Small-Scale Oilseed Presses:

An Evaluation of Six Commercially-Available Designs

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As part of a project on adding value to farm operations with food-grade oils, the University of Vermont Extension and Pennsylvania State Extension teamed up to evaluate the design and operation of several small-scale oilseed presses. While there is a great deal of interest in the production of oilseeds, many questions arise about post-harvesting processing, and many of these concerns revolve around the efficiency, affordability, and best practices of an oilseed press, which is the heart of the oilseed production system.

Most commercially-available oilseed presses have the same basic components (Figure 1). In "cold-pressing," the seed goes into a central hopper of the press and is moved through one or more screws, crushed against a nozzle and screens to extract oil without heating the seed above a temperature of 120°F. Oil and meal are separated.

Presses vary in the number and breadth of adjustment each needs and is capable of. Some presses have multiple nozzles, with differing diameter holes for differing crops (Figure 2). Some have collars that are heated to a given temperature before operation.

Unfortunately, manufacturers' instructions and customer service can vary greatly. Many of the presses are made overseas, and it can be difficult to get guidance in installing, wiring, and operating a press, either due to language barriers or geographical distance. In addition, the operational guidelines for different crops can vary. Here in the Northeast, where many growers are producing more than one type of oilseed crop, there is an interest in the type of press that can handle different crops, and in establishing some guidelines for commonly-used oilseed crops.

This report aims to guide both established oilseed processors in best management practices and collaborative experiences and also aid new or prospective processors in decision-making processes.

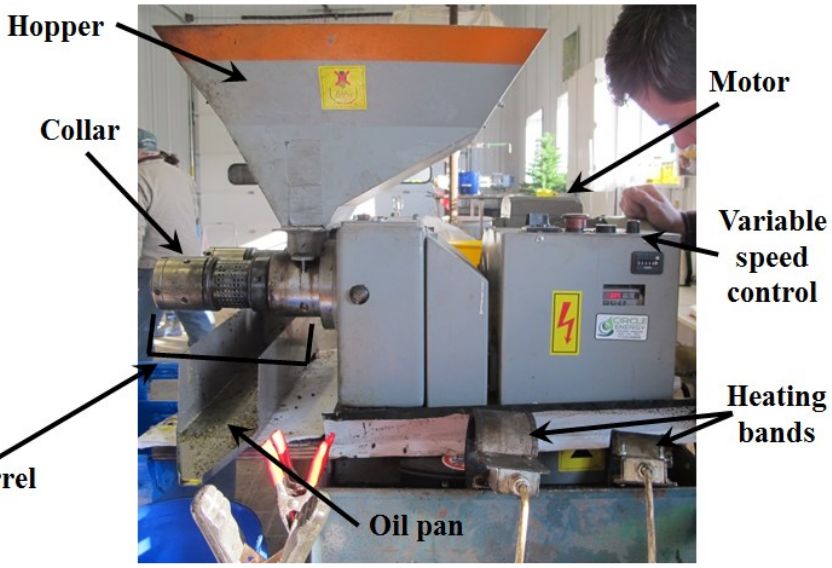

Figure 1. Standard components of a small-scale oilseed press.

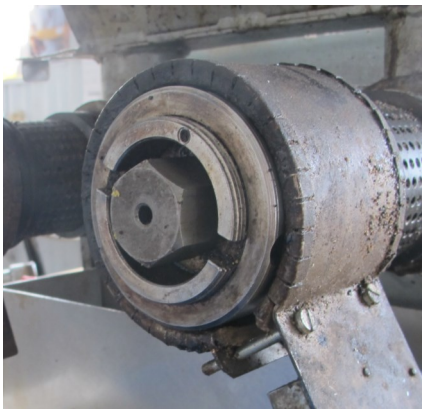

Figure 2. Nozzles vary on different oilseed press designs.

Methods

Researchers visited oilseed processing facilities across the Northeast to interview press operators and conduct objective evaluations of six different press designs (Figure 3). The team evaluated the AgOil M70, Keller KEK P0020, KernKraft 40, Komet CA59G3, Oil Prince, and Täby 70 presses (Table 1).

Figure 3. Researchers and farmers work together on press evaluations.

At each press location, the same seed was used to conduct a controlled experiment. Sunflower seed (var: 'Syngenta 3480') was harvested in 2012 in Alburgh, VT; canola seed (var: '5535 CL') was harvested in 2012 in Brandon, VT; and soybeans (var: 'Boyd') were harvested in 2012 in Charlotte, VT.

Each press evaluation began with normal operation, using the individual operator's preferred tuning of the machine. The second method of operation for each press used the same basic setup but was at a faster speed (adjusted Hz/RPM) to demonstrate a higher pressing capacity. Finally, each machine was run at a lower speed (adjusted Hz/RPM) with the intent of yielding more oil. Quantitative and anecdotal data from each method (and sometimes trials at additional speeds) were noted. Each method was repeated for each of the three oilseed crops when possible.

RULES OF THUMB

- Start with clean seed.
- Test and take note of moisture (this will vary by crop and press).
- Take note of seed temperature.
- Make small adjustments as you go, rather than big changes.

Table 1. Specifications for six presses evaluated during the course of this study.

PRESS	⇓ Estimated capacity (lbs seed/24 hrs)	⇓ Approximate purchase cost + year	⇓ Power source	⇓ Rated load	⇓ Adjustable speed	⇓ Heated barrel / head	⇓ Multiple screws available	⇓ Adjustable nozzle diameter	⇓ Adjustable gap between head and screw	⇓ Ease of set-up
AgOil M70	700	$8,500 (2012)	240v	1.5 kW / 2.0 HP	X	X		X		Simple
Keller KEK P0020	1056	$8,300 (2010)	230v	2.2 kW / 3.0 HP	X				X	Simple
KernKraft 40	1200	$15,000 (2010)	220v	3.0 kW / 4.0 HP	X	X	X	X	X	Finicky
Komet CA59G3	260	$8,000 (2008)	115v AC	1.1 kW / 1.5 HP	X	X		X		Simple
Oil Prince (KernKraft 20F)	1800	$6,000 (2012)	220v	2.2 kW / 3.0 HP	X	X	X	X	X	Finicky
Täby 70	1500	$7,000 (2005)	220-240v	2.2 kW / 3.0 HP	X	X		X	X	Moderate

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Press 1. AgOil M70

Roger Rainville of Borderview Research Farm in Alburgh, VT purchased an AgOil in late 2012. The cold screw press is made in the United States, one of many deciding factors for Rainville, who was interested in readily-available parts and service.

The AgOil has a simple design, with a single screw and an in-line Variable Frequency Drive (VFD) mounted on the gear box (Figure 4). With relatively few adjustments to be made, the press is simple to get running according to Rainville, and can be used to easily switch between crops without stopping to adjust.

The press itself takes up very little space, with dimensions of approximately 10"x10"x39". A clear feed hopper allows processors to watch seed flow into the press, observing cleanliness and any potential malfunctions. A "blast gate" stops seed flow when necessary. As used at Borderview, after the band heater has brought the temperature to approximately 120°F, the heater is removed and the machine's motor is turned on. A central screw inside the barrel forces seed against the crush plate and retainer. Meal is extruded in the form of crude pellets, and oil drips from the crush barrel's holes.

Figure 4. AgOil 70 press at 40 RPM, pressing soybeans.

A variable speed controller allows operators to adjust the speed of the machine and allow for the extraction of more oil. There are three different nozzles that come standard with the press; they can be swapped out for others to achieve the maximum efficiency for a given crop or condition (Figure 5).

MANUFACTURER CONTACT INFORMATION

[made in U.S.A.]

www.agoilpress.com

AgOil
Mondovi, WI

(877) 645-7737
sales@agoilpress.com

Figure 5. The AgOil M70 comes with three different sized nozzles: 220, 250, and 280.

AgOil indicates that oil extraction efficiency on the M70 is 82-90% of the oil content in the seed. Trial results from this study show an average of 24.2% net oil extraction across three crops (canola yielded 24.6% oil, soybean averaged 5.7% oil, and sunflower averaged 38.6% oil).

Rainville has been satisfied with the AgOil so far, though it has a lower capacity than his other presses. Press capacity averaged 697 lbs in 24 hours over multiple crops and speed settings.

The press came with very minimal setup instructions, so initial installation was cumbersome according to Rainville. However, customer service since then has been mostly reliable with this American-made oil press. The company also provides "crush tests," in which a sample of the grower's particular crop can be shipped to the facility for testing.

Press 2. Keller KEK P0020

The German-designed Keller KEK P0020, which is approximately 51”x12”x27”, is simple, with very few adjustments (Figure 6). Only the screw speed and the distance or gap between the head and the collar leave room for fine-tuning, making the press streamlined and effective.

Operator Lloyd Byers in Liverpool, PA, purchased the press for $8300 in 2010, with freight included and an installation cost of about $600. Byers reports that the Keller is easy to set up for pressing, and requires very little supervision once running. When the press is running for long periods of time, he checks a few times a day to make sure seed flow and press operation are optimal, but can generally leave it unattended with a large quantity of seed to press.

Unlike many other small-scale presses, the Keller requires no “pre-heating” with band heaters to start. Operators simply turn on the motor, load the hopper with seed, and begin. Byers generally operates the press at approximately 32 RPMs, and uses the number of visible threads between the screw end and the nozzle as a reference for setting the gap. Oil is extracted through the crush barrel, and the meal produced is in a “flake” form (Figure 7). Byers looks for flakes about the size and shape of potato chips to indicate that the press is operating as it should. The consistency and speed of the meal is the most reliable indicator of problems with press operation. Manufacturers promise that the use of “hard-wearing” steel reduces costly maintenance and repair issues.

In this trial, the average mass oil fraction for sunflowers was 40.7%, and capacity averaged 130 lbs in 24 hours. Byers has used the Keller mainly for sunflower seed, and on the day of the press evaluation, neither soybeans nor canola could be pressed through the mill. Byers has pressed canola with great success in the past, but difficulties with soybeans remain a problem. Customer service, however, has been prompt and thorough.

Figure 6. The Keller press has a single barrel and drive.

DISTRIBUTOR CONTACT INFORMATION

[made in Germany]

www.keller-kek.de

Distributor in the U.S.:

Elwyn Beck
Sioux Falls, South Dakota

(605) 354-1323

Figure 7. This was the only press evaluated in this study that produces meal in the form of flakes, rather than pellets.

Press 3. KernKraft 40

The KernKraft 40 (KK40), owned and operated by Roger Rainville at Borderview Research Farm in Alburgh, VT, is a workhorse design with high capacity and little supervision required (Figure 8). Rainville's model was purchased in 2010 and has been used to press over 60 tons of seed since then.

A large hopper built into the press allows for smooth flow of seed into the two screw chambers. There is a slide closure between the hopper and screw to stop seed flow if necessary.

DISTRIBUTOR CONTACT INFORMATION

[made in Germany]

Distributor in the U.S.:

Circle Energy

Dodgeville, Wisconsin

Eric Hamilton, (608) 574-7449

info@circle-energy.com

Many adjustments are possible with the KK40: operators can modify screw speed, nozzle/die size, the distance between the screw end and the nozzle, and the heat of the barrel (with removable band heaters). There are also two available screw types (hard/deep groove or soft/shallow groove). The soft seed screw comes with the purchase of the press; the hard seed screw (useful for soybean, flax, and other crops) must be purchased separately. A small "key" is removed from one screw and placed in the other before operation. When the screw becomes scuffed, polishing it will help draw more seed through the barrel and increase overall flow (Figure 9).

Figure 8. KernKraft 40 at Borderview Research Farm in Alburgh, VT.

The KK40 has twin barrels, which increases the capacity of the press overall. In 2013 trials, average capacity for varying crops and settings was 1033 lbs in 24 hours. Average oil mass fraction was 24.8% overall (23.8% for canola, 8.2% for soybeans, and 38.0% for sunflowers).

In research trials and based small batches, the dual barrels and multiple possible adjustments sometimes led to frustration. Often, one barrel would become clogged and backed up while the other would continue extracting oil and meal effectively.

Eric Hamilton at Circle Energy has been integral in the setup, maintenance, and operation of Rainville's KK40. Hamilton has been easily accessible by phone or email and has helped troubleshoot and work through problems with the press, even traveling to Vermont to help set it up initially.

Figure 9. Scuffed screws (left) need to be polished (right) to increase press efficacy.

Press 4. Komet CA59G3

Figure 10. The Komet CA59G3 is small but reliable.

The Komet CA59G3 is made by IBG Monforts in Germany. It is an electrically-driven model that is small in size (approximately 26”x22”x23”) and capacity (Figure 10). The Komet is a typical screw-type press, with a screw bringing seed through the shaft to press oil out of it.

The Komet is pre-heated to approximately 130°F with a removable band heater prior to pressing (for approximately 10 minutes). Operators can adjust the screw speed; agricultural engineer Doug Schaufler at Penn State University generally begins pressing at approximately 55-60 RPMs.

While there is no adjustment in the gap between the tip of the nozzle and the screw, there are multiple nozzles, with varying diameters for specific crops, though Schaufler uses the 5 mm nozzle for both sunflower and canola. Because the press is a European model, all units are metric, including bolts and threads. Operators can adjust the speed of the drive.

During pressing, Schaufler looks for a reasonable output when pressing to be sure the mill is operating well.

DISTRIBUTOR CONTACT INFORMATION

[made in Germany]
www.oekotec.ibg-monforts.de/

Distributor in the U.S.:

Nebraska Screw Press
Lyons, Nebraska

(402) 307-0280

rbyrnes@nebraskascrewpress.com

This has been determined through experience with the press on different crops. Another indicator of smooth operation is the temperature of the oil being extracted; when it gets too hot, it may be because a blockage inside the crush barrel is creating friction. Once the press is running well, there is little fine-tuning or supervision required. After the seed has been run through completely, the nozzle is removed from the press and cleaned thoroughly.

Though Penn State University never received installation and operation manuals from the manufacturer, email response from customer service has been prompt and thorough. The Komet press is used at Penn State University for small batches of seed, processing approximately 500 lbs of seed per year. “This has been a real reliable, real consistent machine,” asserts Schaufler. The press has actually been used to demonstrate oilseed processing at farm shows and outreach events, being sent to various locations with little more than a one-page instruction manual on its operation.

The advertised capacity of the mill is 3-5 kg of seed per hour, which would equal up to 260 lbs of seed in 24 hours. Though the Komet was unable to be used for soybeans during these trials, the average oil mass fraction for canola was 34.4%, and sunflower seed averaged 45.1% oil. The average capacity for these two crops, across speed setting, was 193 lbs in 24 hours.

Press 5. Oil Prince (KernKraft 20F)

The Oil Prince, as it is sometimes called, is another name for the KernKraft 20F (Figure 11). This is a smaller, single-screw KernKraft model with similar adjustability and operation to the KK40 (page 5).

The Oil Prince has adjustable screw speed, nozzle diameter, and two available screw types (for hard seed and soft seed). A sliding gate between the hopper and the screw allows operators to control seed flow at the throat of the press. Operators John Hutton and Meghan Boucher at Coppal House Farm in Lee, NH heat the collar with removable band heaters and then add seed. For them, 2-3 rows of holes in the crush barrel full of dripping oil indicates effective operation.

When the press slows down, Boucher adjusts the sliding gate to minimize seed flow until the machine works well again. Operators find that the press clogs less frequently when run at a lower speed. Clean seed going into the hopper makes for more trouble-free pressing, and the built-in magnet on the seed hopper prevents metal from entering the mill.

Average capacity of the press was calculated at 928 lbs per 24 hours. Sunflower averaged 38.3% oil mass fraction during the trial, and canola averaged 26.6% across speed settings. On the day of the press trial, operators could not press soybeans effectively, despite an all-day attempt at data collection. The problem could have been in the moisture level of the soybeans; the Oil Prince at Coppal House Farm has not yet been used to successfully press soy (Figure 12).

Eric Hamilton at Circle Energy in WI, when called to troubleshoot this soybean problem, suggested adjustments and modifications, but said that press operation can sometimes be a moving target.

This press, relatively new to its operators, has a learning curve. During the process of troubleshooting, the team also discovered a fracture in the collar which may have been linked to a prior issue with a ball bearing being passed through the machine; this damage may have been preventing effective pressing of soybeans. While it runs extremely well and is reliable with canola and sunflower, other crops may take some adjustment.

Figure 11. Oil Prince at Coppal House Farm in Lee, NH.

DISTRIBUTOR CONTACT INFORMATION

[made in Germany]

Distributor in the U.S.:

Circle Energy

Dodgeville, Wisconsin

Eric Hamilton, (608) 574-7449

info@circle-energy.com

Figure 12. Close-up of collar head and nozzle with too-hot soy meal.

Press 6. Täby 70

John Williamson runs State Line Biofuels in North Bennington, VT and relies mainly on a Täby model 70 oil press as the center of his operation (Figure 13). John has pressed numerous crops (including sunflower, soybeans, canola, camelina, flax, cranbe, safflower, mustard, and pennycress) with the Täby, which requires minimal adjustments and has proven reliable over the last eight years.

The Täby 70 was designed specifically for small-scale use, and to extract oil from a wide range of crops. A 2.2 kW motor drives the press, forcing seed through the crush barrel (or "press tube") and nozzle. The press has a thermostat and speed control built into it (Figure 14), so that the drive shaft rotates at variable speeds (maximum speed is 80 Hz or 149 RPM). Operating instructions stress the importance of tightening the press collar all the way against the plate, then backing off to leave a gap of approximately 2 mm between the head and the screw.

In 2013 trials, the average mass oil fraction was 25.3% (25.8% for canola, 7.5% for soy, and 38.3% for sunflower). The average capacity was 934 lbs per 24 hours.

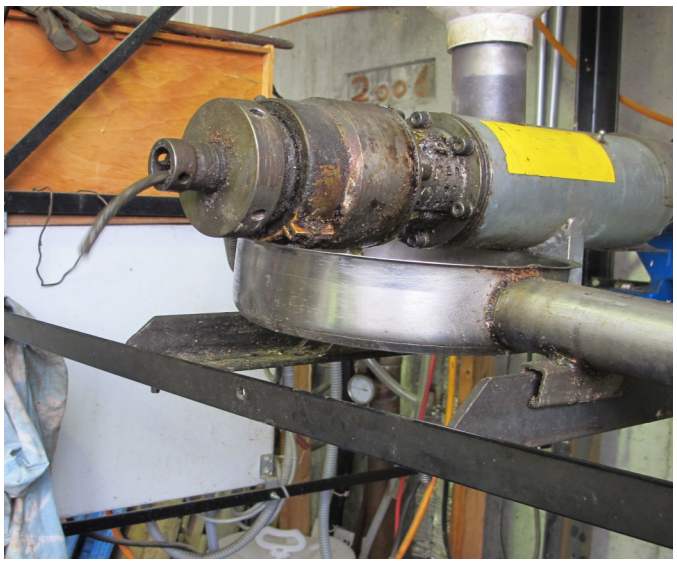

Figure 13. Täby 70 oil press with custom-made oil pan.

As with other presses, only clean seed at the proper moisture should be pressed, in order to extrude the maximum amount of oil possible. The Täby's seed hopper has a built-in magnet to prevent any metal from flowing into the press. A heater control on the gear housing stops the press from running if the collar temperatures exceed 302°F.

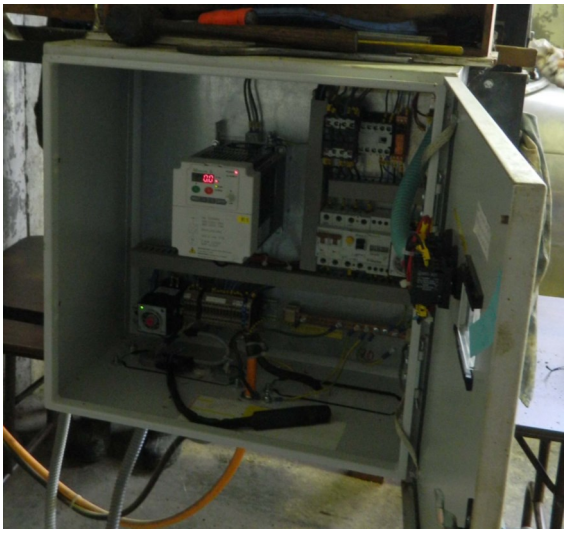

Figure 14. Side-mounted control panel.

Maintenance requirements are minimal with this machine. Approximately every 10,000 operating hours, the gear oil should be changed. The spiral seed screw can become worn over time, and Täby suggests shipping the screw in for repair (re-hardening), rather than purchasing a new one. Using only clean seed reduces and slows the wearing-out of multiple parts.

One stumbling block with the Täby 70 is the language barrier. Manufactured in Sweden, Täby presses come with an instruction manual (installation instructions, safety warnings, and technical advice on troubleshooting and maintenance) in broken English and customer service can be delayed with minimal domestic support.

DISTRIBUTOR CONTACT INFORMATION

[made in Sweden]

www.oilpress.com

Distributor in the U.S.:

Magic Mill
Upper Saddle River, NJ

(201) 785-8840

contact@magicmillusa.com

General Findings

During the course of these evaluations we assessed individual presses and observed general trends in regards to pressing capacity and net oil yield relative to speed, as well as quality characteristics of oil.

Press Setup

It should be noted that these results represent data from a single nozzle and screw setup of each press for each specific crop (Table 2).

Table 2. Nozzle and screw type setup by press, 2013 evaluations.

PRESS	CROP		
	Canola	Soy	Sunflower
AgOil M70	7	7	7
Keller KEK P0020	N/A	N/A	N/A
KernKraft 40	6.5 Shallow, soft shell screw	9 Deep, hard shell screw	8 Deep, hard shell screw
Komet CA59G3	5	*Failed test*	5
Oil Prince / KernKraft 20	10	*Failed test*	10
Täby 70	5	5	8

N/A – The Keller press has only one option for press nozzle setup.
Failed test – The evaluation team was unable to successfully press soybeans on these presses during this evaluation.

Press Capacity

A common consideration among oilseed press purchasers is the capacity of the press, or how many tons it can press in a day. In our evaluations we explored operation of the presses at different speeds (measured as actual screw RPM) and measured the amount of seed pressed in a given amount of time. These data are summarized with capacity listed as pounds of seed in a 24-hour period (Table 3). Not all crops were run at all screw speeds. Those selected were based on operator insight and whether or not seed could actually be pressed at the given speed.

As expected, the faster the press is run, the more seed that is run through it. The press is, after all, a pump with the movement of material through it dictated by the speed of the screw that pushes the material through. However, the measured capacities vary notably by oilseed crop.

Oil Mass Fraction or Yield

A less intuitive finding of these evaluations was the relationship between oil mass fraction and press speed. Oil mass fraction is the measured proportion of oil in the test sample compared to the meal once the seed is pressed. It is often simplified or used as an indicator of oil yield.

Table 3. Capacity (lbs per 24 hr) based on press and crop, 2013 study data.

Press and Screw Speed (RPM)	Crop		
	Canola	Soy	Sunflower
AgOil M70			
18.75			184
25.00	335		
31.25	427		311
37.50	533		
50.00	716	609	545
62.50		932	
75.00	568	1245	773
100.00	1284	1520	1018
Keller			
16.00			35
32.00			86
46.00			270
KernKraft 40			
18.00			382
25.00	967	665	527
40.00	1041	1081	835
60.00	2365	1588	1201
Komet			
30.00			86
37.50	118		
67.50			161
72.50	348		
76.25	217		
95.00			228
Oil Prince			
31.25			899
37.50			891
56.25	718		500
112.50	997		1140
125.00	1136		1166
Täby			
40.00			565
50.00	636	482	717
80.00	920	817	1103
120.00	1513	1361	1415

Table 4. Oil mass fraction (%) based on press and crop, 2013 study data.

Press and 24-hr Capacity	Crop		
	Canola	Soy	Sunflower
AgOil M70			
184			**40.7**
193	22.5		
311			40.4
335	**28.6**		
427	27.3		
533	25.3		
545			39.0
609		2.5	
716	24.9		
773			37.1
932		**7.9**	
943	22.4		
1018			35.6
1245		6.7	
1284	21.3		
1520		5.6	
Keller			
35			**47.7**
86			43.9
270			30.4
KernKraft 40			
382			41.1
527			**44.3**
665		**10.1**	
835			36.5
967	**27.1**		
1041	25.1		
1081		8.0	
1201			30.0
1588		6.3	
2365	19.2		
Komet			
86			**46.9**
118	**37.2**		
161			45.5
217	34.9		
228			42.8
348	30.9		
Oil Prince			
500			41.0
718	**30.9**		
891			**42.4**
899			42.0
985	25.3		
997	26.3		
1140			33.1
1166			32.9
1287	23.9		
Täby			
482		**8.7**	
565			38.0
636	26.0		
717			**39.0**
817		7.5	
920	**27.1**		
1103			38.7
1361		6.3	
1415			37.4
1513	24.3		

Press evaluations revealed a maximum of oil mass fraction in most cases when the press was run more slowly than the default speed (Table 4; see boldface figures). The conclusion is that if an operator is interested in extracting as much oil as possible from a given seed, a slower press speed may be preferable. This is especially true if the press is underutilized on an annual basis (i.e. oversized for the current operation.)

Phosphorus Levels in Oil

Phosphorus is used as an indicator of gum content in oils. Gums accelerate oxidation and therefore reduce shelf life due to rancidity. Gums can also impede effective production of biodiesel by disrupting the transesterification process most often used to make fuel from oil. In our press evaluations we subsampled oil and tested for equivalent phosphorus level using AOCS Official Method 12-55 (Figure 15).

Interestingly, phosphorus in oil is minimized at lower speeds (Figure 16). In some cases, it can be reduced by a factor of 3.7 by simply adjusting press speed.

Figure 15. Oil samples shipped to Penn State University for quality testing.

Fine-Tuning and Troubleshooting

A learning curve is to be expected, especially when working with different crops and conditions. With all presses, there is a certain amount of troubleshooting and fine-tuning that each operator will undoubtedly go through.

For example, when seed flow slows down, as it will invariably do at times, identifying and resolving the blockage is crucial to prevent caking and overheating. Each operator involved in this project seemed to have strategies for overcoming routine problems like this. One press manu-

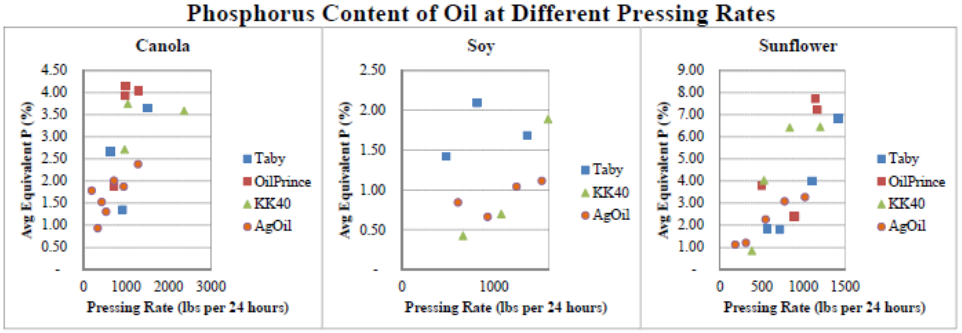

Figure 16. Effect of pressing rate on phosphorus levels in oil by crop, 2013 data.

facturer suggests mounting a thermostat and/or flow capacity controller to detect problems and automatically shut down the machine. Most agreed that the press should be stopped, cleaned out, and started again in order to identify, and hopefully fix, the problem. Occasionally, turning up the speed of the motor can help clear a blockage.

All operators mentioned the importance of taking time to learn the quirks (and strengths) of a particular press. Keeping detailed notes about the temperature, moisture, and cleanliness of seed going into the press, as well as press settings and calculated throughput, will help growers establish local operating procedures. It is our hope that this report gives prospective oilseed processors an advantage in getting started. A YouTube video complements this report and provides more information (see additional resources at right).

Table 5. General moisture recommendations and extraction rates by crop.

	Ideal Pressing Moisture (%)	Average Extraction Rate (%)
Canola	**6-9**	**25-30**
Soybeans	**8-12**	**8-12**
Sunflower	**8-12**	**35-40**

Additional resources:

Schaufler, D. 2013. Oilseed Fact Sheet: Oilseed Presses. Penn State Univ., State College, PA. Available at http://www.uvm.edu/extension/cropsoil/wp-content/uploads/Oilseed-Presses.pdf

Callahan, C., H. Harwood, L. Madden. 2014. Small-Scale Oilseed Presses. University of Vermont Extension, Pennsylvania State Extension. YouTube. http://youtu.be/4bfkb_FOn3w (accessed 27 Feb. 2014).

For more information on oilseed production and processing, please visit **http://www.uvm.edu/extension/cropsoil/oilseeds**

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