OPERATIONAL EFFICIENCY IMPROVEMENTS AVAILABLE TO FARMERS

PAPER PRESENTED BY THE SECRETARYFOR AGRICULTURE, MECHANISATION AND IRRIGATION DEVELOPMENT AT A FARMERS INDABA RUNNING UNDER THE THEME "ENSURING FOOD SECURITY THROUGH ENERGY EFFICIENCY.

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1.0. Introduction

Agriculture development is dependent on energy security were farmers have access to the right amount of energy all the time from a sustainable source. It is also good to note that energy diversity is key to energy security.

2.0. Energy Requirements in the Agricultural Sector

Food systems currently consume **30** percent of the world's available energy, with more than **70** percent occurring beyond the farm gate. At the same time, about one-third of the food we produce is lost or wasted, and with it about **38** percent of energy consumed in food systems. Modern food systems are heavily dependent on fossil fuels. Fossil energy for mechanized agriculture has been an important driver of the "Green Revolution" of increasing farm productivity.

The total energy consumption in Zimbabwe between 2011 and 2015 has ranged between **7,939.8001 GWh** and **8,891.8320 GWh**. The agriculture sector consumes **6%** (**467.823 GWh**) of the national requirement. National energy consumption is expected to fall from **8,253.7068 GWh** in 2014 to **8,891.8320 GWh** in 2015 while that for the agricultural sector is predicted to decrease from **467.823 GWh (6%)** in 2014 to **442.982GWh (5%)** in 2015. The reduction in consumption implies a reduction in agricultural activity.

Case of wheat production in Zimbabwe

Wheat is a strategic food crop. While the national requirement is **450 000 MT**, the country is only able to produce **12%** of national requirement with the deficit of **88%** being met through imports - **50%** unprocessed wheat and **50%** wheat flour. This limited production capacity is increasingly being undermined by unreliable power supply for irrigation.

The crop, being entirely dependent on irrigation faces high risks associated with power cuts and its production decreased from **324 000MT** in 2000 to less than **60 000MT** in 2014 on the back of a reduction in funding from financial institutions, potential contractors and even Government due to power shortages.

Many farmers are now abandoning production of the crop. But this is not without a cost to the nation. Studies have shown that the opportunity cost of not producing and importing stands at **US$236 512 500** per annum and **22%** of this **(US$52 032 750)** is attributed to power challenges. Collectively the agricultural sector is losing nearly **US$5 million per month** due to power shortages. Table 1, is a summary of the overall impact of power shortages on the entire agricultural industry.

Table 1: Overall Impact on the Entire Agricultural Sector.

Aspect	Overall Sector Impact
Viability	• Viability of most agricultural enterprises is compromised by increases in production, processing, storage and repair costs for damaged equipment and use of generators leading to downscaling of activities.
Efficiency losses	• Efficiency loses are inevitable in an environment where plans are not executed due to unpredictable power supplies.
Capacity utilization	• Capacity utilisation at farm, processing, wholesaling and retailing remains low despite availability of demand as exemplified by imports.
Quality	• Quality of most perishable agricultural products is compromised due to disruptions of the cold chain systems.

In order to overcome the challenges cited above, there is need to invest in the renewable energy improving farm level energy efficiency. Farmers should do self-assessment as well as expert-led energy audits as detailed below to identify farm level areas of improving energy efficiency.

Aspect	Opportunity/Strategy Available
Energy Audits	• Good way to determine how much energy is being consumed and what can be done to reduce energy consumption. Traditional audits, performed by a member of your local utility, or a qualified third party, provide the most comprehensive review of your farm. • An energy audit will describe the possible changes that could reduce energy consumption, with a focus on the areas that provide the best return on investment. • Farm operators need to be deliberate in their energy saving choices on the farm.
Energy Self Assessments	• Allows a farmer to do much of the information gathering of an audit on his own to take control of his energy use and determine the best areas for lowering his energy budget. • A self-assessment, while less precise than a full blown audit, can be a good start to help a producer begin considering efficiency changes on their operation. • Two of the most prominent tools are energy use worksheets and energy use calculators.

3.0. IMPROVING EFFICIENCY THROUGH COMMON FARM APPLICATIONS

3.1. Crop Production

Crop production and handling operations have two primary energy intensive practices that farmers must manage carefully: grain storage/drying and irrigation.

3.2. Irrigation

Irrigation requires significant energy and water use. Farmers must know their crop water requirements so as to supply and only use the minimum required energy.

All farms utilize pumps and motors, for activities such as moving water, grain, waste, air circulation, running feeders, or any other number of farm related jobs. Ccurrent studies have shown that irrigation systems on average use about **40%** more fuel than if they were correctly sized and maintained, and **25%** of motor energy is wasted because of poor efficiency. Hence where there is a large energy use of motors on farms means there is a lot of opportunity for energy savings; implementing cost-saving techniques and technologies can save a farm **25%** of its motor related energy costs.

Farmers must ensure that the following:

I. Preventative Maintenance: Pumps and Motors Hard working motors and pumps around the farm often receive very little attention until there is a problem. However, while motors and pumps might be operating fine, they may not be working at full energy efficiency potential. Simple

maintenance measures can ensure they continue to run efficiently. For every dollar spent on maintenance, you will save five in other expenses. Remember, just because a piece of machinery is running, it doesn't mean that it is running as well as it could.

II. Watch for belts that are too tight, too loose, or not aligned. A worn belt can cause a machine to work harder and run slower. Energy efficiency in these situations can drop by up to 20%. Replace pump and fan belts with cogged V belts. These belts grip better, resulting in reduced slippage and a **2-5%** energy savings. Additionally, poorly sized belts can reduce belt lifespan by as much as **50%.**

III. Install an appropriately sized pump or motor. Oftentimes motors are oversized, meaning they run below the full-load efficiency stated on the nameplate. Motors should operate at a load between **65%** and **100%.** A motor too large for its job, operating at a low load percentage, is less efficient than a motor sized to match the load required. Similarly, an installed pump that is too large for your system will cause unnecessary wear and tear on your system.

IV. Use totally enclosed motors for all farm applications in order to prevent excess dirt and dust from entering the motor.

V. Maintain your pump system for maximum efficiency. Common maintenance tasks on pumps include: bearing lubrication and replacement, mechanical seal replacement, wear ring adjustment or replacement, impeller replacement, and pump/motor alignment.

VI. At a minimum, it's a good idea to check all of the motors and pumps at least twice a year. However, older motors and pumps and those that require more care should be checked at least once every two months.

VII. Farmers should also seek to modernise and move to energy efficient irrigation systems that limit energy use and reduce water use, while still maintaining high field production.

3.3. Drying of Produce

After crops have been raised and harvested the next energy intensive farm application begins – grain drying. Grain drying is a yearly chore for most farmers and is a very energy intensive farm application. Every year, farmers work to find the right balance between minimizing expensive grain drying and keeping crops at an optimum moisture and temperature level. With the rising costs of fossil fuels, improving energy efficiency in the grain drying arena can mean significant savings for farmers.

Alternatives to typical hot-air drying, combined with proper equipment maintenance, can help a farmer reduce his or her energy costs in relation to grain drying. Preventative maintenance/low cost improvements to Grain Drying Operations are:

I. Avoid over drying. Over drying is expensive for three reasons: increased fuel use, reduction in the tonnage that can be dried per day, and reduced tonnage for sale.Ensure your moisture meter for

testing grain is accurate so that you make the right decisions on when to begin and end your grain drying.

II. Clean your grain before drying. Remove broken kernels and weed seeds; they cost extra money to dry and they reduce dryer airflow.

III. Level the grain in your bins and dryers. Keep grain levels even throughout your bins. This practice promotes uniform drying which is much more efficient and prevents grain loss due to spoilage.

IV. Clean the aeration enclosure under the floor of a grain bin to lessen the resistance for the fan. Close up holes and leaks that can allow air to escape, clean inlet screens, and time aeration to the weather and time of day for maximum cooling.

V. If possible 'dry' your grain while it is still in the field. While considerations like weather, work time, grain quality, and potential disease need to be kept in mind, allowing crops to dry while still in the field can greatly reduce, or eliminate the need for, mechanical grain drying.

3.4. Dairy Farming

Milk production equipment makes up about **50%** of a farm's energy consumption, and lighting, ventilation, and other incidentals take up the rest. Fortunately, there are numerous energy saving technologies, devices, and techniques that any dairy farmer can implement on his or her farm, some of which require no monetary investment whatsoever. With a few key installations, however, a farmer can start saving thousands of dollars every year on energy costs. Preventative maintenance/low cost

Improvements for dairy operations you can start saving money on your dairy farm today without installing new technologies. The following energy reduction techniques can be implemented on your farm immediately at little to no cost.

I. Turn off fans when the temperatures drop below **21^0C**, when dairy cattle are no longer in danger of overheating.
II. Decrease pressure on compressors to minimum amount needed; doing so will increase the life of the machine and save 10% on energy costs.

3.5. Beef Production

While beef operations may not be the most energy intensive, the following tips that may help beef producers realize additional energy savings.

I. Solar powered electric fencing is available as an alternative to traditional electrical fencing needs. It is just as efficient as traditional electric fencing methods, and doesn't require a connection to your electrical system. Solar chargers can cover areas ranging from 5-50kilometres of electric fence. After the initial cost of equipment and maintenance costs, there are no additional electricity costs to operate an electric fence.
II. Economize your cattle waterers. Cattle require large amounts of water daily. By delivering water to cattle efficiently, you can save money on both your energy and water bill. The biggest problems

and energy use concerning cattle waters comes in the summer, when producers constantly struggle to keep water sources open from drying. While not necessarily the largest farm cost, improving water system performance can save you money and seasonal headaches. Typical livestock waterers can consume up to **36 kWh** of electricity per day, during the driest parts of the year. Energy efficient waters can cut energy costs anywhere from **20-80%** based on level of insulation, heat element efficiency, and cattle use. Make sure that your current water pump is not leaking or overflowing consistently. This wastes both energy and water. Consider changing from a heated water fountain to an unheated super-insulated water fountain. These have been proven to be an efficient way to provide water to livestock without requiring any supplemental energy.

3.6. Poultry Production

There is currently a lack of energy efficient resources relating to the poultry industry. While some of the more general energy saving methods, such as lighting, heating and ventilation have been discussed, the following tips are specific to addressing energy saving methods unique to the poultry industry.

I. Ventilation - There are many different types of ventilation that can be used in poultry barns. The three most common are an exhaust or negative pressure system, a positive pressure system, or a naturally ventilated barn. In all of these systems it is important to make sure that air is moving throughout the poultry house and that it is at a constant temperature throughout the poultry house.

II. Aim for a static pressure of around 20 pascal in all poultry houses. This will mix air entering the building with air already in the building and keep temperatures stable. Air heating and cooling costs make up a large portion of a poultry farmer's energy bill. By making sure that all the walls have been properly insulated both inside and outside a poultry house, the cost of a typical poultry operation can save **10-20%** on heating costs. Not only will your energy bill be lower, birds are more comfortable at a constant temperature.

III. Employing heat exchangers in poultry operations can save you **40%** of the energy required for broiler brooding.

3.7. Piggery Production

In a typical swine production facility, **80-95%** of heat loss is associated with ventilation. Therefore, proper ventilation management is very important when considering energy efficiency.

I. Add insulation to concrete sidewalls. This can raise the inside temperature in a pigsty without increasing the size of your heating bill.

II. Consider using hovers in farrowing rooms. This will allow a small area to be heated to a warmer temperature, thus saving the use of both electricity and natural gas to heat the entire room at a higher temperature.

III. Specific Lighting/Heating using more energy efficient 175W lamps vs. conventional 250W lamps will save a great deal of energy.

3.8. Lighting on the Farm

Lighting Energy used for lighting makes up a large part of any farm's energy bill. Various energy professionals have estimated lighting to account for anywhere from **15-30%** of total energy costs. The good news is lighting is one of the simplest and inexpensive areas to reduce energy use and costs. Using few simple techniques, the amount of energy used for lighting can be significantly reduced. Preventative Maintenance: Low-Cost Improvements Basic maintenance of lights and light fixtures, sometimes in place of potentially costly replacement equipment, can keep lights burning at their optimal energy efficiency. Consider these tips as a first step toward energy efficiency:

I. Clean fixtures, lamps and lenses every 1 to 2 years to make sure you are receiving the full benefit of the light produced by your light fixtures. You'll need to replace lenses on light fixtures if they appear yellow. This will allow light fixtures to work at their full potential.
II. Keep walls and small areas clean and repainted every 2-3 years so they reflect the maximum amount of light.
III. Consider changing all lamps, light fixtures, and light bulbs in an area at once. This technique will save on labour costs for any special installation and making these changes all at once keeps illumination at a constant level and avoids stressing out a system with dying lamps. Newer light fixtures are designed to push light out into the room to insure that all of the light produced by a lamp is used, whereas older light fixtures were not similarly designed for maximum efficiency.

IV. When installing new lighting systems think about the areas that require additional lighting. Providing spot lighting for areas that have a high work load can reduce the need to over-light an entire area unnecessarily.

V. Remember to consider lumens generated when making lighting replacements. While certain efficient lighting upgrades may replace standard incandescent bulbs, they may not provide the same amount of lumens (light produced). Be sure you replace a bulb with sufficient lumen production to make your lighting situation satisfactory.

3.9. Use of Renewable Energy to Enhance Agricultural Productivity

Knowledge has been gained over decades on the adoption of agro-ecological practices that produce more and better food with less and better energy, and renewable energy technologies for reducing post-harvest food losses and adding value. Numerous technologies such as solar crop driers and refrigerators can increase smallholder income (and its diversity) and resource efficiency.

There is significant potential for agricultural involvement in the production and consumption of solar, wind, geothermal, and biomass energy. Renewable resources are abundant and widely distributed throughout Zimbabwe.

Increased efficiency in farm usage of electricity is being driven by greening as well as by economics. Efficient energy use in farm applications is an important, though often overlooked, component of

running a profitable and successful farming operations. Experts estimate that energy costs account for about **10%** of a typical farm's budget. Therefore, making energy efficient improvements can save farmers significant amounts of money. This opportunity is especially important in a time when most farmers operate on margins that are highly scrutinized and tailored down to the last dollar. When implemented correctly, energy efficiency improvements can help widen the operating margin and give added flexibility to maintain or increase the farm operations.

3.9.1. Solar

Livestock and dairy operations often have substantial air and water heating requirements. For example, commercial dairy farms use large amounts of energy to heat water for cleaning equipment. Heating water and cooling milk can account for up to **40%** of the energy used on a dairy farm. Solar water heating systems may be used to supply all or part of these hot water requirements. Other solar applications include greenhouse heating and solar crop drying.

3.9.2. Wind Energy

Small wind systems can serve agriculture in traditional ways, such as using mechanical energy to pump water or grind grain. As costs decrease, small systems used to generate electricity may also become economically efficient by avoiding the expense of installing transmission wires, especially in more remote

applications. Where connected to the electricity distribution grid, small windmills can generate revenue through electricity sales when generation exceeds internal requirements.

3.9.3. Bio-refineries

In a sense, bio refineries already exist. They process sugarcane into ethanol, sugar, animal feed, and other products, or transform trees into a variety of wood products, electricity, and heat, to name two examples. For the next generation of bio refineries, research in Zimbabwe should focus on developing processes for exploiting the large amount of energy contained in plant cellulose which is a difficult but potentially rewarding goal.

Thank You