Efficiency Improvements to Irrigation Systems and Potential Savings in Irrigation Costs for Louisiana Row Crop Production

Introduction

The goal of this document is to help Louisiana farmers and other interested parties understand how changes to existing irrigation systems can influence the overall economics of their production. The information applies to field crops.

Investing in efficient irrigation systems can reduce energy costs and the amount of water applied; however, several factors are at play in the process. Cost is a major factor, but other considerations, such as soil type, access to alternative energy sources and limited knowledge of efficiency practices can limit those improvements. Nevertheless, modifications to existing practices can improve efficiency and increase profits. Moreover, regulatory changes affecting agriculture, such as changing patterns in precipitation, farm management preferences and potential competition from other sectors for water, may influence farmers to invest in efficiency-improvement practices.

Diesel pump using surface water, pic courtesy: Biff handy, NRCS

Examining the economics of furrow irrigation

Decisions and practices that can positively affect efficiency, such as changing the fuel type or changing the water source within furrow irrigation in row crops, are the focus of the analysis in this document. The analysis estimates the value of such changes individually and in combination over a 10-year period to enable farmers to have information regarding long-term costs and benefits of irrigation efficiency improvements. Several factors influence the overall economics of irrigation on the farm. Major factors include fuel type, water source and pump performance.

Fuel type: Two main sources, electricity or diesel, are most often used in Louisiana. Other fuel sources – gasoline, propane and natural gas – are used on some farms, but the economics of the two main sources, electrical and diesel, are the focus here.

When available, electricity is generally more cost effective than diesel; however, if electric power supply lines have to be installed, the initial costs can range from $5 to $10 per foot; 3-phase costs can range from $10 to $15 per foot.

Diesel pumps are considered a reliable source of power and pumping capacity, and they offer pumping capabilities where electricity is not available, a common

Single phase Electric pump, pic courtesy: Biff handy, NRCS

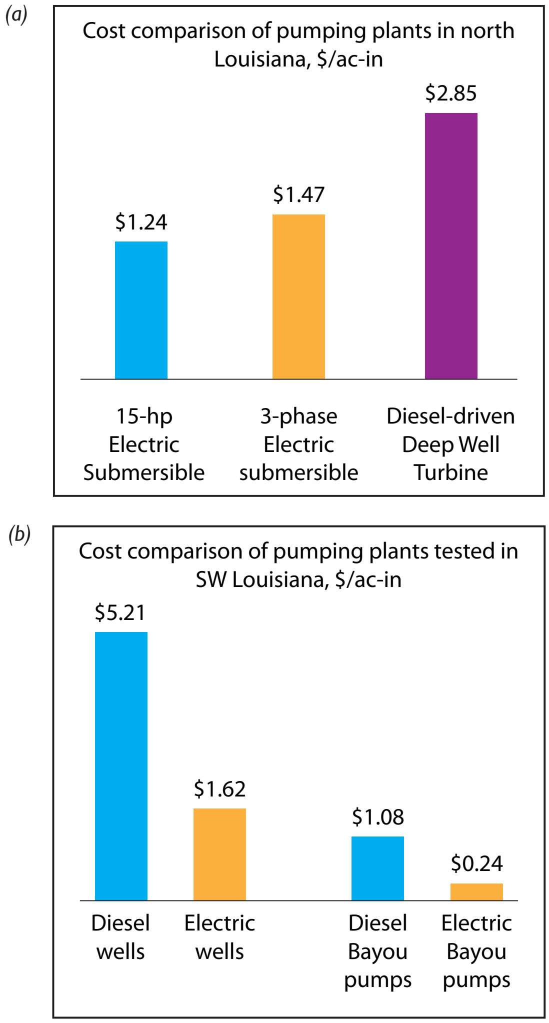

Figure 1a. Cost comparison of pumping plants tested in north Louisiana. Source: Biff Handy, NRCS. Figure 1b. Cost comparison of pumping systems tested in SW Louisiana. Source: Ducks Unlimited. (Assumption: diesel @ $3.50/gallon; electricity @ $7.5c/kwhr; water applied @ 27-inches for rice and crawfish.)

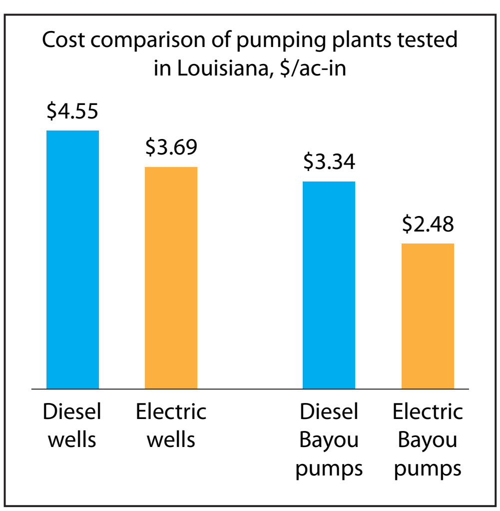

Figure 2. Cost comparison of pumping systems using USDA data on Louisiana. Source: Adusumilli 2015. Assumptions: Diesel @ $3.0/gallon; electricity @ $7.0c/kwhr; water applied @ average of 14 inches for row crops.

aspect in rural areas. Diesel prices, however, are somewhat more volatile than electricity. Moreover, regulatory changes often add additional costs, such as a recent tax on off-road diesel. Such costs, often imposed by state agencies, can reduce Louisiana farmers' profits compared to farmers in other states where such taxes are not imposed. Hence, efficiency improvements through short-term investments are needed to have profitable long-term production. In addition, diesel engines require relatively more repair and maintenance to perform at their peak.

Water source: Water from surface sources such as rivers, bayous and lakes is commonly used for irrigation. Groundwater (underground water) is another major source. The variable that plays an important role between the two is the static lift, which is the vertical distance between the top of the water level and the pump outlet. Since groundwater sources generally have a more distant static lift than most surface water sources, the costs to pump water from a well will most often be higher than the surface water sources. In addition to a less distant static lift for pumping surface water, surface water is relatively warmer and has a residual nutrient content, both of which benefit crop production.

Pump performance or pump efficiency: Pumping plant efficiency is broadly defined by the National Resources Conservation Service (NRCS) as maximizing the volume of water pumped and minimizing the amount of fuel used. An inefficient pump system often loses most of the energy to heat, friction, etc. and produces only minimal output. The objective of improving pump efficiency is to conserve water, energy and money.

Irrigation engineers strongly recommend that farmers have a pump plant evaluation test performed and make the necessary changes to achieve higher overall efficiency. Engineers usually ask for some information from farmers to conduct the pump testing. These parameters include:

- *Irrigation flow rate*. Flow meters, which measures the flow in gallons per minute (gpm), are used to determine the flow rate.
- *Energy or fuel consumption rate*. Electricity use is measured using service meters, whereas diesel is measured volumetrically based on weight or by the fuel meter. Any of the methods, if applied properly, can provide fuel consumption estimates.
- *System operating pressure*. The system operating pressure must be determined for the evaluation to be meaningful. The operating pressure, or head against which the pump is working, can be determined directly from pressure gauge readings or estimated using hydraulic calculations based on the system features observed on site.

Results

Results from three different analyses are illustrated in Figures 1a, 1b and 2. Comparisons in 1a were based on data from north Louisiana, and those in 1b in southwestern Louisiana. Comparisons in Figure 2 were based on local data reported to national statistical agencies, such as the Farm Service Agency (FSA) and the USDA's National Agricultural Statistics Service (NASS). All results present a similar picture: electric pumps using surface water are the most economical, electric pumps pumping groundwater are second, diesel pumps pumping surface water are third and diesel pumps pumping groundwater come in fourth.

The first two studies (Figure 1a and 1b) relied on energy costs alone, which is the most significant cost component of irrigation costs in crop production in Louisiana, in estimating relative advantage of one system over another. The third study (Figure 2) accounts for labor costs and operation and maintenance costs to the pumping system in addition to energy costs to estimate the costs of irrigation. The estimates calculated using data from USDA are slightly higher than the first two studies. Nevertheless, the result does not change; i.e., the relative economic effectiveness of electric pumps using surface water over any other system.

It is important to recognize that any of these pumps not operating at their maximum efficiency can affect the cost-effectiveness of operating the pumps. In other words, pumps properly maintained and operated can achieve higher efficiency than those that are poorly maintained, negating the benefits of using surface water for irrigation or using electricity or both.

Some farms might not have access to either a fuel source (running an electricity line could be a challenge) or a water source (surface water might not be available within a reasonable distance). These factors make some of the results not applicable to all farms. Considering such unavoidable challenges, we present a profitability matrix in Figure 3, which shows the relative advantage of one system over another. The matrix is useful for farmers to identify where they currently stand on profitability with their irrigation systems and also provides an understanding of the opportunity to become more efficient and profitable if opportunities to make modifications do exist.

	Groundwater	Surface water
Diesel	$ $ $ $	$ $ $ $
Electric	$ $ $ $	$ $ $ $

Figure 3. Profitability matrix of irrigation systems based on fuel type and water source. Red = less economical. Green = more economical.

The upper-left, i.e., the diesel-groundwater interaction square (least economical), shows that farmers in this group have the most potential to improve economically. In other words, investments in efficiency improvements can pay off as a reduction in overall costs and can improve the overall profitability in the long run. Farmers identifying themselves in electricity-surface water square, lower right (most economical), should be able to compare their irrigation costs to the numbers provided in figures 1 and 2. The comparison should enable producers to identify any shortcomings within their irrigation system and consider technical assistance from conservation agencies to get the most "bang for the buck." It is important to recognize that the estimates presented in the paper reflect the pumps tested and/or data available for analysis. Some of the estimates could be significantly different from farmers' own estimates.

Based on the information presented above, per acre savings in irrigation costs when converting from diesel-powered irrigation systems to electric powered systems are estimated in Figure 4. These calculations are based on the assumption that 14 inches of irrigation are applied per acre. The financial analysis shows that farmers can benefit by switching from the diesel-powered system if such alternatives are available to make these changes. Although upfront costs are necessary, the overall benefit is positive over a 10-year period. Both options of electrical pumps provide positive benefits over the 10-year period. The long-term benefits of 3-phase are slightly lower but are less variable (a steeper curve) compared to 15-hp pumps, which are slightly higher but are more variable (a less steep curve). The analysis is conducted using data related to the irrigation system alone and does not account for other potential benefits of improved irrigation efficiency.

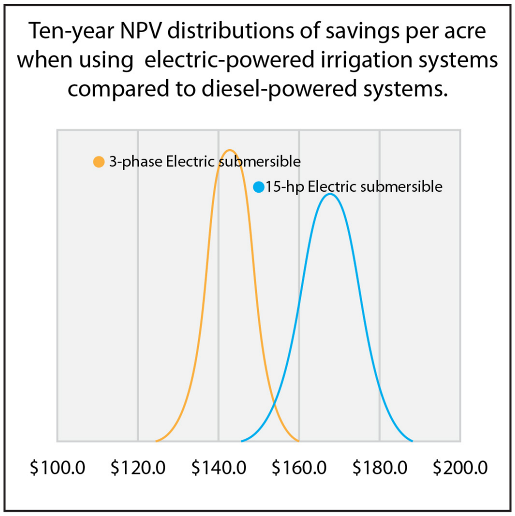

Figure 4. Ten-year Net Present Value distributions of savings per acre of converting from diesel- powered irrigation systems using groundwater to electrically powered systems using surface water.

Conclusion

Using on-farm data and data reported to national statistics, this document compared irrigation costs of electrically powered and diesel-powered pumps that pump surface and/or groundwater. Comparison of the systems shows a clear advantage of using surface water and electric pumps; however, some of those changes are strongly linked to the availability of opportunities to make such adjustments. Volatile market prices of cash crops and inputs, as well as regulatory frameworks guiding irrigation use, farmers' investment in efficiency improvements would improve the bottom line as well as benefit resource conservation.

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