DEEP WINTER GREENHOUSE PRODUCER CASE STUDIES

Carol Ford, Sue Wika, Ryan Pesch

Greg Schweser Associate Director, Sustainable Agriculture and Food Systems, UMN Regional Sustainable Development Partnerships
Katie Myhre Student, St. Olaf College

Deep winter greenhouse technology enables small scale producers to grow cold hardy greens throughout the winter with minimal external heat. This greenhouse style uses passive solar technology that captures the sun's energy through an angled transparent polycarbonate glazing wall and stores it in an underground insulated thermal mass of rock. Perforated drainage tile in the rock bed is connected to pipes that circulate heated air throughout the air and below the ground, allowing the soil and air to warm.

Interest in this system is growing. A Deep Winter Producers Association has recently formed in conjunction with the Sustainable Farming Association of Minnesota. The Regional Sustainable Development Partnerships are working with Deep Winter Greenhouse producers and researchers to learn more about this technology and help connect those adopting the system to information they need to produce successfully.

The following are the stories of three different Deep Winter Greenhouse producers: Carol Ford, Ryan Pesch, and Sue Wika. The experience, goals, challenges, and hopes for the future of these early adopters can help prospective growers understand what to expect as they build and use their own Deep Winter Greenhouses.

DEEP WINTER GREENHOUSE PRODUCER BIO

Carol Ford – Garden Goddess Greenhouse

Carol Ford has been a pioneer of Deep Winter Greenhouse production. Built by her late husband Chuck Waibel in 2004, the Garden Goddess Greenhouse has served as the inspiration of future winter producers. The small-scale structure is attached to a garage and produces enough greens for a 12 share winter CSA. Ford frequently gives tours and promotes the technology to prospective producers in the Upper Midwest.

Introduction

Carol Ford was inspired to construct and operate a passive solar greenhouse because other methods of season extension were not a good fit for Waibel and Ford's geography and values. Hoophouses which are common season extension structures in Minnesota are often unable to withstand heavy winds common on the Southwestern Minnesota prairie. Furthermore hoophouses only allow for season extension, not winter production. Conventional greenhouses, although they allow for abundant winter production, are heavy users of fossil fuel energy. Concerned about a future of climate change and diminishing fossil fuel resource availability, Ford and Waibel sought a more low-tech production facility that could build community resilience, limit reliance on carbon emitting fuel sources, and produce food in the event of economic disruptions caused by resource depletion (the 2008 gas price spike led to limited produce availability in their rural Minnesota community as delivery routes were modified).

The Deep Winter Greenhouse model extends season extension

Because hoop houses structures are built on soil, there is little protection from freezing weather during the winter and warmth from the air is drawn into the floor, creating a heat sink. Conventional greenhouses require high inputs of fossil fuels to maintain a level of warmth conducive to growing during the winter, making this form of production unsuitable for those attempting to minimize fossil fuel use.

Ford's greenhouses combine strengths of both the hoop house and conventional greenhouse models to create a sustainably powered passive solar system. Deep Winter Greenhouses (DWGs) are oriented East-West with a south-facing sloped glazed surface to maximize their capacity to capture solar

energy. This passive solar energy heats a heavily insulated underground rock bed covered with soil, which slowly releases over the night, minimizing the amount of delivered fuel energy needed to grow greens. This allows Ford to produce from early fall through spring, providing greens for a 12-share CSA in addition to sharing with family and friends.

Produce grown in the DWG are cold hardy leafy greens from the cole crop family. Ford states, "I could grow other things (fruit-producing crops), but it takes too much energy and resources." Yet just growing greens does not feel boring to Ford, as she grows over 3 dozen varieties from the cole family. The leafy greens thrive with lower light requirements and are, therefore, a good fit for winter production up north where there are few hours of daylight. Growing greens also enables DWG producers to grow product without costly technological inputs like artificial lights and heat.

Why Carol Ford grows

For Ford, operating a Deep Winter Greenhouse provides her with rewards that come with "feeling like you are a part of the solution" in Midwest agriculture. Education is both one of her greatest rewards from producing through the DWG model, as well as one of her greatest goals. She enjoys helping others benefit from the system she worked to create, as well as bring new growers into the field of production. By creating a bigger community of growers, knowledge can be shared faster and easier. Ford believes that bringing more people into food production is "going to be part of what our paradigm shift will be as a species." To Ford, it's important that people look at food production as the sacred task that it is.

For cold winters in Minnesota, food production in a DWG can also be a therapeutic task. When the outdoor mercury reads 20 below zero and you are working in a warm greenhouse surrounded by sun and living plants, the winter seems less challenging.

Future research needs

There is plenty of work to be done to improve the DWG model. In future years, Ford hopes to continue her research to improve overall production including testing new varieties of plants to find which will be most productive in the coldest months of winter, as well as enhancing soil health and productivity. She is interested in utilizing integrated pest management (IPM), as some producers have had significant problems due to lack of proper pest monitoring. Soil fertilization can be challenging so Ford would like to find the optimum mix of macrobiotics and micronutrients in the soil.

"Get connected"

For those looking to adopt the DWG system, Ford recommends getting involved with the Deep Winter Producers Association. Among DWG growers, there are people doing this who want to help. Visiting other greenhouses, talking to producers, and reading her book *The Northlands Winter Greenhouse Manual* include ways to better understanding of the Deep Winter Greenhouse model.

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Sue Wika – Paradox Farm

Sue Wika operates Paradox Farm in the Northern Minnesota town of Ashby where she raises goats and sheep on 160 acres of pasture. In 2012, Wika built a deep winter greenhouse connected to her milking shed. She uses the greenhouse to raise greens for a winter CSA as well as to provide a winter fodder crop as a supplement for her animal's regular feed.

Introduction

For Sue Wika, operating a Deep Winter Greenhouse (DWG) instead of a typical greenhouse just makes sense. The advantages are numerous, ranging from her personal enjoyment of working during the winter season to the broader environmental benefit associated with operating a greenhouse with a low carbon footprint. Running a grass based livestock operation during the summer months is quite intensive, but the winter season allows Wika to have the time and ability to both raise livestock and produce winter greens. Her greenhouse allows for about 64 square feet of fodder production and 140 square feet of greens, a scale that is manageable for Wika. Producing greens in the middle of winter also provides an opportunity for Wika to market a CSA from early December to mid-April—something she otherwise wouldn't do. The DWG model worked well for her, allowing her to grow fodder in the winter months, which would not be possible in a hoop house. Fodder is a supplement Wika grows to pair with the dry matter that livestock receive during winter months. She claims that "this is their treat, the reason they want to come into the milking parlor. Instead of grain, they come in for fodder." Calling fodder a 'winter vitamin pill,' Wika claims it enhances the quality of the milk, keeping the animals happy and healthy. For their small dairy herds, it allows the farm to be "pastoral in the winter."

Maximizing value of the greenhouse

Though the greenhouse is used primarily for winter production, its value does not end there. Wika's DWG is ideal for not only starting plants to be transplanted into the fields, but is also a great space to dehydrate tomatoes and herbs. The dry and hot days of July and August allow the greenhouse to provide "four seasons of production."

Be responsive to the system

In her various approaches to deep winter production, Wika has anything but passivity in her passive solar DWG. She takes every opportunity to tweak and improve her operation, learning quite a bit in the process. To run a DWG this successfully, Wika asserts "You have to want to 'tend the system' and be on hand. We watch, observe, and adapt."

Wika stresses the need to learn how to 'read the greens' and know how they grow. Watching closely and responding accordingly allows production to quickly become second nature and though there is always a learning curve, the longer you do it, the easier it becomes.

Experimenting with the system and crops

Wika recognizes the importance of being adaptable and responsive, and therefore does not shy away from experimentation. She has tried her hand at growing butterhead lettuces, choys, mini-romaine lettuce, lots of herbs, buckwheat shoots, and different types of cress, dill, mustards, pea and sunflower shoots. Extending the season is another one of Wika's plans and she hopes to test the effectiveness of growing as early as October, something she hasn't been able to do due to managing livestock in the Autumn months. Water use is also a concern and area of experimentation for Wika; a large part of her commitment to the DWG model is its potential for sustainability in a world with intense attention to water footprint. She is interested to know how much water her DWG uses over the course of a season and feels it is important to build an awareness of water use. "People are already sold on the passive solar. It is hard to believe how much we can grow with minimal light…water is next."

Challenges of the system

Despite all of the advantages, there are challenges inherent in this form of production. Wika feels that this is a production scale that doesn't yet fit within a larger production system that is all about control and economies of scale. "This is a very human-scale production model. We don't have a good way of evaluating these scale-appropriate production schemes." DWG greens are part of a whole farm system and represent one cash crop, but there will also be others on your farm. "DWG could be the fourth season income stream…and a fairly nice one" states Wika.

While this production system addresses climate change mitigation, changes may also pose another challenge for producers as Minnesota has experienced fewer sunny winter days in recent years. Again, Wika asserts that DWG need to be able to "adapt and tweak" to the decreasing levels of winter sun.

Recommendations for others

For those considering adopting the DWG model, Wika recommends reading Chuck Waibel and Carol Ford's book *The Northlands Winter Greenhouse Handbook* many times, as well as the *Cold Climate Greenhouse Resource* manual released by the University of Minnesota. It is also important to connect with other DWG growers by visiting other DWGs, attending classes, and speaking with as many people as you can. It is important to understand the personal commitment a DWG requires. Wika recommends to "look at your system holistically to think about whether you want to grow in the winter and consider the change in quality of life. Those 2-3 week vacations might not be a part of the picture anymore."

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Ryan Pesch – Lida Farm

Ryan Pesch of Lida Farms built a Deep Winter Greenhouse at the beginning of the growing season. His greenhouse is built into the side of a salvaged and repurposed beach cabin that has been renovated into a fully livable dwelling unit for future farm apprentices. During his first year of winter production he grew veggies for his CSA program and utilized the space for starting summer crops.

Background

Although Ryan Pesch has only been producing greens in the Deep Winter Greenhouse (DWG) for about 6 months and was merely "happy to get it up and running," he has plenty of experience to share. Growing in Northern Minnesota is no easy feat, and the short length of the growing season makes a system like the DWG all the more valuable. Like many other DWG operators, Pesch was drawn to the model based on its limited reliance on fossil fuels. Though "you could take a random greenhouse kit and grow in the winter…I don't think it would work as well…you'd just burn a lot of propane and sodium halogen lights to make it work." Instead, Pesch's model relies heavily on insulation and passive solar energy, both characteristic of the passive solar DWG model.

The Design

The structure of Pesch's greenhouse is unique in its utilization of surrounding materials and structures. His DWG is a 16'x32' structure that stands two stories tall; the bottom story, which is the main growing area, is attached to a root cellar and also has an outward facing door. The second story shares its back wall with a cabin, where the farm apprentice lives. On the roof, there are two solar thermal panels of 60 evacuated tubes that are used to heat a deeper sand bed, as well as the rock bed that makes up the main thermal mass under the ground of the growing medium.

Production

In the greenhouse, Pesch's grows a variety of cool season vegetables for his winter CSA shares. The variety includes primarily greens mixed in with some bok choy, Chinese cabbage, Asian greens, as well as basil. Pesch was able to experiment with a microgreen broccoli, as well as turnips radishes, and some root crops. Because Pesch's farm is

located so far north, it is important to extend the season wherever possible; Pesch also saved money by growing starts and transplants for the following season field production. “We used to pay someone to do our early starts: herbs, celery, parsley, etc…now we do those in the winter greenhouse.”

In the process of building and beginning to produce from his DWG, Pesch has come up with plenty questions about the process, and he hopes to see the DWG movement grow in a variety of ways. For his own farm, he hopes to produce enough greens for 20 CSA shares, and the ability to produce “a quality mix” more consistently throughout the winter. Pesch also wonders about the specifics of soil mixtures; there is little understanding of the optimum nutrient content for soil mixtures, and balancing out levels of phosphorus and nitrogen could make a huge difference in DWGs.

Additional questions about the DWG design

Pesch has questions about the DWG building design. He’d like to better understand about the importance of the angle of the south-facing transparent glazing wall; “Will the plants perform just as well with a 45 degree angle or the steeper angle that is recommended to capture the majority of sunlight? That is a big deal, a 60 degree (or larger) angle needs to be tall and limits growing space. A less steep angle allows for more growing space. At 45 degrees you would have about 40 feet versus 14 feet or so with a 60 degree angle.” He also would like to figure out how to make the DWG tighter, asserting that silicone doesn’t work so well in the humid environment, so finding out a way to apply caulk most effectively is crucial. Also, the optimal number of vents is another question on Pesch’s mind; if you put too many vents, you aren’t able to store heat, but more vents also means that there is potential to use more heat from the sink.

Learning from Pesch’s experiences

Pesch says he runs into many challenges with his current operation that are helpful learning lessons for those adopting their own DWGs. First, since the space didn’t have a cutting room or a heated room to wash and pack his CSA shares, Pesch was forced to put the produce in a bag and bring it into his kitchen sink. “The packing and washing piece of this pie should be considered in the design. It would be very difficult to do it in the greenhouse itself…if it is sunny outside, it is blazing hot in the greenhouse. One should have that idea in mind when designing the DWG.” Timing is also a challenge for Pesch’s DWG. Being consistent with growing in an unreliable Minnesotan winter season is a challenge, so “you really have to be in tune with the winter seasons, thinking through the planting so you have everything ready at the right time.” To maintain consistency, staggering production and spacing the sprouting is important and very different than summer production. Finally, Pesch ran into another problem: bugs. Aphids infested

some of his DWG produce, a problem that he had never had before, and, as Pesch learned, needs to be addressed right away before it gets out of control.

Operating a DWG isn't "crazy" or "difficult" according to Pesch. Yet, adopting the DWG model goes beyond the technical aspects of regular farming. For those looking to get into this system, Pesch stresses the importance of understanding how this fits with your current system. In Pesch's opinion, a DWG should be a "good next step with what you are doing"; having experience growing in other contexts is important. There is also the day-to-day commitment of tending to and maintaining the greenhouse itself which isn't difficult but you want to have some context with growing in a greenhouse. Also, acknowledging the level of undertaking involved in building a DWG can be crucial in being realistic about the system. There is a fair amount of complexity to building the greenhouse. "If you aren't building one every day, building one of these will be harder than you think."

It's important to take a hard look at the system and think critically about if it's right for you, whether it fits into your life, and where you are currently at in your operation. "Just because it is a neat idea doesn't mean you can or should do it." There are other options like high tunnels and cold season greenhouses, to extend the season if people aren't ready to make the jump to DWG or if it isn't right for their operations.

For the construction of the DWG, Pesch advises to "Go the cheap way...don't experiment with costly additions upfront." He states, "There is plenty of time to get fancy and upgrade your system. Just build the standard thing and do whatever you want to later. The solar thermal panels on my greenhouse complicated the project and made it much more expensive." He could have saved roughly a third of his greenhouse cost if he had followed this advice.

The rewards

"Everyone says it, but really just sitting in there in January when it is sunny is really a benefit." Pesch, like many other DWG producers, appreciates the rarity associated with growing food deep in the winter. "People are inspired by what they see, that we took the leap. People are excited to see this happen in their backyard and the connection with our CSA members is really rewarding."