



## Build your own low-cost dehydrator

By: Tim Bowser, Associate Professor

Did you know that beef jerky is so popular in Okla. that a petition was submitted to make it the official state snack? Dried products such as jerky, fruits, vegetables, and herbs, are a part of our every-day life.

Some Oklahoman's make a living producing dehydrated agricultural products; some derive a supplemental income from it; others just enjoy it as a hobby. From my first days as an extension food process engineer in Okla., I noticed that there were many homemade dehydrators around our state producing jerky at very small meat processing operations.

The U. S. Department of Agriculture (USDA), which serves to inspect and ensure safety in commercial meat processing operations, was naturally distrustful of such contraptions and frequently shut them down. Most small meat processors simply couldn't afford the price tag of the big commercial dehydrators and would quit operations or move "under the radar" as a result of USDA scrutiny. We listened to the problems of small meat processors and contacted the USDA about the possibility of designing and testing a low-cost, safe dehydrator that could be built using off-the shelf components and ordinary construction skills. The USDA agreed that this research would be very useful and funded our project.

We decided to build a walk-in style dehydrator (see below) based on the concept of using rolling bun pan racks (shown at right) to hold and transport products. The final design and construction was completed at the Department of Biosystems and Agricultural Engineering (BAE) laboratories by Wayne Kiner, shop manager, and his staff. After the prototype dryer was built it was disassembled and transferred to the Robert M. Kerr Food & Agricultural Products Center (FAPC) for testing.

The FAPC is a USDA approved and inspected meat processing



facility, and an ideal location to test the dehydrator. Food safety is one of the salient features of the dehydrator. The USDA requires a microbial kill step in jerky processing. The dehydrator has a built-in and tested procedure for achieving the required microbial kill.

The dehydrator is heated by a recirculating hot water system that includes a continuous hot-water heater powered by natural gas. Natural gas (or propane) was selected as the energy source because of its price advantage and abundance in Oklahoma. Electricity is used to drive the fans, water pump, controls and



accessories. Drying temperatures can be adjusted from 100 to 165 F. Capacity of the dehydrator is limited to six rolling bun pan racks or approximately 300 pounds of raw jerky, depending on how thick the slices are cut and how well they are arranged on trays. Drying times vary from eight to 12 hours for a full load.

We have also successfully dried snack foods, nuts, fruits, vegetables, herbs, and pet treats. The dehydrator has a very uniform temperature profile, insuring that all products receive an even treatment. A large fan is used to circulate and mix air inside the drying chamber. We have completed studies and published articles about optimizing and validating the dehydration of jerky (see references below).

Visit the FAPC website at [www.fapc.biz](http://www.fapc.biz) and download a free copy of the construction and operation manual for the dehydrator, found on the food engineering discipline page. Components for the dehydrator can be purchased for about \$9,000 with the additional cost of installation (plumbing, electrical and mechanical) and startup.

Construction time will vary from a week to months, depending on factors such as the installer's skill and available time. We have received notes from around the world describing successful installations. A note of caution is advised: performance of the dehydrator 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.

### References:

- Bowser, T.J., R.S. Frazier, P.R. Weckler, S.J. Kowalski. 2009. Optimizing jerky drying time with minimal product impact. The Open Food Science Journal. V3: 79-83.
- Bowser, T.J. and P.R. Weckler. 2008. Validation guidelines for a jerky pasteurization process in a low-cost dehydrator. The Open Food Science Journal. V2: 43-48.

# OK-FIRE: Oklahoma's operational system for wildland fire management

By: J.D. Carlson, Associate Researcher, Fire Meteorology



Wildland fire, as in many locations around the world, is an important issue in Oklahoma. Wildlands make up more than half of Oklahoma's acreage. It is estimated that about 2.5 million acres are burned annually across the state, about 10 percent by wildfire

and 90 percent by prescribed fire.

During certain fire seasons wildfire can become particularly problematic in Oklahoma. This was the case during the months of November 2005 through September 2006, when more than 16,000 wildfires burned almost 1.5 million acres. On the other hand, prescribed fire is becoming an increasing practice across the state with beneficial impacts for landscape and as a means of excess fuel reduction.

Weather, mainly via relative humidity and wind speed, plays an important role in fire behavior and the dispersal of smoke resulting from fires. It is critical to wildland fire managers to have operational fire and smoke management systems based on recent, current, and forecasted weather conditions.

The benefits of these resources to wildfires include better anticipation of severe wildfire conditions, the ability to determine optimal staffing levels, and better suppression strategies during the wildfire itself. With respect to prescribed fire, benefits include better pre-burn planning and management during the burn. With both types of fire, the potential to save lives and structures is an important benefit as well.

## Development of OK-FIRE

In response to the need for such an operational system in Oklahoma, the OK-FIRE program has been developed during the past six years. Starting off with federal funding of \$321 thousand from the Joint Fire Science Program in 2005,



OK-FIRE has a three-fold focus:

1. A comprehensive suite of real-time and forecast products for fire weather, fire danger, and smoke dispersion;
2. A dedicated website to act as the delivery mechanism, <http://okfire.mesonet.org>; and
3. Regional training and customer support for our user groups. Current user groups include a wide array of federal and state agencies, as well as fire departments, emergency managers, and private landowners.

OK-FIRE is now an official program of the Oklahoma Mesonet, which operates the state's automated weather station network and which provides programming, website, and operational support. J. D. Carlson, BAE fire meteorologist, serves as the OK-FIRE program manager.

## Models and Products

Fortunately, many of the building blocks for OK-FIRE were already in place. The Oklahoma Mesonet, established in 1994, provides weather data in high spatial and temporal resolution. The Oklahoma Fire Danger Model and Oklahoma Dispersion Model, which were developed by Carlson and his fellow researchers, are also important components of OK-FIRE.

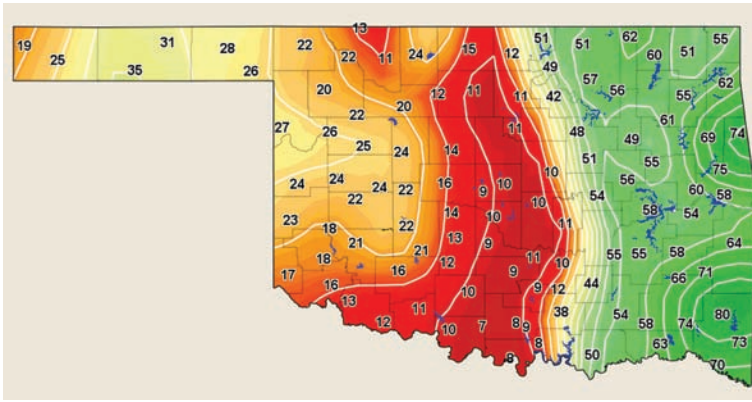
To provide forecasts of fire weather, fire danger, and smoke dispersion, OK-FIRE utilizes 84-hour weather forecast output from a numerical model, the North American Mesoscale (NAM) model. OK-FIRE products come in a variety of formats, including dynamic maps (capable of animation and zooming) and site-specific (Mesonet locations) charts and tables.

The following two figures are from OK-FIRE products during the mega-fire outbreak on April 9, 2009. The first shows a map of relative humidity at 4

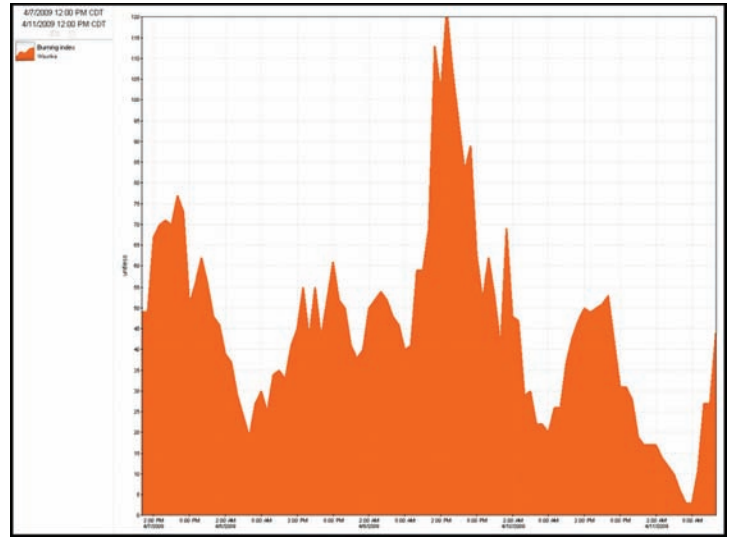
A screenshot of the OK-FIRE website interface. The top navigation bar includes links for WEATHER, FIRE, SMOKE, SATELLITE, RADAR, AIR QUALITY, BURN SITE, and LINKS. The main content area is divided into several sections: a weather forecast for Bessie, Oklahoma on Friday 9/10/10; a 'Weather-Based Decision Support Products for Wildland Fire Management in Oklahoma' section; a 'WeatherScope 1.8 required' section with a 'DOWNLOAD NOW' button; a 'Fire Danger' section showing a 'HIGH' current fire danger; a 'Fall 2010 Training Sessions Announced' section; and a 'Fire Prescription Planner' section. The footer contains the Mesonet logo and copyright information.

Home page of the OK-FIRE website, <http://okfire.mesonet.org>.





**Top left:** Dynamic map of relative humidity at 4 p.m. Central Daylight Time (CDT) on April 9, 2009, showing clearly the position of a strong dryline.



**Top right:** Chart of burning index at Waurika, Okla. from April 7 through 10, 2009; the fire danger rises dramatically on April 9.

p.m. CDT showing clearly the position of a strong “dryline”, behind which (to the west) the wildfires were raging. The second shows a chart of burning index (the most important fire danger index) at Waurika in south central Oklahoma.

### Training

Since the fall of 2006, when the prototype OK-FIRE website was launched, workshops have been offered around the state consisting of presentations and interspersed with computer lab exercises for the participants. About 800 fire professionals have been trained via these workshops. Last fall 28 workshops were given at 16 different locations; more than 300 people participated, most of them fire managers.

### Impact

Two of the indicators of success are website statistics and feedback from wildland fire managers who use the system. The OK-FIRE website has experienced explosive growth since its debut in the fall of 2006. The average number of monthly visitors was 2178 during 2010, compared with 110 monthly visitors in 2007. The total number of hits in 2010 was more than 19 million, compared with 843,762 during 2007.

Hundreds of testimonials regarding the importance of OK-FIRE to wildland fire managers also exist (gathered from written comments on the surveys given at the end of each OK-FIRE workshop). The major applications of OK-FIRE are wildfire management, prescribed burning, and smoke management. The selected comments below attest to the usefulness of OK-FIRE in these areas, especially the first two.

OK-FIRE constitutes a great example of how research has been transformed into a growing extension program of operational importance to fire managers throughout Oklahoma. The OK-FIRE team is looking forward to the continued development of this important program and its expansion into the future.

“I have a great deal of experience with prescribed fires, but even with all my experience I won’t consider burning before using the information that is now available to us. The OK-FIRE system is just as important as a drip torch and backpack fire pumps”

“OK-FIRE is the premiere web-based fire information system in the U.S.”

“We use this technology to help us determine appropriate staffing levels, response procedures, and pre-fire planning and community risk assessment.”

“I have no doubt that this web site has helped to save lives and prevent loss”

“I as fire chief use OK-FIRE regularly – to not be able to use this tool would be detrimental to all firefighters and emergency managers”

“OK-FIRE is the first tool I use to plan a prescribed burn”

“OK-FIRE is an excellent program we use daily to determine manning levels for our fire personnel and planning prescribed burns”

“This site and program are essential to the future of prescribed fire in Oklahoma.”

“We have used OK-FIRE for three years and have found it as useful as a fire truck. Thank you for helping to keep our communities better prepared.”

**Below:** OK-FIRE workshop at McAlester, Dec. 1, 2010



# Biosystems engineers amplify Oklahoma's bioenergy future

Written by: Amanda Erichsen, Extension Assistant

Contributions from: Cara Laverty, Anthony Megel, Drs. Hasan Atiyeh, Michael Buser, Ray Huhnke, and Ajay Kumar

The Department of Biosystems and Agricultural Engineering continues to expand research and extension efforts, addressing the critical issues in further establishing renewable energy industries. Our bioenergy experts are working on several projects with researchers across campus and the state to make sure Oklahomans have the best resources to become a leader in a viable biobased economy.

The following is a summary of projects our department is involved in.

## **OSU Biobased Products and Energy Center**

OSU researchers involved with the Biobased Products and Energy Center have been diligently discovering methods to efficiently enhance biological biofuels production from synthesis gas.

The researchers are investigating the potential of three strains of a new genus and species of microorganisms "Alkalibaculum bacchi" to produce ethanol and other products from syngas. This research is funded by the Oklahoma Bioenergy Center (<http://okbioenergycenter.org/>).

In phase one, syngas fermentations in bottle reactors were conducted to screen the strains with highest ethanol production capability. In the second phase, fermentations in 7.5 L fermenter are underway with the strain that showed the highest ethanol yield.

Researchers are also exploring the capability of several microorganisms for potential use in the production of butanol from biomass using gasification-fermentation technology. Unlike ethanol, the energy density of butanol is comparable to gasoline, butanol can be completely mixed with gasoline, and it can be transported via gasoline pipelines.

The preliminary results showed the capability of some of our microorganisms to produce butanol from syngas. The objective of the future work is to investigate factors that enhance butanol yield and activities of key enzymes in the butanol production pathway.

In the past year, the syngas fermentation group has completed the following projects:

- Feasibility of incorporating cotton seed extract in Clostridium strain P11 fermentation medium during synthesis gas fermentation.
- Enhancement of ethanol production using reducing agents during syngas fermentation by "Clostridium ragsdalei".
- Ethanol production from syngas by Clostridium strain p11 using corn steep liquor as a nutrient replacement to yeast extract.

Researchers from the department working on projects related



biobased products and energy production include Drs. Hasan Atiyeh, Danielle Bellmer, Michael Buser, Nurhan Dunford, Scott Frazier, Raymond Huhnke, Carol Jones, Ajay Kumar, Krushna Patil, and Mark Wilkins; as well as Randy Phillips, research engineer.

## **Sun Grant Initiative - South Central Regional Center**

Our department's bioenergy specialists are also a part of the South Central Sun Grant Center with the National Sun Grant Program. The South Central Region consists of Arkansas, Colorado, Kansas, Louisiana, Missouri, New Mexico, Oklahoma, and Texas.

The Center is administered by Dr. Clarence Watson, Center director, chair of the Sun Grant Association, and associate director of the Oklahoma Agricultural Experiment Station; Dr. Raymond Huhnke, Center associate director and BAE Professor; and Cara Laverty, Sun Grant program specialist.

"The regional concept allows each center to focus on the priority areas and feedstocks unique to their respective areas," Watson said. "The Center has awarded more than \$4.7 million in U.S. Department of Transportation funds to land-grant based university researchers in the South Central region since 2006."

BAE faculty that have active awards from the Center's competitive grants program include Drs. Hasan Atiyeh, Yu "Jessie" Mao, Krushna Patil and Mark Wilkins.

Dr. Atiyeh is studying fermentations under various conditions of pressure; cell concentration; agitation; gas composition and flow rate; and mass transfer techniques.

Dr. Mao is working with cellulase immobilization on nano-carriers for reuse in cellulose hydrolysis.

Dr. Patil is working with a downdraft gasification system for syngas production and testing it with low bulk density biomass





material unique to this region. Demonstrations have begun in the region as well.

Dr. Wilkins is studying the effects of syngas sources unique to the South Central region on ethanol production via fermentation. He is also developing a process for bioethanol production using Eastern Redcedar.

BAE also plays a key role in the USDA Sun Grant Industrial Ecology Project. Dr. Scott Frazier, BAE assistant professor, is organizing input components for the South Central region to develop a national database. The result will be an interactive input/output modeling method for structuring and analyzing agricultural-based biofuels and bioproducts systems.

### **EPSCoR Biofuels Research and Education**

The EPSCoR Bioenergy Research and Educational Outreach project is funded by the National Science Foundation and part of Oklahoma's Experimental Program to Stimulate Competitive Research.

OSU researchers collaborate with researchers from the University of Oklahoma and the Samuel Roberts Noble Foundation to make a dynamic team whose efforts are to develop enhanced methods to extract biofuels from switchgrass. BAE researchers involved in this project include Drs. Danielle Bellmer; Raymond Huhnke, co-principal investigator; Ajay Kumar; and Krushna Patil. Research engineers include Prakash Bhoi and Ashok Sharma.

The primary goals of the thermochemical conversion research are to understand gasification and gas upgrading processes. This will lead to development of robust and predictable systems for productions of energy, fuels and chemicals from a wide variety of biomass.

Removal of tars is a major problem in the use of producer gas from biomass gasification. This team has evaluated several commercial reforming catalysts to crack a model tar. Few of the selected catalysts have shown very promising results. In the next phase of this study, a newly designed reactor to up-scale and "field test" selected catalysts will be used. Effects of reaction conditions will be optimized to improve product composition and yield, and net energy efficiency.

Last year, a lab-scale fluidized-bed gasifier was successfully designed, developed and optimized for switchgrass gasification. Evaluations are being conducted of fluidization characteristics for several mineral-based catalysts that can be used in the gasifier-bed along with switchgrass and residues to increase the gasification efficiency and improve gas quality.

Another research goal is to predict gas compositions from a given composition of biomass or mixture of various biomass. This information could be very useful because it is very desirable that biofuel industry be feedstock flexible.

### **Biomass Research and Development Initiative**

The Bioenergy Research and Development Initiative project seeks to investigate the processes by which Oklahoma's cellulosic biomass materials can be produced

and supplied to a biorefinery.

Researchers in the power and machinery group are investigating harvesting and storage methods of forage sorghum, switchgrass, and mixed native grasses in the Panhandle and South Central Oklahoma. Each crop is harvested at maturity and at least twice after frost. The bales are then stacked according to three storage treatment conditions: uncovered on ground, tarped on gravel, and completely wrapped. Samples are pulled from the stacks at two-, four-, and six-month intervals.

Calculations to estimate dry-matter losses and tests to determine forage quality and energy content will be analyzed over three growing seasons to develop best management practices necessary to ensure efficient, sustainable and profitable production of cellulosic biomass.

OSU researchers include Drs. Raymond Huhnke, project leader; Mike Buser, harvest and machinery specialist; Carol Jones, stored product specialist; and research engineers Anthony Megel, Elizabeth Miller, and Vince Schielack. The work could not be conducted without the help of our partners, the Samuel Roberts Noble Foundation, Idaho National Labs, AGCO Corporation, and Stinger Ltd.

### **BioWinol**

OSU graduate students under the tutelage of Dr. Mark Wilkins are looking at the viability of using wind energy and carbon dioxide to produce ethanol.

"The BioWinol Technologies process uses sequestered carbon dioxide plus wind energy to generate hydrogen and then converts these gases into ethanol and other industrial products," said Raymond Huhnke.

Of course, any new biofuel production technology needs to be able to compete with the cost of gasoline and have a minimal impact on the environment. BioWinol 100-percent green technology can be cost competitive because of the abundance of carbon dioxide and largely positive environmental stewardship inherent with wind energy.

Videographer Craig Woods of OSU Agricultural Communications Services worked with the graduate students to create a video outlining the process, which was then placed on the Planet Forward website at <http://goo.gl/Ek1A0> as a way to garner input. The video is also on the OSU Bioenergy YouTube channel.



## Ethanol Gasoline Blends and Small Engines *Written by: R. Scott Frazier, 2008*

In many parts of the United States, the use of ethanol/gasoline fuel blends is very common. The state of Oklahoma only recently began using 10 percent blended fuels (E10) in many service stations. Along with this new fuel availability are customer concerns regarding compatibility with small engines such as lawn mowers and trimmers. The following presents information so consumers can decide if using ethanol blended fuels is appropriate for them. Also included are some basic suggestions to mitigate some possible problems that might exist.

To read the rest of this fact sheet, use the following link

<http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-6015/BAE-1746pod.pdf>

Other BAE fact sheets

<http://pods.dasnr.okstate.edu/docushare/dsweb/View/Collection-249>

Agricultural Machinery website

<http://www.agmachinery.okstate.edu/>

### Subscription request

To receive a copy of the Engineering Success: A newsletter from OSU Biosystems and Ag Engineering Extension, e-mail 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

E-mail: [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)

Farmstead Structures and Environment, Machinery Management, Forage Harvest Handling and Storage, Biomass Gasification

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

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

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

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