble. He often underseeded those spring small grains with a legume such as red clover or alfalfa. The small grain acts as a companion crop forming a canopy over the smaller legume seedling. After small grain harvest, the legume seedlings remain and regrow to provide soil cover for the remainder of that growing season, and in addition, supply nitrogen to the next crop. This is particularly important for organic farmers as they cannot use synthetic nitrogen fertilizers used by conventional growers.

Chris would usually choose perennial legumes such as red clover or alfalfa to be under-seeded. In the years that Chris planted red clover with the small grain, he would use tillage in the spring of the following year to terminate the red clover in order to plant the next crop in his rotation. When he would underseed with alfalfa, he allowed it to grow for the entire next season and would harvest it several times and sell it as forage. Therefore, for Chris, the underseeded legumes provided winter cover and were a source of fertility for the next year's corn crop. In the years that alfalfa was grown, it

* *While these cases describe actual situations, names have been changed.*

was also a source of income (*see EXHIBIT A: Legume Underseeding in Small Grains*).

A New Crop in the Rotation

Chris enjoyed learning about, and experimenting with, new agricultural techniques that had the potential of improving his farm. He was intrigued by the potential of winter wheat. Unlike the other grain crops Chris grew, winter wheat was planted in early September. Winter wheat's fall and early spring growth helped conserve topsoil by keeping the ground covered through fall, winter and spring. Underseeding a legume with his spring-planted small grains provided this benefit, too, but winter wheat had the potential of providing a better financial return than the legumes. In addition, when compared to the spring-seeded small grains, winter wheat required no spring tillage, and was a good competitor against weeds.

Chris began a new rotation of corn-soybean-small grain-small grain so that he could start including winter wheat. The spring-planted small grains were harvested in August and gave Chris plenty of time to no-till drill winter wheat into their stubble within weeks of their harvest. A spring small grain followed by a winter small grain was an unusual practice because of concerns of disease pressure, but Chris found out that his organic certifying agency allowed the practice. Understanding the risk of disease, Chris chose to plant winter wheat after either oats or barley rather than spring wheat.

His new rotation meant that he had to give up the practice of underseeding red clover or alfalfa with his spring small grains. The clover or alfalfa just wouldn't have enough time to regrow following the spring-planted small grain harvest before it needed to be terminated to plant the winter wheat. As a result, Chris didn't get the nitrogen benefit from the use of legumes. However, this was not much of a concern because he had developed a relationship with a neighboring hog farmer and now had a reliable source of livestock manure to provide nutrients for his crops. Chris was pleased with how no-till planting winter wheat reduced his fall and spring tillage in contrast to underseeded red clover, which he controlled with a chisel plow in the spring. While organic farmers use tillage to kill weeds and prepare the soil for planting, tillage also damages soil structure and can lead to increased soil erosion. Chris knew that reducing the number of tillage passes, especially in the fall, was better for the soil. Plus, winter wheat, just like the underseeded legumes, was able to provide soil cover.

Weed Control Issues

Soil fertility and conservation were important to Chris, but so was weed control. As many organic farmers would agree, weed control was a constant concern. Alfalfa and red clover in the rotation not only helped provide nitrogen for the corn crop, but also helped reduce perennial weed pressure. In fact, planting alfalfa in fields that had troublesome perennial weed issues was a tactic on which Chris regularly used to aid in weed control. Harvesting of alfalfa by mowing three times per year removed weeds and prevented their seed production. The underseeding of red clover could also provide some of the same weed management benefits, even though it was mowed less frequently than alfalfa and not harvested.

But now, there was a new crop in the rotation. Including winter wheat meant that the practice of underseeding was no longer being done. As time went by, Chris noticed that the use of winter wheat in the rotation was resulting in an unexpected weed issue. Canada thistle, in particular was becoming a problem. Chris particularly noticed its regrowth and spread after winter wheat harvest in July.

Canada thistle is a perennial broadleaf weed

that can be difficult to manage, and becomes particularly troublesome in organic no-till rotations. Chris wasn't happy to see it in his fields. Canada thistle can spread by either seed or via its extensive root system. Seedlings emerge from May to June and eventually produce numerous flowers and seeds. The seeds are tufted and easily spread by the wind. Plus, Canada thistle can grow from just one, small piece of root as well as sucker from one plant's extensive root system. This means that tillage can spread it, too. It reduces yields because it is highly competitive for nutrients and water (*see EXHIBIT B: Canada Thistle*).

What were Chris's options? His original rotation offered Chris the opportunity to underseed a legume with his small grains. Whether alfalfa or red clover, the legume provided soil surface protection as well as helped to increase soil fertility. It also was good for perennial weed control, especially when the alfalfa was allowed to grow and be harvested for one or two years after the small grain crop.

Winter wheat had become a valuable small grain in Chris's new rotation. The growth habit of winter wheat was beneficial since it was present during late fall, winter, and spring to help prevent soil erosion. Having a winter annual in the rotation also added diversity. However, Canada thistle was a problem that began showing up once the winter wheat was put into the rotation.

Should Chris discontinue the use of winter wheat in his rotation? If he chose to continue to grow winter wheat, how could he manage the Canada thistle? Are there other crops Chris could add to his rotation to compete with Canada thistle? How could Chris have the best of both worlds?

Exhibit A. Legume Underseeding in Small Grains

Underseeding allows for both a legume and a small grain to be grown in a field at the same time. An example would be oats and red clover. Planting both oats and red clover at the same time in the same field can better stabilize the soil, decrease seedling loss due to wind and water, and better compete against weed pressure. Legumes also form a mutualistic relationship with nitrogen-fixing bacteria which can provide themselves and the next crop with nitrogen. The oats would usually be grown to maturity and harvested for grain. After oat harvest, the clover would be allowed to continue to grow. When managed this way, the underseeded red clover can provide soil cover to decrease erosion and eventually be used as a forage or as a nitrogen-supplying green manure.

Legume companion crops

Organic producers often underseed small grains with red clover or alfalfa. Red clover tends to be less competitive with small grains and is more easily terminated, but alfalfa can be used as an acceptable alternative (Tables 11-6 & 11-7). Red clover can be underseeded at six to ten pounds per acre, while alfalfa can be underseeded at eight to ten pounds per acre. Underseeding legumes is an excellent, low-risk way for organic farmers to incorporate green manures into their rotation. See Chapters 4 and 12 for more information on underseeded legumes.

Table 11-6. Organic oat with alfafa underseeding variety trial in Clay County, MN in 2003 and 2004. *Good yields were obtained when oats were underseeded with alfalfa. Adapted from Kandel and Porter, 2003 & 2004.*

	YIELD (bu/ac)		
Variety	2003	2004	Average
Leonard	138	128	133
Sesqui	136	128	132
Wabasha	124	122	123
HiFi	129	118	123
Ebeltoft	127	112	120
Richard	116	108	112
Youngs	117	104	110
Morton	139	96	118
Hytest	97	90	94

Table 11-7. Organic wheat with alfafa underseeding variety trial in Clay County, MN in 2003, 2004, and 2005. *Good yields were obtained with wheat underseeded with alfalfa. Adapted from Kandel and Porter, 2003, 2004, & 2005.*

	YIELD (bu/ac)		
Variety	2003	2004	2005
Walworth	60	46	46
Oklee	50	41	43
Dapps	58	40	41
Alsen	53	40	43
Hanna	--	44	38

Source: Wiersma, J., Moncada, K.M., and Brakke, M. 2010. Chapter 11: Small Grains. In: K.M. Moncada and C.C. Sheaffer (Eds.), *Risk Management Guide for Organic Producers*. Regents of the University of Minnesota. http://organicriskmanagement.umn.edu/

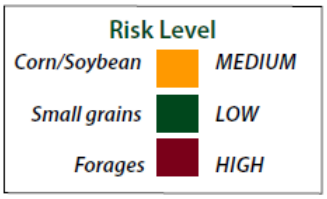
Exhibit B. Canada Thistle

Alternative Names:
Cirsium arvense, field thistle, creeping thistle, Californian thistle

Identification:
Seedlings are spiny and emerge from Mid-May to Mid-June in Minnesota. The root system extends several feet down and horizontally. Canada thistle has an upright stature and can grow to two to five feet tall. Stem branching occurs at the top of the plant and the stems become increasingly hairy as the plant matures. Canada thistle leaves are oblong and lobed and have crinkled edges with spines. The leaves also have a hairy underside. The flowers of Canada thistle are most often ¾ inch in size and purple in color. Numerous flowers are found on each plant with male and female flowers usually on different plants.

Plant and flowers.

Risk to yield:
Corn: potential loss of 5% at 5 shoots/row-ft
Wheat: potential loss of 38% at 14 shoots/10 row-ft



Short Term Management Tips:
- Mid-season crop planting OR
- Tillage to bury seeds at least 2-4" deep (2" results in 50% inhibition, 4" results in 100% inhibition)
- Mowing to prevent seed set
- Take management action when flower buds are present in order to reduce root reserves
- Rotary hoe / disk / tillage can spread Canada thistle via its roots – will need to be done approximately every three weeks in order to reduce soil seed stores

Long Term Management:
Include alfalfa, sweet clover, buckwheat or sudangrass in the rotation

Moncada, K.M. and Huerd, S. 2010. Chapter 7: Weed Profiles. In K.M. Moncada and C.C. Sheaffer (Eds.), *Risk Management Guide for Organic Producers*. Regents of the University of Minnesota. http://organicriskmanagement.umn.edu/

Teaching Notes:

Case Objectives:

- Increase knowledge of organic grain crop rotations in the Upper Midwest.
- Increase knowledge of organic perennial weed management, crop-weed interactions, and how crop rotation affects organic weed management
- Discuss tradeoffs between no-till and tillage soil management types for soil conservation, and how that relates to organic production longevity

Use of the Case:

This case is developed for use by extension educators, post-secondary instructors, state agency personnel, and others interested in increasing understanding of the organic transition process.

Materials Needed:

- Copies of the decision case study/ies on which to make notes as participants read.
- A laptop and projector to show slides of the farm, the markets, and the farm family. It could also be used to project discussion questions, certification requirements, or other materials of interest.
- A "U" or horseshoe-shaped seating arrangement for maximum participation among participants and the facilitator.

Dealing with Controversy:

Often in the discussion of a decision case study, participants will disagree about certain issues. While this is a mark of an effective case, the facilitator should keep the discussion from becoming argumentative and unproductive. Participants should be reminded that there are many points of view and to keep the discussion atmosphere constructive and nonthreatening. If desired, techniques such as role-playing or role reversal can help participants discuss the issues in a less personal way.

Use the following strategies to facilitate a productive, healthy discussion where controversy may be involved:

- Establish ground rules. These may include: allowing only one person at a time to speak; no one should speak twice before everyone has had a chance to speak once; no criticizing of others' comments, etc.
- Encourage participants to use "I" messages when stating their viewpoint. Avoid using "you" or blaming statements.
- Ask clarifying questions such as, "Why do you think that?" A major communication problem is misunderstanding what was said.
- Ask participants to try to imagine the situation from the other person's point of view. (Role-playing can also help with this.)
- Encourage participants to focus on what they want in the future or where they would like to go, rather than where they have come from or what has happened in the past.

Lesson Outline:

Discussion of this decision case study can last from 20 to 60 minutes, depending on the degree of preparation by the participants and the desired depth of the discussion. The outline below is one example of the way a facilitator might structure the discussion. In general, a decision case study discussion is a forum where participants talk to each other in addition to the facilitator. The format described here is useful when advanced preparation of the participants is not possible. If desired, the facilitator can include additional information on local crop production and social issues to enhance discussion and create a broader understanding of those topics.

- Introduction
- Facilitator introduces the case study and describes the goals and approach to be used
- Focus on a real situation
- Practice problem solving
- No single right answer – each person and situation is unique
- The Decision Case Study
- Facilitator introduces the decision case study.
- Participants read or reread the narrative of the decision case study
- Facilitator divides the participants into small groups of 2-4 people and asks them to discuss questions.
- Participants return to large group and share key points of their discussion
- Facilitator guides a group discussion on the remaining questions
- Conclusion
- Group members may select a preferred option or facilitator may have participants write individually and describe their decision in response to the dilemma and the rational for the response
- Closing comments

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 benefits do the legumes underseeded beneath the spring small grains offer for the small grain crop, and Chris Feely's entire crop rotation?

2. What weed control methods did Chris Feely rely upon prior to the incorporation of winter wheat into his rotation?

3. Thus far, Chris Feely has not observed disease problems from planting winter wheat after a spring small grain. However, research has shown that this practice often increases risk of disease. Why do you think Chris hasn't observed disease? Do you think he should continue this practice, if he notices any disease on his small grains?

4. While replacing the legume with winter wheat decreases rotational diversity, what conservation benefit did it offer for Chris Feely's rotation (hint: soil health)? Do the benefits of winter wheat in the rotation outweigh the risks?

5. What methods of weed control could be options in Chris Feely's new rotation with the winter wheat?

6. Why is Canada thistle a troublesome weed in organic rotations? What methods control perennial weeds in organic systems? What practices can control Canada thistle after an invasion occurs?

7. If Chris Feely's Canada thistle problem grows, do you think he should continue with the corn-soy-spring grain-winter wheat rotation? What conservation factors are most important to consider when formulating the organic rotation? What would you advise Chris Feely to do?

The following resolution to the case study, along with an analysis, is offered for the benefit of the instructor in preparing for leading a discussion of the decision case study. The information it contains and the final resolution of the decision case study may or may not be disclosed to discussion participants, at the instructor's discretion. Should the resolution be shared with participants after the discussion takes place, the authors suggest debriefing the epilogue and final decision with the students.

Epilogue:

With the winter grains causing Canada thistle to increase in his fields, Mr. Feely decided soon after this case was written to stop growing winter wheat in his rotation. As of this writing, he has gone back to his typical three-year rotation with corn, soybeans and spring-seeded small grains with underseeded red clover. Additionally, he uses a few years of alfalfa to control Canada thistle in fields where the thistle problem is the worst, as he has done in the past. He said "Once again I have come to understand that alfalfa seems to be the best tool that I have for suppressing Canada thistle."

He feels he is meeting his soil conservation concerns because he has eliminated all fall deep tillage. The only exception is in the years when he grows a small grain underseeded in red clover, where he does a single tillage pass in late fall to set back the red clover in preparation for the next year's crop. However, much of the red clover still remains after the tillage pass to offer decent soil protection over the winter. He also leaves the soybean and corn crop residue on his other fields undisturbed through the winter to cover and protect the soil, while building his soil organic matter. He has noticed that the crop residue catches more winter snow to provide even better soil protection.