Reducing Crawfish Pumping Costs

Farming crawfish requires pumping water. Pumping water costs money. Although there is really no way to get around these facts, we can take action to minimize pumping costs. Pumping costs include the cost of the equipment, the cost of installing the equipment and the cost of running the equipment. The cost of running the equipment includes maintenance as well as fuel costs.

Do Less Work

The first step in minimizing costs is to do less work. You can do less work either by pumping less water or by making it easier to pump the water that you do.

● Pumping less water. We pump water to flood up at the beginning of the year and to maintain acceptable water quality throughout the year.

- The initial flood quite often includes two steps – flooding and flushing. It is usually advantageous, particularly if flushing will shortly follow flooding, to flood at reduced depths (see chapter 7 – Water Quality and Management, Louisiana Crawfish Production Manual).

- Maintaining acceptable water quality means just that – acceptable, not necessarily ideal. Again, Chapter 7 of the Louisiana Crawfish Production Manual is a good source of information on water quality. The single most important water quality characteristic is the dissolved oxygen content of the water. Management based upon oxygen content requires the ability to measure the dissolved oxygen content. Measuring can be done with test kits or with a calibrated dissolved oxygen meter. It cannot be accurately done by just looking at the water. High energy costs easily justify an investment in either test kits or meters.

- Prevent leaks. Water that does not flow where needed is water that is wasted, as is the money it costs us to pump. Sources of leaks include leaks in piping, breached levees or overflowing recirculation ditches.

● Making it easier to pump the water. Having reduced the amount of pumping to only that which is needed and beneficial, the next step in doing less work is to reduce the work that has to be done for each gallon of water that we do pump. We do this by reducing the lift and by not restricting the water flow.

- Lift is the distance the water needs to be raised (or lifted) from the level of the water source to the height of the discharge. We can minimize the lift by pumping from a higher source of water or by reducing the height of discharge. There are three choices for the source of water: a well, a bayou or other surface water, and the crawfish pond itself. Factors other than the cost of pumping determine which of these are suitable. For example, while surface water will have lower lift requirements than well water (except for flow wells), the surface water may not be of sufficient quality for use in the crawfish pond. For example, the surface water may contain pesticides either from agricultural production or from illegal dumping, which would make the water unsuitable. Remember, the surface water quality should be acceptable not just some of the time, but every time you need to use it. Another factor for recirculation is the water flow pattern that would be obtained in the pond. The water should flow essentially as a slug from the point it leaves the recirculation device to the point it returns to the device. Lift also can be minimized by using an efficient aerator that achieves near saturation for modest heights. Please consult Chapter 7 of the Louisiana Crawfish Production Manual for a more in depth discussion of water quality.

- Do not restrict the water flow. Any time water flows in a channel there is resistance to that flow of water. This shows up as pressure drop in a pipe or an elevation drop in a ditch. If the channel is not large enough, pressure drops and elevation differences may be excessive. As a general rule of thumb, water velocities in pipes should be no more than 2 to 3 feet per second. Ditches should be large enough to carry the water flow without overflowing. The water velocity in the pipe can be estimated as:

$V = 0.407*gpm/D^2$ where gpm is the flow rate of the water in gallons per minute, D is the inside diameter of the pipe in inches and V is the water velocity in feet per second

Example: 500 gpm, 6 inch pipe:
$V = (0.407)(500)/(6*6) = 5.65$ feet per second

Do the Work Efficiently

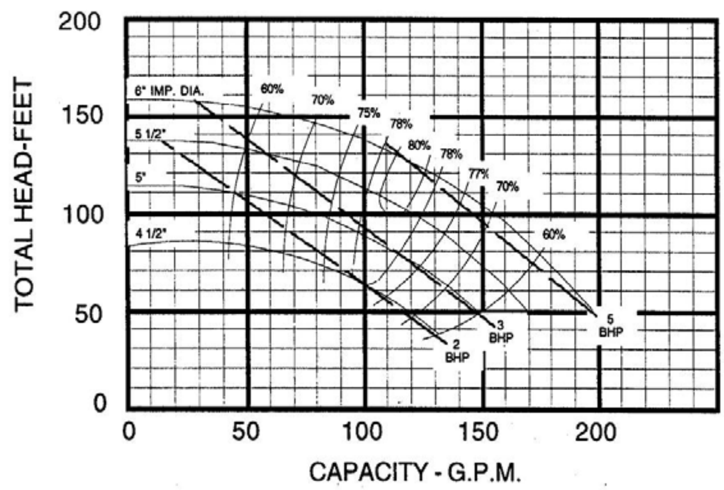
Doing the work efficiently means that you use a pump and a power source that both operate efficiently. The pump should operate efficiently under the conditions of use. The first requirement for the pump is that it can do the job; the second is that it can do it efficiently.

● Pump capable of doing the job.

■ A part of picking a pump that can do the job is choosing one that can handle the water conditions it will encounter. Some pumps can handle trash such as fish and solid materials up to a certain size. The pump must be able to pump the water, including any trash or silt that comes with the water. If you anticipate that you may be pumping something other than water, choose a pump capable of handling the trash you may encounter. Don't forget to include silt- and/or sand-handling capability if you will be pumping silt or sand. Pumps that can handle trash are usually less efficient than clear-water pumps when pumping clear water, but are much more efficient and durable when pumping water containing trash and debris.

■ The pump must meet the flow rate and head requirements of your operation. You should pick a pump that will meet the flow rate requirement (gpm) at your site. The amount of flow a pump produces changes with the head (pressure) that the pump is working against and with the amount of suction the pump must produce to suck in the water. The head and suction depend on the conditions at your site and upon the flow rate. To determine if a pump is satisfactory, you must be able to predict both the head and suction requirements at the desired flow rate, and have access to a pump curve. Determining the head and suction requirements could be a bit complicated (SRAC reference); however, your pump dealer should be able to do this for you and should also have a pump curve. The pump curve is a plot of water flow against head. It often includes information such as efficiency and required suction conditions. Remember, you cannot

Figure 1. Example of a pump curve



determine the pumps performance without knowing the conditions under which it will be operating.

● Do the job efficiently. The efficiency of pumps varies from pump to pump. The efficiency of a pump varies with operating conditions.

■ Pump efficiency is the amount of work you have to put into an actual pump compared to the amount of work you would have to put into an ideal pump that was moving the same amount of water at the same head and suction conditions. The ideal amount of work is called the water horsepower (WHP). The efficiency of pumps vary from model to model and from manufacturer to manufacturer. An efficient pump designed for clear water might reach efficiencies of 70 to 80 percent. A pump designed to handle trash and debris would be expected to have lower efficiencies; 40 to 50 percent is usually considered good for these pumps.

$WHP = gpm*head/3960$ where gpm is the water flow rate in gallons per minute

Head (in feet) produced by the pump; it includes the lift from source to outlet, friction losses in the piping and velocity head (usually minor). If friction loss is calculated in psi, use 1 psi = 2.31 feet for a conversion. Velocity head may be calculated from velocity head (in feet) = V 2 /64 where V is in feet per second

■ The same pump operated under different conditions will deliver different efficiencies. For example, depending upon operating conditions, the efficiencies might only be 1/10 to 1/5 their maximum efficiency. Differences in efficiencies can make very large differences in the amount of energy that the pump requires. For example, compared with a pump operating at 60 percent efficiency, a 10 percent efficient pump performing the same job, would require six times as much energy input. The key to picking a pump that will work efficiently for you is knowing the operating parameters and having the data (pump curve and efficiencies) on the pumps operating characteristics.

● Efficient power source matched to the job. You use an engine or motor to convert the energy in the fuel you buy into work (brake or actual horsepower). How much work you get depends upon the efficiency of the engine or motor. Table 1 lists typical attainable efficiencies and typical useful life of power plants.

Table 1. Typical efficiencies and lifetimes of power plants.

Type of Pumping Equipment	Attainable Efficiency	Useful Life *
Automotive engines (gasoline)	28%	9
Natural gas or lpg	28%	14
Light industrial (diesel)	25% - 37%	14
Electric motors	85% - 92%	25

**Based on 2,000 hours per year use. With proper maintenance and fewer hours of annual use, the useful life could be increased. From Powering Aquaculture Equipment.*

How much work you get for your money depends on the efficiency and the cost of the fuel. The efficiency of power plants varies. Available data for efficiencies are usually listed at or near full load. Efficiencies at full load are higher than efficiencies of the same power plant at part load. This is particularly true for engines but also applies to electric motors. For example, consider the information in table 2.

Table2. Test results of two sizes of paddlewheels. (Power source was an 87 hp tractor)

Aerator	PTO shaft speed (rpm)	Paddle depth (inches)	Power required (hp)	Tractor engine speed (rpm)	Fuel use (gal/hr)	Fuel use (gal/hp-hr)	Fraction
PTO	540	4	4.9	1,800	1.6	0.327	
paddlewheel	**1,000**	**4**	**4.8**	**950**	**0.7**	**0.146**	**0.45**
	540	14	16.9	1,800	2.0	0.118	
(4-inch drum)	**1,000**	**14**	**16.7**	**950**	**1.2**	**0.072**	**0.61**
PTO	540	4	12.4	1,800	1.8	0.145	
paddlewheel	**1,000**	**4**	**12.0**	**950**	**1.0**	**0.083**	**0.57**
	540	14	40.2	1,800	3.0	0.075	
(20-inch drum)	**1,000**	**14**	**39.0**	**950**	**2.3**	**0.059**	**0.79**

This comparison shows the fuel consumption of an engine under different loading conditions. There are four sets of data. In each set the same engine powers the aerator at essentially the same conditions. The only difference is that different speed PTO shafts were used and the engine speed adjusted accordingly. At the 1,000 rpm PTO speed, the engine is running at a lower rpm and is more fully loaded than at the 540 rpm PTO speed. In every instance, the fuel consumption is less for the more fully loaded (not overloaded) engine.

● Maintain the pump and associated equipment. To realize the benefit of efficient equipment matched to the job, the equipment must be maintained. The owner's manual should be the best source of maintenance information. A general rule is, "Keep it clean." This includes such things as air filters, oil and fuel and, if pumping from surface sources, the screens that catch the trash in the water before it enters the pump.

Use a "Value-priced" Fuel

A "value-priced" fuel is a fuel that will deliver the most work for your money. There are three aspects of this. The first is, "Can you get the fuel?" If the fuel is not available (for example , no three-phase service available) that particular fuel option need not be considered. If the fuel is available (you may have to pay to make it available), the two items of concern are, "What is the cost of the fuel per unit of work delivered?" and "What else do you have to pay to use the fuel?"

● What is the cost of the fuel per unit of work delivered? Three factors enter into comparing fuels on this basis: the cost of the fuel, the energy content of the fuel and the efficiency of the power plant in using the fuel. The following table presents the energy content per common fuel unit. Please note that the energy content of fossil fuels vary slightly due to the blend and time of year.

If we know the efficiency of the power plant, the amount of work delivered per unit of fuel could be obtained by multiplying the energy content per unit of fuel by the efficiency. For example, a 25 percent efficient gasoline engine would deliver: 49.09*0.25 = 12.27 Hp-hr of work per gallon of fuel. Dividing this value into the cost per gallon of gas would give us the cost per horsepower hour

Table 3. Typical energy content of fuels				
Fuel	Fuel unit	BTU/fuel unit	Kwh/fuel unit	Hp-hr/fuel unit
Gasoline	Gallon	125,000	36.62	49.09
Diesel	Gallon	138,000	40.43	54.20
Propane	Gallon	91,600	26.84	35.98
Butane	Gallon	103,100	30.21	40.49
Electricity	Kwh	3,413	1.00	1.34

delivered. If gas were $2.50 per gallon, then $2.50/12.27 = 20.4 cents per horsepower hour delivered.

The cost of the fuels could be compared on the basis of work delivered if we knew the efficiency of the power plants and the cost of fuel. An example is shown in Table 4.

Table 4. Equivalent cost per gallon for an 85% efficient electric motor, 25 % efficient engine

Cost per Kwh	$0.10	$0.12	$0.15	$0.20	$0.25
	Equivalent price per gallon				
Gasoline	$1.08	$1.29	$1.62	$2.15	$2.69
Diesel	$1.19	$1.43	$1.78	$2.38	$2.97
Propane	$0.79	$0.93	$1.18	$1.58	$1.97
Butane	$0.89	$1.07	$1.33	$1.78	$2.22

If electricity cost 10 cents per Kwh, the electric motor were 85 percent efficient and the diesel engine were 25 percent efficient, for the same cost per unit of work you would pay $1.19 per gallon for diesel. If you paid more, the fuel cost for each unit of work would be greater for diesel than for electricity.

The cost of electricity is not necessarily easy to determine. It depends on how much energy you use, when you use it, and the rate structure of the utility. For example, many utilities charge commercial customers a demand charge based upon the highest rate that the customer uses (or demands) electricity during the year. The best way to estimate your average cost per Kwh is to estimate your pattern of use (how much power you need and how many hours a month you would use that power) and consult your utility company.

● What else do you have to pay to use the fuel? Most fuels have costs associated with them other than the cost of the fuel. For example, diesel fuels will usually require a tank for the fuel. Electricity costs may include power line installation, new user fee, connection fees, equipment cost such as electric motors and motor control boxes and electrician fees to install the equipment. Routine maintenance costs tend to be higher for engines as compared to electric motors. An additional cost penalty for maintenance of 1 cent per horsepower hour has been recommended by some authorities. On the other hand, electric motors may be more vulnerable to lightning strikes. Some utilities will install a surge protector and insure you against loss for a monthly fee. Another consideration should be "What backup do I have and how long would it take to get back in service if I had an equipment failure?"

Where Do I Stand Now?

Minimizing the cost of pumping could involve doing less work and/or doing that work more efficiently. The feasibility of doing less is a management question and depends to large measure on water quality and what is needed. Doing the work more efficiently is more technical in nature. The amount of improvement that is possible depends on how well you are currently doing. A measure of this can be obtained by comparison with the Nebraska Performance Criteria for properly designed and maintained pumping systems. These criteria list obtainable performance as water horsepower per unit of fuel. The criteria are:

Diesel 12.50 WHP-HRS/gallon
Propane 6.89 WHP-HRS/gallon
Natural Gas 61.70 WHP-HRS/MCF
Electricity 0.885 WHP-HRS/kilowatt-hour

These criteria were developed for wells and clean water. If you are pumping from surface water and have chosen a pump capable of handling trash it would be appropriate to reduce these values to 70 to 75 percent of the clean water numbers. A 75 percent reduction would result in:

Diesel 9.4 WHP-HRS/gallon
Propane 5.2 WHP-HRS/gallon
Natural Gas 46.3 WHP-HRS/MCF
Electricity 0.66 WHP-HRS/kilowatt-hour

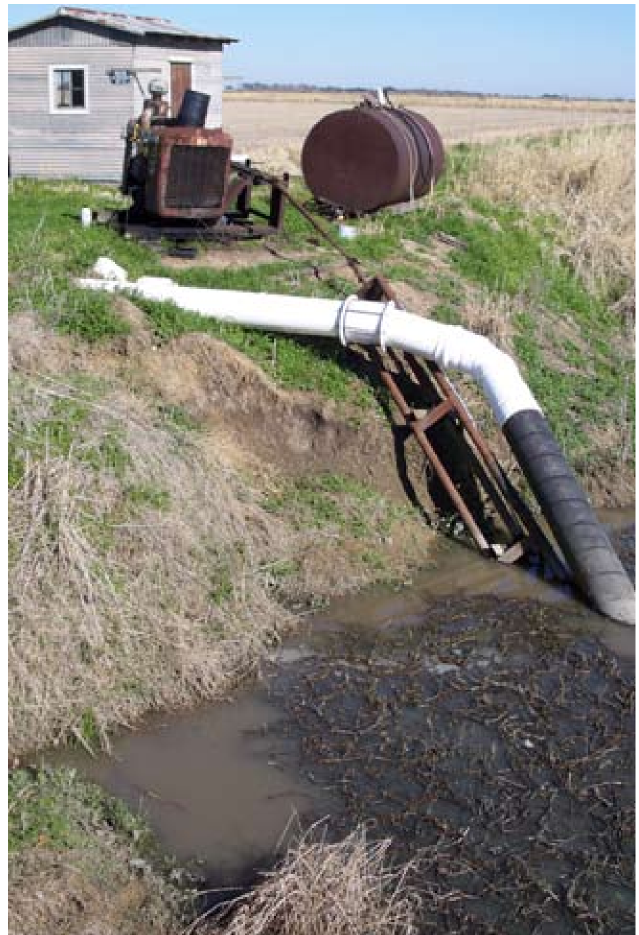
Performing the comparison is not always easy. The most difficult operation is determining the water horsepower. Not only do you need to know the friction loss in the piping, you also need to know the water level of the water source while you are pumping. Knowing these factors can be difficult if you are pumping from a well. A rough estimate may be obtained from the depth of the water table from which you are pumping – not how deep your well is but the level of the water when no pumping is occurring. You may add another 10 to 15 feet to account for draw-down while pumping. Well drillers in your area may be a good source of information. If you assume friction losses are minor, you can calculate the water horsepower from the previous equation as WHP =

gpm*lift(in feet)/3960. Dividing this by your hourly fuel usage would give you a number to compare with the Nebraska numbers.

For example, suppose you wanted to know the efficiency of your diesel pump. Last season you averaged 4 gallons an hour of diesel fuel to pump 800 gpm to the top of an aerator 6 feet above the surface. The water source was a well whose water level was 80 feet below the surface in the absence of pumping activity. Ignoring friction losses and adding 10 feet for draw-down results in 80 +10 +6 = 96 feet of lift. The water horsepower is: WHP = gpm*lift/3960 = 800*96/3960 = 19.4. Dividing by 4 gallons per hour yields 4.85, which is less than half of the Nebraska number. This would indicate room for improvement. You could also use this method to compare your pumping system's performance with your neighbors. Additional information on estimating friction losses can be found in Piping Systems, (1994).

Summary

Very simply, energy costs money. The less energy you use, the lower your pumping costs will be. Reducing irrigation costs can come from several areas. This bulletin has given several tips on how to pump less water and to make sure your pumping plant is being used as efficiently as possible. It also has discussed the importance of using an inexpensive fuel and how you can compare the efficiency of your pumping system to others to check to see how well of a job you are doing. Please feel free to contact your parish LSU AgCenter office for more information.



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