



# Biological Systems Engineering

*Engineering Update*

*Summer 2010*

## **Engineering Update: ASABE Blue Ribbon Winner!**

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### **Engineering Update**

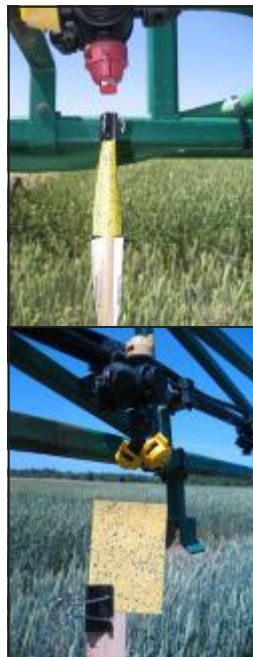
Biological Systems Engineering  
June 2010



To: Extension Unit Directors, Extension District Directors, Extension Program Leaders, and ANR Agents

**Dear Co-Workers:** Engineering Update is a joint effort of Biological Systems Engineering and other interested parties. Subject matter areas include timely information on water quality, natural resource management, TMDL, air emissions, animal waste management, machinery management, precision farming, application technology, farm safety, energy, engineering education, and technology. Please use this information in your on-going Extension programs and circulate to all Extension staff and interested parties. Engineering

Update is electronically accessible at:  
(<http://intra.ext.vt.edu/anr/bse/index.html>).



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# EPA Orders Two Virginia Farms to Cease Waste Discharges

On June 2, 2010, the US Environmental Protection



(EPA, Region 3) ordered two Virginia farms and one Pennsylvania farm to

cease discharging pollutants to streams without a National Pollutant Discharge Elimination System

(NPDES) permit, as required by the Clean Water Act. The order were given after followed a Clean Water Act inspection.

1. Turley Creek Farms in Linville VA, (April 14, 2010) is a chicken broiler operation with approximately 100,000 birds. According to EPA report, "the inspection found that the farm was improperly storing large piles of uncovered chicken manure and evidence that pollutants, including nitrogen and phosphorus, were discharged into Turley Creek, a tributary of the North Fork of the Shenandoah River."
2. Windcrest Associates LLC, farm in Timberville, VA, was inspected on April 15, 2010. This farm operates dairy with approximately 250 cows and 275 heifers and turkey operation with 22,800 birds. "The inspection determined that pollutants, including nitrogen and phosphorus from animal manure were being discharged into an un-



*This interactive map provides information on Federal/EPA enforcement actions and cases since 2009.*

named tributary of the North Fork of the Shenandoah River and the Shenandoah River itself contrary to the requirements of the Clean Water Act".

3. The Melvin and Moses Peterseim of Manheim PA was inspected on April 1, 2010. The farm is a 36,000 bird layer operation collocated with a dairy with about 80 dairy cows. "The inspection determined that pollutants, including nitrogen and phosphorus from animal manure from both operations were discharged into an unnamed tributary of Chickies Creek, a tributary of the Susquehanna River."

The EPA has ordered the farms to cease discharging pollutants to the waters until they have applied for and received authorization to discharge via a Clean Water Act Discharge permit. The farmers are also required to submit a compliance plan to EPA explaining what actions the facilities have taken and will imple-

ment in order to comply with the Clean Water Act. The farms are located in the Chesapeake Bay watershed and these actions are part of the Agency's efforts to implement the President's Executive Order for the Chesapeake Bay watershed, and a compliance and enforcement strategy

to improve water quality in local waterways and the Bay. More information about the Chesapeake Bay watershed compliance and enforcement strategy visit <http://www.epa.gov/compliance/civil/initiatives/chesapeakebay.html>

The **Chesapeake Bay Watershed** is North America's largest and most biologically diverse estuary, home to more than 3,700 species of plants and animals. It is about 200 miles long, contains more than 11,000 miles of tidal shoreline, and is fed by 100,000 creeks, streams and rivers. The watershed spreads over 64,000 square miles and includes parts of six states - Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia - and all of the District of Columbia. Approximately 17 million people live within the Bay watershed. The Bay provides significant economic and recreational benefits, estimated to exceed \$33 billion annually, to the watershed's population.

(J. Arago)



<http://yosemite.epa.gov/opa/admpress.nsf/0/2656C0C97320A62D85257736006EC5C1>

## Farmers Need to Learn about Oil Spill Regulations

The deadline for farmers and ranchers to comply with new federal oil spill prevention regulations, Nov. 10, 2010, may be postponed, according to EPA officials. They would not say what the new compliance deadline would be, but they have submitted a proposal to the Office of Management and Budget.

Regardless of when the deadline is, the Spill Prevention, Control and Countermeasure (SPCC) rule is something that farmers and ranchers need to pay attention to.

For more information, visit ([www.epa.gov/oem/content/spcc/index.htm](http://www.epa.gov/oem/content/spcc/index.htm)). In addition to a general SPCC web page, the agency has posted a fact sheet for farmers at [www.epa.gov/emergencies/docs/oil/spcc/spccfarms.pdf](http://www.epa.gov/emergencies/docs/oil/spcc/spccfarms.pdf)

Farms with total above-ground fuel storage capacity of more than 1,320 gallons or buried storage capacity of over 42,000 gallons will have to have an SPCC plan in place and maintain records to show that they are following the plan. The EPA classifies a farm as "a facility on a tract of land devoted to the production of crops or raising of animals, including fish, which produced and sold, or normally would have produced and sold, \$1,000 or more of agricultural products

during a year."

EPA has had SPCC rules in place for decades, but it changed them in 2002 to clarify which facilities had to comply. There is virtually no history of such spills within agriculture, and Farm Bureau argued that Congress never intended the law to apply to farms. The agency, however, pointed out that there is no specific exclusion for agriculture. In response to comments by Farm Bureau and others in the agriculture community, EPA attempted to make the regulations easier for farmers and ranchers.

Now the federal government is getting ready to enforce the rules, and Farm Bureau is pushing EPA to ensure that farmers have the information they need. EPA will implement the new regulations under a tiered approach, with facilities with total above-ground fuel storage of 10,000 gallons or less, no single container of more than 5,000 gallons and no history of oil spills into navigable waters falling under Tier I, the least burdensome set of requirements. Tier I operations will be allowed to use an SPCC plan template and self-certify their plans rather than having to hire a professional engineer (PE) to certify them. The



Tier I plan template with instructions can be found at [www.epa.gov/emergencies/content/spcc/tier1temp.htm](http://www.epa.gov/emergencies/content/spcc/tier1temp.htm)

Oil, gasoline and diesel stored on the farm will count toward a farm's regulated storage capacity. However, the rules will apply to more than oil tanks. Pesticides that are oil based or mixed with oil and stored on the farm also will count toward the farm's storage threshold, as will containers that are not permanently capped.

If you can't say for certain that your farm or ranch is not covered by SPCC, you need to log onto EPA's informational Web pages to find out for sure. One thing that is certain is that EPA will start enforcing these rules. You don't want to wait and find out, too late, that you should have put one of these spill prevention plans in place. Do it now and you could save yourself a lot of trouble later on.

(B. Grisso)

[www.epa.gov/emergencies/docs/oil/spcc/spccfarms.pdf](http://www.epa.gov/emergencies/docs/oil/spcc/spccfarms.pdf)

# Six Degrees of Hand Vibration

Hands are critical for our lives and our work.

The ability to grasp, hold and manipulate tools and objects with strength and dexterity is critical to our everyday lives and especially to our work. It is what sets us apart from most other creatures. Common phrases referring to "manual labor" and "being handy" recognize the central place our hands play in work.

However, because of their vital role in our working lives, hands are also vulnerable to injury. Thus, it's not surprising that protecting hands is a fundamental part of most workplace safety programs. Most people focus on cut, slash, or puncture protection, but there is another all-too-common hazard in many occupations: vibration.

## Vibration Exposure

Exposure to hand and arm vibration is a familiar reality for the modern worker in a wide variety of tasks. The list is long and includes riveting, grinding and sanding, deburring, demolition, drilling and mining, oil and gas refining, heavy construction, assembly and fabrication, and chainsaw and jackhammer work. Exposure can be prolonged and severe in these occupations and can lead to discomfort and disability. Over time, it also can result in the serious condition known as Hand/Arm Vibration Syndrome (HAVS). HAVS can cause permanent numbness and damage to the hands and arms and has been estimated to affect one in 10 people who work regularly with vibrating tools.

More widespread, however, is exposure to "nuisance vibration." Nuisance vibration, while not as severe as that caused by heavy equipment or vibrating tools, can give workers a "tingling" sensation in their hands and arms. While this sensation usually subsides shortly after expo-

*Several types of gloves are effective in lessening vibration exposure. The standard hierarchy of controls is the right way to proceed against this common hazard.*

sure to the vibration stops, it is a concern for those using smaller tools, driving automobiles or buses, doing repair work on certain types of machinery, and in numerous other applications. The result is often worker discomfort and decreased productivity.

Exacerbations to both HAVS and the effects of nuisance vibration include cold temperatures, damp environments, and nicotine use.

## Protecting Our Hands

Engineering controls are always the preferred method for hand injury prevention. Designing work environments, equipment, and tasks so that workers' hands are never placed in jeopardy is the best approach. However, this is not always possible, especially when workers are engaged in construction, assembly, disassembly, or repair tasks that require extreme handling.

Training, work practices, and administrative controls are also effective in keeping workers' hands out of danger zones. However, this can be difficult when addressing vibration reduction because the operation of vibrating tools frequently requires workers to operate the tools with their hands. Therefore, the combination of a "hands off" policy is most effective when supplemented with the proper personal protective equipment (PPE).

Various PPE solutions are available to combat both severe and nuisance vibration. The governing standard (ANSI S3.40-2002/ISO 10819:1996) desig-

nates performance criteria that certify compliant gloves as vibration-reducing (VR). In order to comply with this standard, gloves must be full-fingered, must use a polymer or pad of uniform thickness, must not amplify mid-range vibration frequencies, and must reduce high-range frequencies by 40 percent versus a bare hand.

Gloves that meet this standard are vital in situations where workers are exposed to severe vibration. However, their full-finger design and traditionally thicker palm padding limit finger dexterity and make them less desirable for more detailed work.

Other hand protection options are available for workers exposed to less severe, nuisance vibration. For example, an "impact glove" is a common style featuring a padded leather palm. In addition to protecting workers' hands from the impact of a blow to the palm, their padded palms also provide protection from nuisance vibration. Typically of a half-finger design, impact gloves allow for excellent finger dexterity to perform common tasks.

Additionally, some "trades" or "mechanic" style gloves feature gel polymers in portions of the palm that provide some protection from mild to moderate vibration. These gloves are typically more dexterous and breathable than impact gloves because they are made of lighter materials. They also are available in more functional designs, including full, three-quarter, or half-finger options.

## The Bottom Line

Exposure to hand and arm vibration in the workplace can range from severe and debilitating to nuisance and productivity sapping. Whatever the task or level of exposure, there is likely a hand protection solution available to reduce the vibration and allow the worker to focus on doing his job effectively and safely.  
(B. Grisso)

## New: Pull-behind Cob Harvester

Vermeer Corporation introduces the CCX770



Cob Harvester that is towed behind a combine for collecting corncobs. The new cob harvester is one of the first pieces of equipment developed to handle biomass materials for ethanol production. The harvester works with select combines.

Vermeer officials report that they developed the harvester as more growers, look ahead to cob harvesting for ethanol plants that will use biomass materials.

The self-contained CCX770 Cob Harvester holds up to 8,000 lbs. of material and unloads in about 90 sec. It includes a patented separation system that redistributes leaves and husks back to the ground. The harvester will unload into high-box semitrailers or wagons with its

flexible unloading heights that range from 9 ft. 7 in. to 15 ft. 6 in. A bolt-on hitch is added to the combine to hook to the harvester. The harvester is equipped with its own engine, which reduces stress on the combine.

Vermeer will only rent the CCX70 Cob Harvester to customers next year. Contact Vermeer Corp., Dept. FIN, Box 368, Pella, IA 50219, 800/370-3659

*(B. Grisso)*



## Tips for biodiesel storage

At today's prices, not taking steps to lessen evaporation can cost a farmer thousands of dollars a year.

With the high cost of biodiesel fuel, every gallon counts. Improper storage of biodiesel could mean thousands of dollars disappearing into thin air.

Biodiesel blends, like petroleum diesel fuels, should be kept in a clean, dry, dark environment. As with any fuel, water must be prevented from entering the tank. Algae can also grow in biodiesel fuels just as it does in petroleum fuels.

Clean, inspect and repair your tank before filling with biodiesel fuel. Have older tanks cleaned professionally to remove particles and deposits that might contaminate the fuel supply.

A single 300-gallon tank of biodiesel blend can lose up to 120 gallons each year due to evaporation. At today's prices, not taking steps to lessen evaporation can cost a farmer thousands of dollars a year.

Paint tanks white or aluminum to better reflect the sunlight. Place the tanks in an east-west orientation. Keep tanks shaded, if allowed under local building and fire codes. This is especially important for tanks and containers constructed from polyethylene or polypropylene, which should be protected from sunlight.

Pressure-relief vacuum caps rather than conventional gas caps also will help reduce evaporation.

Inspect tanks regularly for material decomposition. Some materials, including aluminum, tin and

zinc, reduce the shelf life of biodiesel. Biodiesel will break down concrete, varnish and PVC tank linings.

Pure biodiesel will readily dissolve rubber components in your tank's plumbing. Low-biodiesel blends reduce degradation of rubber, but there has been little research on the long-term effects of low-biodiesel blends on rubber components.

During inspections, tighten components between the storage tank outlet and the pump.

Check valve packing's and look for nozzle seepage.

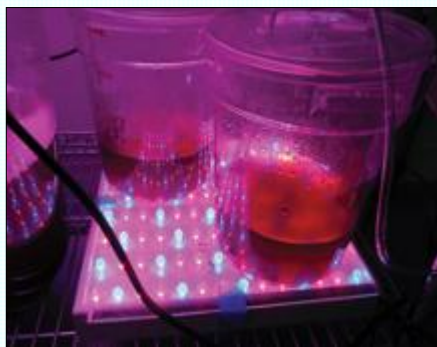
Be especially careful about inspecting underground storage tanks. Leaks can contaminate groundwater. *(B. Grisso)*



## Biofuels: Greener than Ever

*Plant-based and algae-based biofuels are becoming more profitable than ever, leading to more green backs for opportunists of the green age.*

Oil has long been the preferred source of energy for human industrial activity and has thus driven the progress of mankind more than a century. However, the overuse of oil or fossil fuel has led to (and this is still a controversial topic) a number of environmental disasters such as the phenomenon of global warming. This is not news to anyone. And, not surprisingly, to decrease our dependence on the old "black gold," there has been increasing interest and intensive research, development, and commercialization of so-called alternative energy sources (wind energy, hydrothermal energy, and nuclear energy) over the last half-century. More recently—over the last decade or so—there has been intensive work into the development of biofuels, which are basically naturally occurring oils produced by a



Testing growth rates of algae cultures under red and blue LED lighting. (Source: OriginOil)

number of different organisms including plants and algae. Some com-

panies are biofuel developers, while others provide technologies that enable this development.

### Fueling biofuel growth

One company that provides technologies for biofuel development is **Eco-Solution**. The company has actually developed a platform to improve some microorganisms (bacteria, yeast, and microalgae) without having to produce genetically modified organisms. The organisms are actually put under specific selective pressure that enhances desired characteristics akin to natural evolution. Because of their rapid growth rates (with division times of one hour or less), bacteria naturally offer greater genetic variation than organisms like microalgae, which has a division time of 24 to 48 hours or more. In response to the different growth rates, Eco-Solution had to develop a high throughput platform to work with microalgae.

The main differences between the two microorganisms as follows: There may be millions of microorganisms in 20 milliliters of bacterial culture. And if you put a selective pressure on them, you will obtain mutants that are best fit to survive the stressing environment. To get the same amount of variation in a microalgae culture during a same period of time, they had to implement the high throughput platform. Different microalgae are grown on the platform to improve their productivity in a way of reducing the production cost of algae-based biofuel. By developing specific strains for biofuel production, problems related to the productivity such as

their growth rate, their resistance to inhibitors (e.g., temperature and pH), as well as to increase photosynthetic efficiency...to improve cost and efficiency of algae-based biofuel development.

Microalgae require  $CO_2$  for growth as it is the raw material for photosynthesis. So in order to grow microalgae commercially for the production of biofuels, there must be a way to deliver  $CO_2$  to the microalgae culture. The technology barriers to scaling up algae-based biofuel production is critical so that it can eventually compete with oil.

There are currently two methods for extracting oil from microalgae—a dry method and a wet method—both of which are very energy-dependent. Wet extraction such as cavitation technology is very efficient at breaking down without requiring a lot of energy. In the extraction stage, a low power electromagnetic pulsing, which essentially cracks the algae cell and then the oil separates itself over the course of an hour from the biomass.

In summary, biofuel development is becoming more profitable and more efficient. As a result, there is an increasing number of biofuel companies looking to become players in the game.

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## Round Bale Safety

It won't be long and hay fields will be dotted with large, round hay bales. They're also very heavy and roll easily so you have to know how to safely handle them.

A round hay bale weighs between 1,000 and 1,500 pounds. They're compact and dense, reaching a diameter of five-to-six-feet. The size affects the stability of the tractor handling them, so make sure it can handle the load. The proper equipment for moving the bales is also important.

The predominant way to handle round bales in the field is to use a front-end loader with a spike so you can spear the round bale. A lot of

times to balance out, farmers will actually put a spear in the three-point-hitch, and that way they can carry two bales at a time. If they are going to be stacking it, they'll attach on the front-end loader a grapple-type system that'll actually put some tongs around the bale so that you can lift it up without it rolling back into the cab.

Accidents can happen quickly so it takes some skill in handling a tractor loaded with a round bale. Avoid ruts and bumps, and drive slowly with no sudden turns. The bale needs to be positioned so it has the least amount of affect on your center of gravity.

Keep the bale as low to the ground as possible and that way you can look

over the bale instead of lifting it up. Some people think lifting up the bale and then look underneath it through the front end but that gives you a real case to be able to roll it over if it's not well-speared, or you're picking it up with just a front-end bucket.

If the bale falls off and starts rolling down a hill, let it go. With that kind of weight and momentum, it will win if you try to stop it. When moving round bales on public highways, producers should put them on a trailer and strapping each one securely in place. Keep in mind there may be certain highway regulations as to when and how they can be transported.

(B. Grisso)

<http://www.pubs.ext.vt.edu/442/442-454/442-454.html>

## Countering Heat Damage To Moist Hay

*Did you bale some first cutting hay a little tough due to high humidity and frequent rain showers? If so, it could mold, spoil, or suffer heat damage.*

Excessive heat can cause hay to be less digestible, especially the protein. Heat-damaged hay often turns a brownish color and has a sweet caramel odor. Cattle often eat this hay readily, but because of the heat damage, its nutritional value might be low.

Heat produced by a bale basically comes from two sources:

- The plants produce some heat

through biochemical reactions as hay cures. This heating is relatively minor and rarely causes hay temperature to rise above 110°. Little damage occurs to hay cooler than 110°.

- Most heat in hay is caused by the metabolic activity of microorganisms. Millions of these microbes exist in all hay, but they will thrive and cause even more heat when extra moisture is abundant. As the metabolic activity of these microbes increases, the temperature of your hay rises. Hay with only a little excess moisture probably will get no warmer than 120°. Wetter hay, though, quickly can get as warm as 150°. Hay that gets this

warm nearly always becomes discolored and its nutritional value will drop. If hay temperatures rise above 170°, chemical reactions can quickly raise temperatures to over 400° and start a fire.

We all bale hay a little too wet from time to time, but be wary of the fire danger that can result from this practice. Store baled moist hay away from buildings and other hay. Also, remember that it likely will have a lower feed value and be sure to get a thorough forage test and feed accordingly.

(B. Grisso)



<http://pubs.ext.vt.edu/442/442-105/442-105.html>

# Summer Forage Harvesting - Energy Savings Tune Up

As you prepare for the hay and forage harvesting season, there are many simple activities that you can do to reduce production costs.

**Mowing Hay:** Sharp knives will reduce the energy to cut forage. On sickle bar cutting, the knife sections should set flat against the cutting surface of the guard. Worn pads on the guards cause the knife section to ride above the guard and not cut properly. Hold down clips keep the knife against the guards and may need to be adjusted or replaced as they wear. They should be adjusted to a 0.010 inch gap. The maximum gap between the knife sections and the guard ledger area should be 0.030 inch for course crops and 0.020 inch for grass and seeding year alfalfa. The knife section can wear in three areas: along the back edge, at the cutting edge, and at the top of knife section. Replace sections where wear on the back edge or the cutting edge exceeds 3/16 inch or when grooves are cut into the top of the knife section. Replace dull knife sections so they don't slow the cutting process and cause uneven feeding of the crop.

Rotary or disc mower knives are typically subjected to higher rates of wear and prone to more breakage because of their exposure compared to sickle bar mowers. Dull knives increase power requirements. Check knives and knife bolts each day before mowing and immediately after striking an object. Replace broken, worn or distorted knives, bolts and nuts.

Check your mower-conditioner or windrower owners manual for the proper roll clearance for the type of rolls your machine uses. The correct clearance will enhance conditioning by cracking the plant stem and promote faster drying. A piece of aluminum foil rolled up in a tube shape can be used to measure the gap. Place a foil roll in the middle and a foot from each end of the roller. Spin the roller by hand until the foil is completely through the rollers. Use a pair of cali-

pers to measure the smallest thickness of the foil.

Laying the crop in a wide swath promotes faster drying and can reduce drying times by up to six hours under typical Wisconsin weather conditions compared to narrow swaths or windrows.

**Raking:** Many advances have been made with merging or inverting equipment for hay crop forage. Rakes and mergers can be used to promote drying by turning windrows and exposing new surfaces to air movement and sunlight. Merging windrows saves fuel by better matching harvester or baler capacity with crop yield. Harvesters and balers work more efficiently, and take less fuel per ton of crop if they are operated close to capacity. If the harvester is picking up a single swath and not loaded near machine capacity it will not only take longer but also wastes fuel.

**Forage Harvesting:** Three items have a significant effect on forage harvesting fuel consumption: length-of-cut, knife sharpness and knife-shearbar clearance. The cutting energy will double as the blade edge wears from a 0.004 inch radius (sharp) to a 0.012 inch radius (dull). The cutterhead power requirement also increases as the knife to shearbar clearance increases. The cutterhead power requirement will double for each 0.01 inch increase in clearance. The clearance can be caused by worn knives and worn shearbar or by knife sharpening. Each time the knives are sharpened, the shearbar must be adjusted. Refer to your forage harvester's operators manual for adjustment instructions.

Increasing the length-of-cut reduces fuel consumption but must be weighed against the nutritional requirements of the animals and storage facility. If you have a choice, longer length cuts will save energy and money. Roughly 40 percent of the energy used by a harvester is consumed by the cutterhead, so the

effect on fuel consumption can be considerable from dull knives and worn shearbars.

All current forage harvesters can be equipped with processors to crush and crack kernels and cob for whole plant corn silage. Based on research, there isn't any benefit to using a processor on hay forage crops, therefore it is recommended that the processor be removed from the crop stream when harvesting any other crop.

**Balers:** Lubricating and making adjustments according to the manufacturer's recommendations will reduce down time and maintenance issues. Balers like forage harvesters are most efficient if operated near capacity so combining windrows to maximize baler capacity will reduce the time and energy required. Square Balers - Sharpen and adjust the clearance of the plunger and stationary knives on the feeder side of the bale chamber. Dull knives increase power consumption.

**Blowers:** Blowers are generally the bottleneck or the machine that limits the capacity of forage harvesting when using tower silos. There are several things that will reduce the energy consumption and maximize the capacity of the blower.

The clearance between the fan tip and the housing is the most important adjustment on a forage blower. The rule of thumb is that the blades will move a nickel but pass over a dime - about 1/16 inch clearance. The most critical zone is from the bottom of the housing to the horizontal point of discharge. Blade tip wear increases the clearance so checking the clearance each time the blower is moved to a new silo is a good practice.

No matter what hay or forage harvesting operation you are conducting, the most important energy savings task you can perform is to carefully and properly maintain your equipment and tractors. Simple tasks like cleaning radiators, keeping air filters clean, properly inflating tires, sharpening knives and checking clearances can each save fuel in small ways, adding up to a more profitable cost per ton of feed. When making many of the adjustments discussed above, make sure to use safe practices including eye protection when sharpening knives and cylinder stops in place when adjusting roll clearance.

*(Adapted by B. Grisso)*



## Elderly Falls Linked to Altered Blood Flow

A new study shows that altered blood flow in the brain due to high blood pressure and other conditions may lead to falls in elderly people. The research published in *Neurology*, the medical journal of the American Academy of Neurology.

Each year, unintentional falls in the US account for more than 16,000 deaths and 1.8 million emergency room visits.

At age 60, 85% of people have a normal walking ability. However, by

age 85, only 18% of seniors can walk normally.

For the study, researchers followed 419 people age 65 or older. Ultrasound tests were used to measure brain blood flow response to carbon dioxide levels, a standard test of blood vessel function in the brain. Walking speed was measured by a four-meter walking test. The seniors and their caregivers reported any falls that occurred over two years.

The study found that the 20% of people who had the smallest blood

flow changes in the brain were at a 70% higher risk of falling compared to the 20% of people who had the largest blood flow changes in the brain. Those with the slowest rate had an average of nearly 1.5 falls per year, compared to less than one fall per year for those with the highest rate.

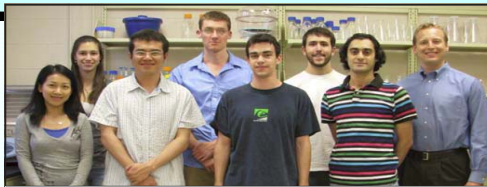
The findings suggest there could be a new strategy for preventing falls, such as daily exercise and treatments for high blood pressure, since blood pressure affects blood flow in the brain and may cause falls.

## Ryan Senger's Research Group

The Senger Research Group (SRG), led by Ryan Senger, BSE assistant professor, was established in January 2009 and focuses on problems in metabolic engineering and systems biology. The group's primary focus has been to engineer microbes to produce advanced biofuels (e.g., bio-butanol) from cheap, renewable, and highly abundant substrates such as plant-derived cellulose.

They also have interests in producing value-added chemicals and are currently working on strategies to over-produce valuable amino acids using *Escherichia coli* K12. Future directions include engineering microbes to sequester atmospheric CO<sub>2</sub> and manipulating the photosynthetic process to result in the production of liquid biofuels.

The developed technologies will also allow the group to engineer meta-



Front (l-r): Yanjuan Hong, Rui Zhou, Mike McAnulty, Hadi Bokaei Nazem  
Back (l-r): Alexa Tenga, Ben Freedman, Charlie Mayo, Ryan Senger

bolic pathways to remediate toxic compounds and cure infectious diseases. Shortly after opening the laboratory, Senger received funding from the USDA for the project that is described below.

The need for renewable fuels to replace those from oil is well established. At this point in time, ethanol from corn represents a grand achievement in this area. But many do not care to turn their food into fuel. The alternative that SRG is exploring is to turn the non-food part of plant materials into biofuels by engineering a bacterium that can degrade this "cellulosic" plant material effectively and convert it to

biofuel.

Thus, SRG hopes to replace the phrase "corn to ethanol" with "corn stalks to ethanol." Recent studies have concluded that in order to economically turn this into a sustainable process, the same bacterium must break-down the plant material, consume it, and turn it into a biofuel. To date, no microbes exist that can do this efficiently. One that does exist, *Clostridium cellulolyticum*, grows much too slowly for an industrial process. One of their objectives is to map all of the chemical reactions that occur in *C. cellulolyticum* metabolism and apply mathematics to determine how its metabolic rate can be improved. The approach of screening random elements of a genome in order to improve a particular function has been termed "combinatorial metabolic engineering" and has proven widely successful.

# Rural Road Safety is Everyone's Concern

As farmers across the country gear up, many of them will be traveling on rural roads and highways, often with large pieces of machinery. As the rural landscape shifts to include more non-farm drivers, it often becomes risky to travel with farm equipment. Impatient drivers, narrow roadways, over-sized equipment, and slower speeds often contribute to the risk.

A study about crashes between farm equipment and other vehicles was published in the *Journal of Rural Health* entitled, "Characteristics of crashes with farm equipment that increase potential for injury." The study's crash database identifies farm equipment. Most state crash reporting systems don't make this distinction.

The results show that crash fatality and injury rates are higher on rural roadways than other roadway type. Rural fatality rates are more than twice as high as urban rates for wide variety of injuries, including motor vehicle crashes.

Crash rate fatalities in the most rural counties are almost double the rate in urban counties, and they are more frequent, more severe, and more likely to result in death than urban crashes.

According to the article, Iowa has the highest rate of farm equipment crashes reported on public roads in the United States, with a rate of 10.7 crashes per 100,000 population per year. North Carolina has the second highest rate of 3.9 per 100,000 per year. Research on the fatality rates in crashes with farm vehicles/equipment indicates that 2

in every 100 crashes involving tractors and 1 in every 100 crashes involving other farm equipment leads to a fatality.

The rural roads themselves often contribute to the increased crashes and severe injuries. Paved rural roads typically have two narrow lanes. Gravel roadways do not necessarily have two fully functional lanes under all weather conditions and have even fewer safety features than paved rural roads.

Certain types of crashes, such as those involving motor vehicle collisions with farm vehicles and equipment, are unique to rural environments. These crashes most frequently involve slow-moving tractors.

The study included fatal, major, and minor driver injuries. Crashes that involved injuries only to passengers were excluded, and passenger injuries were not included. Restricting the data to only crashes resulting in at least 1 driver injury resulted in 825 crashes with 1,700 drivers.

Study results found that non-farm vehicle drivers were more than 5 times as

likely to be injured than the farm vehicle/equipment drivers. Crash characteristics increased the odds of injury for non-farm drivers included speeding, passing the farm vehicle, driving on a county road, front-impact collisions, and darkness, but ejection was the strongest injury predictor for the farm vehicle driver.

These finds suggests that farm vehicle/equipment crash prevention should be a priority for all rural road users.

**ABSTRACT:** *Context: Crash fatality and injury rates are higher on rural roadways than other roadway types. Although slow-moving farm vehicles and equipment are risk factors on rural roads, little is known about the characteristics of crashes with farm vehicles/equipment. Purpose: To describe crashes and injuries for the drivers of farm vehicles/equipment and non-farm vehicles involved in an injury crash. Passengers are not included in this analysis. Methods: Injury crashes were included that involved a farm vehicle/equipment and at least one non-farm vehicle reported in Iowa Department of Transportation crash data from 1995 to 2004. Odds ratios were calculated through logistic regression to identify increased odds for injury among drivers of non-farm vehicles and farm vehicles/equipment. We examined frequently occurring crash characteristics to identify crash scenarios leading to the highest odds for injury. Findings: Non-farm vehicle drivers were 5.23 times more likely to be injured than farm vehicle/equipment drivers (95% CI = 4.12–6.46). The absence of restraint use was a significant predictor of injury for both farm vehicle/equipment drivers (OR = 2.85; 95% CI = 1.14–7.13) and non-farm vehicle drivers (OR = 2.53; 95% CI = 1.54–4.15). Crash characteristics increasing the odds of injury for non-farm vehicle drivers included speeding, passing the farm vehicle/equipment, driving on a county road, having a frontal impact collision, and crashing in darkness. Ejection was the strongest predictor of injury for the farm vehicle/equipment driver. Conclusion: Non-farm vehicle drivers were much more likely to be injured than farm vehicle/equipment drivers, suggesting that farm vehicle/equipment crash prevention should be a priority for all rural road users. Prevention strategies that reduce motor vehicle speed, assist in safe passing, increase seat belt use, and increase conspicuousness of the farm vehicle/equipment are suggested.*

# More Rewards from Crop Residues

Wheat and barley producers can refine crop residue management to build soil organic matter, curb soil erosion, retain soil moisture and maximize crop yields.

Soil scientist conducted a two-year study of post-harvest crop residues to identify links between decomposition processes and fiber and nutrient characteristics of the straw.

The researchers looked at residues from 17 cultivars of winter wheat, 16 cultivars of spring wheat and nine cultivars of spring barley. The team measured the content of hemicellulose, cellulose and lignin in each type of residue.

They also measured residue levels of carbon and nitrogen and the ratio of the amount of carbon to nitrogen (C/N).

The researchers found that the straw from the different cultivars had notable differences in fiber composition and C/N ratios. Fiber composition, C/N ratios and carbon levels also varied significantly by location, probably because of different soil and growing conditions.

These results and other tests on the straw residues indicated that 14 percent of the cultivars had characteristics for slow residue decomposition and 14 percent had char-

acteristics indicating a potential for rapid decomposition.

Crop residues decompose into soil organic matter, which provides nutrients to crops, limits erosion and helps retain soil moisture. Rapidly decomposing cultivars are less likely to impede no-till seeding in higher rainfall areas where more straw is produced.

The identification of differences in these crop characteristics could help growers select cultivars that produce residues best adapted to reduced-tillage cultivation. These residues may also benefit subsequent crop establishment, maximize soil organic matter to improve yield and increase carbon stored in the soil.

## Upcoming Meetings



### BMP Clearinghouse meetings:

- June 21: Special meeting on manufactured treatment devices and testing protocol prepared under contract with VT BSE and OWML

- July 19: Regular meeting

Both meetings at 10 am and are at the Department of Forestry in Charlottesville at the UVA research park.

Contact: **David Sample**, (703) 361-5606 x 128

Email: [dsmample@vt.edu](mailto:dsmample@vt.edu)

## PLANS

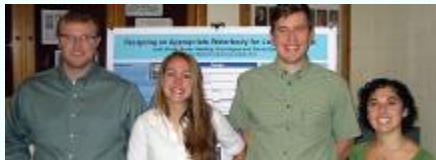
In response to numerous requests, building and facility plans are now available for download from the Virginia Cooperative Extension (VCE) Intranet. Plans are categorized under five main categories: Forage Storage and Feeding, Grain Handling and Feeding, Beef, Horse, and Sheep. You will need Adobe Acrobat to download these files. For the building and facility plans, as well as additional resources, please visit: <http://intra.ext.vt.edu/anr/bse/index.html>



# Senior Capstone Design Teams

The BSE 4125 and 4126 Comprehensive Design Project is a two-course sequence that serves as the capstone experience for our undergraduate students. It allows students to experience working in a team environment and to apply the knowledge they have gained in their coursework to "real-world" design problems that are identified by members of industry or engineering consulting firms. The design projects, teams, and their advisors for 2009-10 are:

*Designing an Appropriate Waterbody at Lakewood Park*, Advisors: Bork/Wynn/Yagow, Students: **Josh Arnett, Susan Handley, Gina Hayes, and Travis Stables**



*Riparian Zone Development for an Impaired Stream*, Advisor: Barone, Students: **Joshua Flickinger, Scott Kesecker, and Jessica Palazzolo**



*Designing a Pilot Algal Culture System for Biofuel Production*, Advisors: Wen/Vaughan, Students: **Joshua Anderson, Julee Harlow, and Erin Norton**



*Removal of Nitrates from an Urban Stream Using a Denitrifying Biofilm*,

Advisor: Barone, Students: **Koren Breighner, Jennifer Downs, Mike McAnulty, Melissa Thies, and Alex Tucker**



*Plant Design and Analysis for Consolidated Biobutanol Production*, Advisor: Senger, Students: **Jorgen Berg, Jon Miller, and Cally Zanarini**



*Wastewater Disposal System for the Escuela Primaria de Verón in the Dominican Republic*, Advisor: Dillaha, Students: **Vivian Camacho, and JD McCoy**



See - [http://bsesrv214.bse.vt.edu/SeniorDesign/SD\\_09-10.htm](http://bsesrv214.bse.vt.edu/SeniorDesign/SD_09-10.htm) for details of project executive summary and poster presentation. If you have ideas for a future design projects that you would like to submit, please develop a brief description of the proposed project and send to Bobby Grisso ([rgrisso@vt.edu](mailto:rgrisso@vt.edu)).



2010 BSE Commencement Reception  
BSE Family & Friends



[http://bsesrv214.bse.vt.edu/SeniorDesign/SD\\_09-10.htm](http://bsesrv214.bse.vt.edu/SeniorDesign/SD_09-10.htm)

# Promoting Success in Agriculture for People w/ Disabilities

The Centers for Disease Control & Prevention reports that arthritis is the leading source of disability in the US. Arthritis affects approximately 1/3 of all adult farm and ranch operators and is considered one of the leading causes of disability by customers of the USDA AgrAbility Project. Arthritis can cause significant impairments to one's mobility, dexterity, capacity to lift heavy loads and emotional well-being due to unmanaged pain and other factors.



Arthritis is especially detrimental to farmers, ranchers, farm workers and their families and caretakers because of the nature of their work. Climbing grain bins, mounting and dismounting tractors or horses, baling hay, feeding livestock, harvesting vegetables, milking cows, and using heavy tools and machinery all require strength and mobility, which are lessened by the affects of arthritis.

Trauma to joints often occurs in agricultural settings. Such trauma may include the impact on joints when jumping off of tractors or combines, being kicked by large livestock, locking knees when riding in vibrating machinery, or the stress from constant bending when milking cows. This trauma increases the



joint stress and pain felt by many agricultural workers.

Since there is no known cure for arthritis, education and awareness of pain management techniques are considered the best practices for treating the disease. This includes, but is not limited to, joint protection, work simplification and stress reduction. Encouraging individual weight loss, promoting behaviors that reduce shock to joints, and modifying work-sites to eliminate high-risk tasks are significant to preventing joint damage. Thus, it's extremely important that agricultural professionals be kept abreast of the latest education and research based information on arthritis management to ensure their health and well-being.

With the average age of the American farmer climbing above 57, increasingly more farmers will find tasks difficult to complete.

Many agricultural workers do not know they may be at risk of developing arthritis.

Tasks such as lifting heavy objects, operating machinery, and working with livestock will become harder to complete as arthritis affects agricultural workers. However, removing these tasks from everyday life may not be an option for a farmer or rancher.

A few solutions can be implemented to help control joint stress and pain in farming situations.

- Wear quality, non-slip footwear
- Use appropriate assistive aids
- Use proper posture when sitting for long periods of time in tractors
- Use the largest joint possible to complete a task
- Avoid gripping and grasping for long periods of time
- Simplify jobs and tasks, and pace yourself throughout the work load

A farmer, rancher, or farm worker may continue to live a productive life in agriculture if they are willing to commit to controlling their arthritis by diet, exercise, modifying their work, and respecting the physical limitations of their bodies. Info from [www.arthritis-ag.org](http://www.arthritis-ag.org)

(B. Grisso)



<http://pubs.ext.vt.edu/442/442-083/442-083.html>

## Shoveling 101: How to Maximize Efficiency of Body & Task

As you know, shoveling most often affects the lower lumbar region of the back and your upper extremities - shoulders, elbows, wrists, and fingers. The majority of serious injuries while shoveling occur in one's back, so below are a few tips to help you stay healthy while doing all of the shoveling your chores require!

### General Tips

- First and foremost consider the way you are breathing while shoveling. Don't hold your breath - inhale upon putting shovel into ground/material and exhale on moving the material.
- Take frequent breaks.
- Drink plenty of water.
- Proper footwear is a must. Footwear assists you in getting and maintaining proper body

alignment & balance while shoveling.

- Be considerate to your hands - you only get one set. Wear gloves and if your hands start to hurt, take a break. If you do a lot of shoveling, I would highly recommend that you invest in a paraffin bath or some icepack gloves (some people prefer heat, while others prefer cold) to pamper your fingers and wrists.

### Body Tips

- Doing a few yoga-pose stretches prior to a shoveling task is a good idea. It sets the stage for awareness of breathing and alerts the body that it is going to work.
- Stand with your feet a comfortable distance apart and establish a good base to maintain your balance.

- Bend at your knees and tighten your stomach as you place the shovel into the material. Breathe. Keep stomach pulled in and lift/transport the material with your legs - not your back!
  - Position your hands at a comfortable distance apart. By keeping hands apart you also provide more leverage on the shovel to assist with task.
  - If you can avoid twisting your body while shoveling - it is easier on your back and upper extremities, so planning where to put the dirt/material prior to starting the task is something to keep in mind. If you are putting material into a wheelbarrow - place it in front of you, not to the side where you have to twist with each load.
- (B. Grisso)



# Growers Prepare for Hurricane Season

As the 2010 hurricane season nears, remind farmers to take necessary steps to help protect their farms, families and workers if a storm strikes. Planning now can help reduce the potential damage from hurricanes and tropical storms later. All farmers should review their plans and get ready for what could be an active storm season.

Hurricane season runs June 1-Nov. 30, and weather researchers have predicted 15 to 18 named storms forming in the Atlantic this year, with as many as 11 becoming hurricanes.

Farmers need to make preparations for their families, workers, equipment and buildings, and have

backup plans for electricity and drinkable water for their barns and other critical farm facilities. In addition, livestock operations should maintain emergency plans that address power needs and on-site feed capabilities.

Farmers should have a transfer switch properly installed so they can use a generator. A properly installed transfer switch is critical for the protection of farm facilities and utility workers.

*Planning now can help reduce the potential damage from hurricanes and tropical storms later. I encourage all farmers to review their plans and get ready for what could be an active storm season.*

The following tips should be considered for preparing farms for major storms:

- Store or secure items or equipment that might blow away.
- Identify places to relocate animals from low-lying areas.
- Check generators to be sure they are in good working order and se-

of farm and phone numbers, brands, paint markings on hooves or coat or clipped initials in the hair.

- Move feed to higher ground or to a more accessible place in case of flooding or transportation problems.
- Pesticide storage areas should be secure, and farmers in low-

lying areas should do whatever they can to elevate or move pesticides to locations that are less likely to flood.

- Coordinate with neighbors beforehand and discuss what resources can be shared. Examples include a backhoe or set of livestock panels.
- Keep a list of important phone numbers in order to make calls

following a storm. Examples include the local emergency management office, county Extension agent, insurance agent, county Farm Service Agency and private veterinarian.

- Monitor local weather reports for up-to-the-minute information on storms.

**For more information, go to:**

[www.ext.vt.edu/news/mediakits/emergencypreparedness.html](http://www.ext.vt.edu/news/mediakits/emergencypreparedness.html)

<http://www.vaemergency.com/threats/hurricane/index.cfm>

[www.ncagr.com/paffairs/stormprep.htm](http://www.ncagr.com/paffairs/stormprep.htm)



[www.ext.vt.edu/news/mediakits/emergencypreparedness.html](http://www.ext.vt.edu/news/mediakits/emergencypreparedness.html)

## Eliminate One Field Operation

As row crop budgets tighten and producers cover more acres, it's important to evaluate each field operation.

Tillage practices and operations are continually changing over time as equipment changes and new systems are developed. As we have experienced, fuel costs are currently rising and can represent a significant portion of the typical crop production budget. For this reason it is important that producers evaluate each tillage operation they make and determine if the benefits outweigh the costs or expense. By reducing the number of trips through the field, producers can save fuel and labor and reduce machinery costs and wear.

Numerous examples of producers reducing the number of tillage operations can be shared. As mentioned earlier, gross returns to crop production are related to yield. High yields, however, can be obtained with any of several well-managed tillage systems. As producers have changed from conventional to conservation tillage, they've eliminated trips across the field and in many cases with no effect on yield.

The question becomes, "What is the anticipated outcome of shredding stalks?" Is it to improve planting by reducing the residue in the row? Practice shows that if the planter is properly weighted and downpressure springs are used to keep the proper planting depth, there is no advantage

to removing the residue. Attachments are available for the planter to handle the residue at planting time if need be. Better yet, the combine can be used to process the residue at harvest time and eliminate the need for a shredding operation.

It is important that producers evaluate and analyze each tillage or field operation they make. Reducing operations can add to the producer's bottom line by reducing fuel, labor and machinery costs. When properly managed, yields are maintained and often increase due to the improved timeliness of the remaining operations.



## Ag Efficiency Reduces Environmental Impact

A new report shows improvements in agriculture's impact on the environment.

The Field To Market study demonstrates that during the past 20 years, ag industry "has become more efficient in utilizing resources and increasing productivity, which decreases its impact on the environment."

The survey quantified the impact of corn, soybean, cotton, and wheat production on land use, water use, energy use, soil loss, and the climate between 1987 and 2007. The plant science industry has made significant contributions to agriculture during this time period, which have

supported the following progress towards sustainable agriculture: Preserving topsoil through conservation tillage is enabled by herbicides, biotech crops, and direct seeding equipment. Conservation tillage can help reduce soil erosion by an estimated 50% to 98%.

Global fuel savings associated with switching to conservation tillage farming systems and less frequent passes in farm equipment over the field made possible by biotech crops and the use of broad spectrum herbicides have prevented carbon dioxide emissions equivalent to removing almost 500,000 cars from the road.

Since 1996, the permanent carbon

dioxide savings are equal to removing 2.05 million cars off the road for one year.

Crop protection products have reduced losses due to weeds, insects, and plant diseases, making agriculture more productive and a much more efficient user of land, water, and other resources.

Since the introduction of biotech crops in 1997, there has been a marked increase in the consistency of yields. The most detailed study to date shows that plant biotechnology helped increase US agricultural production 8.34 billion pounds on 123 million acres in 2005.

*(Source: CropLife International)*

Visit our website:  
<http://www.bse.vt.edu>

