HIGH TUNNELS:

increase production and profitability for small farmers in the Salinas Valley, CA

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High Tunnels: Increase Production and Profitability for Smallholder Farmers in the Salinas Valley, CA

High tunnels are the least expensive form of "Protected Agriculture" – an umbrella term for a wide range of structures built to house vegetables and small fruits, to prolong the season, increase production, volume of packaged production and harvest quality.
A high tunnel, or covered arch, is a portable structure that is covered with UV-resistant polyethylene plastic. You can also roll up the sides and open both ends to provide ventilation to control temperature and air movement.
Heat can be added by using heaters, particularly to protect a crop from frost damage. Air extractors can be placed at one end of the structure, as an alternative method, to lower the temperature, avoiding the need to open the structure and thus prevent insects and other pests from entering.

High tunnels are all the rage lately, in part because of the proliferation of beginning and small-scale farmers looking for ways to increase incomes, as well as support from the Environmental Quality Incentive Program; Natural Resource Conservation Service EQIP; USDA NRCS.

Both the nature of high tunnels, and the rules of the EQIP, require planting crops directly into the ground and incorporating drip irrigation.

What is Protected Agriculture?

Protected agriculture is any investment in structures that contribute to the production (mainly) of vegetables and blackberries, covered, to create a more controlled and favorable environment; and thus reduce unwanted loss due to weather, wind, rain, insects and insect vector diseases.

The technology, for protected agriculture, mostly comes from three countries, each for a different reason. In Israel, it was water scarcity that led to the need to increase production on small irrigated plots. In Holland, it was an agricultural industry focused on the quality of produce and flowers that could be competitively shipped across the Atlantic and bring in enough premium prices to cover expenses. In Spain, it was its position in the southernmost and hottest part of the large and lucrative European market.

In our hemisphere, it has been Mexico, driven by a limited availability of land and water, support from the Mexican government, increased demand from the U.S. market, and the proliferation of technical support (mainly) from Israel, but also from the Dutch and the Spanish.
There are two main types of structures used in protected agriculture in Mexico, each considerably more expensive than the high tunnels that are increasingly common among beginning and small-scale producers in the United States.

What is called the "insect mesh" or "aphid mesh" is a permanently unheated structure, usually large enough for a small tractor to pass through. The "mesh," or net, is a woven polypropylene net strong enough to prevent aphids and all the large disease-vectoring insects from entering. The notable exception, due to its small size, is thrips. It is supported by the steel frame that is cemented in the ground and contains a separate structure inside that supports parallel rows of wire placed directly on each crop furrow so that vegetables, usually tomatoes or cucumbers, can be suspended and trained to grow vertically.

The combination of adding a full third dimension (height) to the length and quality of the harvest has made this investment very profitable for producers/exporters. The structure, however, does not protect against very cold temperatures in the winter, nor against the most common problem, very hot temperatures in the summer.

These additional protections are achieved with the construction of a greenhouse, which in agricultural technical terms means an almost perfectly controlled environment. This addition of heating and cooling, along with coverage that can be automatically removed or used to block rain or reduce direct sunlight, have created the best conditions for the highest and most consistent production for as long harvest time as possible. Nine-month tomato harvests, with high production and packed production volume exceeding 96% number one export-quality fruit, are common.

There are also "hybrid" versions of these two structures, usually involving a removable plastic cover that protects against unwanted rain, adds ventilation or draws heat.

The advantages and limitations of high tunnels

High tunnels don't do everything these more expensive structures do, but the benefits they offer make them an economical and valuable addition to a small ranch. The equation that makes any ranch lucrative (or not) is production multiplied by price minus cost. In vegetable and blackberry production, the part that relies most on labor in our agricultural economy is productivity – the amount of labor needed to produce a unit of tradable product – becomes the most important factor for the farmer, in terms of cost. High tunnels contribute more to the production equation side, but they can also help create higher prices and increase productivity. Some of the advantages of high tunnels are:

1. **Protect against unwanted rain.** Absent from the discussion about supporting more locally grown food is why production of high-value vegetables and blackberries has moved to California over the years: the near absence of rainfall during the 180 hottest and longest days of the growing season, along with the availability of irrigation. Rain falling on plants can cause and spread a whole host of plant diseases. This year, late blight epidemics in tomatoes and potatoes on the East Coast were an unfortunate and serious example of preventative diseases by protecting against rain. The proliferation of high tunnels, designed specifically for raspberry production has created a historic increase in the economic value of raspberries for the Central California Coast in recent years. That's because tunnels can protect water-sensitive crops from rain, dew, and small amounts of moisture. High-value crops susceptible to small amounts of unwanted rainfall include tomatoes, basil, and cut flowers.
2. **Reduce, not eliminate, unwanted pests.** Because a high tunnel requires the opening of both sides and ends for cooling and ventilation, pests will not be left out and those that do enter, may find it in their interest to stay and multiply. However, a good number of migratory insects can be reduced, and with the use of anti-aphid meshes at the ends and sides of the arches, the presence of such insects can be reduced much more. Careful monitoring of the presence of insects, use of sticky tapes, and timely release of suitable beneficial insects can create greater control. Beneficial insects, such as harmful insects, will also find it harder to get out and will multiply rapidly if they can feed on insects.

3. **Reduce Dust.** Dust is a vector of spider mites, a serious problem in tomato production. It also reduces the plant's ability to absorb chlorophyll, essential for all photosynthesis. The powder is also a carrier of unwanted pathogens, many of which are difficult to wash off plants like basil.

4. **Reduce wind.** Wind is a serious problem throughout the Salinas Valley. Not only can high tunnels reduce damage to wind-sensitive crops, but when strategically placed, the structures themselves can become windbreaks for the other crops on the ranch.

5. **Extend the harvest season.** This is the most hyped and, in fact, the most economically important reason for using high tunnels. Although the prolongation of a harvest season is a key component for increased production on a given piece of land – and therefore a direct and important contributor to potential profitability – it also has significant side effects. The amount of time a farmer invests in bringing a crop to market adds value to any wholesale buyer or steady-volume direct buyer, such as a restaurant. Even a two-week extension at the beginning or end (or both) of the season often brings the added advantage of higher prices and the coveted position of first to market in the market.

6. **Increase the speed of growth.** Although most of the attention on the value of a high tunnel comes from the ability to sow earlier and harvest later, it also shortens the time from planting to harvest. A shortened growth cycle allows the possibility of putting more crops within a normal season, another important and often forgotten component in terms of increasing production. All crops have something known as their growth threshold – a temperature under which the plant does not grow and over which it grows relative to the number of degrees above the threshold, multiplied by the amount of time above that threshold. An unheated high tunnel in the Salinas Valley will add very few degrees during the coldest hours at dawn, but it will greatly increase how quickly the air temperature rises once sunlight hits the structure, and it has the ability to retain more of that heat into the evening. This results in a significant reduction in the amount of time between planting and harvesting, especially early in the season. Less time to grow a crop creates fewer opportunities for disease or other crop loss.

7. **A place to work during rainy weather.** One overlooked consequence of hiring farm labor is the expense of maintaining them during bad weather. Not only is it directly advantageous for the farmer and his paid staff to be able to stay productive all the time they are "in working hours", but ensuring stable employment is essential for a small producer to obtain and maintain reliable support. Similarly, the more a producer expands the amount of land to covered production, the possibility of a highly skilled and productive workforce is created. And a season of elongated growth means a season of elongated work for employees.

8. **Reduce input costs.** Reducing evaporation rates reduces the need for irrigation. In the Salinas Valley, water itself isn't expensive, but the cost of pumping is. This also saves water that may be limited by concession or other availability, for outdoor crops. Also, a slow evaporation rate is beneficial for the effectiveness of organic aerosols, which depend on contact and increase efficiency in relation to how slowly it dries. Both water and pest control costs are directly reduced. Fertilization costs will be reduced per unit, as production of the market-quality product increases.

9. **Environmental benefits.** This is one of the main objectives of NRCS's investment in this program. While much of its focus is on the environmental benefits of improving the number of products that can be sold with fewer miles of transportation, there are other benefits. As water use is reduced, so does the use of salts, chlorine and other elements harmful to the soil. For an organic grower in the Salinas Valley, with its strong winds, sometimes low cloud cover and the predominance of conventional producers, a high tunnel can serve as protection against chemical spray.

10. **The** biggest contribution that protected agriculture makes to the equation of "Production multiplied by Price minus Cost" – is the possibility of planting crops that benefit from trellises and make the most of the space invested in protection. This requires investment in labor and trellis materials; However, it will ultimately offer better support to crops that will bring the highest return on investment for crops in covered environments. These include cucumbers and indeterminate tomatoes, blackberries, especially raspberries, but also thornless blackberries.

11. **Reduce selective discarding.** Cucumbers with trellises are unmatched in value to cucumbers grown in soil; cucumbers grow upwards (simply with gravity) do not have a nasty yellow color from touching the ground, and will make investment in more expensive but superior seeds, affordable. Also impressive is the volume of packaged production of tomatoes grown in covered environments and with trellises instead of in the ground. In Baja California, where tomato diseases were a serious problem, tomato covered production has increased the average number of tomatoes qualified for export from 40% to 96% or more.

12. **Cultivate in soil.** Unlike some modern techniques using hydroponics that save tremendously on water use and create another potential for added value and production, high tunnels continue to grow in the ground. Not only does that make them economical, but it doesn't require a different farming system than the rest of the ranch and can result in the training and experience that can eventually justify transferring more land to soil-based covered production.

All these specific advantages add up to one – the ability to significantly increase income for a producer with limited land.

Challenges and Problems of High Tunnel Cultivation in the Salinas Valley

While most of my observations on the advantages of protected agriculture come from personal experiences in Mexico; last season's observations with two hatchery farmers at ALBA's ranch in Salinas, each of whom had purchased and built arches covered with NRCS/EQIP grants or cost-sharing grants, as well as production on the old but larger fiberglass structure managed by Martin Bournhonesque, They gave me an understanding of many of the challenges that exist for covered production in the Salinas Valley. While these producers had a number of successes and failures, I was able to observe the following challenges:

1. **Efficient use of space.** Because the NRCS grant limits the structure to a certain size, both producers built a covered arch that measured nearly half the length of the furrows in their field. Any gains they had in using the space in the protected area were lost in the little-used land behind their structure. I would certainly recommend taking on the additional cost of building a structure the full distance of whatever length you are working with. In addition, it is important to ensure that all the land on each side of the structure is used.

2. **Preparation of the field and cultivation.** The larger structures I am used to have the advantage of being designed so that special tractors with little width can enter and be used. There has to be a way to design the opening of both ends of the covered arch to get a tractor to pass through the arch when necessary for bed preparation or cultivation. This could be achieved by rotating the place of the covered arch and preparing beds before closing the structure, but something has to be incorporated

into the production engineering so that any gains in production are not outweighed by the losses of labor productivity.

3. **Pollination.** One of the unintended consequences of keeping insects out is that both bees and pollinating insects can also be left out. Even plants that rely on the use of wind for pollination can suffer. This was noticeably observed in a well-cared for, but low pollination crop of hanging cucumbers. With cucumbers this can be easily corrected with the use of autogamous seed. Bumblebees are commonly used in pollinating tomato plants, as they do not need nectar and are relatively docile to the workers around.

4. **Irrigation management. Later in the** season, I observed the same grower with a good harvest of tomatoes growing along the covered arch, while the tomatoes inside were much larger, but visibly lacking in water. This went against all theories that say the covered production tomato would require less water, but it made sense that the larger plant with a sizeable set of fruits would take several weeks in actual development, ahead of the plants outside, and needed to be on a different watering schedule.

5. **Condensation.** Condensation inside the roof of the greenhouse is the result of water vapor, high humidity in the greenhouse, condensing on the cooler roof of the greenhouse. Condensation accumulates inside the plastic cover of the covered arch and finds a less sturdy place to accumulate and then fall on the plants. This usually occurs along the metal structures of the roof. Larger greenhouses are built so that this humidity drops, if at all, in designed areas where there are no plants. Ventilation helps a lot. Both techniques are significantly more difficult in a small house. Water management, to reduce the relative humidity inside the covered arch until night, will help but it is impossible to remove or control the temperature outside. The unwanted dripping of condensation on the tomato plants of one of the growers was causing an ideal situation for the growth of bacteria and fungi. Working closely with the manufacturer of a given structure is important, both to design the location of the condensation drip so that it falls between the grooves of the plants, and for them to participate in any other structural solution to this problem.

Strategies to Make Covered Arches Lucrative in the Salinas Valley

It's hard to be a small, beginning farmer in the middle of the most productive and valuable agricultural region on Earth. How is it that one benefits from the huge cost savings East Coast growers are receiving now, when Salinas companies are paying nearly $8.00 to ship a box of broccoli to their markets. That price savings, along with the willingness of a growing segment of the population to pay a premium for the product that has not only traveled fewer miles, but is a total of five days cooler, has made it more profitable to return high-value crops to parts of the country that long abandoned them.

It's hard to find a competitive advantage in an industry where much of the profit is determined by production and productivity. It is extremely difficult to do so in the region where a relatively small number of crops are grown with maximum production and with some of the most effective agricultural labor management in the world. Add to this that the most difficult years for a farmer's success – their survival – are the same years they lack experience, are more likely to make mistakes and less likely to have mastered the most important components of the equation, production and productivity.

The good news is that it can be done and with the lack of crop diversity in the valley right now, coupled with a demand from producers that still rewards a small farmer, and the support of the ALBA Organics marketing team, all of this makes it possible.
I recommend the following techniques to accelerate the return on investment in covered arches:

1. **Prepare for fertility and weed control before starting any construction.** Once a covered arch is built, the soil must be leveled, tilled deeply, cover crops incorporated or effective use of tillage between rains and after pre-irrigation as weed control is almost impossible. All this must be done ahead of time.

2. **Design and purchase the right sized structure for your space.** This means not only one that is the full length of the furrow of the field it will be in, but one that has the ability to manage irrigation regardless of what is grown outside.

3. **Select high-value crops.** Crops for the Salinas Valley that come to mind are raspberries, select tomatoes or *heirloom*, different varieties of medium-sized lettuce for restaurants or high-quality banquet service, medium-sized chicory or bleached endive, freshly cut basil, and any number of cut flowers.
4. **Grow one thing at a time in one house.** I know everyone is talking about biodiversity these days; this can be achieved by planting a mix of plants that attract beneficial insects on the outer edges of the covered arch or any other unusable space. Efficiency is key. You have to plant the entire covered arch at once, you have to water evenly and be ready to harvest and replant as quickly and completely as possible.

5. **Be strategic about when it is planted.** What is the benefit of investing in a structure to get a two-week lead in tomato production in Salinas, when you can drive twenty miles north, to Hollister, to an open field and beat yourself in marketing by growing outdoors? On the other hand, planning a tomato crop that begins in the summer and is covered when the first rains of early November and late October destroy all outdoor cultivation from Hollister to King City, will give you access to the lucrative market before Thanksgiving and beyond. Likewise, the different varieties of lettuce can be scheduled for transplantation the morning that the annual lettuce moratorium ends in Monterey County. In 3 weeks you can harvest lettuce, which has been grown indoors, ready to market. This is accomplished a total of six weeks before the larger lettuce, which has been grown with no-till or which has been grown outdoors. It's all in sync.

6. **Get two harvests (at least) a year and be ready to switch from one to the other.** The advantage of mid-summer tomatoes following lettuce is that there will be little or no plant residue to incorporate, nor will it cause downtime during the growing days of summer peaks. Use transplants to further exploit your maximum production in minimum times. And be ready for rapid change. Ideally, the distance between the furrows of each crop is properly planned, so that no deep tillage is needed between the two and the second is sown in low weed pressure. If both ends of the greenhouses could be dismantled to bring in an implement to add additional fertility and rebuild shallow beds, this would be ideal.

7. **Control weeds.** There is no such thing as the constant pressure of weeds. It's either getting worse or it's getting better. Anything less than total weed control and it will most likely get worse. That's why my suggestions to prepare the ground before the construction of the covered arch are important. I also suggest short-season crops that are transplanted and exceed the capacity of any weed to grow

until there is seed at the beginning of the season and the most difficult crops planted in conditions already difficult for weed emergence. One remaining issue is temperature-induced weed germination, such as grasses going through falling autumn temperatures. This can be mitigated by timing tomato plants that have already provided shade-induced competition or by using the right seasonal plastic mulch.

8. **It is cultivated well.** In the end, it all comes down to this. The high tunnel is an opportunity to increase the quantity and value of your crop – an essential formula for your survival as a farmer on limited land. Get it right. Ask for help and advice. Don't buy a structure from a company that isn't willing to offer to help. Find out who at your local Extension Service is willing to provide guidance throughout the season. And consider selling the crop through a buyer/agent, such as ALBA Organics or another company that may be looking for a more difficult crop to grow, but with lower volume of its product line. Avoid the kind of sales that takes you off the ranch during this pivotal learning stage of your career in agriculture.

Michael O'Gorman - a brief biography.

I started my career in agriculture in 1970. In 1990, I was hired to manage the production of the first certified organic ranch in Salinas and spent the next seven years on the growth crest of both large-scale organic vegetable production and the development of mass production of baby lettuce, spinach, mustard greens and full-size chicory that is now a pillar of economic importance to the Salinas Valley.

In 1999 and 2000 I had the first opportunity to study and learn from Dr. Leon Gallegos, one of the leading agronomists in Mexico and collaborate with him in some of the first productions covered with organic vegetables in Mexico. In 2006 and 2007 I was able to prepare under the tutelage of partner and colleague David Rifenback, who grew for the company I managed, *Agroproductos Del Cabo*. David and his companions at the time were growing about five acres of covered production in Maneadero, Baja California, near the Pacific coast and protected by its temperate climate. David had spent several years cultivating on Houweling Tomatoes in Ojai, California and studied in Holland as well. David was able to successfully produce organic crops for the wholesale market with a value as high as $250,000 per acre. In 2006, I oversaw the construction of 25 acres of "counter-aphid mesh" in Vizcaíno, Baja California Sur and several successful spring and fall tomato and cucumber crops. I have volunteered to help small and beginning farmers in ALBA since 2008.