Green Winters

An analysis of the economic and environmental sustainability of passive solar greenhouses and indoor aquaponic operation

Stephen Johnson Dr. Jean Lavigne

Abstract

Rising oil prices have brought uncertainty to the longevity of the American food system. If oil prices do make transportation of vegetables unfeasible in the future, people in colder climates will have to find a way to produce healthy foods, even in the winter. Through my research I discover how both passive solar greenhouses and indoor aquaponic operations have economically and environmentally sustainable aspects for growing vegetables during cold Minnesotan winters, and move on to prove why a combination of the two systems is the most sustainable option for the future. To come to this answer, I used a plethora of secondary research along with first hand interviews. At St. John's University, I am the student in charge of the construction of a passive solar winter greenhouse. I was able to use knowledge gained during this process to help determine the answer to my research question. Passive solar greenhouses use far less energy than indoor aquaponic operations but indoor aquaponic operations produce higher yields. If these high yields of aquaponics could be reached without consuming so much energy, a truly efficient system would be created. I propose that this system can indeed be created. Combining the highly efficient greenhouse structure with the enclosed growing methods of aquaponics has the potential to be an incredibly efficient system.

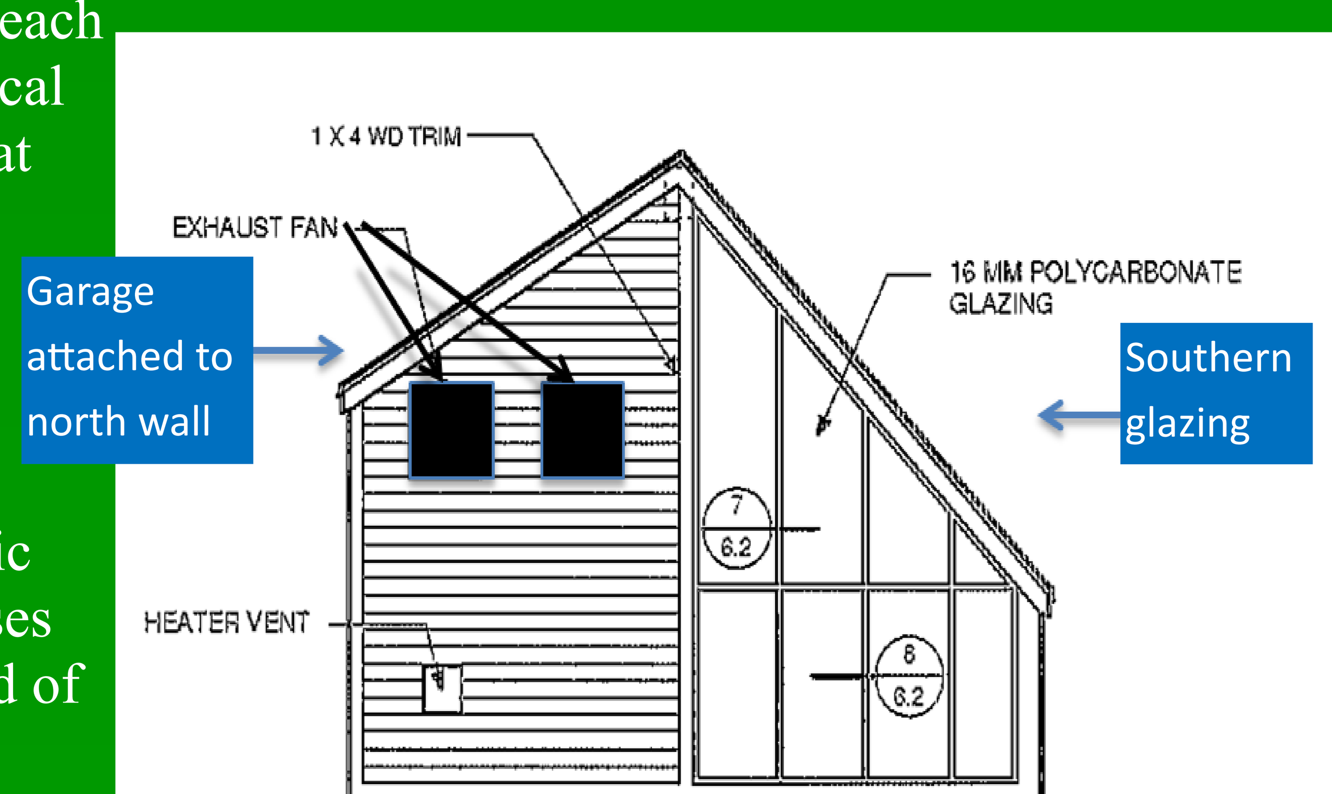
Environmental Sustainability

	Pounds of Vegetables Produced	Pounds of fish fillets produced	CO2 emissions from artificial heat	CO2 emissions from artificial light	Pounds of Vegetables/Pounds of CO2 emissions	Pounds of total Food/Pounds of CO2 emissions
Aquaponic	258,250 lbs.	90,000 lbs.	1,397,731 lbs.	158,892 lbs.	.1659	.2237
Passive Solar Greenhouse	2,160 lbs.	0 lbs.	346 lbs.	0 lbs.	6.2428	6.2428
Hybrid Solution	4,320 lbs.	1,507 lbs.	692 lbs.	0 lbs	6.2428	8.4205

Conclusion

In comparing pay back periods for each operation, one can see the economical feasibility of each operation and that aquaponic operations have a much shorter payback period. Environmental sustainability, measured by yields compared to carbon footprint, presents an interesting contrast. Compared to indoor aquaponic operations, passive solar greenhouses have a much higher yield per pound of yearly C02 emission released.

Hybrid operation external view



Indoor Aquaponic Operations

- In cold climates, most often found in warehouses
- Requires heating and artificial lighting
- Uses fish manure to fertilize plants

Passive Solar Greenhouses

- Ideal for cold climates
- Highly Insulated leading to $75 heat/year
- Suitable for growing 6 months of the year
- Plants grown vertically in hanging gardens to conserve

Economic Sustainability

	Pounds of Vegetables Produced	Pounds of fish fillets produced	Startup Costs	5 Year Operation Costs	Pounds of Vegetables/ Startup Costs and 5 years operation	Pounds of total Food/Initial investment and 5 Years operation
Aquaponic	258,250 lbs.	90,000 lbs.	$750,000	$1,403,250	.1199	.1617
Passive Solar Greenhouse	2,160 lbs.	0 lbs.	$43,000	$29,000	.03	.03
Hybrid Solution	4,320 lbs.	1,507 lbs.	$53,000	$70,130	.0351	.0473

Solution

Combining the highly efficient greenhouse structure with the enclosed growing methods of aquaponics has the potential to be an incredibly efficient system. The greenhouse would eliminate both the heat, and lighting costs associated with indoor aquaponic operations. From an operations standpoint, these greenhouses would no longer depend on nutrient rich soil; instead, all the elements, light, water, and nutrients that the produce depends on will be produced within the structure.

Hybrid operation internal layout