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Horticulture Research

Energy Use and Cost of Starting Seedlings at Three Iowa Farms

Staff Contact:

Liz Kolbe – (515) 232-5661
liz@practicalfarmers.org

Cooperators:

- **Susan Jutz – Solon**
- **Tim Landgraf and Jan Libbey– Kanawha**
- **Eric and Ann Franzenburg– Van Horne**

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http://bit.ly/pfi_horticulture

In a Nutshell

- Three farms recorded the energy used during seed starting for the 2013 season.
- For each plant started, energy cost ranged from $0.002 - $0.033.
- Commercial grow lights were the most energy intensive item used by any farmer in the study.
- Though energy efficiency improvements could be made, farmers found that starting their own seeds was cost-effective.

Project Timeline:

October 2012 – October 2013

Germination in the high tunnel at Susan Jutz's ZJ Farm in Solon, Iowa.

About the Cooperators

Eric and Ann Franzenburg operate Pheasant Run Farm in Van Horne, IA. A truly diversified operation, Eric and Ann raise row crops, hogs, vegetables, and cut flowers and medicinal and culinary herbs in their four greenhouses. They sell to restaurants, florists, and at the Iowa City and Cedar Rapids Downtown Farmers Markets.

Susan Jutz operates ZJ Farm in Solon, IA. She is the primary vegetable grower for Local Harvest CSA, which provides 200 share boxes for families in the Iowa City and Cedar Rapids area. In addition to vegetables Susan maintains a 40-ewe flock on 26 acres of pasture and markets the lambs to local consumers.

Tim Landgraf and Jan Libbey operate One Step at a Time Gardens in Kanawha, IA. They offer 10 different vegetable CSA share options to 120 consumers in Northern Iowa, as well as pastured poultry.

Background

Each year looks different on a diversified vegetable farm, but every year begins with the seeds – and the seedlings, too. To get an early jump on the season, many vegetable farmers start plants indoors in seedling trays, then transplant the seedlings (also called "starts") to the field when conditions are appropriate.

Seed companies, commercial greenhouses and nurseries sell flats of seedlings for transplant, but most farmers prefer to use their own seedlings to ensure quality and variety, and to reduce production costs. For comparison, a pack of 250 tomato seeds costs $5.80 ("Heirloom Tomatoes" -- $0.02/seed), but a flat of 100 tomato seedlings costs around $40 ("Wholesale Tomato Plants" -- $2.50 per plant). Farmers were curious, however, how energy costs (light, heat, etc.) to start seedlings in the early spring impacted the expected cost savings. When additional energy is needed, is it still cost effective for farmers to grow their own starts? Three farms installed energy meters on their equipment used for starting seeds to find out.

The objective of this project was to Compare the energy use and cost of starting seedlings on three Iowa farms.

Method

Three farms participated in this study. Energy data loggers were placed on electrical equipment used for starting seeds. The data loggers measured kWh and hours of use. Each farm recorded readings from the data loggers when they made changes to their energy use (turned on lights, removed heat mats, etc).

One Step at a Time Gardens (OSTG) starts their seedlings under lights in a heated

space. In 2013 they started 10,080 seedlings, a combination of: broccoli, cauliflower, cabbage, tomato, eggplant, peppers, and eight kinds of herbs. They recorded their energy use for lights and heat in the seeding room.

ZJ Farm starts seedlings for three CSA farms (400 shares total) in a germination house, an 18' x 55' high tunnel. The germination house uses a circulation fan, a blower to inflate the air space between the two plastic covers (for increased insulation), and heat mats. The mats are used for germinating early tomatoes and all peppers and eggplants. In total, 10,000 of 165,000 seedlings are germinated on mats, removed from heat and transplanted as soon as the first true leaves appear. All other seedlings are germinated without heat with propane being used rarely, only when the greenhouse temp drops below 32 degrees F.

Pheasant Run Farm starts their seedlings using a commercial grow light and fluorescent lights with a nearby space heater; they collected electrical use data for each. In 2013 they started 2,970 seedlings.

Energy use and cost per seedling was calculated by dividing the total energy used by the number of seedlings produced. The number of ten-100-Watt light bulb-days and CO2 lbs-equivalent (US Energy Information Administration) were calculated from the energy use for the entirety of the recording period and per hour recorded.

Results

Lights contributed the largest energy use and cost per hour and over the entire recording period (**Tables 1 and 2**). The commercial grow light uses the most energy (along with the estimated use of the propane): over 1kW/hour (lighting one commercial grow light is the same energy use as lighting ten 100-Watt light bulbs). The energy cost to each farm was less than $0.04 per seedling (**Table 3**). Pheasant Run Farm had the highest energy cost per seedling followed by One Step at a Time Gardens; ZJ Farm's energy cost was $0.02 per seedling.

Per hour, the seed start set-up at Pheasant Run Farm used the most energy (**Table 2**) and was the most costly per seedling (**Table 3**). The cost per seedling outcome may be impacted, however, by the time of recordings. Pheasant Run Farm recorded energy use for 4 weeks during February and March; the other two farms began recording at the end of February and beginning of March and continued recording into June. The absolute need for light and heat is greater earlier in the season, which may have contributed to the higher per

Table 1

	Total Energy Use and Cost					
Farm	**Energy Use (All electric)**	**Total kWh**	**Use Hours Measured**	**10, 100W light-bulb equivalent**	**CO2 equivilent (2.1lbs / kWh)**	**Estimated cost at $0.11/kWh**
One Step at a Time Gardens	Seedling Room Light	1,113	1,842	46 days, 7 hours	2,337	$122.43
	Seedling Room Heat	597	3,355	24 days, 21 hours	1,254	$65.67
	Total	**1,710**	**5,197**	**71 days, 4 hours**	**3,591**	**$188.10**
Pheasant Run Farm	Comm Grow light	393	378	16 days, 9 hours	825	$47.17
	Space Heater	355	718	15 days, 19 hours	746	$42.64
	Flourescent lights	65	719	2 days, 16 hours	136	$7.75
	Total	**813**	**1,815**	**34 days, 20 hours**	**1,707**	**$97.56**
ZJ Farm	Blower	150	2,976	6 days, 6 hours	315	$34.65
	Heat Pads	902	1,899	37 days, 14 hours	1,894	$208.36
	Circulation Fans	367	2,442	15 days, 7 hours	771	$84.78
	Propane	2,144	1,899	89 days, 8 hours	4,502	$77.00
	Total	**3,563**	**9,216**	**148 days, 9 hours**	**7,482**	**$404.79**

Table 2

	Energy use and cost per hour recorded				
Farm	**Energy Use (All electric)**	**kWh**	**10, 100W light-bulb equivalent**	**CO2 equiv. (2.1lbs / kWh)**	**Cost**
One Step at a Time Gardens	Seedling Room Light	0.604	36 minutes	1.27	$0.066
	Seedling Room Heat	0.178	11 minutes	0.37	$0.020
	Total	**0.329**	**20 minutes**	**0.69**	**$0.036**
Pheasant Run Farm	Comm Grow light	1.040	1 hour, 2 minutes	2.18	$0.125
	Space Heater	0.495	30 minutes	1.04	$0.059
	Flourescent lights	0.090	5 minutes	0.19	$0.011
	Total	**0.448**	**27 minutes**	**0.94**	**$0.054**
ZJ Farm	Blower	0.050	3 minutes	0.11	$0.012
	Heat Pads	0.475	29 minutes	1.00	$0.110
	Circulation Fans	0.150	9 minutes	0.32	$0.035
	Propane	1.129	1 hour, 8 minutes	2.37	$0.041
	Total	**0.387**	**13 minutes**	**0.81**	**$0.044**

Table 3

Per seedling energy use and cost

Farm	Seedlings Produced	kWh per seedling	Cost per Seedling
One Step at a Time Gardens	10,080	0.17	$0.019
Pheasant Run Farm	2,970	0.27	$0.033
ZJ Farm	164,880	0.02	$0.002

seedling cost for Pheasant Run Farm.

The timing difference is indicative of the farms' respective markets. Pheasant Run focuses on farmers markets, where having the first tomato, first pepper, and first eggplant gives you a competitive advantage. ZJ Farm and One Step at a Time Gardens primarily grow for CSAs. With CSA, there is no in-season competition; the produce is already bought when it leaves the field. Because of this, CSA growers needn't push the season as hard. Says Jutz, "We start the bulk of tomatoes, peppers, and eggplant in early April and into May for late tomatoes, reducing the risk of cold nights and thus reducing our energy costs."

Tables 1 and 2 detail the CO2 lbs-equivalent emitted and translate the energy used into ten-100-watt light bulb-days. Ten-100 watt light bulb-days provide an easy visual of energy use. For example, the energy used to start seeds at ZJ Farm is equivalent to leaving ten light bulbs lit, 24 hours per day, for 148 days and nine hours. For context with CO2 lbs-equivalent, a 2005 Chevy Malibu emits 0.79 CO2 lbs-equivalent per mile; ZJ Farm's energy use is comparable to driving a Malibu 5,312 miles (Travel Matters)

Conclusions and Next Steps

This study did not attempt to measure the quality of the seedlings produced, nor the number of days each flat was under light or on a heating mat. Additionally, this study did not account for the initial cost of the seed starting structures, equipment, bedding, or labor. To determine if starting seedlings is indeed cost effective for a farm, those measures should be included.

Though the energy cost per seedling is quite low for each farm, each could identify areas where efficiency could be improved to save money and electricity. For example, each farm used a source of heat. Heating the soil and roots with a heating mat is more efficient for seed starting that heating the ambient air, but either method could be made more efficient by adding insulation around the system. Using reflective materials to direct light to the seedlings can similarly increase the efficiency of lights. "The trial confirmed that we need to replace the heat mats we use to germinate peppers, eggplants, and tomatoes with a homemade germination chamber," said ZJ Farm's Jutz. One Step at a Time Gardens noted their surprise at the overall expense compared to purchasing seedlings. They will continue to document their energy use, but plan to continue using both heat and light for their starts.

Within its limited scope, this study showed that the energy cost per seedling, $0.033 at most, will likely not impact the cost-effective strategy of farmers starting their own transplants. However, this study showed that cost per seedling can vary between farms by more than $0.03 per start. Increasing efficiency, even at this low cost, could result in significant savings of dollars (and kWh) each year. ZJ Farm is continuing to explore their seedling production by documenting the labor, supplies, and equipment costs for Spring 2014.

References

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Travel Matters. 2014. "Individual Emissions Calculator." Web. 20 Feb. 2014.

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PFI Cooperators' Program

PFI's Cooperators' Program gives farmers practical answers to questions they have about on-farm challenges through research, record-keeping, and demonstration projects. The Cooperators' Program began in 1987 with farmers looking to save money through more judicious use of inputs. If you are interested in conducting an on-farm trial contact Stefan Gailans @ 515-232-5661 or stefan@practicalfarmers.org.