**Low Tunnels and Season Extension**

**Introduction:**

Low tunnels are a low-cost season extension technique that can allow small and large scale gardeners to grow well into the winter months. While outside temperatures might be in the 30s, the temps under the hoops might reach into the 80s or 90s. While most plants will stop growing due to lack of enough hours of sunlight around mid-December, the low tunnels will allow them to resume growing as early as late-January. You can start new cold hardy spring crops in February and even get your summer crops into the ground in April rather than May.

**Materials Needed:**

Hoops: The hoops are the skeleton of the low-tunnel system and there are a variety of materials that you can use to make them. They each have pros and cons. We are using ½” EMT metal conduit, which is a little pricey and requires a special tool to bend into shape. However, the conduit is very sturdy, will hold up to heavy snow, and will last for many years.

Green-house plastic: The plastic is what traps the heat from the sun and creates a mini-greenhouse over your rows.  **Do not use regular plastic you can buy at a hardware store, which will very quickly degrade from the ultraviolet radiation.** You will need to use greenhouse plastic that is rated for at least 4 years of solar exposure. It’s slightly more expensive, but you get four times the use out of it. You can choose between 4 mil and 6 mil thickness. We are using 4 mil, which will allow up to 6 degrees of frost protection. This means it must get below 26F before the space under the covers will frost. This plastic is not permeable, meaning you will need to water your crops while they are covered by the hoops.

Row cover cloth: We have also provided you with spun poly cloth. This can be used by itself either over the hoops or laid directly on top of your plants. By itself, this cloth with provide 2-3 degrees of frost protection. For crops like spinach and arugula, this might be enough to survive a mild winter. Unlike the plastic, the cloth is permeable to water and as long as we get regular rain, you will not need to provide water for your plants. **If we are expecting unusually cold weather down in the teens or below, you can use the cloth to double up with the plastic.** Place the cloth directly on top of your plants and use the plastic cover over the hoops. Together, this protection will be the equivalent of moving your garden two agricultural zones further south.

Clamps: Special clamps are made to attach your plastic or cloth to the hoops. Make sure you are buying clamps that are sized to fit your hoops. Also, make sure the manufacturer has rated the clamps for outdoor use, so they don’t degrade too quickly in the sunlight.

**Construction:**

Poles in the ground: Our hoops are four feet tall and four feet wide. You want to space them 5-6 feet apart with a hoop at either end of your row. If your hoops do not easily insert into the ground, you can gently tap them with a rubber headed mallet or use a piece of rebar to create a pilot hole. You can use a metal hammer or mallet to drive the rebar, though it might be difficult to pull out. The hoops should go approximately one foot into the ground, so the top of the hoop is about 3 feet off the ground.

Measure your row so you know exactly how long it is. Then add 5-6 feet on to each end. This is how long your sheet of plastic needs to be in order to reach the ground on the ends. **If the plastic is too short, you will not be able to secure it, making it prone to blowing off and allowing frigid air into your rows.**

Stretch your plastic over the hoops. You will need to use three clamps per hoop, one on each side and one on the very top. The tighter the plastic, the better it will withstand heavy snow fall. However, we do not get big snow storms very often, so it is not too much of a worry in our region. Snow acts as an insulator, so do not try to go out there and knock the snow off your hoops unless they look like they are in danger of collapsing.

**During days when it gets above freezing, you will want to raise up your plastic.**  Fold the plastic up from the ground and use the side clamps to hold it up. This will allow airflow around your plants. If it is 40 degrees outside, it could easily be in the 80s or 90s under your hoops. If it gets above 45 degrees, you run the danger of cooking your plants to death if you leave the plastic down during the day. You must pay attention to weather forecasts, and for added protection, we recommend that you get a thermometer that you can leave under one of the tunnels. This way you can see what the temperature is under the plastic and make adjustments as needed.

**Cold Hardy Varieties**

Here is a great planting guide from Sow True Seed:

<http://sowtrueseed.com/blog/wp-content/uploads/2012/05/STS-Planting-Guide.pdf>

Here is a great article from Mother Earth News with specific variety recommendations:

<http://www.motherearthnews.com/organic-gardening/gardening-techniques/winter-gardening-tips-best-crops-zm0z13onzsto.aspx>

Each packet of seeds will tell you the “Days to Maturity,” which you will need to count back from Dec. 15 to see when is the last possible day you can plant the seeds. By mid-December, there is simply not enough hours of sunlight for plants to grow. By late January, we will once again receive at least 10 hours of sunlight and plant growth will resume, providing plants were not killed by frost. If you time planting correctly, then plants will be mature by mid-December. Then you can harvest them as needed.

By using low tunnels, you can start planting out new plants in early February if day time temps are in the high 30s and 40s. You will need to start the seeds indoors, using grow lights and heating pads. Most spring crops need soil temps to be above 60 degrees, so you can’t start the seeds in the soil just yet. Here is a good primer on seed starting from Mother Earth News:

<http://www.motherearthnews.com/organic-gardening/gardening-techniques/starting-seeds-indoors-zm0z12djzsor.aspx>

The low-tunnels will cause soil temps to be warmer than soil without protection. This means that you can start crops like peas, spinach, and other cold hardy greens earlier and more reliably. You will need to get a soil thermometer to know exactly when to plant. Check the seed packets for the ideal range of soil temps for germination, but it’s usually a minimum of 60 degrees spring crops. This will occur several weeks earlier under your tunnels, so check regularly starting in late February and early March.

Because the soil and air will be warmer, you can get summer crops into the ground earlier than usual. Most summer crops need night time temperatures above 50 degrees, or they will suffer from stunting and low production. This usually occurs after mid-May. If you have thermometers monitoring the soil and air temps under your tunnels, you can get tomato and pepper plants in the ground and growing in early to mid-April. This will allow you to get summer crops to market 2-4 weeks before everyone else, so you can ask a premium price during this time.

**The biggest problem with using low tunnels is overheating.** It’s hard to think about heat damage to plants in the middle of winter, but these tunnels are pretty effective at what they do. You must be vigilant or you risk losing your crops! We are in a high risk zone for this. Further north, they can leave the plastic on the whole winter because it gets cold in November and stays that way until March. Slightly further south, they don’t need any protection at all because it stays the right temperature for greens to grow naturally. Our temperatures fluctuate all over the place. Some winters, I’ve played tennis in shorts in December. Other winters we were under 2 feet of snow for the entire month of January.

This winter, climate scientists are predicting an El Nino effect in the Pacific, which means we are likely to have a mild wet winter. If this proves to be the case, it will be a great winter for season extension. You will likely need to cover your rows at night and lift the plastic up during the day.  **It will be best to lift the plastic before 10am and lower it before 4pm. By lowering it while there is still sunlight out, the tunnels will trap the last of the heat and carry it over until later in the night.**

**Insect Control:**

You can leave the hoops in the ground over the summer. We will be experimenting with insect barrier in 2016. Insect barrier is a thinner version of the row cover cloth we use for frost protection. Because it is thinner, it doesn’t hold much heat in and it allows 85% of light to be transmitted to your plants. Winter row cover only allows at most 70% of sunlight. It also allows rain to reach your soil, so you don’t need to water unless we don’t get enough precipitation.

What it does keep out is insect pests, so you will greatly reduce the need for pesticides. For greens and other crops that don’t need pollinators, you can just go ahead and leave the insect cloth on for the whole growing season. For plants that do need pollination, like squash, cucumbers and eggplant, you can leave the row cover on until flowers start to appear. Some farmers will go through and hand pollinate their squash and cucumbers every day, so they don’t have to remove the row covers. By the time plants are this old, they are generally large enough to withstand insect pests and you will get a good crop off of them. It’s up to you if you want to try hand pollination or not.

**Other Considerations for Winter:**

Mulch your plants really well. Even if we do get a hard frost, a thick layer of mulch will help keep soil temperatures more even. A hard frost can cause the soil to buckle and shift. This can be quite violent, ripping the plants off of their roots. Mulch will make the temperatures more stable and freeze at a slower rate, keeping the earth from shifting as much. Six inches of straw or leaf mulch will do. We are getting straw bales donated from the town of Jonesborough after they are done using them for outdoor displays. They will come in the week before Halloween!

For any ground that you are not growing crops, we highly, highly recommend that you plant a cover crop and apply a couple of inches of mulch. Keeping live roots in your soil at all times will work wonders for fertility and weed control. By combining cover crops with mulch, you will make it possible to not have to till in the spring, further boosting soil fertility and productivity and saving us all a lot of backbreaking labor. Too deep of a mulch will prevent the cover crop from germinating, so keep it between 2-4 inches.