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# Maine Greenhouse & Covered Agriculture Program

Topic:

A SURVEY OF STYLES AND METHODS OF  
MAINE WINTER FARMING

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The Maine Sustainable Agriculture Society

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### **Double Coverage for Passive Climate Control in Winter**

Non-woven crop coverings have become extremely popular on small farms. Their light-weight translucent protection are helpful at mitigating everything from insects to snow and can help ensure a successful crop. Winter crop blankets - the heaviest among the non-woven options for farmers - can help keep crops and soils warmer than the air above them. When used in combination with a greenhouse or tunnel, a farmer can effectively create favorable environment for many viable leafy green crops through Maine's winter.

In 1992, Eliot Coleman published his first "Winter Harvest Manual" and discussed his success with double covering crops. Double covering can "shift your climate" he said and create a winter in your covered space in Maine that has a climate like that of region much further south- with the exception that hours per day of sunlight and solar day arc angles stay the same. Over the past two decades, farmers have been finding inventive and creative ways to integrate non-wovens and clear plastics in all four seasons to grow valuable covered crops out of season and bring positive cashflow, and increase market opportunities long before snowmelt and summer markets.

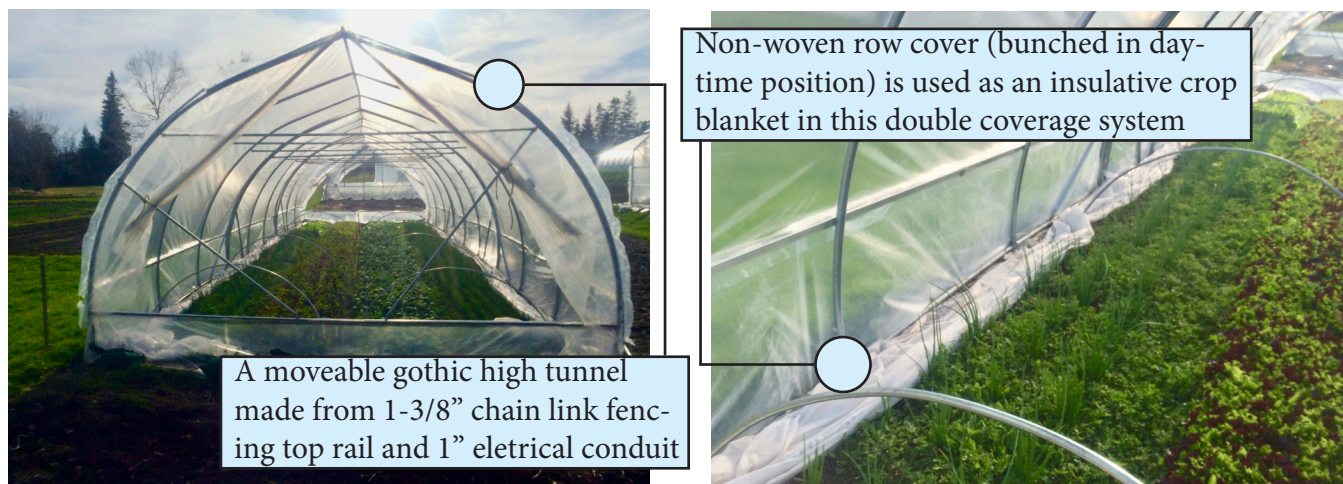
Coleman proved for vegetables what the horticulture industry proved for potted plants, that one can farm the back side of the growing calendar with careful planning and use of resources. The increase in the amount of farmers using these systems for vegetables - effectively scaling crop volume regionally - is helping create a stronger supply of year round vegetables, and increasing year round labor retention on farms across Maine and the region.

For a review of Coleman's concepts see [Jean English's 2007 article in the Maine Organic Farmer and Gardener](#) and Coleman's books [Four Season Harvest](#) and the [Winter Harvest Handbook](#).

### **Double Layering for Shoulder Season Crops; Gothic Low-Tunnel for Plastic + Electrical Conduit for Non-Woven Crop Blankets**

It's well worth the effort to consider, what you can grow to achieve production goals without supplemental heat or energy. Heating a greenhouse in winter is often done for people as much as plants. However retaining natural heat to keep a covered tunnel between 34 - 50 degree temperatures through winter is suitable for a range of useful crops with excellent market value and room to scale up across the region.

Coleman, Barbara Damrosch and Clara Coleman have popularized this system - it's cheap, it's quick, and it works well for bio-intensive small farms. Chain link fencing top rail from the hardware store is bent into shape and used secure plastic for quick and moveable high-tunnels. Then electrical conduit pipe is similarly bent and used to support for crop blankets just above the delicate plant canopy. Be sure to anchor your tunnel so it doesn't blow away in high winds! There are a number of benefits to crop quality when your plant canopy, and the row cover itself is protected from harsh winds and weather.



*Snow Shedding Workhorse: This gothic caterpillar tunnel design is now available as a kit with endwalls from [Farmer's Friend](#). Similar low tunnel kits and pipe-benders for those wanting to build their own are available from [Johnny Selected Seeds Tool Division](#). One person can handle covering/removing crop blankets at this scale. Blankets here are bunched in daytime positions.*



**Six River Farm in Bowdoinham** sets up their heated and insulated tunnels with a double covered system for a full production winter green cold crops. Under dual poly with an air gap, air heaters at ground level distribute heat using inflatable ducts. Thermostats are set only to keep foliage above freezing and at peak market value during planned harvest. Most nights and even on the coldest days crop blankets cover the entire set up.



**Ground level inflatable duct:** The large crop blanket is pulled over metal poles on cold days and nights. The air duct has slits at 4 and 8 o'clock so warm air is released under the crop blanket and remain at the plant canopy.



**LP Gas Air Heat:** Warm air from this ground level Reznor LP Gas Air Heater is funneled to the fan and pushed through the duct. The crop blanket is bunched on the far side of the tunnel in its daytime position.

Beth Schiller, owner/operator of **Dandelion Spring Farm in Bowdoinham**, pulls crop blankets the full length of her tunnel. She attaches metal wire to horizontally. This is a great solution for double layering areas of larger square footage quickly, compared to Coleman's two-row quick hoop system.



**Winter Greens:** No supplemental heat is used to keep these cold tolerant crops at Dandelion Spring Farm marketable through Maine's winter. Moving large crop blankets is easiest with two people and water-proof clothing. Accumulated condensation on blankets can make them wet. Once fully covered, wire hoops keep the blanket off the crop canopy.



## Bio-intensive Soils for Covered Agriculture

Sustainable agriculture farms prioritize production systems that maximize the value of their soils. Bio-intensive soils on a small scale can be highly effective at meeting yields goals by concentrating soil and water management and cropping in smaller areas compared to broad acreage systems. Crop spacing in bio-intensive soils can shrink the acreage needed to produce similar yields. For more on bio-intensive growing this [NCSU bulletin is helpful](#).

Bio-intensive farming that is condensed into smaller growing areas are well suited to covered agriculture innovations. Vegetable farms in our trials yield in ranges between \$20 - \$65 per square foot for a 10-month season. These kinds of yields per square foot are hardly possible in a broad acreage operation with the same crops. However, not all crops are well suited to this approach.

In bio-intensive soils, stimulating soil microbial activity encourages macro and micro nutrient cycling. This in turn can help keep plants in optimum growing conditions. Doing so can increase water retention, minimize run-off, increase microbial activity, and overall fertility well into the subsoil. Bio-intensive soils are also considered a cultural pest mitigation method; “plant positive” - a term developed by Eliot Coleman - rather than pest negative approach to pest management, whereby the plants themselves battle unwanted pests and insects through their season. Plant’s immune systems (and strong cellular walls on a microscopic level) can fend off pests and disease and reduce stress and dieback.

While the same methods work well on broad acreage, it can be cost prohibitive. In this way building bio-intensive soils under cover can allow a farm to meet similar yield goals compared to a broad acre system with larger crop spacing, but in much less space and with the advantage of an extended season under cover.



*Bio-intensive soils: Frith Farm in Scarborough, Maine uses a permanent no-till bed system and deep mulched woodchip paths at the end of each field and in between rows. This bio-intensive approach demands labor and lots of compost in year one. While expensive up front it can pay off in high yielding, high quality vegetables with low weed pressure in following years.*



## Multi-cropping

Bio-intensive soils at optimum health can also support multicropping. Multicropping - also known as *intercropping* and sometimes *annual polycultures* - is a system of growing crops together in a row in a staggered timing that doesn't create crop competition in the roots or canopy. When successful it can increase yields. When executed poorly or with missed timing crops can compete for soil or canopy space and both will grow sub par. Multicropping relies on viable tilth, low weed pressure and a deep oxygen-rich subsoil that comes from biological activity, balanced ph and ample macro and micronutrients.

Multicropping requires an experienced farmer and a hands on approach to soil fertility. However unlike broad farming systems that relies on moldboard plowing or deep rototilling, between plantings, bio-intensive farms can use low till, no till, shallow tilthing and broadforking beds to keep beds in optimum health for multicropping systems.



*Multi-cropping: At Stonecipher Farm in Bowdoinham, multicropping experiments are common especially in high tunnels. These lettuces (right) will be harvested before the longer cycle of swiss chard (left two rows) and a slow growing crop will be planted in the furrow before the swiss chard is done. That crop will then be mature when the next crop is transplanted in the beds.*



### To heat or not to heat?

Supplemental heat to your high tunnel can help increase crop quality and eliminate cold weather stress. For many cold tolerant leafy greens, heating to keep your tunnel above freezing is all that is necessary. Much of the work of these crops happens in the fall; growing slows dramatically in low light months.

For greenhouse operators, a more robust heating system can help you grow high value crops well out of season. A major drawback is that the heating cost can make this proposition very expensive. Maine's small farmers who grow in winter at 60degrees or above range \$10,000 - \$20,000 in annual heating costs. Costs vary dramatically depending on the type of heat, how it is distributed through your structure and the insulation in your tunnel or greenhouse.



*Many Maine farms scale their businesses by developing reliable markets with unheated tunnels (left) and eventually build a heated structure (right) as capital improvements are made.*

### Supplemental Light

Electric lighting, when combined with winter heating, can increase plant productivity during low light months. However the utility cost- both the fixed cost of installation, and variable yearly operating costs - must be weighed against target yields and overall farm goals. For nurseries and off-season growing, supplemental light is essential and well worth the investment.



**LED Lights** are the most efficient lighting systems to run for year round systems. Remember that supplemental lighting can be important to avoid nitrate toxicity in winter greens. Farmer's growing in unheated tunnels often monitor for nitrate levels in plants

### Soil-less growing

Hydroponic producers are making an impact in Maine's year round markets. Olivia's Garden in New Gloucester produces hydroponically in climate controlled facilities. Scott Howard has developed an "indoor ecosystem" approach that allows his farm to grow a range of crops and keeps dedicated space for host plants and beneficial predatory insects as part of his Integrated Pest Management System.



***Hydroponic ecosystem:** Nutrient Film Technique: A row of host plants for beneficial insects that predate on other problematic insects that IPM system at Olivia's Garden in New Gloucester. Two styles of electric lighting, high pressure sodium and LED are also*

Springworks Farm in Lisbon has developed an aquaponics system for growing lettuce hydroponically in a closed loop system by storing fish in a tank and employing them as filters and fertilizer for their lettuces. Innovation in aquaponics can be traced back to John and Nancy Jack Todd's work at the [New Alchemy Institute in Wood's Hole, MA between 1970 -79](#). Similar systems are used to clean wastewater using a combination of aquatic plants and animals.

### Concern for Labeling

Maine Organic Farmers and Gardener's Association recently joined a lawsuit against the USDA arguing that the [National Organic Program](#) should not include certifications for hydroponic or aquaponic producers. For background on the issue view Eric Sideman's article [here](#), and dualing reports from the USDA task force [here](#). We support hydroponic producer's attempts to scale sustainably but we agree that the organic label - a hard earned legacy for many Maine growers - shouldn't be coopted by soil-less growers seeking a market advantage. Organic, as defined by [Rodale Institute](#), implies a cyclical engagement with the soil food web and carbon cycling.



## Vertical and Urban Farms

Farmers, consumers and professionals across industries should consider a healthy level of skepticism on the sustainability of vertical farms when there is ample horizontal space nearby. Even in the most dense urban areas in North America horizontal farms within an hour's drive are within reach. Vertical farms are presenting problem solvers with a new frontier. However, to paraphrasing the words of Cornell University's Dr. Louis Albright, why must we add defying gravity to the already laborious and challenging proposition of the diversified small farm. Early studies suggest that "horizontal" farms operating in a consortium or cooperative in soil and sunlight would likely outpace productivity, crop quality and yields. Even if those metrics were equal in both systems, then reduced energy demand alone makes what Albright calls peri-urban horizontal farms much more cost effective to operate. Furthermore for urban rooftops, air filtration from pollution adds another potentially expensive factor that needs to be mitigated.

For more detailed analysis view [Louis Albright's presentation](#) on the topic from 2014.

For Maine businesses considering roof top farms or greenhouses, we recommend first talking with your nearby farmers and discussing crops that you'd like to see grown out of season. Collaborative partnerships can help reduce our overall energy and heating costs and provide win-win solutions for the regional food economy. Depending on the level of investment you are planning, a collaboration with a year round farm will likely help you meet your goals at a fraction of the cost of building urban farm infrastructure.



***Vertical infrastructure vs vertical economics:*** This rooftop greenhouse in downtown Brunswick creates a new opportunities to produce fresh produce for the commercial kitchen and retail space on the ground floor as well as for the Chinese/American restaurant in the adjacent building. The ground floor commercial space drastically helps reduce heating costs in the greenhouse upstairs. While vertical farms are hard to compare to nearby farmland in terms of efficacy, vertically integrated economics can help add value to everything that is produced in a bio-intensive greenhouse or high tunnel.



**Additional Resources:**

[UMaine Cooperative Extension's Agricultural Plastics Recycling Program](#) is in its trial year. Please recycle agricultural plastics.

Need help budgeting for new tools and infrastructure? Check out [ME SAS' draft editable Enterprise Greenhouse Budget Planning Tool](#). Use the tool to plug in and calculate cost, depreciation, estimated payback and even carbon emissions for whole farm accounting. This draft of the tool comes pre-loaded with a model budget.

For more info on solar greenhouse technologies see [National Center for Appropriate Technology "Solar Greenhouses" Fact Sheet](#). For info specific to Maine see [UMAINE Cooperative Extension Season Extension Bulletin](#) and the [Sustainable Year Round Agriculture Program Final report](#).

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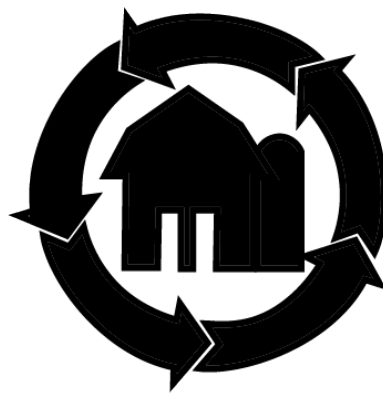
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