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Oklahoma State University

Engineering Success

A newsletter from Biosystems and Ag Engineering Extension

How much do turns affect field application inputs?

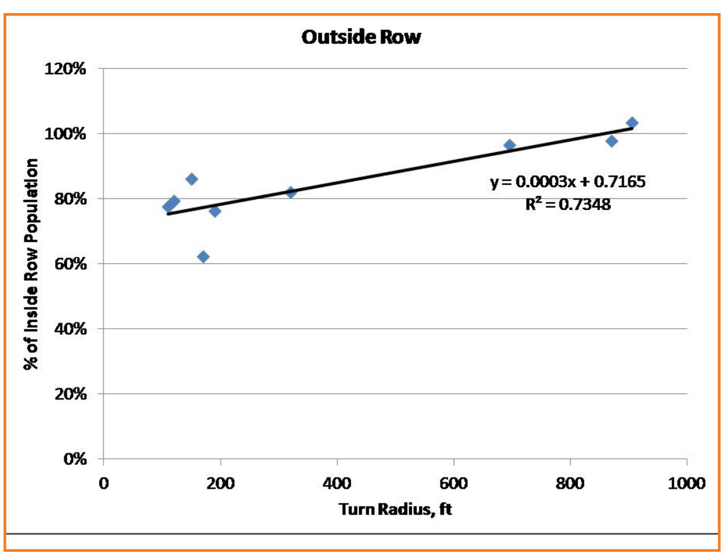
By: Randy Taylor, Extension Machinery Specialist
and Elizabeth Miller, Research Engineer

In most cases, turns are an unavoidable part of farming. Field shapes force at least some of our equipment passes to be conducted while turning. As we try to plant and apply other inputs as uniformly as possible, these turns can create some issues. The outer end of a planter or sprayer is moving faster than the inside end of the equipment. If the metering rate is uniform along the implement then the application rate will vary along the width when turning. Naturally, sharper turns will have larger variations than more gradual turns.

Several fields of corn were checked this spring to determine the impact that turning has on plant population. Locations within the field were identified where the planter was turning while planting. Spacings for 100 plants were measured in the inside and outside rows to determine population. A GPS unit was used to help determine the radius of the turn.

As shown in the graph below, the population in the outside row was nearly 80 percent of the population found in the inside row for turns with a radius less than 400 feet. For reference, the turn radius at the outside of a center pivot irrigation system on a quarter-section is approximately 1,200 feet. The three data points with a turn radius greater than 600 feet were taken from a center pivot irrigated field that was planted in a circular pattern.

In general, our results found that the outside row had a much lower plant population, but the inside row was only slightly higher than the intended population. These results would say that for every 24,000 plants per acre population, the outside row would be 19,200 plants per acre. Is this enough to affect yield in that row? That probably depends on the growing season. How much impact would this have on a field scale? That depends on the amount and degree of the turns within the field. It would have a greater impact on a field that has a lot of sharper turns.



Adding value to Oklahoma's wheat: A wheat biorefinery system

By: Nurhan Turgut Dunford, Professor and Oil/Oilseed Specialist

Wheat is the most important crop in Oklahoma. According to the U.S. Department of Agriculture statistics, nearly 3.9 million acres of wheat were harvested and 120.9 million bushels of winter wheat was produced in the state during 2010.

The flour milling industry is the major processor of wheat in Oklahoma. Currently most of the wheat produced in the state is shipped to domestic and international markets as a raw commodity but only a small portion of the ultimate value of consumer products to benefit Oklahomans.

My research group is committed to changing this trend. We have been working on an "Oklahoma Wheat Biorefinery" concept for the last ten years. The term "biorefinery" is defined as a factory which takes agricultural inputs and produces a wide range of products which are specifically targeted to different market uses and are refined to market specifications. Wheat is an excellent crop for application of the biorefinery concept.

Commonly, wheat is grown for its flour (protein and starch). Various forms of bran, wheat germ and the "clean-out" of the cleaning house or screen room are by-products of the wheat milling operations. As these products represent nearly 25 percent of the original grain, they are potentially of considerable economic significance to the miller. In Oklahoma, by-products of the wheat milling industry have not yet been exploited to their full capacity.

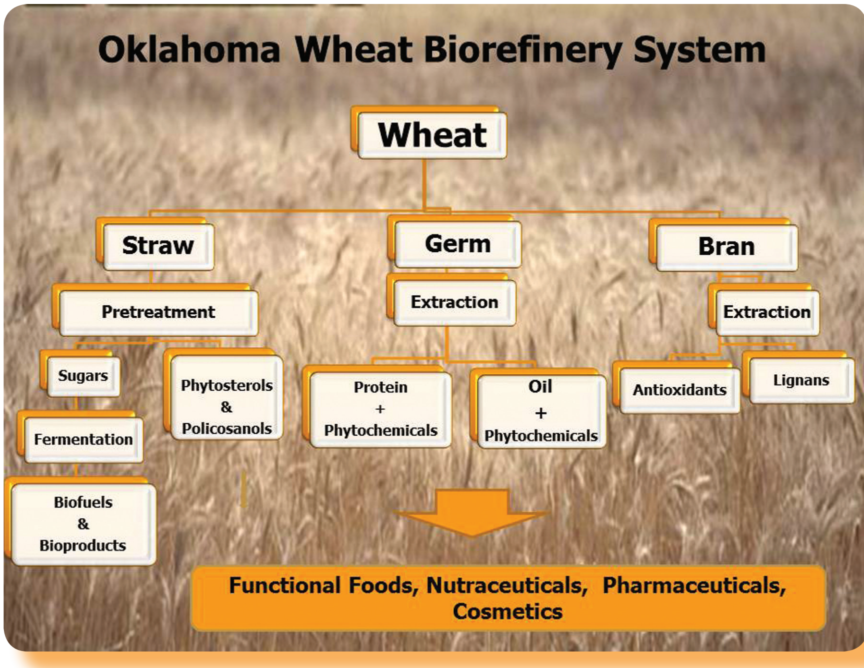
Wheat germ is a unique source of highly concentrated nutrients. It offers three times as much protein of high biological value, seven times as much oil, fifteen times as much sugar, and six times as much mineral content when compared with flour from the endosperm. Wheat germ contains approximately 8-14 percent oil. Wheat germ oil (WGO) has a number of nutritional and health benefits such as reducing plasma and liver cholesterol levels, improving physical endurance and fitness, and possibly helping to delay the effects of aging. Wheat germ is the richest known source of α-tocopherols (vitamin E) of plant origin and also a rich source of unsaturated fatty acids, phytosterols (PS), policosanols (PC), thiamine, riboflavin, and niacin which are compounds with diverse health benefits. Although WGO is used in foods, biological insect control agents, pharmaceuticals and cosmetic formulations today, to the best of our knowledge organic WGO and WGO enriched in PS and PC are not commercially available.

Bran is the outer layer of the kernel and a byproduct of grain milling. Its function is to protect the grain against mechanical and insect damage. Wheat bran comprises approximately 15 percent of the kernel weight. Carbohydrates are the primary components in bran, followed by protein, ash and lipids. Bran also contains vitamins and phytochemicals. Aleurone which is the outermost cell layer in the endosperm is rich in proteins and antioxidants. Aleurone normally remains attached to the bran and makes up to 45-50 percent of the bran fraction and is removed with bran during conventional milling. Hence, commercial bran is rich in antioxidants and biologically active health beneficial compounds.

Wheat grain comprises only 40 percent of the biomass produced by the crop. One hectare of wheat produces more than 4.8 tons of straw. It is estimated that more than 90 million metric tons of wheat straw is produced annually in the U.S. Currently, straw is baled for use as livestock bedding or low-grade animal feed providing minimal return. At present, only about 3 percent of the economic return on wheat is from straw. My research group has already demonstrated that wheat straw is a good source of the healthy and beneficial bioactive compounds PC and PS.

I strongly believe that a wheat biorefinery system designed for Oklahoma has a great potential for success. Based on more than a decade of research and development work carried out in my research group, we envision a biorefinery system that produces value-added health beneficial products including functional foods and nutraceuticals from wheat milling industry by-products and straw (Shown in the figure at the top left of page 3). A nutraceutical is a product that is isolated or purified, usually from plants, and has demonstrated health benefits including providing protection against chronic diseases. Nutraceuticals are generally sold in medicinal forms (i.e. tablets, capsules) not associated with foods.

Our goal is to commercialize wheat-based extracts enriched in health beneficial compounds. These products



can be formulated as certified organic dietary supplements (nutraceuticals) and functional foods (gourmet oils, salad dressings and beverages). We have already designed and optimized processes for extracting oil from wheat germ and antioxidants and other bioactive compounds from bran and straw.

We propose supercritical fluid technology which utilizes carbon dioxide over its critical temperature and pressure (31°C and 7.3 MPa, respectively) as solvent to obtain pharmaceutical grade extracts. This technology produces high purity products because when solvent pressure is reduced after the extraction of desirable compounds from the feed material carbon dioxide returns to gas phase leaving no solvent residue in the final product. Our patented process produces high purity WGO enriched in PS, PC and vitamin E.

Unfortunately, supercritical fluid technology might not be economically feasible for commodity products due to the high capital cost associated with high pressure processing. In an effort to improve the economic viability of the products we have also developed inexpensive processes to produce food-grade extracts and ingredients. Mechanical pressing, aqueous and enzymatic extraction processes have been optimized for maximum WGO and phytochemical-enriched extract yields.

Efficacy of these products for disease prevention will be tested by using model cell culture systems in collaboration with the Department of Nutrition at Oklahoma State University. We are also exploring the potential funding sources for animal testing of wheat extracts.

I envision that the products and processes described in this article will lead to establishment of a "Wheat Biorefinery" in Oklahoma. Some of the manufacturing techniques optimized in my group are inexpensive, easy to operate, environmentally benign, and free of hazardous chemicals. Hence, they can be adapted by small processors in the state. It might also be possible that these products are commercialized by farmers' cooperatives.

Initially, the products can be marketed through the Made in Oklahoma Coalition. Development of a new business sector which specializes in production and marketing of innovative and science-based, high value wheat-based products is important for the state. Such an initiative would support long-term sustainability of the wheat farming community and processing industry, stimulate the local economy, and advance human health in the state.

Pictured on previous page: Crude and refined wheat germ oil, wheat germ and grain.
Pictured above at left: The proposed biorefinery system for Oklahoma.
Pictured above at right: Supercritical fluid fractionation system designed by Dunford and custom built by a company in Tulsa, Okla.

Selected References - *Patent:* Nurhan Turgut Dunford and Jerry W. King. January 13, 2004. Supercritical Fluid Fractionation Process for Phytosterol Ester Enrichment in Vegetable Oils. U.S. 6,677,469 B1.

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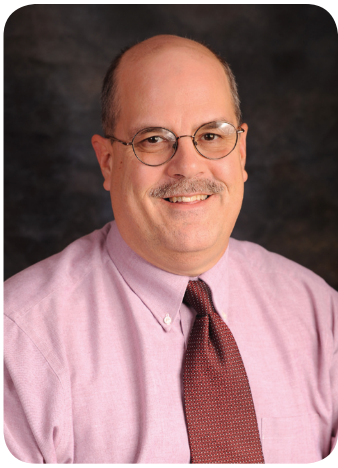

Evaluating the benefits and risks associated with renewable energy systems

By: Scott Frazier, Assistant Professor and Energy Management Specialist

As energy prices rise, many Oklahoman's, both rural and urban, are considering investing in alternative or renewable energy systems for their homes and businesses. OSU Biosystems and Agricultural Engineering extension specialists, Drs. Scott Frazier and Douglas Hamilton recently partnered with the National Sustainable Information Service on a grant to produce an education program discussing the benefits, drawbacks, savings and costs of installing some of the more common renewable energy systems available. The material was presented at an in-service in Oklahoma City and at an agricultural trade show in Le Flore County during the week of April 16.

While Frazier and Hamilton conduct applied research examining the possible benefits associated with various renewable energy systems, they also provide information regarding the possible costs and risks for Oklahoman's considering these technologies. For customers wishing to reduce the carbon footprint of some of their energy use, these systems are possibilities. For remote locations, these systems may be very viable (economically and operationally). However, the economics of such systems are often not competitive with current utility associated energy prices and costs. In other cases, the installation, operation and maintenance of the systems may be difficult enough that farmers or residents would not be interested. Regardless, as BAE extension engineers, Frazier and Hamilton have to present as many facts as possible so that the customer can make the final decision.

The systems discussed were: small wind electric generation, solar photovoltaic panels, solar thermal (water and air), anaerobic digesters with electrical and thermal output, and biomass heaters (wood, grasses and etc.). For all systems, a detailed economic breakdown of costs and savings were presented using typical small farm-sized examples. For example, a 5 kilowatt wind turbine might produce 14,000 kilowatt-hours worth of electricity in a year in the western part of the state. If the turbine costs $30,000 installed, with tax and other incentives, the payback could be 10-20 years depending on the utility cost of electricity and wind available at that location. The same wind turbine in the eastern part of the state might produce much less energy and have a correspondingly higher payback period. If the wind turbine is in a remote, windy area with no utility power available, the economics are much better as we are comparing costs to other renewable energy systems or gas generators. At the other end of the spectrum, solar water heating systems are simple and can have paybacks in the 4-year range.

On the fuels side, biomass heaters and anaerobic digesters for smaller operations were discussed. Complete economic analyses were presented so that farmers could decide if they were interested in such systems. In general, the economics will change in favor of the renewable energy systems as their initial prices drop and the utility cost of energy rises with time. All systems were discussed showing energy economics.

Maintenance and other costs were also included in the presentation. Energy storage and coincident power production versus need was discussed. Issues such as zoning and system location were also presented. Federal incentives, general economics and long term risks and benefits were presented by Dave Ryan, an engineer for the Appropriate Technology Transfer to Rural Areas (ATTRA)[1].

Pictured at right: Farmers listening to a Energy Risk Assessment Presentation.

The background of the psychology related to purchasing decisions for these energy systems was also presented. For example, why is the customer interested in investing in these technologies? Are they trying to save money on month bills? Do they want to become self-sufficient? Or, maybe the customer is concerned about environmental issues. Finally, perhaps the customers like to experiment and might consider this a hobby. The customer's answer to this question largely determines the success of some of these renewable energy systems for their use. If the customer has utility power available, it will probably be difficult for the renewable energy system to compete on economics alone.

Overall, participation was successful. Several Oklahomans asked questions and requested more information. A short survey regarding knowledge and views on renewable energy systems was collected and Kill-A-Watt® energy meters were given away as participation gifts.

The Kill-A-Watt meter allows a person to monitor the electrical usage of a small electrical appliance in their home. The meter plugs into the wall and the appliance plugs into the meter. After some time one can read the meter to see the kilowatt-hours used. This number, times the customers average cost per kilowatt-hour, is the approximate cost to run the appliance over the time period[2]. The meter also shows the current, voltage and instantaneous power draw of the appliance. The meter is mainly used to heighten awareness of electrical energy and cost issues in the home.

1. Part of the National Center for Appropriate Technology (NCAT), Nonprofit previously funded under USDA.
2. This information is available from the local electric utility and averages about 9 cents per kWh.

For more information, please visit **https://attra.ncat.org**.

New video series available on drought and its effects within agriculture and natural resources

By: J. D. Carlson, Fire Meteorologist

Partially motivated by the extreme drought of last year, the Oklahoma Water Research and Extension Center has released a series of videos on drought and its effects within agriculture and natural resources. The videos were filmed by Agricultural Communication Services during a period from last fall through spring.

As part of that series, J. D. Carlson a BAE fire meteorologist, discusses the effect of drought on wildland fires. He first begins by discussing the main categories of wildland fuels, live fuels and dead fuels, showing examples of each. Then Carlson talks about the effect of drought on these fuels and how this relates to wildland fire as a function of time of year and fuel complex, rangeland versus shrubby/forested landscapes. To conclude, he provides a brief introduction to the OK-FIRE website at **http://okfire.mesonet.org**, the online weather-based system for wildland fire management which he developed with the help of Oklahoma Mesonet.

The video series can be found on the Center's YouTube channel at **http://www.youtube.com/user/OkstateWaterCenter?feature=mhee**.

Biosystems & Agricultural Engineering
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Learn more about BAE Extension programs at **http://biosystems.okstate.edu/Extension.html**.

BAE Extension Website *Spotlight:* OK-FIRE

OK-FIRE is a weather-based system for wildland fire management featuring products for fire weather, fire danger and smoke dispersion. Utilizing the Oklahoma Mesonet for recent/current weather conditions and an 84-hour numerical forecast, OK-FIRE is useful for both wildfire (anticipation of high fire danger periods and suppression guidance) and prescribed fire (planning for and conducting the burn). OK-FIRE is a program of the Oklahoma Mesonet and is directed by J. D. Carlson of the BAE department. Half-day computer workshops are offered throughout the state during the fall to train wildland fire managers in the available products and use of the website. View the OK-FIRE website at **http://okfire.mesonet.org/**.

Upcoming OK-FIRE events

August 20 - OK-FIRE Training Workshop, OEMA Training Day (Norman)
August 31 - OK-FIRE Training Workshop, National Weather Center (Norman)

Registration is required. For more information, contact J. D. Carlson at jdc@okstate.edu or 405-744-6353.

Subscription request

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

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