

# Center for Agricultural and Rural Sustainability

## Faculty Spotlight

February 2015

### Jun Zhu

**Title:** Professor, Biological and Agricultural Engineering

**Program Title:** Agriculture waste management and resource recovery

**Program goal:** To achieve zero waste or minimize waste production from agriculture by recovering waste products and creating something of value.

**Collaborators:** BAEG departmental faculty

**Project Timeline:** ongoing long-term projects

**Tools/Equipment Used:** Reactors are fabricated in house based on project needs and are equipped with monitoring systems such as for pH, temp, online measurements. Lab equipment and processes include gas chromatography for analyzing methane, hydrogen, carbon dioxide, organic acids, and volatile organic acids; spectrophotometer for nutrient analyses; ovens for drying solids; wet chemistry for measuring nitrogen (N) and phosphorus (P) in liquid manure; and a powerful ventilation hood because it's important to keep colleagues and neighbors happy.

**Project Description:** Dr. Jun Zhu came to the University of Arkansas just over a year ago from University of Minnesota Southern Research and Outreach Center. Zhu is the lead co-director of CARS, specializing in waste management. Zhu takes a two prong approach in his research program. The first is through waste management and treatment technology and the second is through resource management and recovery technology. Having been in Arkansas for just one year, most of his prior work was in animal systems such as swine and dairy manure in the upper Midwest. Since moving to Arkansas he has expanded his work to include poultry litter waste treatment technologies and is developing technologies to use it as a resource.

Much of the poultry litter in NWA is exported to neighboring states. Alternatives to this practice are needed for various reasons including the possibility that regulations could change prohibiting this practice and it is expensive. Additionally, Arkansas farmers in other parts of the state require annual applications of fertilizer to support crop production. Although a waste product, litter is a good source of N and minerals and a potentially a good, inexpensive fertilizer. Zhu is investigating technologies of converting



this resource into an affordable fertilizer and an environmentally friendly product by reducing the volume of the product and using various treatments to make different products. The challenge of this issue is developing technologies that are affordable. Although many of these processes can be done, they are not yet economically feasible.

In Zhu's previous research on agriculture waste treatments he worked on liquid swine and dairy manure projects such as reducing odors using a two phase lagoon. In this system the 1<sup>st</sup> stage supernatant discharges to the 2<sup>nd</sup> lagoon where the top layer is aerated to create a biological cover, preventing odors from the bottom reaching the top. This system can reduce up to 80% of noxious fumes. In another project liquid manure was treated with sequencing batch reactors to remove N and P, so the remaining water met the discharge limits. The N was changed to gas and released to the atmosphere while the P could be used in compost or fertilizers or other products.

In Zhu's research on resource recovery, he is producing bio-hydrogen from animal waste. He first started this system using liquid swine manure and added glucose to produce the hydrogen (H). Although this worked, it was cost prohibitive. To make the system more economical he replaced the glucose with sugar processing wastewater because it contains high levels of carbon. With this approach he can treat two waste streams in one process to produce H. Next, methane can be produced with the waste of the H production process and struvite fertilizer can be made with the effluent of the methane production. The resulting water is quite clean. There is still more work to be done in this arena, however. The two gases H and methane are not pure enough for a fuel cell. The gases contain 60-70% and 40-50% CO<sub>2</sub>, respectively, and must be cleaned up for a more pure form. A green gas can be made from the H, methane and CO<sub>2</sub> that is carbon neutral and is a substitute for natural gas.

Other research Zhu is conducting is recovery of N from dairy manure for use in culturing media of fungi and bacteria that produces lactic acid. Lactic acid is of interest because it is the precursor for poly-lactic acid polymer which is used in bioplastics. The obstacle of this process is the sterilization of the culture media since manure is a biologically rich material. Autoclaving is cost prohibitive and consumes too much energy. Zhu is looking into filter technologies that can block the bacteria but allow the nutrients to pass.

**Future areas of work:** Zhu is considering expanding into rice waste management since Arkansas is the leading producer of this crop. He is interested in examining the conversion of rice straw into useable products or developing technologies that use the residues to co-ferment with another resource like manure.

**Funding:** Zhu has received funding through national, state and local sources including USDA-NIFA, Minnesota Department of Agriculture and local producer groups while in Minnesota and through the Arkansas Agriculture Experiment Station.

**More info:** For more information, visit the following links:

<http://cars.uark.edu/ourwork/Waste-Management/default.aspx>;

<http://www.baeg.uark.edu/6522.php> ; <http://www.baeg.uark.edu/6590.php>;

<http://www.baeg.uark.edu/6428.php>

