

**The Andersons Research Grant Program**

**Project Title:** On-farm Storage of Winter Canola – Study of Lined and Unlined Steel Bins

**Principal Investigator(s)**

Name	Institution/Agency/Other
Carol Jones, Ph.D.	Oklahoma State University
Kevin Moore	Oklahoma State University

**Project Contact (list one person to act as the primary contact):**

Name:	Carol Jones
Address:	216 Agricultural Hall
	Biosystems and Agricultural Engineering
	Oklahoma State University
	Stillwater, OK 74078
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**Period of Proposed Project Dates:**

Beginning: April 1, 2014    Ending: March 31, 2016

**Amount Requested (maximum \$25,000 per year for two years):**

Year 1: \$25,000

Year 2: \$25,000

## **Problem Identification and Related Research**

Traditionally considered a northern crop, Canola production has grown rapidly in the Southern Great Plains since 2002, when Dr. Tom Peeper of Oklahoma State University began evaluating canola varieties that could be planted in the fall and tolerate winter in Oklahoma. (Boyles & Peeper, 2008) Working closely with researchers at Kansas State University, several winter canola varieties were developed which thrive in this region. While North Dakota dominates domestic production – with 83% of the US canola crop in 2012 – Oklahoma has grown to be the number two producer of canola in the US since 2009. (USDA) Canola has performed well in the Southern Great Plains and is proving to be an excellent alternative for wheat producers in this region.

However, there is limited information available concerning the long-term storage of winter canola. Most research concerning the storage of canola seed has been performed in cooler climates with spring varieties that are harvested in early fall. Storage guidelines from the Canola Council of Canada recommend the binning of canola at a maximum of 8% moisture with cooling to at least 15°C (59°F) if it is to be stored for 5 months or longer. (Mills, 1996) Cooling the canola seed suppresses the formation of free fatty acids, which must be removed during the refining process and decreases the value of the seed. Fact sheets concerning the storage of winter canola in Oklahoma call for aeration to reduce moisture and temperature to safe levels for long term storage, but these guidelines are based on data from northern varieties. (Jones)

As canola production increases in the Southern Great Plains, on-farm storage of canola is also likely to increase. Steel bin storage is common for non-commercial farms, but most of these bins lack aeration. Bin temperatures increase quickly during

the summer in this region, especially without aeration. Grain bags are a possible alternative, but the specialized loading and unloading equipment they require can be a deterrent. As farmers look to utilize the storage capacity that already exists at their farm, guidelines for on-farm storage of canola will be needed.

The goal of this research project is to monitor the quality of canola seed in unaerated steel bins with and without the use of a polyethylene liner. Guidelines will be developed on how long canola can be safely stored in steel bins without aeration. This will assist farmers in making economic decisions concerning storage of canola. If the formation of FFA can be suppressed by the installation of a polyethylene liner then storage times can be increased, providing more flexibility to farmers in marketing their product.

The PI's are currently investigating the commercial storage of canola in Oklahoma. A project partially funded by the Oklahoma Oilseed Commission and with the support of W. B. Johnston Grain and Northstar Agri Industries is exploring the storage of canola in commercial steel bins, concrete bins, flat storage, and grain bags. The goal of this project is to investigate the different storage techniques and develop guidelines for commercial storage of winter canola.

## **Objectives**

NC-213 objective #2 will be addressed in this project. *“To develop methods to maintain quality, capture value, and preserve food safety at keys points in the harvest to end product value chain.”* Specifically, maintaining the quality of canola seed during storage on the farm will be investigated. The project will monitor the formation of FFA in canola seed during storage as an indicator of canola quality. Guidelines will be

developed concerning the duration that canola seed can be stored without aeration in lined and unlined steel bins.

## Methods

This project will take place at OSU's Stored Product and Research Education Center (SPREC). The SPREC facility was designed to generate and disseminate information about protection, management, and marketing of agricultural stored products. This facility provides an ideal environment for the testing and provides the steel bins necessary for realistic testing of canola storage. There are twelve 170 bu steel bins at this facility. Six bins will be reserved for this project.



Stored Products Research and Education Center (SPREC) at Oklahoma State University

Canola seed will be obtained as soon as possible after harvest and will come from a single lot to limit variability of the seed. Moisture content will be 8% or less. The canola will be graded and tested for baseline free fatty acid (FFA) concentration. FFA production will be used as the main indicator of canola seed degradation during this study. Canola seeds contain approximately 40% fat, which is readily broken down into

free fatty acids and glycerol. The FFA content of grain is a sensitive indicator of in-storage deterioration. (Jayas, White, & Muir, 1995)



170 bu bin at SPREC

The canola will be loaded into one of six bins selected for the study. Three of these bins will be randomly selected to receive the treatment of the liner material. The liner will be made from polyethylene plastic (PE) grain bags. The grain bags will be modified to fit inside the grain bins and sealed at each end. A chute will be constructed into the liner to facilitate loading/unloading of the seed and periodic sampling. This chute will be accessed through

the manway opening at the top of the bin. Temperature cables will be installed in each bin and temperature data will be collected at regular intervals throughout the study.

Ambient temperature and relative humidity will be monitored as well. Canola has a high respiration rate for approximately six weeks after harvest and must be closely monitored for deterioration during this time. (Sathya, Jayas, & White, 2009) Samples will be obtained from each bin every two weeks during the first three months of storage and monthly for the following seven months. Canola samples will be tested for FFA content. Any signs of degradation during storage (off-odors, mold, etc.) will be noted as samples are obtained. The study will be replicated in year two.

### **Anticipated Results, Products, and Impacts**

This project will generate new information concerning the storage of winter canola in the elevated temperatures common in the Southern Great Plains. Specifically, data will be generated concerning on-farm storage of canola without aeration. This will

include storage in standard steel bins as well as those utilizing a novel method of sealing the grain in a lined steel bin. Knowledge gained during this study will be disseminated to farmers via fact sheets and extension presentations. Elevator operators will also be targeted as a means of distributing the results of this study to canola producers. This information will assist farmers in maintaining the quality of the crop during storage by providing guidelines on how long canola can be stored in steel bins without aeration. If the lined bins extend the safe storage time significantly then this will also assist farmers who wish to hold their crop for sale later in the year. This will also provide crushing facilities access to canola seed without additional on-site storage.

### **Leveraging Resources**

Positive results obtained during this study can be leveraged in several different ways. One would be the development of efficient and cost effective methods of manufacturing and installing liners in on-farm and commercial storage structures. Collaboration with grain bag manufacturers or other PE film manufacturers could lead to funding via the USDA SBIR program. Another possible avenue is to work with commodity groups and/or elevator operators to study the use of liners in older structures that are not weather tight and are therefore unsuitable for grain storage. The impact of lined bins on storage pests will also need to be explored. The Andersons Funds will provide the baseline data on the performance of lined grain bins necessary to attract additional research funding in these areas.

## **Timetable**

The following timetable is proposed for this project. This is based on typical harvest times for canola seed and may need to be adjusted slightly.

April – May 2014: Explore techniques for sealing and installing liner material in grain bins. Test loading and unloading procedures.

June 2014: Obtain canola seed for testing during harvest and load seed in lined and unlined bins. Collect baseline samples for grading and FFA analysis.

June – August 2014: Collect samples every two weeks and submit for FFA analysis.

September – March 2015: Collect samples once per month and submit for FFA analysis.

April 2015: Submit year 1 progress report.

May 2015: Prepare bins for year 2 of study.

June 2015: Obtain canola seed for testing during harvest and load seed in lined and unlined bins. Collect baseline samples for grading and FFA analysis.

June – August 2015: Collect samples every two weeks and submit for FFA analysis.

September – March 2016: Collect samples once per month and submit for FFA analysis.

April 2016: Submit final report.

## Literature Cited

- Boyles, Mark, & Peeper, Thomas. (2008). OKANOLA - Bringing Crop Rotation to Winter Wheat Producers. 3. <http://canola.okstate.edu/canolaprogram/overview08/overview08.pdf>
- Jayas, Digvir S., White, Noel D. G., & Muir, William E. (1995). *Stored-grain ecosystems*. New York: M. Dekker.
- Jones, Carol. Storing Oklahoma Winter Canola. 4. <http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-3643/BAE-1110web13.pdf>
- Mills, J. T. (1996, 2011). Canola Encyclopedia - Storage Management. Revised by M. Hartman in 2011. Retrieved 4/29/2013, from <http://www.canolacouncil.org/canola-encyclopedia/storage-management/storage-of-canola/#storage-of-canola>
- Sathya, G., Jayas, D. S., & White, N. D. G. (2009). Safe storage guidelines for canola as the seeds slowly dry. *Canadian Biosystems Engineering / Le Genie des biosystems au Canada*, 51, 3.29-23.38.
- USDA. National Agricultural Statistics Service. Retrieved 4/25/2013, from United States Department of Agriculture <http://www.nass.usda.gov/>

## Carol L. Jones

### Earned Degrees

Ph.D., Biosystems Engineering, Oklahoma State University, 2006.

B.S., Agricultural Engineering, Oklahoma State University, 1977.

### Employment History

Associate Professor and Extension Agricultural Engineer, Biosystems and Agricultural Engineering Dept., Oklahoma State University, Stillwater. July 2011 - Present.

Assistant Professor and Extension Agricultural Engineer, Biosystems and Agricultural Engineering Department, Oklahoma State University. August 2006 – July 2011.

Research Engineer, Biosystems and Agricultural Engineering Department, Oklahoma State University. August 2002 – August 2006.

Technology Coordinator, Network Administrator and Math Instructor, Dover Public Schools. August 1994 - April 1999 and August 2001 – August 2002.

Network Coordinator, Ok CareerTech, April 1999 – August 2001.

Manager, Boeckman Farms, October 1984 – April 1994.

Facility Manager and Design Engineer, W. L. Somner Co., April 1982 – October 1984

Manager of Marketing Applications Engineering, Worthington Pump Co., January 1978 – April 1982.

### Books

2006 (revised in 2007, 2008, 2012). "Storage" (Chapter 20). Great Plains Canola Production Handbook, MF-2734, Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Pages 14 - 16.

Jones, Carol, Mark Casada, and Otto Loewer. 2012. "Drying, Handling and Storage of Raw Commodities." Ch. 10 in "Stored Product Protection," a web publication scheduled for print publication in 2012, edited by David W. Hagstrum, Thomas W. Phillips and Gerrit Cuperus. Available at <http://www.entomology.ksu.edu/doc4909.ashx>.

### Refereed Journals

Hardin, J.A., P.R. Weckler, and C.L. Jones. 2013. Microwave backscatter response of pecan tree canopy samples for estimation of pecan yield in situ using terrestrial radar. *Computers and Electronics in Agriculture* 90: 54-62.

Pasangulapati, V, A. Kumar, C. Jones, and R. Huhnke. 2012. Characterization of switchgrass, cellulose, hemicellulose and lignin for thermochemical conversions. *Journal of Biobased Materials and Bioenergy*.

**Hardin, J. A.**, C. L. Jones, P. R. Weckler, N. O. Maness, J. W. Dillwith, and R. D. Madden. 2012. Rapid in situ Quantification of Leaf Cuticular Wax Using FTIR-ATR. *Transactions of the ASABE* In review.

**Hardin, J. A.**, M. W. Smith, P. R. Weckler, and B. S. Cheary. 2012. In situ measurement of pecan leaf nitrogen concentration using a chlorophyll meter and Vis-NIR multispectral camera. *HortScience* 47(7): 955–960.

**Jones, C.** and G. Dilawari. 2012. Quality estimation of canola using machine vision and VIS-NIR spectroscopy. *Proc. 9<sup>th</sup> International Conference on Controlled Atmosphere and Fumigation of Stored Products*. Antalya, Turkey, 15 – 19 October, 2012. CAF268.

- Okiror, G., and C. Jones. 2012. Effect of temperature on the dielectric properties of low acyl gellan gel. *Journal of Food Engineering*.
- Pasangulapati, V., K. D. Ramachandriya, A. Kumar, M. R. Wilkins, C. L. Jones, and R. L. Huhnke. 2012. Effects of cellulose, hemicellulose and lignin on thermochemical conversion characteristics of the selected biomass. *Bioresource Technology*. (Accepted, Mar 9, 2012).
- Lawrence, J., D. Maier, J. Hardin, and C. Jones. 2012. Development and validation of a headspace model for a stored grain silo filled to its eave. *Journal of Stored Product Research* 49: 176-183.
- Jones, C.** and G. Okiror. 2011. Improved models for predicting moisture content in dried pineapples using dielectric properties. *Proc. 9<sup>th</sup> International Conference on Electromagnetic Wave Interaction with Water and Moist Substances, ISEMA, Kansas City, MO, USA. 31May – 3June.: 272-278.*
- Okiror, G. and **C. Jones**. 2011. Effect of temperature on the dielectric properties of low acyl gellan gel. *Proc. 9<sup>th</sup> International Conference on Electromagnetic Wave Interaction with Water and Moist Substances, ISEMA, Kansas City, MO, USA. 31May – 3June: 92-99.*
- Opit, G., **C. Jones**, F. Arthur, T. Phillips, E. Bonjour, and R. Beeby. 2011. Efficacy of Heat Treatment for Disinfestation of Concrete Grain Silos. *Journal of Economic Entomology* 104(4): 1415-1422.
- Bonjour, E. G. Opit, J. Hardin, **C. Jones**, M. Payton, and R. Beeby. 2011. Efficacy of ozone fumigation against the major grain pests in stored wheat. *Journal of Economic Entomology* 104(10): 308-316
- Sharma, B., **C. Jones**, and A. Khanchi. 2011. Physical properties of switchgrass (variety: Kanlow) as related to before and after frost harvesting. *Biological Engineering Transactions* 4(1): 43-54.

### **Professional Activities**

#### ***National ASABE (past 4 years)***

- 2006-Present IET348 Electromagnetics and Hyperspectral Sensing Committee  
Secretary, 2006-08; Vice-Chair, 2008-2010; Chair, 2010-present;  
Transactions associate editor
- 2006-Present FPE702 Crop and Feed Processing and Storage Committee  
Secretary, 2007-2009; Vice-Chair, 2009-2011; Chair, 2011-present
- 2011-Present IET Standards Committee, Publications Committee, and Planning Committee
- 2006-Present GEAPS
- 2006-Present NC213 Executive Committee, Chair 2012-13
- 2010-Present Board of Directors InfraGard
- 2012-2014 OSU Faculty Council
- Professional Engineering, Oklahoma Registration

## **KEVIN G. MOORE**

### **EDUCATION**

Ph.D., Biosystems Engineering, Oklahoma State University, in progress - expected May 2017

M.B.A., Oklahoma State University, December 2001

B.S., Chemical Engineering, Oklahoma State University, December 1995

### **PROFESSIONAL EXPERIENCE**

#### **Oklahoma State University, Stillwater, OK**

#### **College of Engineering, Architecture, and Technology**

Research Engineer, Biosystems and Agricultural Engineering

December 2012 - Present

- Support two faculty members in the execution of their research objectives.
- Emphasis areas include stored products engineering and energy recovery.

Director, Student Academic Services

August 2006 – November 2012

- Directed programs focused on recruitment, retention, and career services for students in the college.
- Communicated effectively with students and families through one-on-one meetings and large group presentations.
- Advised over 400 freshmen, sophomores, and transfer students each semester from across the country and around the world.
- Led a team of nine full-time employees.
- Co-led student group traveling to Washington, DC seven times and Japan one time.

Adjunct Instructor, Engineering Design with CAD (ENGR 13x2)

Fall 2011 and Spring 2012

- Instructed over 200 students each semester.
- Introduced students to the design process, CAD tools, and engineering communication.
- Led students in completion of a design project and final technical report.
- Managed nine teaching assistants.
- Received Mortar Board Golden Torch Award in Spring 2012.

Adjunct Instructor, Introduction to Engineering (ENGR 1111)

Fall 2010

- Introduced students to the engineering profession, major selection, academic success strategies, and completion of a design project.

Manager, Proposal Services  
November 2003 – July 2006

- Coordinated annual submission of approximately 200 research proposals valued at \$60MM.
- Supported development of faculty research proposals and budgets.
- Provided guidance to faculty concerning university, sponsor, and federal regulations.

### **Sulzer Chemtech USA, Inc., Tulsa, OK**

Design and Sales Engineer  
July 1998 – November 2003

- Utilized proprietary software to design distillation column internals with trays, structured packing, and random packing. Included new applications, revamps, and troubleshooting of existing equipment.
- Prepared technical and cost proposals for clients.
- Directed activities of the Gas Applications group for the North and South American market in 2002 and 2003.
- Developed a business plan for random packing products as part of an international team.
- Completed numerous international trips for special projects and task forces.

Technical Marketing Analyst  
January 1996 – June 1998

- Developed corporate marketing plan.
- Coordinated development of advertisements, brochures, target marketing programs, and trade shows.

### **PROFESSIONAL AFFILIATIONS**

- American Institute of Chemical Engineers (AIChE)
  - Served as Chair, Treasurer and Program Chair for the Tulsa Section (1997 – 2001)
- National Academic Advising Association (NACADA)

### **TRAINING AND CERTIFICATIONS**

- Oklahoma Engineer Intern Number 10145
- Internal Auditor Transition Training, ISO 9001:2000 – Gilbreath's
- Planning and Implementing and Internal Audit System – Gilbreath's
- Practical Distillation Technology – Henry Z. Kister
- Project Management – The Center for Professional Advancement

## CURRENT & PENDING SUPPORT

**Name: Dr. Carol L. Jones**

**Instructions:**

**Who completes this template:** Each project director/principal investigator (PD/PI) and other senior personnel that the Request for Applications (RFA) specifies

**How this template is completed:**

- Record information for active and pending projects, including this proposal.
- All current efforts to which PD/PI(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
- Provide analogous information for all proposed work which is being considered by, or which will be submitted in the near future to, other possible sponsors, including other USDA programs.
- For concurrent projects, the percent of time committed must not exceed 100%..

NAME (List/PD #1 first)	SUPPORTING AGENCY AND AGENCY ACTIVE AWARD/PENDING PROPOSAL NUMBER	TOTAL \$ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
Sunkar, Mali, Kakani, Wu, Dunford, Bellmer, Babu; Kumar, Atiyeh, Frazier, Jones,	NSF	\$296,842	10/1/13 – 09/30/16	5	REU Site: Interdisciplinary Approach to Sustainable Biobased Products and Energy Development
Kumar, Patil, Jones, Bellmer, Tumuluru	SunGrant	\$160,000	1/12/12 – 1/12/14	5	Torrefaction and densification of switchgrass to improve syngas quality and transportation logistics
Jones, Moore	Northstar Agri Industries and WB Johnston	\$5,000	5/13 – 5/14	0	Canola Storage in Southern Climates
Jones, Moore, Kirtley	Oklahoma State University	\$46,877	7/1/13-6/30/14	0	Grain Handling and Storage Safety and Rescue Research and Education
Jones, Moore	Oklahoma Oilseed Commission	\$10,292	8/31/13-7/1/14	0	Storage of Winter Canola in Oklahoma
Karagozian, A. Et al	<b>Pending:</b> FAA-COE-AJFE	\$11,987,230	10/1/13-9/30/23	5	Center of Excellence for Alternative Jet Fuels and Environment
Jones, Moore	<b>Pending:</b> The Andersons, Inc.	\$50,000	4/1/14-3/31/16	0	On-farm Storage of Winter Canola – Study of Lined and Unlined Steel Bins

## CURRENT & PENDING SUPPORT

**Name: Kevin G. Moore**

**Instructions:**

**Who completes this template:** Each project director/principal investigator (PD/PI) and other senior personnel that the Request for Applications (RFA) specifies

**How this template is completed:**

- Record information for active and pending projects, including this proposal.
- All current efforts to which PD/PI(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
- Provide analogous information for all proposed work which is being considered by, or which will be submitted in the near future to, other possible sponsors, including other USDA programs.
- For concurrent projects, the percent of time committed must not exceed 100%..

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Jones, Moore	Northstar Agri Industries and WB Johnston	\$5,000	5/13 – 5/14	0	Canola Storage in Southern Climates
Jones, Moore, Kirtley	Oklahoma State University	\$46,877	7/1/13-6/30/14	10%	Grain Handling and Storage Safety and Rescue Research and Education
Jones, Moore	Oklahoma Oilseed Commission	\$10,292	8/31/13-7/1/14	10%	Storage of Winter Canola in Oklahoma
Moore	<b>Pending:</b> Southwest Center for Agricultural Health, Injury Prevention and Education	\$18,519	9/1/13-8/31/14	8.3%	Forces Experienced by the Human Body During Grain Entrapment and Rescue
Jones, Moore	<b>Pending:</b> The Andersons, Inc.	\$50,000	4/1/14-3/31/16	8.3%	On-farm Storage of Winter Canola – Study of Lined and Unlined Steel Bins

## Budget

Category	Year 1	Year 2	Total
	Amt. requested from Andersons	Amt. requested from Andersons	
<b>Salary and Wages*</b>			
Post-Ph.D. research associate(s)			
Graduate assistant			
Stipend			
Tuition and fees			
Hourly wage			
Research engineer	\$ 3,652	\$ 3,762	\$ 7,414
<b>Total</b>			<b>\$ 7,414</b>
<b>Fringe Benefits</b>			
Post-Ph.D. research associate(s)			
Graduate assistant			
Hourly wage			
Research engineer	\$ 1,612	\$ 1,660	\$ 3,272
<b>Total</b>			<b>\$ 3,272</b>
<b>Materials and Supplies</b>			
Testing supplies	\$ 336	\$ 178	\$ 514
1200 bushel canola seed	\$ 14,400	\$ 14,400	\$ 28,800
Sample analysis	\$ 5,000	\$ 5,000	\$ 10,000
<b>Total</b>			<b>\$ 39,314</b>
<b>Equipment</b> (List individual pieces of equipment that are essential to the project in the Budget Narrative.)			
<b>Travel</b>			
<b>Publication charges</b>			
<b>Indirect costs**</b>			
<b>Total (max. \$25,000/yr from Andersons Research Grant Program)</b>	<b>\$ 25,000</b>	<b>\$ 25,000</b>	<b>\$ 50,000</b>

\*Andersons funds cannot be used for faculty salaries, departmental space, or facilities.

\*\*The Andersons Research Grant Program policy specifies that no indirect costs can be charged to this project.

## Budget Narrative

Budget expenditures are summarized above. One calendar month of salary is allocated to Kevin Moore (research engineer) for year one and year two of the project.

Employee benefit rates are negotiated annually and will be adjusted accordingly. 1,200 bushels of canola seed will be purchased each year of the project. A price of \$12/bu is assumed for canola seed. \$5,000 is allocated to each year for independent analysis of the canola samples. A small amount of funding is requested each year for miscellaneous materials and supplies. Steel bins are available for use at the SPREC at no cost to the project. Grain bag material for lining the steel bins will be donated to the project by a supplier.