The Retractable Roof Production System™

for berry production

The challenges and limitations of producing in conventional tunnels

While the open field and conventional tunnels are a lower capital investment than an automated retractable roof, they also have many limitations.
Many growers agree that, conventional tunnels have reached their maximum productivity gains and their static growing environment limits significant increases in production resulting in increased production requirements being met simply by building more hectares of tunnels.
Growers are also facing challenges with the spotted wing drosophila, the elimination of methyl bromide, a shortage of desirable or affordable land, production moving to warmer climates, and production costs rising faster than yields or prices. Hence the need to focus on how to make the overall production system more efficient. And with growers now looking to ship further from their production locations, fruit quality and firmness become even more important.

Strategies which can be used to improve profitability of berry production using "The Retractable Roof Production System"™

When implementing "The retractable roof production system"™ for berries the gross profit /kg can frequently be increased approximately 12% and a 2-6 year return on investment on the automated retractable roof house can be realized. In order to achieve these results, the strategies of this production system include:

- target the high price windows first, when open field and tunnels have difficulty in supplying
- evaluate if the improved climate control would make it preferable to grow in a different farm location
- consider if organic production makes sense since it is easier to produce organically in a retractable roof
- reduce production costs like labor, chemical fungicides and insecticides
- implement strategies to increase both plant densities and the yield per plant
- evaluate if other varieties could and should be grown
- improve fruit quality and firmness in order to be able to target more distant markets

Cravo®

Challenges in conventional tunnels	Automated retractable roofs
Farm location and size	
• Ideal land for berry production is frequently expensive or limited due to competition with residential development • Land or water constraints in some regions may limit the ability to meet growth in demand	• The improved climate control options can allow for production to move to warmer climates (less optimal for tunnels) where land and water may be more plentiful and land costs are typically lower • Production in warm or hot climates is much easier especially due to the increased cooling capacity and a wider choice of roof coverings when using an automated retractable roof • The farm size can be minimized since the harvest per acre or hectare can usually be increased

Plants per acre or hectare	
• Plant density is reduced since plants grown under tunnels frequently have stretched internodes • Plant density per acre or hectare is frequently reduced due to the many roadways required to allow for mechanical spraying	• Plant density can typically be increased 10% to 50% since plants in a retractable roof tend to develop an overall smaller structure (shorter internodes) allowing plants to be planted closer together and distance between rows to be narrowed • Roadways for mechanical spraying could be reduced or spaced farther apart since there is typically a 50%-100% reduction in fungicide applications. The taller and more open structure could also allow for other methods to apply sprays

Yield per plant	
• Yield is limited by light loss through the covering in the winter, and excessive heat and humidity in the summer • Light levels inside drop ever year due to dirt accumulation on the plastic • Plants can develop too much vegetation due to the high humidity conditions inside the tunnel • Fruit ripens too fast when temperatures are excessive • Climate and water is different at the post row potentially causing changes in harvest volumes • Pollination can be more difficult under a tunnel environment	• Yield per plant can be increased due to overall higher light levels when the roof is retracted and preventing plants from being exposed to excessive humidity levels • Light loss due to dirt accumulation on the roof is minimized since the roof is retracted when outside temperatures are optimal • Losses due to sunburn can be prevented due to improved management of light and temperature • Speed of ripening can be increased or delayed to meet market conditions or to react to supply of pickers • Climate and soil moisture is uniform under a retractable roof • Pollination rates can be naturally increased by creating better conditions for pollination and for bees to be more active (Roof could be closed or retracted depending on temperature, rain and wind)

Quality	
• Fruit can become softer under a tunnel compared to when it is grown outside without protection • Nighttime temperatures may be greater than 16C (60^0F) causing a reduction in sugar accumulation in the fruit	• Higher light and transpiration rates could result in larger fruit and increased fruit firmness when the roof is retracted to allow plants to be exposed to natural outdoors • During hot summer nights, fruit temperature can be lowered at night by retracting the roof to expose plants to the cold temperatures and the clear sky to maximize infra red radiation loss
Varieties	
• The climatic limitations in a tunnel environment limits which varieties perform well	• The improved light, temperature and humidity control combined with lower disease and insect pressure may allow for a wider range of varieties to be grown

Challenges in conventional tunnels

Timing

- Excessive heat in the tunnel can delay summer transplanting consequently delaying the start of the winter harvest
- Lack of light and heat in the late winter can delay the early spring harvest

Insects

- Open walls and low roof openings in tunnels facilitate the entry of pests like spotted wing drosophila into the growing area necessitating frequent spraying
- The excessive temperatures in the summer can cause an increase in mite populations

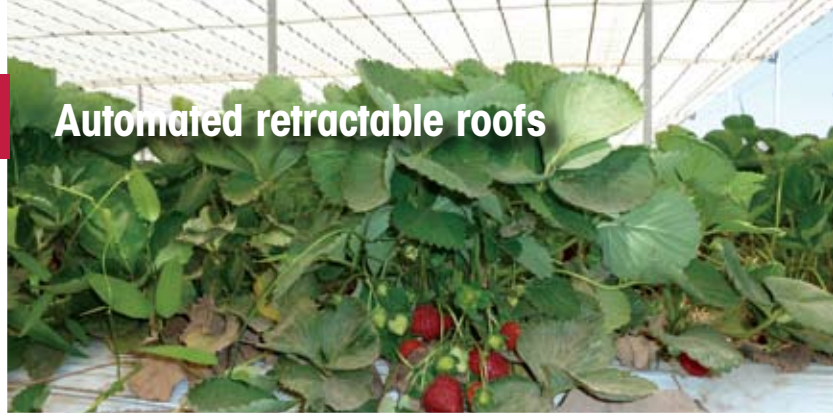
Foliar and fungal disease

- Botrytis, powdery mildew and fungal diseases of the cane can be major problems due to the lack of direct UV and infra red radiation combined with high relative humidity levels inside tunnels necessitating frequent spray applications of fungicides.

Soil Health

- EC, soil borne diseases and nematodes can increase over time if growing in the same soil for several years due to soil staying constantly wet and plants being stressed from being in a tunnel environment necessitating the use of methyl bromide
- If soil problems become too severe and methyl bromide is not available, then production may need to move to hydroponic systems. Initiatives on using hydroponic system in warm or hot climates have occasionally not proven cost effective on a large scale

Automated retractable roofs



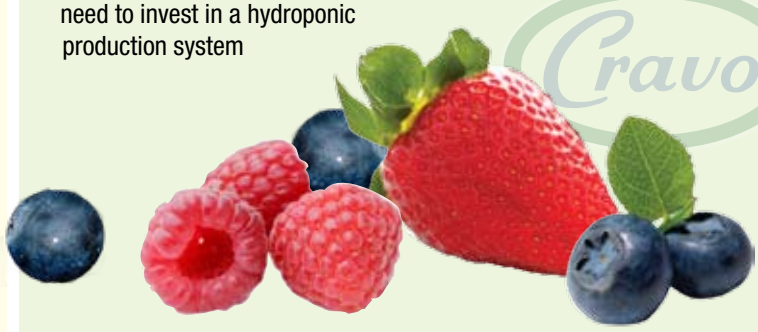
Strawberries grown in Mexico under retractable flat roof. Picture taken June 6, 2014 when soil temperatures in the direct sun reached 60C (140°F)

- The cooling capacity of the retractable roofs can allow summer transplanting to occur 4-6 weeks earlier and can reduce transplant shock helping growers to realize higher prices by being first to the market for the winter season
- Spring harvest could be brought forward by increasing light and radiation by retracting the roof when outside temperatures are suitable and by retaining more heat at night when the roof and walls are closed

- Since the primary ventilation is through the roof, the 5m tall walls can be left closed during periods of high pest pressure to help reduce the entry of pests like spotted wing drosophila
- The cooling capacity of the retractable roof can help reduce spider mite populations

- 50%-95% reduction in fungicide usage is possible

- EC levels in the soil can be reduced by retracting the roof during rainfall when house is empty or plants are not in harvest
- Soil borne diseases can be reduced by reducing soil wetness and by increasing overall plant health
- it may be possible to delay or eliminate the need to invest in a hydroponic production system



Challenges in conventional tunnels

Labor

- Workers efficiency drops during hot conditions inside tunnels and workers movement is more difficult due to the low roof close to post leg rows
- More labor is required for frequent application of fungicides and insecticides and to manually cover and uncover tunnels
- Poly roofs typically need to be replaced every 2-4 years
- Use of mechanical harvesters may be limited due to structural interference

House models

- All tunnel designs function very similarly

Automated retractable roofs

- Workers are more efficient since comfortable working conditions can be maintained regardless of weather conditions outside and the structure does not limit head clearance for workers
- Reduce labor requirements for spraying of fungicides and insecticides and no labor is required to open or close roofs
- Roofs typically last 8-12 years and occasionally as high as 16 years
- Wide spans between postlines and tall head clearance allows for the use of mechanical harvesters

- Retractable roof houses are available with two different roof profiles:
  1. A flat roof for crops like blueberries or for strawberries and raspberries being grown in dry climates
  2. A peaked roof with gutters for rain sensitive crops

Roof covering

- Typically a clear roof is used since high light transmission is required... which causes excessive temperatures inside during the summer
- Roofs can be damaged from high winds

- Retractable roofs can be clear or white. Clear is used in colder climates and white is used in warm or hot climates
- Retractable roofs have never blown off over the last 30 years including exposure to 9 hurricanes

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Automated retractable roof technology will make your business more profitable every year and will increase the value of your business should you ever wish to sell.