# Evaluation of Winter and Spring Canola in Two Dairy Farm Rotations for On-Farm Tractor Fuel and Dairy Cattle Feed

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## Introduction

We are evaluating growing canola (*Brassica napus* L.) for on-farm fuel production for a straight vegetable oil tractor and dairy cattle feed in the NESARE Sustainable Dairy Cropping Systems Trial. We compared growing canola in two dairy crop rotations that are primarily no-till. The rotations evaluate strategies to reduce herbicide use or conserve manure nutrients.

*Canola oil fuels a tractor converted to to run on straight vegetable oil (Elsbett conversion)*

**Objectives:** Evaluate ways to integrate canola into a dairy rotation:

- Compare canola planted after alfalfa versus canola after corn silage
- To reduce herbicide use, compare planting canola after terminating alfalfa with plowing versus terminating alfalfa with an herbicide.
- To conserve nutrients, compare injected manure versus surface applied manure.

## Methods

In 2010– 2013, we grew winter and spring canola in two dairy crop rotations that are primarily no-till in the NESARE Dairy Cropping Systems project at the Penn State Agronomy Farm. Each crop entry is planted every year in 36.6 m x 27.4 m plots with farm-scale equipment.

**Experimental Design:** Nested split plot design, replicated four times.

**Treatments:**

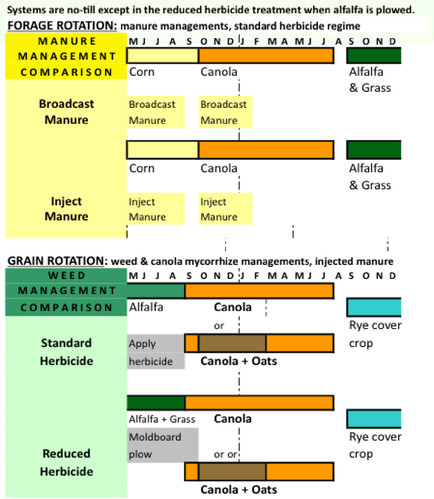
**After Corn Silage, in 2011 Canola** *winter canola Witichita' was planted in fall 2010 after Corn Silage in the 'Forage/Manure Rotation*' that compares shallow disk manure injection & surface application.

**In 2012 and 2013 Canola:** *Weather delayed Corn Silage harvesting and manure applications; manure was injected or surface applied prior to planting a Rye cover crop. Spring canola 'CL5525' was planted after Rye (Table 1).*

**After Alfalfa, in 2011, 2012, 2013** *winter canola 'Witichita' was planted after Alfalfa in the 'Grain/Pest Rotation' that* compares strategies to reduce herbicide use, including terminating alfalfa before canola with plowing versus herbicides.

**Dairy Crop Rotations with Canola after Corn Silage or Alfalfa**

**2011:**




**2012 and 2013:**

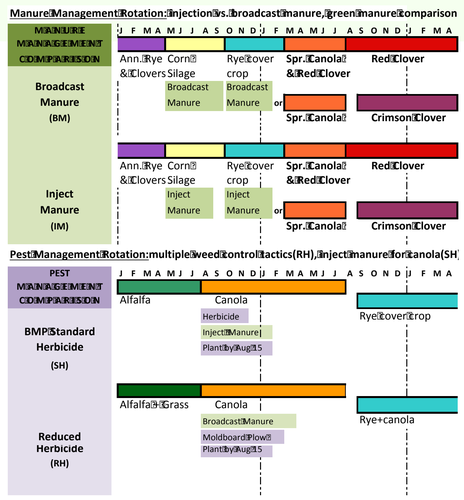



**Table 1: Canola Planting Date**

| | Plowed | No-tilled | Injected manure | Surface manure |
|---|---|---|---|---|
| 2011 | Sept. 12 | Sept. 12 | Sept. 16 | Sept. 16 |
| 2012 | Sept. 14 | Sept. 14 | April 10 | April. 10 |
| 2013 | Aug. 25 | Aug. 25 | April 27 | April. 27 |

**Table 2: Nitrogen was top-dressed in Spring as Ammonium Sulfate and Urea in addition to dairy manure**

| | Plowed | No-tilled | Injected manure | Surface manure |
|---|---|---|---|---|
| | | (kg/ha) | | |
| 2011 | 101 | 101 | 70 | 101 |
| 2012 | 118 | 118 | 75 | 101 |
| 2013 | 65 | 65 | 75 | 101 |
| Average | 95 | 95 | 73 | 101 |

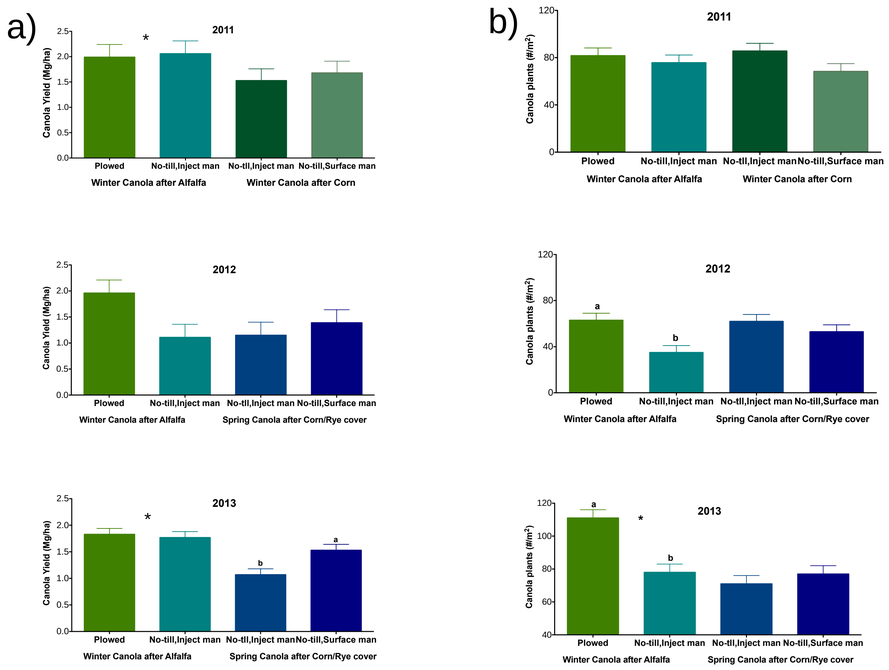
*Liquid dairy manure (53 MT/ha) was applied to all treatments, either shallow disk injected in 76 cm rows (left photo) or surface applied/broadcast (right).*

**Data Analysis** for each year was conducted with PROC MIXED of SAS with rotations and treatment as fixed effects, block as random in 2011, and block as fixed in 2012 and 2013. Least squares means were compared with Tukey's test at p <0.05.

**Acknowledgements:** Special thanks for research assistance from Caitlin Andler,Stephanie Bailey, Dianna Durán Castro, Justin Dillion, Marissa Keys, Veronica Le Pas, Heidi Musshafen, Brian Gray, Scott Harkcom, Andrew Kirk, Erika Samian, Julie Schubert, Elina Snyder, Andrew Puglia,William Verbeten, and Joshua Walker.

**Funding:**

## Results and Discussion




**Figures 1a and 1b**: Canola yield and plant populations when planted after alfalfa in the "Grain/Pest" rotation or corn silage/rye in the "Forage/Manure" rotation in 2011, 2012, and 2013. * indicate significant differences between the two rotations at p<0.05. Different letters indicate significant differences (p<0.05) within the rotations between the weed or manure management treatments.

**Table 3: Canola Tissue Sufficiency Tests for Nitrogen and Boron**

| Year | Plowed | No-tilled | Injected manure | Surface manure |
|---|---|---|---|---|
| 2011 | OK | OK | Low N & B | Low N & B |
| 2012 | OK | OK | Low B | Low B |
| 2013 | Low N | Low N | Low N & B | Low B |

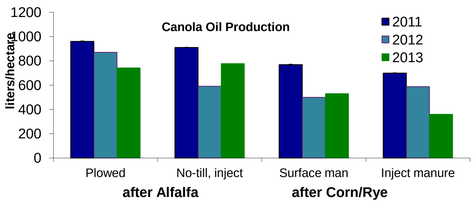



**Figure 2:** Cold-pressed Canola oil produced in the weed and manure managements after alfalfa or corn/rye cover in 2011, 2012, and 2013.

In 2011, winter canola yields were 26% higher after alfalfa than after corn silage (Fig. 1a) when plant nutrient analyses suggested that nitrogen and boron levels were deficient (Table 3).

In 2013, winter canola yields after alfalfa were 39% higher than spring canola planted after corn silage and a rye cover crop. The winter canola population densities were significantly higher and the proportion of plants damaged by herbivory by slugs and flea beetles was lower than the spring canola (data not shown). Plant tissue nutrient analyses indicate nitrogen also likely limited canola yield in both weed management treatments when top-dressed N rates were reduced after alfalfa, and nitrogen and boron likely reduced yields after corn/rye cover in the injected manure treatment where manure banded in 76 cm spaced rows likely limited nutrients to some canola plants in the narrower spaced 19 cm rows.

In 2012 and 2013, winter canola plant populations were higher after tillage (Fig. 1b), primarily due to reduced slug herbivory. In 2012, two of four no-till winter canola plots did not establish due to slug activity (Karsten et al, 2012). In an effort to reduce slug herbivory, the 2013 winter canola crop was planted 3 weeks earlier (Table 1).

Cold-pressed canola oil yields aligned with canola yield treatment trends. An economic analysis model developed for on-farm canola production and oil processing (Julius, 2011) estimated the average cost of canola oil production in 2011 and 2012 was $1.24/liter or $4.68/gallon. The lowest cost treatment (2011, plowed after alfalfa) cost $1.0/liter or $3.79/gallon.

**Summary**: In two out of three years, winter canola planted after alfalfa produced more than winter or spring canola planted after corn silage or corn silage/rye cover crop, respectively. Although alfalfa and liquid dairy manure supplied some crop nutrients, supplemental nitrogen and boron was needed to meet canola nutrient needs. Injecting manure after corn in 76 cm spaced rows appears to have limited manure nutrient availability to some canola planted in more narrow rows. Plowing prior to canola planting reduced slug herbivory and increased canola plant populations in two out of three years. Planting winter canola after alfalfa and tillage is likely to produce higher yields and lower cost fuel than no-till winter canola or spring canola planted after corn/rye.

**References:**

Julius, C. 2011. Straight Vegetable Oil as a Replacement Fuel for Diesel: Comparing Tractor Performance and Farm Economic Implications. MS Thesis. Penn State University.

Karsten, H.D., W.Verbeten, G. Malcolm, M. Douglas and J. Tooker. 2012. No-till Establishment of Alfalfa and Canola and Slug Herbivory. Proc. ASA, CSSA, SSSA Annual Meetings. Oct. 21-24, Cincinnati, OH. 337-25.