Engineering Update

Biological Systems Engineering
September 2012

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
Every year the President signs a proclamation declaring the third week of September National Farm Safety and Health Week. It’s a great opportunity to bring attention to the importance of safety on the farm.

This year September 16-22 will be declared “Farm Safety and Health Week” with the theme of “Agricultural safety and health... A Family Affair.”

Presidential Proclamation -- National Farm Safety and Health Week

Every day, the lives of Americans are touched by the hard work and dedication of our Nation’s farmers, ranchers, and farmworkers. The food they produce through their tireless efforts fuels our Nation, nourishes our bodies, and sustains millions at home and around the globe. As we celebrate National Farm Safety and Health Week, we recognize the tremendous contributions of these individuals and rededicate ourselves to ensuring their safety and health at all times.

Our farmers, ranchers, farmworkers, horticultural workers, and their families and communities are among the most productive in the world. Our agriculture industry employs only a tiny percentage of the United States workforce, yet its yield is worth billions of dollars a year and supports the growth and development of the American economy. Agricultural producers are stewards of our natural resources and precious open spaces, and they are playing a key role in developing renewable energy and moving America towards energy independence.

To safely continue this important work, those in the agriculture sector must take special precautions in their daily tasks. Despite the great advancements in modern agriculture, farming remains a labor-intensive and sometimes dangerous occupation. America’s agricultural producers work in harsh weather conditions, handle dangerous chemicals and materials, and operate large machinery and equipment. I encourage these individuals and their families to conduct regular training on respiratory protection; proper handling and usage of pesticides and other hazardous materials; the inspection, maintenance, and safe operation of machinery and other equipment; and emergency response and rescue procedures. Additionally, farms and ranches with children or novice farmers should receive proactive health and safety instruction to prevent injury or illness.

By working together to ensure the highest standards of health and safety for our agricultural producers, we will build upon this vital industry and its contributions to make our Nation stronger, more secure, and more prosperous in the years to come.

BARACK OBAMA

(adapted by B. Grisso)
A recent August workshop held in Rocky Mount, VA focused on farm energy efficiency. Speakers highlighted tools and resources to help farmers identify and capitalize on energy efficiency improvements. All of the presentations, videos and additional resources from the workshop are posted online.

The workshop was hosted by Virginia Cooperative Extension in partnership with USDA Rural Development, USDA/NRCS, and Virginia Farm Bureau/Virginia FAIRS. The workshop was part of a larger multi-year project funded by a grant awarded to Virginia Cooperative Extension by the Virginia Tobacco Indemnification and Community Revitalization Commission to assist farmers to identify improvements with energy usage and options for more efficient equipment and systems. The workshop was organized by VCE faculty: Walker, Martel & Ignosh.

(by J. Ignosh)

http://ww2.bse.vt.edu/green/Workshops/From%20Energy%20Audit%20to%20Funding.htm
Researchers consider how lighting improvements have impacted productivity and predict that LED lights are poised to take over as the next, more efficient lighting source.

Researchers suggest that the biggest gains that resulted in advances in efficient lighting are represented not only in energy savings, but in increased productivity.

Over the course of history, advances in primitive lighting sources – from candles to gas lamps to electric bulbs – led to increased light consumption rather than lower overall energy use. Workers no longer had to call it a day shortly after nightfall, and instead could continue to work at night with the help of lighting.

Researchers recently predicted that light-emitting diodes (LEDs) are poised to take over from the Edison light bulb as the next, more efficient light source of choice. While the focus on advances in lighting generally surrounds the potential energy savings these new lights can offer, instead drew attention to the increased productivity that was possible with better lighting.

With their article, “Rebound Effects for Lighting,” in the journal Energy Policy, the researchers strive to clear up misconceptions that their earlier research created. Namely, their original findings in 2010 were misinterpreted to suggest that efficiency improvements in lighting actually were not improvements at all because reductions in neither overall energy usage nor overall lighting costs would occur.

While the researchers did highlight that historically, improvements in lighting have led to increased light consumption rather than lower overall energy use by society, they were not setting out to discount the strides taken in energy-efficient lighting. Rather, their efforts were focused on how better, more advanced or more efficient lighting could lead to increased productivity.

Researchers thought that many in the energy economics community were still unaware of the work, and of the benefit – even when there is no direct energy-use savings – of energy efficiency and other welfare-enhancing technologies.

Improve visual ergonomics at work:

1. Use blinds or drapes on windows in order to eliminate bright light. They should be adjusted during the day to allow light into the room without being able to see the bright light directly. Natural light is not a dependable light source and it changes all the time.

2. If task lighting is used, it should be directed so that it illuminates the task field or paperwork, but does not bounce up into the eyes or onto a computer screen.

3. Indirect lighting systems often provide the best visual environment.

4. Wear a visor or cap to shield eyes from bright overhead lights.

5. Reorient workstations so that bright lights are not in the field of view.

(Continued on page 5)
Klein E. Ileleji is an Associate Professor & Extension Engineer for the Department of Agricultural & Biological Engineering at Purdue University, West Lafayette, Indiana. He was born at Kaduna, Nigeria and his education includes agricultural engineering (1992) from University of Ilorin, Nigeria; MPS, applied economics and business management from the Institute of Economic Studies in Nitra, Slovakia and a PhD in agricultural engineering from Slovak Agricultural University, Nitra, Slovakia.

**Klein’s projects?** Klein’s current research effort focuses on three primary areas:
- Logistics and particle technology for biomass feedstocks - developing biobased carriers from biomass, developing improved feeding/conveying systems for biomass feedstocks, and developing efficient logistics systems for biomass feedstocks.
- Post-harvest engineering of wet biofeedstocks - mycotoxin reduction in wet co-products and improving the shelf-life of wet co-products.
- Food security - developing a low-cost crop dryer for small-scale farmers in developing countries, developing improved methods for storing grains in the humid tropics, and capacity building in the commodity grain sector in sub-Saharan Africa.
- Global engineering design - working with a team of faculty and students to help develop a small hydropower station in a rural community in Cameroon, an EPA-P3 funded Phase-II project.

**What drew you to agricultural and biological engineering (ABE)?** Ag and biological engineering wasn’t my first career choice initially; aviation was. However, the major driver for me choosing ABE as a profession is the impact the profession has on current global challenges. Having grown up in an environment where you see hunger and poverty around you, you can’t help to think about what you can do to make a change and impact many lives, most of whom depend on the land as their source of livelihood. It is obvious ABE stands out from this perspective. For example, of the eight U.N. Millennium Development Goals, five are directly impacted by the efforts of our profession. So, we have an opportunity to make an impact globally.

(ASABE.org)

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**Light on Productivity (cont.)**

(Continued from page 4)

6. Avoid white reflective surfaces. Desktops and tabletops should have a matte, medium-reflective surface.
7. Ceilings should be painted white and walls should be medium light.
8. Turn down lights around computers - too much room illumination makes the room too bright in comparison to the computer - and turn off fluorescent light fixtures that are in an employee’s field of view and are bothersome. But be considerate of the effects on other employees.

(Adapted by B. Grisso)
GPS-based yield data has proven to be an extremely valuable management tool on many farms. However, improperly calibrated yield monitors can essentially generate difficult to interpret or useless data.

Economic risk in agriculture has increased dramatically. Considering the amount of economic risk involved in each decision, taking the time and patience to properly calibrate a yield monitor is essential if the yield data will be used to make future agro-nomic decisions for your farming operation.

Most yield monitors operate on the same basic principles. Yield monitor manufacturers strive to build accuracy into their units; however, each machine has its sources of errors.

Proper calibration requires harvesting 3 to 5 separate calibration loads. Each load should represent different flow rates. This can be easily accomplished by harvesting at different speeds (i.e. 3 mph, 3.5 mph, 4 mph, 4.5 mph, 5 mph, etc.). The different flow rates represent different yield levels to the yield monitor. Additionally most manufacturers recommend that the calibration load weigh between 3,000 to 6,000 pounds, approximately 50 - 100 bushels. Each load should be individually weighed in a weigh wagon or other accurate scales. If one load appears to be uncharacteristically high or low, redo that load before completing the calibration.

Check the accuracy of your yield monitor throughout the harvest season. To insure consistent data additional calibrations may be necessary. Multiple calibrations are essential in higher moisture grain. For example corn at 25% moisture moves through a combine much differently than corn at 17% moisture.

**Other important tasks:**

- Calibrate for each grain type.
- Calibrate grain moisture sensor
- Calibrate temperature sensor

In addition to measuring yield, these systems allow for the recording of crop moisture, elevation, variety, and a number of other harvest variables.

Maps depicting yield variations across fields can be developed and used to provide farm management decisions to improve crop productivity.

However, for the information produced from yield monitors to be accurate and reliable, calibration is the most important step whether you are collecting data for yield maps and management or are just interested in seeing the instantaneous yield as you move across the field.

(adapted by B. Grisso)
New Factsheets: Lawncare Safety

New series of BSE factsheets focused on the safety of youth workers in lawncare (green industries) has been posted. The 5 factsheet 2-pages in length are entitled:


Each of these factsheets cover the general safety information such as individual and crew safety by using correct PPE, proper use of and maintenance of lawncare equipment.

These factsheets will be part of a total training curriculum that will consist of training manuals for instructors and online training modules. The lawncare training guides will be come soon and will be titled:

- Protecting Youth Workers: Lawncare Training Guide
- Hand Tools Safety: Lawncare Training Guide
- Powered Hand Tools Safety: Lawncare Training Guide

The training modules also contain an on-line test that supervisors can use for support of their on-going safety training. Three of five modules have been drafted and they can be found at:

http://connect.ag.vt.edu/safe-utv/
http://connect.ag.vt.edu/safe-mower/
http://connect.ag.vt.edu/safe-pools
http://connect.ag.vt.edu/safe-h-tools
http://connect.ag.vt.edu/safe-tractor

(by B. Grisso)

New Factsheet: Turf Application

New BSE factsheet entitled: "Accurate Application and Placement of Chemicals on Lawns," has been posted. Pesticides and fertilizers used in landscape management are normally applied as a liquid through spray equipment, or as a granular formulation through dry application equipment. Each method and type of equipment has advantages and disadvantages. Selection of specific application equipment depends upon economics, availability, and suitability for the intended use. This factsheet focuses on the accuracy and uniform application of agro-chemicals.

(by B. Grisso)

Storm Safety: Preparedness

Lightning, heavy rainfall and high winds accompany the nearly 100,000 thunderstorms that occur annually in the US. These storms can result in injuries, loss of life and property damage.

The warm, humid conditions of the spring and summer seasons greatly favor the development of thunderstorms, though thunderstorms can occur at any time of year. Thunderstorms may occur singly, in clusters or in lines and usually only produce heavy rain for a brief period of time ranging from 30 minutes to an hour. However, the most severe thunderstorms can affect one location for an extended period of time. At any given time, nearly 1,800 thunderstorms simultaneously are occurring on the Earth (American Red Cross, 2012), and can develop into conditions such as tornadoes and damaging hail. Lightning strikes can be fatal, and there also is a variety of permanent injuries employees can develop as a result of a lightning strike. These injuries can include – but are not limited to – muscle spasms, chronic pain, sleep disorders, memory loss and fatigue (National Weather Service [NWS], 2012). According to NWS, lightning kills more than 70 people and injures at least 300 others each year in the US. In 2012, there have been at least five reported fatalities attributed to lightning strikes in the US.

Due to the immense amounts of rainfall that can occur during thunderstorms, flash flooding also accounts for roughly 140 fatalities each year in the US, according to the FEMA. The deaths that occur during flash flooding are greater than any other hazard associated with thunderstorms. And the destruction due to thunderstorms does not stop there. When severe high winds are present, homes and automobiles also can be damaged. High winds can knock down trees and utility poles, which can cause extensive power outages and account for a handful of deaths each year.

How Thunderstorms and Lightning Develop

As thunderstorms progress, they go through a series of stages that can be described as development, mature / growth, electrification and dissipation. Pockets of warmer air begin to rise into the atmosphere early in the day, due to solar heating the air near the ground. These pockets of air then begin to form cumulus clouds. The formation of these clouds may be the first sign that a thunderstorm is developing. The final stage of development occurs as the cloud cools to a point where it may no longer rise and is forced to spread out, which is what gives these clouds their anvil shape.

(Continued on page 9)
As additional warm air continues to rise, the cloud continues to grow and precipitation begins to form within the thunderstorm cloud. Well-developed thunderstorm clouds contain minute ice crystals in the upper levels of the cloud, a mixture of ice crystals and small hail in the middle levels of the cloud and a mixture of rain and melting hail in the lower levels of the cloud. These various types of precipitation collide due to air movement in the middle of the cloud and cause the precipitation particles to become charged.

Lighter ice crystals develop a positive charge and are carried by updrafts into the upper part of the storm. A negative charge is then developed by the heavier hail, and is either suspended in the air by the updrafts or falls toward the lower part of the storm.

Air between the positive and negative charges in the cloud acts as an insulator, but the differences in charges become too great at times, which results in a breakdown of the insulating capacity of the air. Lightning is created as the charges in the air are broken down and result in a rapid release of electricity. Lightning can move in many more ways than just from clouds into contact with the ground; lightning also can move from cloud-to-cloud, within a cloud or cloud-to-air.

**Safety for the Workplace**

Thunderstorms and lightning can be a significant issue for employees working outdoors. The risk of being struck by lightning increases when individuals are outdoors near isolated tall objects, in open spaces and close to metal objects. Proper thunderstorm and lightning safety procedures or guidelines should be contained in an emergency action plan, which should address several areas, such as:

- A chain of command;
- A means of monitoring weather conditions;
- A list of designated safe sites to take shelter;
- Criteria for suspension and resumption of work; and
- The use of recommended safety strategies.

**Safety Precautions**

A person’s chance of being struck by lightning are estimated to be 1 in 600,000 by FEMA, but can be reduced by following some proper safety precautions. If you are isolated and your hair stands on end (which indicates that lightning is about to strike), then crouch low to the ground on the balls of your feet. Place your hands on your knees and your head between your knees to minimize your body’s surface area and minimize your contact with the ground. Lightning current often enters a victim through the ground rather than by a direct, overhead strike. Keep safety in mind when a thunderstorm begins to stir – know how to prepare before, during and after a thunderstorm.

It is important to establish an emergency action plan that prepares workers for the appropriate action to take during a thunderstorm. All workers should be trained on these procedures so they know how to properly respond to an approaching thunderstorm. Consider these safety measures to be prepared for thunderstorms:
- Monitor the daily weather forecast to be aware of thunder-storm watches and warnings.
- Know the signs that a thunder-storm is approaching; listen for thunder in the dis-
Storm Safety: Preparedness (cont.)

(Continued from page 9)

tance and look for dark clouds, rain, high winds and lightning.

- Follow all company procedures regarding working outdoors during thunderstorms.
- Remove any dead or rotting tree branches that could fall and cause injury or damage.
- Postpone any outdoor work, if possible, when a thunderstorm is nearby.
- Secure outdoor objects that could blow away.

Even when inside a safe shelter, be cautious during thunderstorms. Keep informed on the weather forecast, avoid using electrical equipment and corded telephones if possible and unplug any electronic equipment. Keep away from plumbing and bathroom fixtures as they can conduct electricity. While driving, if it begins to hail or rain heavily during a thunderstorm, safely pull over to the side of the road, turn on the emergency flashers and park the vehicle until the storm calms down.

The best way to protect yourself from thunderstorms is to avoid the threat. If you are caught outside during a thunderstorm, take shelter in a substantial, permanent, enclosed structure that contains plumbing or wiring (i.e., such as a home, office building, school, church, or shopping center). If such a place is unavailable, then select an enclosed metal vehicle for a suitable shelter. Do not seek shelter in open areas, on high grounds, under tall isolated objects (trees, poles), under picnic shelters, in carports, tents or near materials that can conduct electricity (metal objects, utility lines and water). Make sure the place you choose for shelter is not prone to flooding during heavy rains, and go to a low-lying, open place, away from trees, poles and metal objects that is not susceptible to flooding when no other safe cover is available.

After a Thunderstorm
Safety is still a priority after a thunderstorm. Remember to follow the 30/30 rule. This rule is important to follow because 50 percent of lightning-related injuries happen after the thunderstorm has passed.

After seeing lightning, go indoors if you cannot count to 30 before hearing thunder. Stay indoors for 30 minutes after hearing the last clap of thunder. Continue to monitor the weather for storm updates by listening to a local radio station or television station. Use generators outdoors and on a flat level surface if a power outage occurs to avoid exposure to carbon monoxide. Stay away from any downed power lines and areas damaged by the storm.

Assist others if they have been struck by lightning or need help. Call your local emergency number and remember, people who have been struck by lightning do not carry electrical charge and are safe to handle and assist. Give first aid; if breathing has stopped, begin rescue breathing, and if the heart has stopped beating, a trained person should give cardiopulmonary resuscitation (CPR).

Thunderstorms and lightning are more prevalent during warm and humid conditions, but still can arise during any other time of year. Taking the necessary steps to prepare yourself before, during and after a thunderstorm will help to ensure your safety and the safety of others.

(adapted by B. Grisso from EHSTday.com)
Manage Harvest To Curb Traffic Damage, Compaction

When harvesting alfalfa, minimize wheel-traffic damage by avoiding unnecessary trips across the field. University of Wisconsin research revealed that the amount of damage is related to the amount of regrowth when the crop is driven on. Research showed a 4-6% yield reduction when alfalfa was driven on one day after mowing, and 20% when wheel traffic happened five days after cutting.

Soil compaction from tractors and manure spreaders also reduces alfalfa productivity and persistence. Compacted soil reduces pore space and hinders fine root growth. Lower field areas usually are most susceptible to compaction because the soil is wetter and tends to have more silt and/or clay compared to higher areas.

Five management practices to minimize alfalfa damage caused by wheel traffic and compaction:

1. Harvest as quickly as possible after mowing, using wide swaths to speed drying, to avoid traveling on alfalfa regrowth.
2. If applying manure, apply it as soon as possible following harvest, always before regrowth, and avoid spreading on wet fields.
3. Utilize controlled-traffic patterns to minimize the field area traveled on. For example, utilize the same area of the field to the extent possible when entering and exiting the field with trucks or forage wagons.
4. Consider planting traffic-tolerant alfalfa varieties.
5. Avoid using dual-wheel tractors on alfalfa fields, and try to utilize lighter-weight tractors when merging, raking, etc.
The two-stage hydraulic pump is commonly used to demonstrate hydraulic systems. Unfortunately, many textbooks do not provide a good explanation of how the pump works. The two-stage hydraulic pump is frequently used in log splitters.

A two-stage hydraulic pump provides an excellent source of cylinder speed and cylinder force with a relatively small amount of engine power. The following components are typically found in a log splitter application:

- Double-acting cylinder (B)
- Directional control valve (C)
- Pump (D)
- Power Source (E)
- Check valve
- Unloading valve
- Main system relief valve
- Reservoir
- Filter

Some splitters use a suction filter, while others place the filter on the return line. The housing of a two-stage pump contains two pumps: a large volume pump and a low volume pump. The unloading valve, an additional and necessary component, may also be located in the housing. The large volume pump gives the machine a high flow capacity at a low pressure setting. This low pressure setting is established by the unloading valve. The low volume pump provides the machine a high pressure capability that is governed by a relief valve.

The two-stage pump is unique in that it allows a hydraulic system to produce either high flow or high pressure, which can be powered with a moderately sized engine. Typical power sources of log splitters range from 5 to 12 hp. To provide both high flow and high pressure at the same time, the system would require a significantly higher amount of power.

The hydraulic power equation is a function of two factors, pressure (psi) and flow (gpm). If the log splitter requires an increase in flow or pressure, then the splitter requires a corresponding increase in engine horsepower.

\[
\text{Power (hp)} = \frac{\text{gpm} \times \text{psi}}{1,714}
\]

For example, consider using a conventional single-stage pump that supplies a log splitter a capacity of 14 gpm and up to 4,000 psi. To simplify this example, assume that the hydraulic system is 100% efficient. This splitter would require an engine horsepower of:

\[
\frac{14 \text{ gpm} \times 4,000 \text{ psi}}{1,714} = 32 \text{ hp}
\]

As stated earlier, a log splitter uses a two-stage pump that provides a hydraulic system with either high flow or high pressure. For example, the high volume pump might provide a flow rate of 12 gpm. This flow is used to provide fast cylinder extension and retraction while the cylinder is operating under no load. The unloading valve will regulate the large volume pump at a low pressure value, for example 300 psi.

When the cylinder reaches a (Continued on page 13)
While the unloading valve is diverting the high volume pump flow to the tank, the small volume pump flow provides oil to the cylinder at a much higher pressure capability. Note that the check valve is used to ensure that the low volume pump (high pressure pump) can provide oil to the hydraulic system, rather than being diverted back to the tank.

The low volume pump flow provides a high pressure capacity that is necessary to split logs.

The relief valve allows the system to build high pressure, for example 4,000 psi. Even though the low volume pump might only provide a minimal amount of flow, for example 2 gpm, once the log initially splits, the pressure often drops, allowing both pumps to then supply maximum amount of oil flow to the cylinder at a lower pressure setting (for example, below 300 psi).

Using the hydraulic power equation shows that a two-stage pump requires significantly less horsepower. For this example, presume the splitter is attempting to split a log. What would be the engine horsepower requirement, assuming the system is 100% efficient?

High volume pump:
\[
\frac{12 \text{ gpm} \times 300 \text{ psi}}{1,714} = 2 \text{ hp}
\]

Low volume pump:
\[
\frac{2 \text{ gpm} \times 4,000 \text{ psi}}{1,714} = 4.7 \text{ hp}
\]

Total engine power would be:

\[
\text{high volume pump} + \text{low volume pump} = 2 + 4.7 = 6.7 \text{ hp}
\]

It is easy to see why manufacturers use two-stage pumps for log splitters: A customer is more likely to purchase an economical log splitter powered by a 6.7 hp engine, rather than a more expensive log splitter powered by a 32 hp engine.

(adapted by B.Grisso from Tech Direction magazine)
NEW “SAFE IMPLEMENT HITCHING” GUIDE
Lost the operator’s manual to your tried and true older tractor? Wondering how to safely tow an older implement with your new high-speed tractor? Find the answers to these and other farm equipment hitching questions in a new guidebook – “Safe Implement Hitching.”

Prairie Agricultural Machinery Institute (PAMI) assembled a team of farmers, engineers and machinery experts to produce the guidebook. Over the years, many questions from farmers who wanted to hitch their older equipment safely, has spurred the development of a new comprehensive guide. The 42-page “Safe Implement Hitching” guidebook is written in farmer-friendly language featuring color photos, illustrations and simple tables of data. Obtain a copy to use as a supplement for tractor and implement operator’s manuals. “Safe Implement Hitching” is available as a free, downloadable PDF (link below). It will also be made available to farm safety organizations across Canada and the USA.

Why is hitching safety important?
- Accidents can injure, disable, and kill
- Accidents can be very costly
- Accidents can be avoided

Example of proper hitching is illustrated in the picture below.

(by B. Grisso)

http://www.pami.ca/pdfs/safety/sih_guide_Final.pdf
Tractor Implement Stability & Ballasting

It is important that the tractor be properly ballasted. Ballast consists of ensuring the tractor has sufficient weight and proper weight distribution.

- Although ballast may be needed to counterbalance certain loads, it also plays an important role in achieving uniform traction, preventing excessive wheel slip, and preventing “wheel hop” when the tractor is pulling hard.
- There are several means of ballasting. Fluid ballast (weight) consists of filling the tractor tires with a fluid such as calcium chloride. Other options include metal (cast iron) weights that can be added to the wheels (attached to the axle or rims) and cast iron “suitcase” weights that can be hung on brackets, usually at the front of the tractor.
- Improper ballast can also have a negative effect. Over ballasting (too much weight or in the wrong place) can overload tractor components, use extra fuel and engine power that results in poor performance such as sluggish engine response when under load, difficulty starting under load, and may cause extra wear and strain on critical drive components.
- Ballasting is best done by qualified technicians who have the proper tools, relevant guidelines, and personal experience.
- For information, the following table provides approximate weight distribution guidelines, but always follow the tractor operator’s manual to properly ballast your tractor:

<table>
<thead>
<tr>
<th>Tractor/Implement Type</th>
<th>Weight Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two-Wheel Drive, Trailing Implement</td>
<td>25% Front 75% Rear</td>
</tr>
<tr>
<td>Two-Wheel Drive, Semi-mounted Implement</td>
<td>30% Front 70% Rear</td>
</tr>
<tr>
<td>Two-Wheel Drive, Mounted Implement</td>
<td>35% Front 65% Rear</td>
</tr>
<tr>
<td>Front-Wheel Assist, Trailing Implement</td>
<td>40% Front 60% Rear</td>
</tr>
<tr>
<td>Front-Wheel Assist, Mounted Implement</td>
<td>45% Front 55% Rear</td>
</tr>
<tr>
<td>Four-Wheel Drive, Trailing Implement</td>
<td>55% Front 45% Rear</td>
</tr>
<tr>
<td>Four-Wheel Drive, Mounted Implement</td>
<td>60% Front 40% Rear</td>
</tr>
</tbody>
</table>
Limiting Power Hop

One factor that can severely inhibit productivity is power hop - a bouncing effect a tractor can experience when pulling a high draw-bar load. By understanding what causes power hop, farmers can better diagnose the problem and make minor adjustments to correct it.

In farming, productivity means profitability, and when a tractor isn’t performing like it should, it could mean lost dollars. One factor that can severely inhibit productivity is power hop.

One of the major causes of power hop is unfortunately out of the farmer’s control—soil type. Power hop has been shown to be most common in dry, loose soils, where traction is harder to obtain than in a moderate moisture soil. Fortunately, other known causes of power hop can be addressed through adjustments to overall tractor weight, weight distribution and tire inflation pressures.

Overall tractor weight
Insufficient overall tractor weight for the horsepower is one of the major causes of power hop. Every tractor manufacturer has different recommendations on weight-to-horsepower ratios, but these recommendations generally fall somewhere between 100 pounds per horsepower (lbs/hp) and 145 lb/hp. In other words, a 450-hp tractor should weigh somewhere between 45,000 and 65,250 lbs.

Where your tractor falls within this range is dependent upon average speed during heaviest draft operations and whether the tractor is a mechanical front wheel drive (MFWD) or four wheel drive (4WD).

As a general rule, the slower the average speed of a tractor, the higher the lbs/hp ratio should be. MFWD tractors generally have a higher recommended lbs/hp ratio than 4WD tractors. So, a 4WD tractor traveling at high average speeds (5.5 mph or more) should fall within the lower end of the aforementioned lbs/hp ratio spectrum, whereas a MFWD tractor traveling at low average speeds (4.5 mph or less) should fall within the higher end of the spectrum.

To determine the most appropriate lbs/hp ratio for a tractor, it’s best to consult with the tractor manufacturer, as each company’s recommendation will differ slightly based on type of tractor and average speed. If it is ultimately determined that the tractor is underweight, it is recommended that the farmer add cast ballast to achieve the proper ratio. Liquid ballast has been shown to increase tire stiffness, which can increase susceptibility to power hop.

Weight distribution
Even more important than overall tractor weight is the way the weight is distributed between front and rear axles. Without proper weight distribution, a tractor is far more susceptible to the bouncing and swaying motions of power hop. Similar to overall tractor

(Continued on page 17)
weight, proper recommendations on weight distribution will again differ between MFWD and 4WD tractors.

The general rules see the article on Tractor Stability.

One important thing to consider when adjusting weight distribution, however, is that adding weight to an axle also increases overall tractor weight.

Tire inflation pressures
Inflation pressures can also play a part in susceptibility to power hop. As a general rule, the stiffer the tire, the more susceptible the tire will be to power hop. So, for optimum performance, it is recommended that farmers adjust their inflation pressures to the lowest possible pressure for the static load, as recommended in the Tire and Rim Association’s inflation pressure tables.

Tire size has been shown to influence susceptibility to power hop, simply because size dictates recommended inflation pressures. The larger the tire, the larger its air chamber, which means it can carry a load at lower inflation pressures than a smaller tire.

The lower the inflation pressure, the less stiff the tire, and the less susceptible the tractor will be to power hop. So, for optimum tire performance, it is recommended that farmers select the largest possible tire allowable for the equipment.

What to do if still experiencing power hop
If all of the aforementioned guidelines have been followed for adjusting overall tractor weight, weight distribution and tire inflation pressures, but power hop is still occurring, the farmer should consult with the tractor manufacturer for advice on next steps. These recommendations will often include raising front inflation pressures and/or removing weight from the front axle in order to shift the tractor’s center of gravity toward the rear of the machine. Every scenario is unique and every machine is unique, which is why manufacturers’ recommendations will vary slightly based on factors such as tractor type, soil type and average speed.

Bottom line
Power hop inhibits productivity in the field, and although one of its main causes is soil type, its other causes can be controlled through proper adjustments. By ensuring overall tractor weight, weight distribution between the axles and tire inflation pressures are at the manufacturers’ recommended levels, farmers can limit the effects of power hop and remain productive in the field.

Video Clips: http://filebox.vt.edu/users/rgrisso/Hop/hop_video.htm
The agricultural working population is aging. About 50% have significant mobility problems, including issues of getting on and off of agricultural vehicles. Consequently, there is a need for affordable, improved-safety, off-road vehicle lifts for disabled (including paraplegic) and/or aging agricultural workers.

Many commercially vehicle lifts have focused on powered lifts. Lifts using electric-actuator based systems are moderately high cost because few actuator suppliers are willing to certify their actuators for human lifting. Such bottlenecks in the development effort are the primary motivation for a human powered lift. Such lifts may provide auxiliary advantages such as physical therapy and exercise, and may have environmental sustainability benefits. Additional advantages of human powered lifts include increased reliability because of elimination of power-source failures and potential convenience in off-site lifting.

In 2006-2007, a concept was developed for a human-powered lift for a wheelchair user. The concept was made by a student capstone project design team from Portland State University, Oregon. Their objectives for the human-powered lift were compact assembly and suitable for a small apartment. The project requires the team to build a small functional device that will lift a person from the floor (2”) to the height of a wheelchair or walker (24”-30”). The device was firmly mounted to a wall, and be powered by the person being lifted. Their final design was a manually operated, hydraulically-driven scissor-lift arrangement with a bottle jack (Figure above). During the prototype test, the design failed to meet the lifting capacity goal of 113 kg.

Currently, two mechanical engineering teams have been formed to develop two concepts for their Mechanical Engineering capstone design project. The first team will develop an “arm-powered” lift for farmers that have upper-body mobility. The other team will develop a “leg-powered” lift for farmers with lower-body mobility.

The teams are encouraged to incorporate current popular design themes. These include a “universal design” approach that generates the more innovative and popular products. A universal design for the lifts will make the lifts inherently accessible to both people with and without disabilities. Secondly, environmental sustainability (in material selection, for example) will be incorporated, in keeping with popular sustainability trends such as “human-cars.”

Finally, a user will be given the option of “exercise-as-you-work” and therapy guidelines, allowing users of the lift to get exercise and therapy as they physically power the lift. Just as there is often resistance to health-related activities, some user-resistance is anticipated in employing the built-in exercise mode. The teams will be charged to investigate “marketing” schemes to promote the “exercise-as-you-work” option.

(by D. Ohanehi & B. Grisso)

http://www.docstoc.com/docs/74770345/Personal-Mobility-Lift-Chair
Steps to Preparing Bins and Equipment for Harvest

Grain harvested is essentially insect-free, but can become infested by storage insects, which originate in or around the bin or in contaminated equipment such as combines and grain augers. Take time now to clean and prepare bins for this year’s grain by following these tips:

Start with Clean Grain and Equipment
First, be sure to store sound, clean, dry grain. It may be advisable to screen out broken grains, trash and fines to increase the quality of the final storage product. Also, the elimination of trash will enhance fumigation, should this procedure be required later.

Since stored grain insects can invade new grain from infested harvesting and handling equipment (combines, augers, etc.), cleanup is essential. Carefully remove all traces of old grain from combines, truck beds, grain carts, augers, and any other equipment used for harvesting, transporting, and handling grain. Even small amounts of moldy or insect-infested grain left in equipment can contaminate a bin of new grain. Then clean grain bins thoroughly, disposing of spilled, cracked, and broken grain and grain flour, along with the insects feeding on such material. A simple broom and a vacuum cleaner are essential pieces of equipment in cleaning grain bins.

“How clean is clean enough?” is a question many producers ask. A good rule of thumb to follow when cleaning bins and equipment is: If you can tell what was stored or handled last season by looking in the auger, bin, or combine, it is not clean enough to prevent re-contamination of the new crop.

Clear Away Clutter, Landscaping Near Bins
Around the bins, be sure to remove old equipment, junk, and clutter to make the area less attractive to insects and rodents. Make sure that the bin is insect and rodent-proofed by plugging holes, sealing bins, caulking, and making general repairs. Grain spilled near the bin attracts insects and draws mice and rats. Clean up and dispose of any spilled grain several weeks before harvest. If rats have tunneled under foundations, use baits or traps to reduce or eliminate them. Tall weeds can harbor insects and provide cover for rodents. Mow around the bin site to remove tall grass and weeds to reduce the potential for insect and rodent infestation. If necessary, re-grade the site so that water readily drains away from bin foundations. One cannot always wait for the soil to dry before loading or unloading grain from bin sites. Make certain that travel lanes have enough rock or gravel to bear the weight of heavy trucks and grain carts.

Landscaping should be maintained well away from grain storage facilities. Leave a 4-foot wide strip of bare gravel around the perimeter of storage bins. If buying old crop grain for storage with newly harvested grain, watch for insects in the incoming grain. If infested grain is purchased for livestock feed, store it away from the new crop and feed it as soon as possible. Grain stocks may be rotated or moved and a grain protectant applied at the time of turning.

Manage Grain Conditions to Reduce Insect Problems
Stored grain insects cannot live on extremely dry grain (less than 10%); however, it is impractical to reduce grain

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Steps to Preparing Bins (cont.)

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moisture much below minimum moisture levels necessary for long-term storage. Insect activity and reproduction are favored, however, by high grain moisture (14% or more), especially when condensation and molds occur, and fermentation raises temperature in the grain mass.

Spoilage and internal heating allow insects to remain active even in winter. Manage aeration to manipulate grain temperature. Since insects are "cold-blooded," they are not active much below 50°F, and grain cooling can be particularly important in reducing insect reproduction. Condensation of moisture in the grain mass is prevented by slow cooling and gradual reduction of the gradient between the grain mass temperature and the outside (ambient) temperature.

Check and Repair Mechanical Areas
A bin of 19% moisture corn with a starting temperature of 75°F can lose a full market grade in about five days if the aeration system shuts down, allowing the grain to heat and deteriorate. Electrical system maintenance before harvest can prevent costly downtime. Wiring for fans and other electrical components should be inspected for corrosion and cracked, frayed, or broken insulation. Exposed wiring should be run through waterproof, dust-tight conduit. Avoid kinking the conduit and make sure all connections are secure.

Mice often nest in control boxes where they are protected from predators. They can strip insulation from wires for nest material and their urine sometimes causes corrosion on relays and other electrical components. If rodent damage is found, clean and repair or replace damaged wiring, relays, and other electrical equipment. Then seal over knock-outs and other openings that may permit rodent entry.

Fans, heaters, transitions, and ducts should be checked for corrosion and other damage. Remove any accumulated dust and dirt that may reduce operating efficiency and be sure all connections are tight to prevent air leaks that can reduce operating efficiency.

Treatment of Bins and Stored Grain Insects
Once empty bins have been thoroughly cleaned, a residual treatment may be applied to bin surfaces to protect incoming grain from insect infestation. Follow label instructions carefully. The following materials are listed for empty grain bin surface treatments:

- silicon dioxide, also known as diatomaceous earth - available under many brand names
- Butylcarityl + Pyrethrins - available under many brand names. Related chemicals include Bifenthrin (Capture) and Pybuthryn (Butacide, Pyrene Crop Spray).

For bins with false floors, which are inaccessible for cleaning, chloropicrin, a bin "clean-out" fumigant, is legal to use, prior to binning the grain.

Other fumigants that could be used on empty bins would be magnesium phosphide and methyl bromide.

Caution! Fumigants are dangerous, restricted-use pesticides and may require gas monitoring devices and respirator protection for the applicator. It is highly recommended that fumigation be done by a commercial pesticide applicator who has been trained and EPA/NDA-certified in safe fumigant handling and application techniques. Refer to current labels for specific details and instructions.

http://lancaster.unl.edu/ag/crops/storage.shtml

(adopted by B. Grisso, from University of Nebraska)
For many social, political, and economic reasons, biofuels are moving quickly from the fuel of tomorrow to the fuel of today. Researchers are working on new systems of biofuel production that involves on-farm processing of biomass.

Below are emerging concepts that could have a great impact on agriculture and the fuel-production industry.

**What are Biofuels?**

Biofuels are fuels produced from biological source materials (feedstock). Many types of biofuels exist. Most people are familiar with ethanol that is made mostly from cornstarch, sugar cane or sugar beets. Ethanol is similar to gasoline, and most of the US gasoline supply is a blend of at least 10% ethanol. Biodiesel is another biofuel that is becoming more prevalent for use in diesel. Biodiesel commonly is made from oil feedstock, such as soybean or other vegetable oils, but also can be produced from waste cooking oil or animal fat.

Federal mandates that at least 9% of the US gasoline and diesel fuel supplies in 2012 will be from renewable sources, and that requirement will likely increase every year. Also, there is a cap on the amount of ethanol that can come from corn sources. Therefore, other sources such as biomass for our renewable fuels are needed.

**Biofuels from Biomass**

Recent effort has been focused on the use of biomass for energy. Biomass is any kind of plant material that can be used for energy. Biomass can be combusted for thermal energy, for example, using firewood to heat a home or co-firing bales of grass biomass with coal in power plants to create electricity. Biomass can also be converted to liquid fuels such as ethanol or bio-crude oils.

One of the main challenges of using any biomass for production of biofuels is its relatively low energy density (the amount of energy per ton of biomass). As an example, a 3’x4’x8’ rectangular bale of corn stover or wheat straw, which weighs about 1,000 pounds, could potentially produce about 40 gallons of ethanol. That means a tractor-trailer load of bales (about 25 bales) would produce about 1,000 gallons of ethanol. By comparison, a semi fuel tanker holds about 7,500 gallons of fuel. The bottom line is that it takes about eight truckloads of biomass to produce one truckload of transportation fuel.

**The Old Way**

The few biomass-to-ethanol conversion systems that have been developed require the biomass to be hauled to a centralized processing facility where it is converted to ethanol. The byproducts of the conversion must then either be hauled back to the farms for land application or disposed of in some other way. Depending on the proximity of the farm to the processing plant, this transportation of low energy-density products makes the current systems inefficient and costly.

**Emerging Concepts**

New concept being explored involves some on-farm or near-by processing of the biomass. The vision is a simple process that would allow individual producers to treat biomass on the farm (or near-by) to extract a liquid that is a crude form of the fuel such as bio-crude. This bio-crude fuel, which is more energy dense than the raw biomass (four to five truckloads of biomass to one

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truckload of bio-crude), could be transported to a centralized processing facility where specialized equipment would be used to refine it into a transportation fuel.

The plant material byproducts that remain after the on-farm processing can easily be land-applied at the farm with common spreader equipment. Depending on the management of the process, these byproducts might even have some fertilizer value to the land or possibly some feed value for livestock.

It is unclear what the exact on-farm process will be. One example being pursued is a process that ferments the biomass in a relatively simple bunker type facility. Biomass could be stacked into the bunker and treated periodically with water and inoculants (reaction agents). The leachate from the bunker would be collected and concentrated by evaporating the water from the resulting butanol mixture. The bio-crude then would be stored until it is transported to a refining facility.

The time to process a batch of bales may be from several weeks to a couple of months. The equipment required likely would be relatively simple components such as storage tanks, pipes, pumps, and charcoal filters.

Researchers anticipate new systems will not only revolutionize the production of biofuels, it will provide an additional revenue stream for farmers to make them more profitable in a difficult economic climate.

(Adopted by B. Grisso from publication AEN-112, University of Kentucky)