Continuous Flow Grain Dryer Operating Cost Estimation

Continuous flow (CF) grain drying is one technology that producers can use to dry grain to safe storage moisture content (MC). CF grain drying is not a new concept. The original systems used traditional grain bins with tapered floor augers that continuously removed dried grains from the bottom of the bin as wet grain entered the top of the bin. These systems are still available today and are a viable choice for many growers.

Advancements in technology and grain dryer design have allowed modern CF dryers to increase capacity and reduce fuel consumption. Even with these advancements, management decisions must be made that will influence grain quality and energy use.

This publication presents some management and operational options for CF grain drying and provides a guide to estimate heating fuel and electrical consumption. Note that the goal of this publication is not to directly compare the performance of specific manufacturers' grain dryers, but rather to help consumers compare manufacturers' publicly available data sheets and make sound decisions based on that information.

Data sheets and brochures for two comparable grain dryers were accessed from their respective websites. One was from GSI (model 2320, Grain Systems Inc., GSI Group LLC, Assumption, Illinois), and the other was from Sukup (model TC205, Sukup Manufacturing Co., Sheffield, Iowa). Both of these CF dryers consist of two stacked modules and have similar throughput of around 2,000 bu, but one uses axial fans and the other uses centrifugal. There are a few key aspects to consider: capacity, heater energy use, and horsepower of the fans and augers.

Dryer Capacity

The first step in estimating cost is to estimate the capacity of the dryer. The drying capacity is given for shelled corn and is calculated in bushels per hour (BPH). The capacity is given for a few common operating conditions in which the amount of moisture to be removed and the final temperature of the grain are varied (**Table 1**).

Choose the condition that will most closely reflect the expected operation of the dryer. It is very important to read the footnotes typically referenced in the specifications. There are usually two points made in the manufacturer's footnotes.

The first point is that the capacities are estimates based on physical principles, field studies, and simulations. Variety selection, fines, foreign material, weather, and other factors can influence dryer capacity. The manufacturers state that these values are best estimates, but they are still estimates.

The second point is that grain exiting the dryer after full heat will usually not be at 15 percent MC. In other words, if the grain exits the dryer at full heat without cooling, then it will actually exit at around 17 percent and not 15 percent MC. The extra moisture is expected to be lost in what is called dryeration.

Table 1. Estimated dryer capacity.

	Capacity (BPH)	
Drying conditions	GSI 2320	Sukup TC205
Full heat (20-15% MC)	2010	2020
Full heat (25-15% MC)	1250	1250
Full heat (30-15% MC)	920	–
Heat and cool (20-15% MC)	1380	1380
Heat and cool (25-15% MC)	850	860

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Dryeration occurs when hot grain is cooled in a bin with a full plenum floor, typically at aeration rates higher than 0.5 cfm/bu (Cloud et al., 1998). The grain will lose additional moisture as it steeps and cools. Capacity is lower in a CF dryer with a cooling cycle because the dryer typically performs this operation as a batch process. In a batch process, grain is held in the dryer with the fans running, and the cooling cycle is performed internally. The decision to run a dryer with full heat as a true continuous process or to run as a batch process with a cooling stage will depend on the desired capacity, bin availability, and other factors.

Heater Fuel Usage

The next aspect to consider is the heater performance, given in maximum BTU per hour (**Table 2**). This should be the maximum amount of energy needed to operate the dryer at full capacity. The worst-case scenario for fuel usage if the dryer is operating correctly can be estimated using this number. Some specifications give the total BTUs as just one number, while other manufacturers split the heater performance between two drying units. Adding the energy requirements together gives the total maximum amount of energy per hour.

Table 2. Heater maximum energy usage (BTU/hr).

Maximum energy (BTU/hr)	
GSI 2320	Sukup TC205
1 @ 7.5 mil 2 @ 4.5 mil	16.5 mil

A simple calculation can be used to estimate the fuel costs associated with running a dryer now that the capacity and energy usage are known (**Equation 1**). This calculation includes the number 1,000,000 since energy use is given in millions of BTUs. Other important parts of this calculation are the energy content of the fuel that the dryer will use and the cost per unit of the fuel. **Table 3** contains the energy contents of the two most common fuel types: liquid propane and natural gas (Uhrig and Maier, 1992). Fuel costs can be estimated from a current bill or by contacting a local service provider.

Equation 1. Estimated fuel cost.

$$\text{energy cost (\$/bu)} = \frac{\text{heater energy use (BTU/hr)} \times 1{,}000{,}000 \times \text{fuel cost (\$/unit)}}{\text{fuel energy content (BTU/unit)} \times \text{dryer capacity (BPH)}}$$

Table 3. Energy content by fuel type.

Fuel type	BTU/unit	Unit
Liquid propane (LP)	92000	gallon
Natural gas (NG)	1000	cu ft

The example below demonstrates how to calculate the fuel cost for the GSI 2320. Different capacities, fuel costs, or operating conditions can be substituted to estimate fuel use under local conditions. Keep in mind that this should be a worst-case scenario.

Heater Fuel Use Example
GSI 2320 using LP fuel ($3/gal)
Capacity: heat and cool 20-15% MC - 1380 BPH
Total energy:
7.5 million BTU/hr + 2 x 4.5 million BTU/hr = 16.5 million BTU/hr

$$\text{energy cost (\$/bu)} = \frac{16.5 \text{ BTU/hr} \times 1{,}000{,}000 \times \$3/\text{gal}}{92{,}000 \text{ BTU/gal} \times 1380 \text{ BPH}} = \$0.39/\text{bu}$$

Figure 1 was created by using the same calculation as above, assuming the use of LP fuel at $3 per gallon. A mean of fuel energy costs was calculated for all dryers from a single manufacturer. The vertical bars represent the maximum and minimum costs for each drying case. Across all the drying types and moisture content ranges, there was very little change in fuel energy cost as dryer capacity increased. Drying using full heat from 20 to 15 percent moisture content had the lowest estimated fuel costs. Batch drying with a cooling phase increased costs because of decreased capacity and longer running time. This figure is a comparison of a single manufacturer's dryers with an assumed fuel type and cost. It should not be used to estimate specific costs for drying.

Electricity Usage

The electrical energy consumption can be roughly estimated by knowing the horsepower (HP) of all the fans and augers used in the dryer (**Table 4**). This could be a diversified load, meaning that in batch mode with a cooling cycle, all of the motors may not be running at the same time. Assuming that all motors will be running the entire time the dryer is in use will provide a high estimate of electricity consumption. Without having the individual motor nameplates, a specific estimate of total power is impossible, but this method provides a general estimation of dryer electrical costs.

Table 4. Total dryer motor power (HP).

	Motor power (HP)	
Motor	GSI 2320	Sukup TC205
Stage 1 fan	30	40
Stage 2 fan	2 @ 15	40
Input auger	7.5	5
Output auger	7.5	5
Meters, inverters, control (assumed)	1	1
Total	76	91

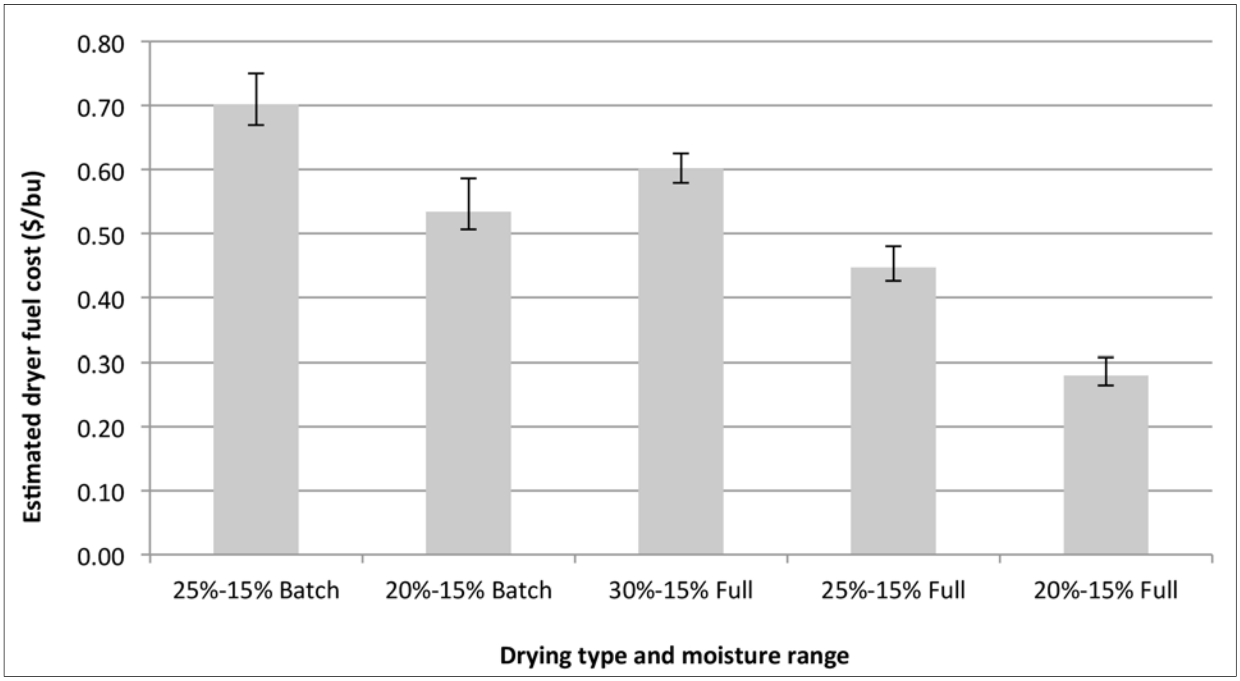

Figure 1. Estimated drying fuel cost by drying case ($3/gal LP).

Some manufacturers may also provide an expected electrical load in amperes (amps or A) that can be used to estimate consumption at specific line voltages. Electrical energy consumption is billed in kilowatt-hours (kWh). To estimate the electricity cost, multiply the consumption in kilowatts by the number of hours in operation (**Equation 2**). Since the capacity of the dryer is given in bushels per hour, time is already included in the calculation. A conversion rate of 0.746 kW per HP is also included in the calculation. The electrical cost per kWh can be estimated by taking a current power bill and dividing the total cost by the kWh used.

Some electrical providers may use peak billing in which the consumer is billed at their peak power consumption for the entire day. Contact the local service provider for more details.

Equation 2. Estimated electrical costs.

$$\text{electricity cost (\$/bu)} = \frac{\text{total HP} \times 0.746 \text{ kW/HP} \times \text{\$/kWh}}{\text{dryer capacity in BPH}}$$

Electrical Use Example
Sukup TC205
Capacity: heat and cool 20-15% MC – 1380 BPH
Total HP = 91
Electricity = $0.15/kWh

$$\text{electricity cost} = \frac{91 \text{ HP} \times 0.746 \text{ kW/HP} \times \$0.15\text{/kWh}}{1380 \text{ bu/hr}} = \$0.07\text{/bu}$$

Conclusions

Postharvest management decisions determine an operation's profitability. Using publicly available information from grain dryer manufacturers and some basic calculations, the cost of operating a continuous flow grain dryer can be estimated. These tools can be used to budget for drying expenses and to compare the feasibility of different options for harvesting, drying, and storing crops. This method allows grain managers to choose a strategy that manages the moisture content of their grain while also accounting for costs.

References

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