



# Engineering Success

A newsletter from Biosystems and Ag Engineering Extension



If the dishes are grimy and the pots don't shine, it's because I have better things to do with my time.

~Author Unknown

By: Tim Bowser, Food Process Engineer

Some may agree with the unknown author, but food processors know that shiny pots and pans make for better quality products and are a necessary

part of doing business.

How can food processors excel at the necessary job of cleaning dishes without spending too much time and resources? There are a host of commercial ware-washing machines, or dishwashers, available on the market that allow the user to open a door, insert dirty dishes, and after a period of time, remove clean dishes. Most American households have mechanical dishwashers that serve the same function. What happens though when the item that needs cleaning won't fit in the dishwasher? Food processors deal with this issue daily. Examples of items that don't fit into a dishwasher include tanks, mixing bowls, pumps, kettles, barrels and racks.

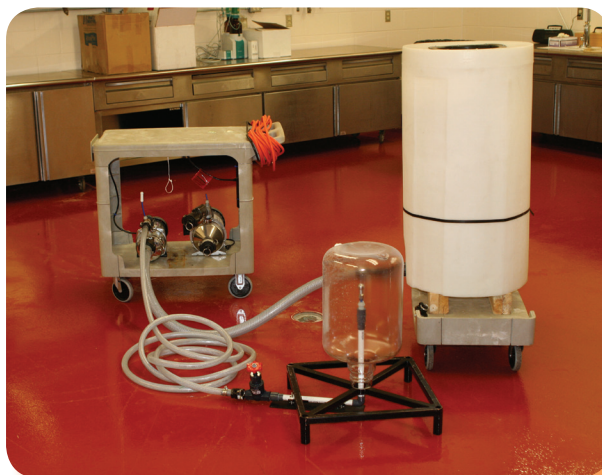
Manual cleaning methods are common for the large equipment mentioned, but manual techniques can be dangerous. Cleaning chemicals, which often contain strong acids or bases, may subject workers to handling, inhalation and splashing hazards. Entering large tanks for manual cleaning is dangerous and scrubbing procedures may require working in awkward positions. Finally, manual cleaning systems may be more expensive than mechanical due to an increased usage of chemicals, water, energy, labor, time and other resources.

Clean-In-Place (CIP) procedures are the state-of-the-art for cleaning large food processing equipment and systems. They are often highly automated, and are designed to completely clean a processing system without disassembly. CIP systems have the following advantages:

- Repeatable process that can be validated;
- Save energy and chemical costs;
- Reduce labor requirements;
- Reduce wear-and-tear on equipment; and
- Reduce operator hazards associated with handling equipment and chemicals

CIP systems are rarely installed in small and very small food processing operations for one or more of the following reasons: 1) they are expensive; 2) most facility managers do not have experience with CIP systems techniques; 3) operator training is required; or 4) selection of cleaning chemicals is not well understood.

Our research group received grant funding from the U.S. Department of Agriculture to design and build a low-cost, reliable CIP system that could be built and used by smaller-scale food processors. The system we developed uses off-the-shelf components that was built in the BAE shop and tested at the FAPC Food Engineering Lab. You can visit the FAPC website at <http://www.fapc.okstate.edu/services/engineering.html> to download a free copy of the construction and operation manual for the CIP system. Basic components for the CIP system can be purchased for about \$1,600 with additional costs for options, installation and startup.



Construction time to build the CIP system will vary from one to two days, depending on factors such as the installer's skill and options. We have received notes from around the world describing successful installations, especially from micro-breweries. *A note of caution:* performance of the CIP system isn't guaranteed. While it has been proven to work well, much of the success will be in the hands of the installer and operator.



# Understanding manure handling systems

By: Doug Hamilton, Extension Waste Management Specialist

Perhaps the most quoted, and misquoted, movie line of all time comes from the 1967 Paul Newman film, *Cool Hand Luke*. Luke (Newman) is put in chains for escaping from a prison farm. When he talks back to the Captain (Struther Martin), the captain knocks him down ... then most folks

remember the Captain saying with a halting, hick accent, “*What we got here is a failure to communicate!*”

But he doesn't say that. What the captain actually says is, “*What we got here is failure to communicate.*”

The point is the captain is not angry over a single, specific case of failing to communicate, but Luke's failure to do as he is told; generally and systematically. These lines of dialog can teach us something about systematic failures on the farm.

If you ask an angry farmer why he's frustrated with manure handling, he'll probably say something to the effect, “My storage pond fills up faster than it ought to,” or “I can't get the tractor on wet fields to spread.”

They see the situation as one isolated problem. But, once they fix that one thing, chances are something else will go wrong next month.

They are failing to see manure handling as a system.

The frustration of watching farmers repeatedly getting punished for systematic failures led to creation of OSU Fact sheet BAE 1734, *What is a Waste Handling System?*

The fact sheet was revised during the summer of 2011. The core idea remains: “A system, by definition, is a set of interdependent components working together to perform a task. The components are interdependent because you cannot change one part of the system without affecting the other parts.”

The task of manure handling is to please three clients: the farmer, his neighbors and the environment. The manure handling system accomplishes this task using four basic components linked by material transfer operations as shown in Figure 1.

If properly designed, these simple, linked components make the system extremely flexible.

**Production:** Animals convert feed to feces and urine, but other byproducts are produced. Other inputs include: bedding, flush water, spilled feed, and runoff.

**Storage:** Storage is the system's shock absorber. For example, storage allows the farm to temporarily hold material until the cropping cycle and field conditions are optimal for land application.

**Treatment:** Treatment components alter the volume or character of waste to improve handling, reuse, appearance or odor.

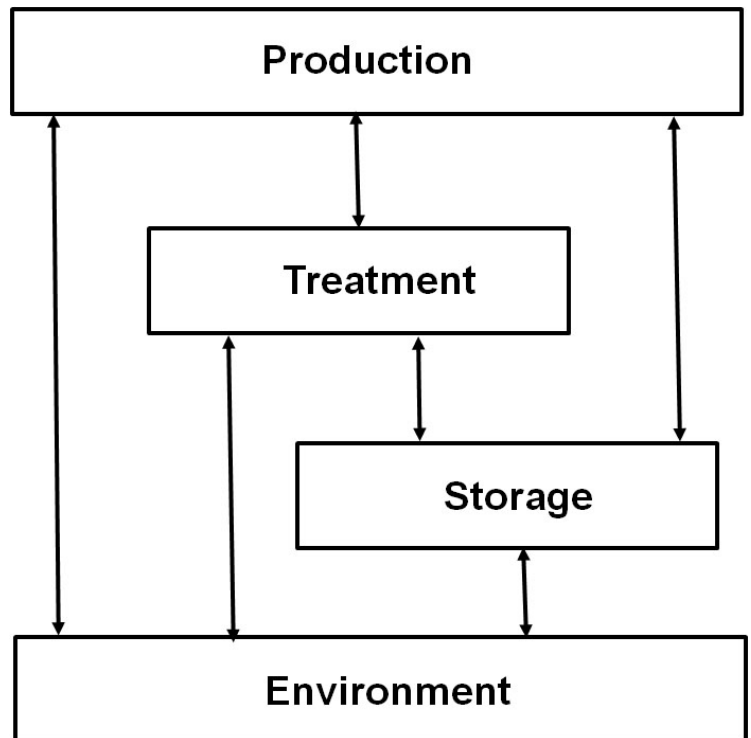
**The environment:** Manure is too valuable of a resource to throw away. Manure nutrients and organic matter are recycled to the environment. A properly designed system delivers these resources at rates which allow beneficial absorption into the environment.

**Material transport operations:** This transport, shown as arrows in Figure 1, is perhaps the most important part of the system. Material transport is a fancy way of saying moving stuff from one place to another. Transport operations serve as lines of communication tying the system together.

Notice that the arrows are double ended. This means material travels in both directions. For instance, manure moves from storage to the environment during spreading, but the environment can also send rain to fill the storage. Rainfall reduces storage, which increases the need for spreading ... this is an example of the environment providing feedback to the system.

Managing the system becomes a matter of paying attention to the various feedback functions constantly taking place within the system.

Let's use an example of a dairy farm with a storage pond that keeps filling up faster than it ought to.



**Figure 1.** Simplified schematic of a waste management system, from OSU Fact sheet BAE 1734, *What is a Waste Handling System?*

The farmer's first reaction is to dig a bigger pond. By stepping back, and looking at the thing systematically; however, a number of potential causes of the pond filling too quickly appear, such as:

- Storm water falling on the milk barn roof runs onto the holding area;
- The milking machine wash water was not accounted for when the pond was built; or
- The farmer may not be able to empty the pond fast enough to leave room for more storage.

Digging a bigger pond could solve these potential problems, but might create more trouble by increasing the area to collect rainwater. If roof runoff is the greatest source of volume, adding gutters would be an easier solution. Trading up for a larger honey wagon would also increase storage, if time of emptying is really the problem.

Once producers gain a better understanding of this approach and start seeing the components of a system as parts of whole, lots of little problems become solvable.



**Picture at left:** A well designed, constructed, and operated system accomplishes its task of pleasing the farmer, his neighbors, and the environment.

**Picture at right:** A poorly conceived and operated system leads to employee backaches.

## Alternative Manure Technology videos earn ASABE's Blue Ribbon



Doug Hamilton (left) and Craig Woods (below), OSU Agricultural Communication Services, were named recipients of a Blue Ribbon Award during the 2011 meeting of the American Society of Agricultural and Biological Engineers (ASABE) in Louisville, Ky.

The award was given in recognition of their efforts in producing outstanding quality educational materials. Typically only the best projects are nominated and about one nominee in five receive Blue Ribbon designation.

The video project title is "Alternative Manure Technology" Video Series in the Electronic Delivery category.

ASABE is an international scientific and educational organization dedicated to the advancement of engineering application to agricultural, food, and biological systems. Its 9,000 members, from more than 100 countries, are consultants, managers, researchers, and others who have the training and experience to understand the interrelationships between technology and living systems.



To view the blue ribbon winning videos go to: <http://www.youtube.com/user/OSUWasteManagement>  
More information about the program can be viewed at <http://osuwastemanage.bae.okstate.edu/>



# Natural stream restoration and enhancement demonstrations and workshops forthcoming

By: Jeri Fleming, Project Manager; and  
Jason Vogel, Assistant Professor and Stormwater Specialist

## **OSU's unique opportunity to improve Oklahoma's waterways**

Oklahoma State University has the unique opportunity to be involved in two exciting projects that will enhance and protect one of Oklahoma's scenic rivers and improve one of OSU's public areas while providing education to teach Oklahomans natural stream restoration techniques. The projects involve restoring over 6,000 linear feet of stream banks using natural techniques.

Funding for these projects comes from two contracts with the Oklahoma Conservation Commission (OCC). The OCC received the funds through the Oklahoma Water Resources Board as a result of the American Recovery and Reinvestment Act.

## **Need for the projects**

The first project OSU was involved in is at Cow Creek, which runs through the Botanic Gardens at OSU in Stillwater. Cow Creek (image of restoration shown on the next page) is similar to other Oklahoma streams in that the stream was widening and deepening as the banks were becoming vertical and eroding. The bank erosion was threatening buildings, service roads, and overhead and underground utility lines.

The second project is located in and around Tahlequah in the Illinois River watershed. Twelve sites have been identified for restoration; they are located on the Illinois River, Tyner Creek, Barron Fork Creek and Town Branch Creek. These sites also have highly eroding stream banks and are threatening buildings, service roads, underground utility lines, and other infrastructure (example shown below). Increased streambank erosion at the Cow Creek and Illinois River sites are having a negative impact on water quality with increased sedimentation, a primary cause of water-quality degradation.

Because of changes to Cow Creek and the streams in the Illinois River watershed, both from natural occurrence and human interference, the streams are experiencing increased erosion resulting in reduced water quality and wildlife habitat. In some instances, landowners are seeing a significant loss of their land to the streams. To help restore these streams to a more natural state, thereby reducing these detrimental effects, natural stream restoration techniques are being used.

## **Methods and processes of natural stream restoration**

Natural stream restoration uses bioengineering methods such as re-sloping of vertical banks, planting of native vegetation and trees, and installation of in-stream structures. Using these techniques helps bring the essential services of the stream back into balance.

Bank sloping and re-vegetation are used to stabilize the bank which reduces erosion and sediment loads. Re-sloping the bank helps the water spread into the natural floodplain and flow over the bank with less velocity. Planting native vegetation and trees helps further stabilize the bank through their root structures and also reduces the velocity of the stream flow at the soil-water interface. It provides other benefits such as re-establishing the riparian area, which in turn increases shade resulting in decreased water temperatures and providing essential habitat.

Installation of various types of rock vanes and rootwads within the stream channel is another way to help reduce erosion and improve water quality. These techniques not only relieve pressure on the bank, but create small scour pools for habitat enhancement.

Rock vanes decrease the gradient of the stream bed, thus decreasing the velocity of the water and reducing erosion. They also shift the flow of water away from the bank to the center of the stream, where a scour pool is developed which will dissipate energy and provide fish habitats. Rock vanes can be designed in several different ways. They can be a diagonal placing of rocks that go less than halfway into the stream, or as a Cross-Vane, which is the shape of an A and goes from bank to bank. Rock Vanes can also be designed as a J-Hook



*Picture above:* Example of extreme bank erosion at the Illinois River

which is a rock structure built in the shape of a J (Figure 1). The material used in the hook portion is spaced apart to allow sediment to flow through and can increase the enjoyment of recreational boaters in larger streams by creating or enhancing riffles (Figure 2). Each technique provides a slightly different benefit and can work together down the stream channel to repair the corridor to its natural state.

Using a rootwad placed at the base of a bank is another way natural materials are used to enhance aquatic habitat and reduce stream bank erosion. A rootwad consists of a tree's root mass and 10 – 15 feet of trunk. Its purpose is to capture sediment and serve as a barrier between the stream bank and the stream flow. Several rootwads can be used together and are often placed on the outside of a meander bend. Rootwads are installed with the trunk portion entrenched in the stream bank with the ball exposed to the stream. The trunk is anchored in place using large boulders with soil and vegetation added for protection. The root ball serves as fish habitat and mimics the natural root scouring that occurs in a stream. They can be used when stream bank sloping is not an option, typically on vertical banks.

### **Environmental and economic impacts**

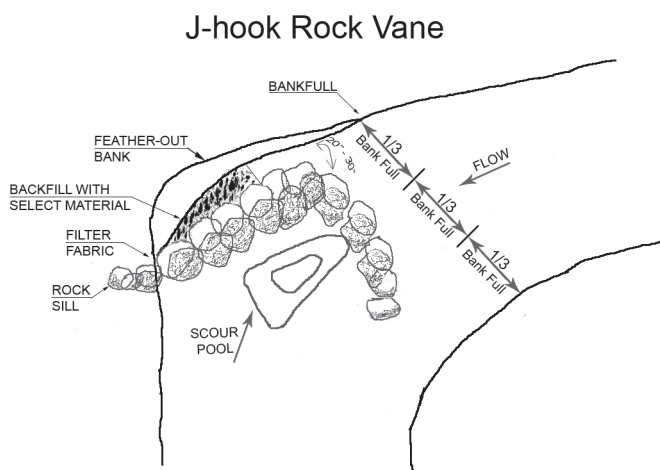
Each of these methods uses natural materials, some of which can be found in the stream corridor itself or nearby. The cost of doing natural stream restoration can be higher than more common methods, even though materials may be easily obtained. One of the issues with cost is that these techniques have only recently been used and there are a limited number of companies with the needed expertise to design and construct natural stream restoration projects. However, those increased costs should be balanced with the benefits to the natural and human communities within the corridor, and beyond. Decreased pollution and economic benefit can reach beyond the corridor and have a long-term impact that can outweigh the costs. The decrease in sedimentation and other pollutants in the stream will result in lower costs of drinking water treatment, and increased tourism can impact the economy of the entire region, creating jobs and bringing in tax dollars from out-of-state. The project investigators in BAE on the project are currently working with Dr. Tracy Boyer in the OSU Agricultural Economics department to better quantify these benefits in the Illinois River watershed. Drs. Garey Fox and Dan Storm in BAE are also currently working in the Illinois River watershed to development a prioritization scheme to help guide selection of future stream restoration projects in the basin.

### **How to learn more**

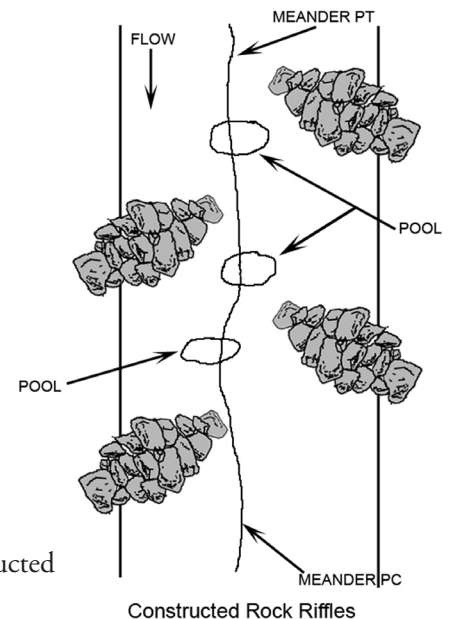
These techniques and their benefits will be further explained during a series of workshops being conducted in Tahlequah later this spring and summer. During the workshops participants will learn about stream morphology, the purpose for each of the types of techniques, and will go on site visits to see the techniques and how they are working.



*Picture above:* Progress shown at Cow Creek.



*Figure 1 (above):* Diagram of J-hook Rock Vane.



*Figure 2 (at right):* Diagram of constructed rock riffles.

For more information on natural stream restoration and for additional information on OSU's ongoing stream restoration projects visit <http://lid.okstate.edu/natural-stream-restoration>.



# What wood you do with it? Making use of Eastern red cedar

By: Elizabeth Miller, Research Engineer; Michael Buser, Bioenergy Machinery Engineer; and Ray Huhnke, Extension Agricultural Engineer

The prevalence and growth of Eastern red cedar (*Juniperus virginiana L.*) in Oklahoma is well documented. The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS)

estimates Eastern red cedars are increasing at a rate of 852 acres per day, or more than 300,000 acres a year; whereas the population is doubling every 18 years. The acreage of coverage increased to 8 million acres by 2004 and without control will reach 12.6 million acres by 2013 (28 percent of the Oklahoma landscape) (NRCS 2008).

The red cedar population poses safety risks from wildfires and there have been recent efforts to eradicate Eastern red cedar in Oklahoma. Uses of Eastern red cedar include paneling, furniture, animal bedding shavings, mulch and renewable fuel. As a fuel source, there are 18.9 million BTUs of potential available heat from each standard cord at 20 percent moisture (Slusher 1995).

Processing the wood for biofuel production starts with a mechanical size reduction; commonly used methods include milling, grinding and chipping, or a combination of these processes. An innovative process by Forest Concepts, LLC of Auburn, Wash. has the potential of increasing the net energy from woody biomass. To evaluate this method for red cedars, Elizabeth Miller took five trees for processing to the Forest Concepts lab in Auburn, Wash. this past fall. The five trees were of various heights and shapes. The trees were selected from the Stillwater area and harvested in mid-September. Each tree was measured and divided into bottom, middle and top sections. The section ends and limb scars were sealed with a heavy latex paint to seal in moisture and sap for transport.

At the Forest Concepts' lab, the trees were trimmed to fit

Material	% Based on weight
Roundup	27
Sapwood	33
Transition	6
Heartwood	27
Cores	4

**Table 1:** Eastern red cedar product classification distribution

into the veneer lathe (Figure 1). The veneer machine was set to 2 or 6 mm thickness (Figure 2). The veneer material was separated into heartwood, sapwood, transition and roundup/bark portions (Table 1 and Figure 3). Material classified as "Roundup" is bark and sapwood that does not provide a full width veneer. Transition wood is material that results from the irregular shape of the tree section. Heartwood is the inner most section of the tree, indicated by the purplish color. Sapwood is the younger wood on the outermost section of the tree's cross section. The product classification information was gathered to determine if differences exist in the processing energy required. The classification will also be used in future work on quantifying product energy contents and conversion efficiency differences.

Our material was processed into veneer, a thin sheet of wood that is peeled off one of the log sections. After veneering, the material was reduced in width to match the width of the prototype WoodMuncher™ machine (Figure 4), a rotary bypass shear. The WoodMuncher™ cuts the veneer sections parallel to the wood grain to minimize the energy needed to creating the smaller particles (Figure 5).

Energy usage for the process was determined by recording the power load on the motor through a torque arm method rather than by the gross electricity used by the process. The torque arm



Sample Material	Sample Size	Moisture Content % wwb	Specific Energy MJ/odMg
Douglas Fir	2 mm X 2.0 mm	44	44.50
	6 mm X 4.6 mm	27	40.35
Eastern red cedar sapwood	2 mm X 2.0 mm	38	46.04
	6 mm X 4.6 mm	57	38.34
Eastern red cedar heartwood	2 mm X 2.0 mm	21	42.98
	6 mm X 4.6 mm	22	35.66

**Table 2:** Processing Energy

method allowed us to determine the amount of energy (by the load on a load cell and time to process the sample) the shearing tool head needed to move through each portion of material, rather than the whole machine and motor efficiency effects. Torque information was then used to calculate a specific energy per oven dry mass. The results from our tests were compared to Douglas fir results that were provided by Forest Concepts (Table 2). Since the energy requirements for processing Eastern red cedar are close to that of other woods, special processing or sizing methods should not be required.

Advantages of a crumbling process (vener machine plus WoodMuncher™) versus other traditional size reduction processes include:

- Taking advantage of the natural modes of failure
- High density transport can be achieved through veneering
- Veneer can come from waste portion of graded engineered components
- A single pass shearing process minimizes energy
- Resulting particles have a high surface area and uniformity
- High yield Crumbles™ particles are flowable

### Future Work

In the coming months we will evaluate the moisture content and drying rate of each Eastern red cedar component. This information will provide researchers additional information for determining the feedstocks viability as an economical biofuel.

*Figure 1 (previous page, at left):* Pre-weighing of trimmed samples

*Figure 2 (previous page, at right):* Producing industrial Eastern red cedar veneer (Sapwood Section)

*Figure 3 (top, at right):* Veneer types: Heartwood (left), transition (middle), and sapwood (right)

*Figure 4 (middle, at right):* Producing Crumbles™ from the industrial veneer

*Figure 5 (bottom, at right):* Heartwood Crumbles™

### Resources

NRCS. (2008). "Fact Sheet About Eastern Red Cedar."

from <http://www.ok.nrcs.usda.gov/news/OKReleases/htmlReleases/08Releases/ercFactSheet.html>.

Slusher, J. P. (1995). "Wood Fuel for Heating." University of Missouri Extension Fact Sheet G 5450.



# Mesonet has an App for that!

## Go mobile.

The Mesonet app brings a host of Oklahoma weather information right to your phone, including forecasts, radar, and severe weather advisories. Get fast access to the same info that the experts use! Search "mesonet" in the Apple App Store.

Have an Android or BlackBerry? Try out our new mobile website at [m.mesonet.org](http://m.mesonet.org)



### Subscription request

To receive the Engineering Success: A newsletter from OSU Biosystems and Ag Engineering Extension, email Randy Taylor at [randy.taylor@okstate.edu](mailto:randy.taylor@okstate.edu) with **BAE Newsletter** in the subject line.

### Biosystems and Ag Engineering Extension

124 Agricultural Hall  
Stillwater, OK 74078  
Phone: 405-744-5277  
Email: [randy.taylor@okstate.edu](mailto:randy.taylor@okstate.edu)

### Extension faculty

### Subject areas

Tim Bowser, P.E.  
[bowser@okstate.edu](mailto:bowser@okstate.edu)

Food Processing

Mike Buser  
[buser@okstate.edu](mailto:buser@okstate.edu)

Agricultural Production and Processing Machinery, Agricultural Commodity Storage and Traceability, Air Quality

J.D. Carlson  
[jdc@okstate.edu](mailto:jdc@okstate.edu)

Boundary-Layer Meteorology, Fire Meteorology and Behavior, Atmospheric Dispersion, Agricultural Meteorology, Operational Models in Agriculture and Natural Resources

Nurhan Dunford, P.E.,  
[nurhan.dunford@okstate.edu](mailto:nurhan.dunford@okstate.edu)

Food Processing, Oil/oilseed Processing, Functional Foods and Nutraceuticals, Value-Added Product Development and Biofuels (Biodiesel)

Scott Frazier, P.E.  
[robert.frazier@okstate.edu](mailto:robert.frazier@okstate.edu)

Renewable Energy Applications, Energy Management

Douglas Hamilton, P.E.  
[dhamilt@okstate.edu](mailto:dhamilt@okstate.edu)

Managing Waste to Reduce Nonpoint Source Pollution, Designing Agricultural Waste Treatment Systems, Odor Control for Animal Agriculture

Ray Huhnke, P.E.  
[raymond.huhnke@okstate.edu](mailto:raymond.huhnke@okstate.edu)

Biomass Supply Logistics, Biomass Gasification, Bioenergy

Carol Jones, P.E.  
[jcarol@okstate.edu](mailto:jcarol@okstate.edu)

Stored Product Engineering, Electromagnetic and Spectroscopic Sensing, Cereal Grain and Oilseed Storage and Handling, Alternative Crop Post Harvest Technology

Al Sutherland  
[albert.sutherland@okstate.edu](mailto:albert.sutherland@okstate.edu)

Agriculture and Horticulture Weather Applications, Computer and Internet Utilization, Horticulture Crop Production

Randy Taylor, P.E.  
[randy.taylor@okstate.edu](mailto:randy.taylor@okstate.edu)

Agricultural Machinery, Precision Agriculture

Dan Thomas, P.E.  
[daniel.thomas@okstate.edu](mailto:daniel.thomas@okstate.edu)

Interim Extension Irrigation Specialist, Professor and Department Head

Jason Vogel  
[jason.vogel@okstate.edu](mailto:jason.vogel@okstate.edu)

Low Impact Development, Emerging Contaminants in the Environment, Environmental Pathogens

Oklahoma State University, in compliance with Title VI and VII of the Civil Rights Act of 1964, Executive Order 11246 as amended, Title IX of the Education Amendments of 1972, Americans with Disabilities Act of 1990, and other federal laws and regulations, does not discriminate on the basis of race, color, national origin, gender, age, religion, disability, or status as a veteran in any of its policies, practices or procedures. This includes but is not limited to admissions, employment, financial aid, and educational services. This publication is prepared, distributed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources at a cost of 000 cents per copy. 3/12 AE