

# 10 steps

## ...to customizing your “Retractable Roof Production System”™

### LOWER COST TENSION STRUCTURES

for covering large fields or orchards



## Auto-Dry™

Use: Crops needing occasional protection from rain, hail and cold without a gutter system



## Flat Roof

Use: Protection from cold and heat, but where complete rain protection is not required or not cost effective



## X-Frame

Use: Crops needing frequent protection from rain, hail, dew, heat and cold with a gutter system

### RIGID FRAME STRUCTURES

for smaller installations  
or where maximum strength is required



## A-Frame

Use: House must withstand heavy snow, high wind, crop or equipment loads, or requiring many zones or blackout



## Rafter

Use: Tropical and arid climates where the land is flat

Create Over  
**75**  
DIFFERENT  
Solutions

USING...  
5 house models  
11 different coverings  
and 1-3 layers





# Why How What

## Why we at Cravo are so passionate about what we do:

We believe that the profitability of producing crops and the return on invested capital can be increased by combining the advantages of both nature and a protective environment, and that this combination will also make it easier for growers to meet

current and future market demands.

## How we will accomplish this:

We will analyze your company goals, market pricing, climate conditions, current practices, production challenges, and then together we will create an innovative production system that increases yields, improves

quality and extends or shifts production to hit the high price windows while minimizing the cost of production.

## What do we do:

We lead the world in designing and supplying automated retractable roof greenhouses, cooling houses, and covers for field crops and orchards



## The 10 Steps to create a “Retractable Roof Production System”™ based on your Climate and Crop Requirements

1. Decide if insect net is required under the retractable roof.  
Net can be stationary or retractable.
2. Choose the house model: **A-Frame, Rafter, X-Frame, Flat Roof or Auto-Dry™**
3. Decide whether one retractable roof layer is sufficient, or if two retractable layers are justified to provide optimum control during summer and winter.
4. Decide how to ventilate a peaked roof house during rain conditions
5. Guidelines for creating the layout for the retractable roof house or automatic retractable field / orchard cover
6. Decide if additional climate control is required:
  - a. High pressure fog or low pressure mist
  - b. Horizontal airflow fans.  
Retractable interior curtain systems for cooling, heat retention, insect control or blackout
  - c. Bird net
  - d. Supplemental heat or light
7. Choose the wall design for each of the 4 walls
  - a. Choose wall covering: Stationary insect net, bird net white cooling covering or clear greenhouse covering
  - b. Is white or clear wall covering going to be stationary or installed on a motorized roll-up curtain?
  - c. Will insect net be installed over the roll-up curtain opening?
  - d. If insect net is not installed over the roll-up, will roll-up extend down to the ground or to a kneewall?
8. Decide if crops will be grown in soil or in containers
9. Determine the optimal plant density
10. Decide if the climate control computer that will automate control of the roof, walls and misting system will also control internal growing systems like irrigation, fertigation and heat



## Step 1:

### Decide if stationary or retractable insect net is required under the retractable roof

Deciding whether you need insect net under the retractable roof to protect your plants is the first step since this decision will impact on your choice of house model and roof covering. When installing insect net under a retractable roof, there are positive and negative impacts caused by the net. The degree to which the negative impacts are experienced will depend on whether the insect net is stationary or retractable. If insect net is not required, go to step 2

#### Stationary insect net



##### Positive benefits

- Insects are excluded
- The combination of a cooling roof plus insect net and low-pressure mist can lower temperatures compared to a conventional nethouse
- Insect net helps to create a stable microclimate and higher humidity for crops like peppers and cucumbers

##### Negative consequences

- Blocks sunlight and prevents heating of leaves and soil
- Traps heat at night during hot summer conditions
- Prevents bees from entering
- Causes excessive soil wetness and humidity if rain is allowed to enter the house
- Insect net or structure can be damaged during cyclone or hurricane conditions

#### Retractable insect net



##### Positive benefits

- Insect net can be retracted at night to help cool down crops and soil and vent excessive humidity
- Wider variety of crops can be grown
- Insect net can be retracted during winter conditions when insect pressure is lower
- Insect net can be retracted during hurricanes or cyclones

##### Negative consequences

- Head clearance is reduced which may necessitate increasing the gutter height
- Higher investment



There are several strategies available to users of retractable roof houses which can either eliminate the need for insect net, or minimize the negative impacts of the insect net

## 5 Strategies to manage the negative impact of insects

	Positives	Negatives
<b>1. Grow plants that are strong and healthy with “hard leaves”</b>	<ul style="list-style-type: none"> <li>no increase in cost of production</li> <li>sucking insects like whitefly and leaf miner tend to avoid strong hard plants</li> </ul>	<ul style="list-style-type: none"> <li>not effective for insects that attack the flowers or fruit (spotted wing drosophila, pepper weevil, thrip)</li> </ul>
<b>2. Choose virus resistant varieties</b>	<ul style="list-style-type: none"> <li>can eliminate the need to install insect net below the roof especially if growing short cycle crops</li> </ul>	<ul style="list-style-type: none"> <li>limited varieties to choose from</li> <li>not effective for insects that attack the fruit (spotted wing drosophila, pepper weevil, thrip)</li> </ul>
<b>3. Install a 5m or 6m tall wall covering to block the entry of insects through the walls.</b>	<ul style="list-style-type: none"> <li>5m tall walls will create a significant barrier to the entry of whitefly, leaf miner, thrips and spotted wing drosophila since they tend to fly at heights &lt; 2m (6ft)</li> <li>does not reduce light levels or the heating effect of the sun</li> <li>low investment</li> </ul>	<ul style="list-style-type: none"> <li>restricted air flow can cause temperature and humidity to be higher close to the walls</li> <li>plants close to the walls could stay wet for a longer period of time if rain is allowed to fall on the crop</li> </ul>
<b>4. Use a retractable cooling roof or interior curtain system to prevent excessive leaf temperatures and water loss to maintain the optimal water status.</b>	<ul style="list-style-type: none"> <li>no additional cost to select a white cooling roof compared to a clear retractable roof</li> <li>maintaining optimal water status helps reduce the attractiveness of the plant to sucking insects</li> </ul>	<ul style="list-style-type: none"> <li>if white roof needs to be closed in the daytime during cold conditions, too much light is blocked</li> </ul>
<b>5. Install a low pressure misting system or high pressure fogging system</b>	<ul style="list-style-type: none"> <li>does not reduce light levels or heating effect of the sun</li> <li>is very helpful to reduce reproduction of pests such as two spotted mites</li> <li>low investment</li> </ul>	<ul style="list-style-type: none"> <li>requires additional investment</li> </ul>

## Options for installing insect net under the roof

<b>6. Install stationary insect net below the roof</b>	<ul style="list-style-type: none"> <li>insect exclusion</li> <li>creates a good micro climate midday during hot summer conditions</li> <li>Typically, 10x16 (40 mesh) insect net is sufficient on the roof unless it is critical to manage thrips in which case 10 x 20 (50 mesh) is required</li> </ul>	<ul style="list-style-type: none"> <li>Insect net collects dirt which reduces light levels and blocks heat which is especially negative during low light conditions</li> <li>prevents natural pollination by preventing entry of native bees and blocking the wind</li> <li>insect net traps heat during warm summer nights</li> <li>insect net cannot be quickly removed before a hurricane</li> <li>if using a flat roof house, insect net traps rain in the soil and can cause excessive humidity levels</li> </ul>
<b>7. Install retractable insect net below the roof</b>	<ul style="list-style-type: none"> <li>insect exclusion only when you need it</li> <li>creates a good micro climate midday during hot summer conditions</li> <li>light, plant temperature, soil wetness and humidity can be better managed if net can be retracted when beneficial</li> <li>insect net can be retracted during hot summer nights to help cool down plants and soil</li> </ul>	<ul style="list-style-type: none"> <li>highest capital cost</li> </ul>

## Step 2: Choose the roof profile and house model: A peaked roof with a gutter (A-Frame, Rafter, X-Frame), without a gutter (Auto-Dry™), or a Flat roof

There are 3 primary factors which will influence the choice of house model:

1. Do the plants have to be protected from the impact of rain or should plants and soil be kept dry?
2. Is the ground flat or are there changes in the slope of the land?
3. What are the structural loads required for wind, snow, hail, crops and equipment?

Do the plants have to be protected from the impact of rain or be kept completely dry?

**Condition 1. Crops and soil (especially heavy soils) must be kept dry and rainwater is collected:**

**House Model:** Peaked roof houses; A-Frame, Rafter and X-Frame

Rainwater is collected in gutters. Connecting downspouts allows rainwater harvesting



**Condition 2. Crops need to be protected from the rain, but it's fine if rain falls on the ground away from the crops.**

**House Model:** Auto-Dry™ Retractable rain shelter



**Condition 3. Rainfall is minimal or crops can tolerate rain but need protection from the impact of a hard rain and hail.**

**House Model:** Flat Roof - Rainwater passes through the roof covering resulting in all rainwater entering the house



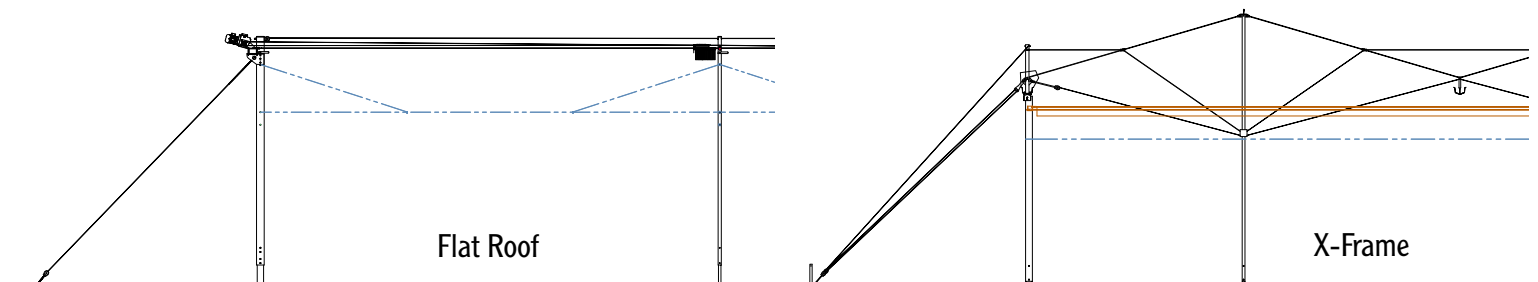
Crops are protected from the impact of rain but all crops get wet as the woven uncoated roof covering is water porous. (RC02 White Uncoated)



Cravo houses have survived all direct hits from 24 hurricanes cyclones and typhoons since 2003

	Climate and Crop Requirements				
	Auto-Dry™	Uncoated Flat Roof	X-Frame	Rafter	A-Frame
<b>Loading capabilities</b>					
<b>Wind speed house must resist when roof and walls are closed: kph (mph)</b>					
0 - 93 ( 0 - 58 )	✓				
0 - 110 ( 0 - 70 )		✓	✓	✓	✓
0 - 177 ( 0 - 110 )				✓	✓
0 - 233 ( 0 - 145 )					✓
<b>Snow and hail load when roof is closed: kg/m<sup>2</sup> ( lb/ft<sup>2</sup> )</b>					
0 - 25 ( 0 - 5 )		✓	✓	✓	✓
0 - 50 ( 0 - 10 )				✓	✓
0 - 240 ( 0 - 50 )					✓
<b>Crop and equipment load</b>					
Can support a hanging crop like tomatoes		✓	✓	✓	✓
Can support an irrigation boom from the truss				✓	✓
Can support a hanging gutter system for tomatoes or strawberries					✓
<b>Crop requirements</b>					
Plants can be protected from the impact of a hard rain and from excessive cold and heat	✓	✓	✓	✓	✓
Stationary or retractable insect net can be installed under the roof		✓	✓	✓	✓
Crops require blackout		✓		✓	✓
<b>Ground Conditions</b>					
Structure can follow gently rolling grades	✓	✓	✓		✓
Maximum slope across the truss			4%	1%	3.3%
Maximum slope along the gutter			4%	4%	4%

**CROSS SECTION OF HOUSE MODELS (PRODUCT COMPARISONS)**



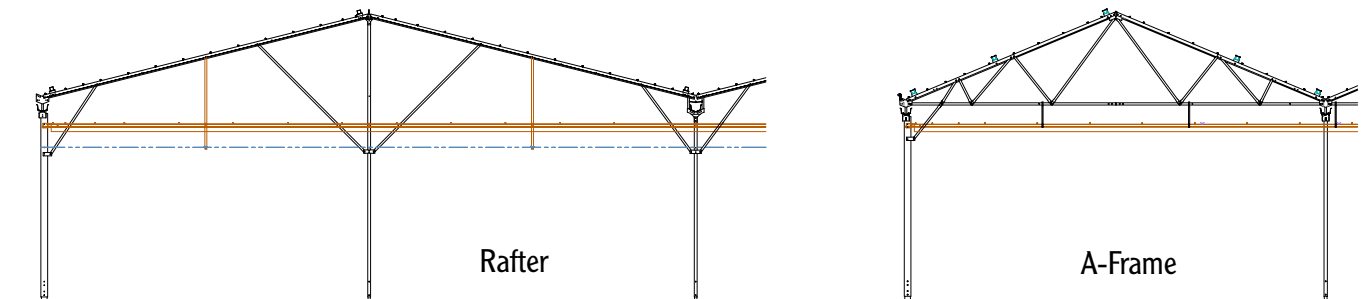
# STANDARD HOUSE SPECIFICATIONS\*



	Auto-Dry™	Uncoated Flat Roof	X-Frame	Rafter	A-Frame
Construction Type		Tension	Tension	Rigid Frame	Rigid Frame
House width; Meters (Feet)	3.5 ( 11.5 ) 4 ( 13.1 ) 4.5 ( 14.8 ) 5 ( 16.4 )	8 ( 26 ) 9.6 ( 31.5 )	9.6 ( 31.5 )	14.63 ( 48 ) 16 ( 52.5 )	6.57 ( 24 ) 9.14 ( 30 ) 9.6 ( 31.5 ) 11 ( 36 ) 12.8 ( 42 ) 14.63 ( 48 )
Standard gutter height: Meters (Feet)			4.3 ( 14 ) 5 ( 16.5 )	4.3 ( 14 ) 5 ( 16.5 )	4.3 ( 14 ) 5 ( 16.5 ) 5.5 ( 18 )
Roof height (top of post): Meters (Feet)		5 ( 16.5 ) 6 ( 19.7 )			
Post spacing along the post line; Meters (Feet)	6 ( 19.6 ) 8 ( 26.2 ) 10 ( 32.8 )	4 ( 13.12 )	3.65 ( 12 )	3.65 ( 12 )	3.65 ( 12 )
Suitable for sloped surfaces along the gable	Yes	Yes	Yes	No	Yes
Secondary layer can be added for insect control or additional temperature control		✓	✓	✓	✓
Exterior perimeter bracing	All 4 perim- eter walls	All 4 perimeter walls (Optional Interior bracing)	All 4 perimeter walls	None or on gables only	None
Roof closing time in minutes (approximate)	6	6	2.5	2.5	2.5
M <sup>2</sup> (ft <sup>2</sup> ) of roof powered by one motor	7,680 (82,600)	9,300 (100,000)	4,400 (47,000)	4,400 (47,000)	4,400 (47,000)
Rain canopy can be added to allow ventilation during rain	N/A	N/A	✓	✓	✓
Investment ( 1 = lowest , 5 = highest )	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>

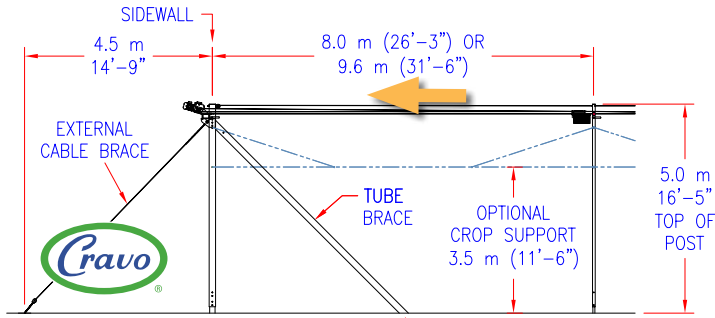
\* Protected by the following patents: Chile: 56,400, Israel: 230,612, Mexico: 342,562, Spain:2,739,131, South Africa: 2014/00826, United States: 9,163,401. Other patents pending

## CROSS SECTION OF HOUSE MODELS (PRODUCT COMPARISONS)

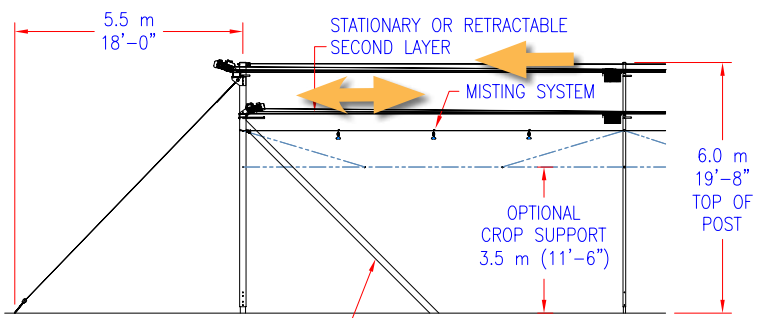




## 5 m TALL FLAT ROOF

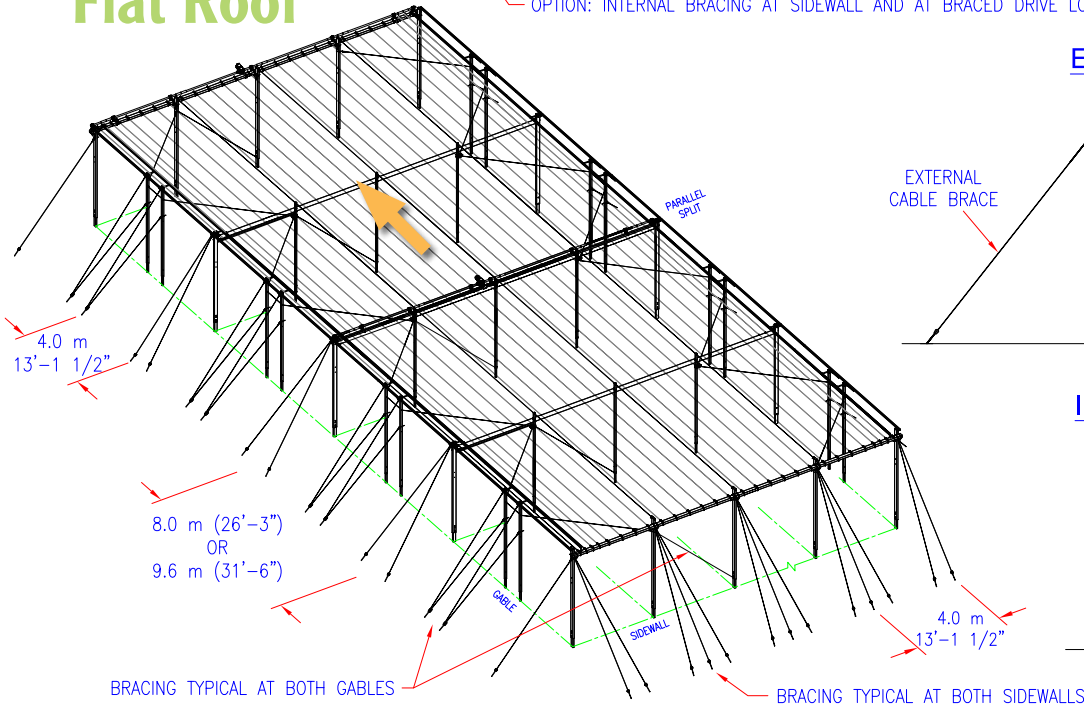


## 6 m TALL FLAT ROOF

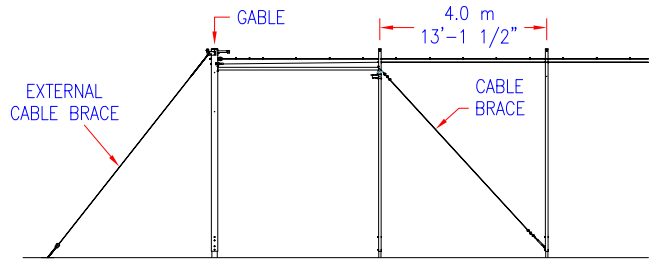


## Flat Roof

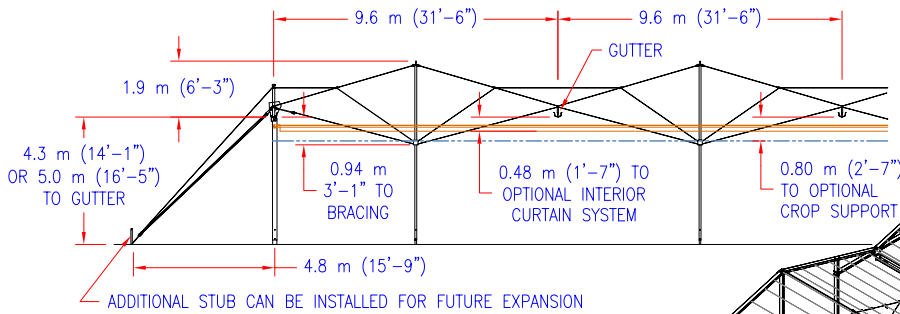
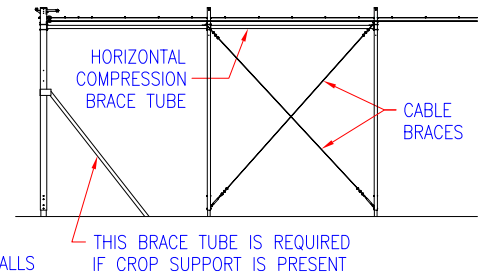
OPTION: INTERNAL BRACING AT SIDEWALL AND AT BRACED DRIVE LOCATION



## EXTERNAL BRACING AT GABLE

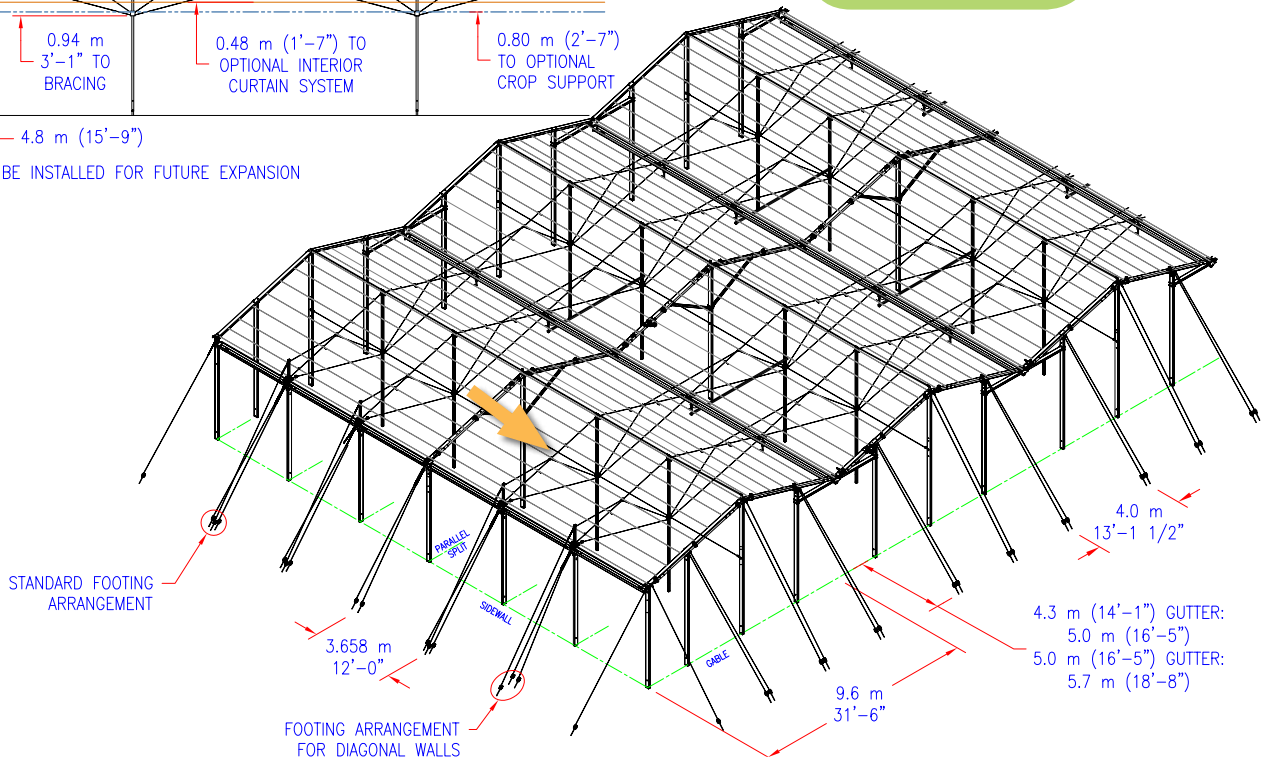


## INTERNAL BRACING AT GABLE



Arrow indicates Roof closing direction

## X-Frame



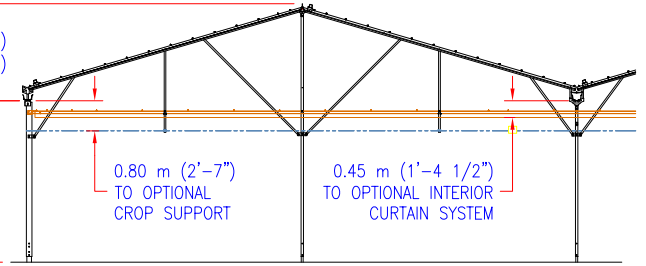




# Rafter

14.63 m (48'-0") HOUSE - 2.6 m (8'-6")  
16.00 m (52'-6") HOUSE - 2.8 m (9'-2")

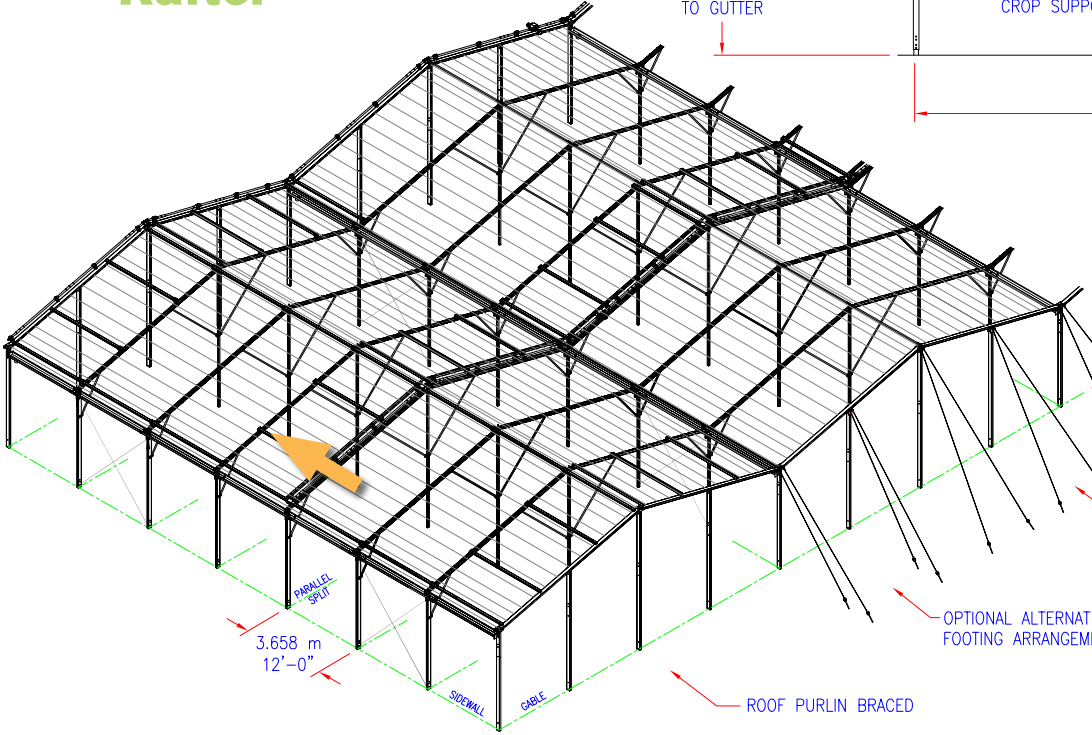
4.3 m (14'-1")  
OR  
5.0 m (16'-5")  
TO GUTTER



0.80 m (2'-7")  
TO OPTIONAL  
CROP SUPPORT

0.45 m (1'-4 1/2")  
TO OPTIONAL INTERIOR  
CURTAIN SYSTEM

WIDTH OPTIONS:  
14.63 m (48'-0")  
16.00 m (52'-6")



4.3 m (14'-1") GUTTER - 4.9 m (16'-0")  
5.0 m (16'-5") GUTTER - 5.6 m (18'-4")

EXTERIOR CABLE BRACED

OPTIONAL ALTERNATE  
FOOTING ARRANGEMENT

ROOF PURLIN BRACED

3.658 m  
12'-0"

PARALLEL  
SPRIT

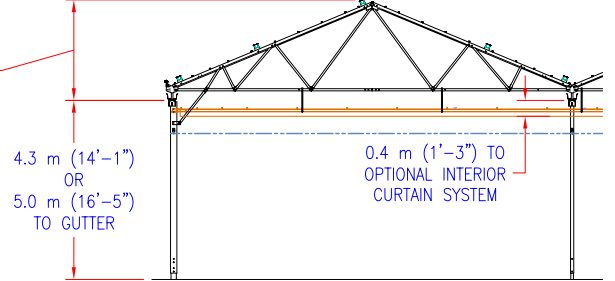
SIDEWALL

CABLE



# A-Frame

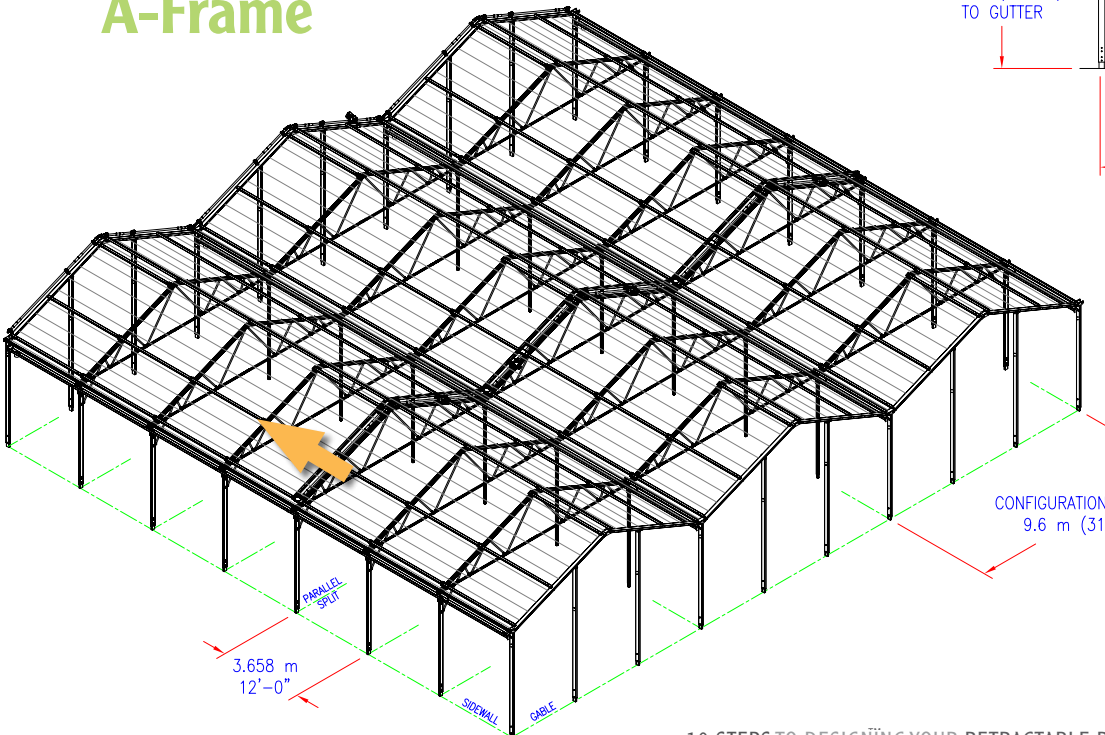
7.32 m (24'-0") HOUSE - 1.9 m (6'-4")  
9.14 m (30'-0") HOUSE - 2.3 m (7'-7")  
9.60 m (31'-6") HOUSE - 2.4 m (7'-11")  
10.97 m (36'-0") HOUSE - 2.7 m (8'-10")  
12.80 m (42'-0") HOUSE - 3.1 m (10'-1")  
14.63 m (48'-0") HOUSE - 3.5 m (11'-4")



4.3 m (14'-1")  
OR  
5.0 m (16'-5")  
TO GUTTER

0.4 m (1'-3") TO  
OPTIONAL INTERIOR  
CURTAIN SYSTEM

WIDTH OPTIONS:  
7.32 m (24'-0")  
9.14 m (30'-0")  
9.60 m (31'-6")  
10.97 m (36'-0")  
12.80 m (42'-0")  
14.63 m (48'-0")



CONFIGURATION SHOWN:  
9.6 m (31'-6")

3.658 m  
12'-0"

PARALLEL  
SPRIT

SIDEWALL

CABLE

### Step 3:

Decide whether one retractable roof layer is sufficient or if two retractable layers are justified, to provide optimum control during summer and winter



30° N

30° S

Growers closer to the equator struggle more with excessive heat, whereas growers farther from the equator struggle more with excessive cold

Retractable clear greenhouse roof coverings are recommended where cold is a bigger problem than heat (latitudes 30-50)

Retractable white cooling roofs are recommended where excessive heat is a bigger problem than cold (latitudes 0-30)





Retractable clear greenhouse roofs **and** white cooling roofs can be installed on the same house



**If rainfall can occur for extended periods of time**, then a retractable clear greenhouse roof is recommended to allow for maximum light penetration when the roof is closed during rainfall. A secondary retractable cooling roof can be installed below to manage the heat. **The life of the clear greenhouse roof will also be extended** since it will be retracted for more hours in the day



## Step 4:

**In peaked roof houses, decide if it's necessary to ventilate through the roof during rain conditions:**

Opening roll-up walls will typically be sufficient to ventilate during rain if the houses are less than 1 hectare in size. If houses are larger than one hectare, roof ventilation will be required: if rain events usually last more than 3 hours, crops are highly susceptible to foliar disease, or if they are exposed to extended periods of high humidity. To allow for ventilation during rainfall, a rain canopy can be installed on every 5th or 6th house to allow the roof to be closed to 95%. Houses with rain canopies are powered by separate motors from adjacent houses. Rain canopy is not designed to support a snow load





## Step 5:

### Create your layout using guidelines for the retractable roof house or automatic retractable field/orchard cover

**When designing how to integrate a retractable roof house into your business, the follow are the factors to consider:**

1. Are you wanting to build a certain size house, or are you wanting to cover as much of your land as possible?
2. Is the land relatively flat, or does it contain rolling grades?
3. Will the access roadways be located on the inside or the outside of the house?
4. The perimeter bracing options if you are considering building a rafter or flat roof house
5. The optimal orientation of the retractable roof houses
6. Limits of the retractable roof drive system

1. Are you wanting to build a certain size house, or are you wanting to cover as much of your land as possible?  
Whether you are looking to build a house for vegetables, or cover hectares of berries or cherries, the retractable roof house can be designed to cover hectares at a time, since ventilation and cooling is never a constraint

Retractable flat roof house covering 17 hectares of berries



45 hectare (115 acre) retractable flat roof cooling house: 1,200m x 400m with 54 motors opening the entire structure in 5 minutes!



2. Is the land relatively flat, or does it contain rolling grades?

The X-Frame house is specially designed to allow growers to be able to cover fields with rolling grades



The maximum slope along the gutter is 4% and the maximum slope of the roll-up curtains is 2%. The perimeter roll-up curtains can be custom designed for excessive grades by incorporating additional motors and telescopic drive shafts



**3. Will the access roadways be located on the inside or the outside of the house?**

Materials handling can be made more efficient by incorporating roads inside the house allowing trucks or wagons to be brought closer to the crops



**4. The perimeter bracing options**

If you are considering to build a retractable rafter or flat roof house, the tension from the roof system can be resisted by either internal or external bracing. External bracing is typically less expensive, but it can use up precious land or interfere with perimeter roadways

**Rafter house gable bracing**



External cable bracing on the gable ends



Roof purlins eliminate gable cable bracing ( optional upgrade )

**Flat roof bracing options**



External cable bracing on all 4 walls is standard



Internal interior compression bracing is an optional upgrade



## 5. The optimal orientation of the retractable roof houses

Since crops are exposed to direct sun when the roof is partially or completely retracted, it is critical to ensure that all plants receive similar amounts of direct sunlight to ensure uniformity of growth and development

### All peaked roof houses ( A-Frame, Rafter and X-Frame)

### Flat roof houses



When the roof is retracted, it is also desirable that the shadows from the retracted roof covering move across the crops as the sun moves from east to west throughout the day



To make sure that crops are not exposed to excessive direct sunlight or shadow, it is important to orient the houses as shown below

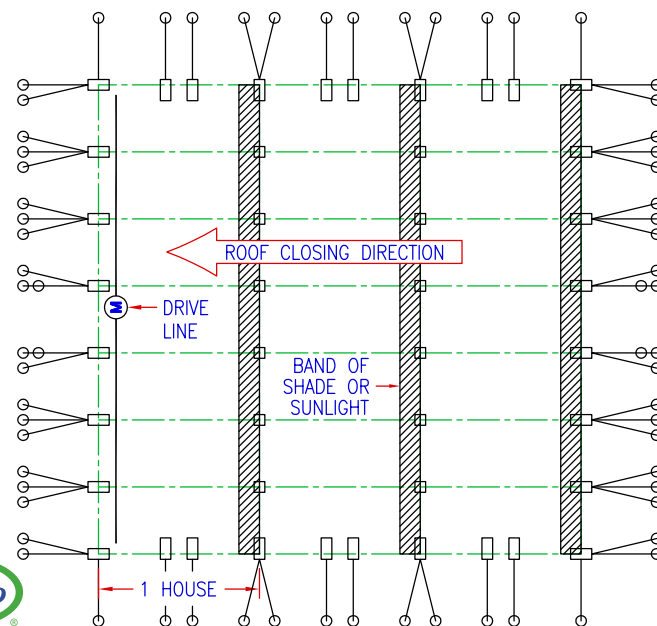
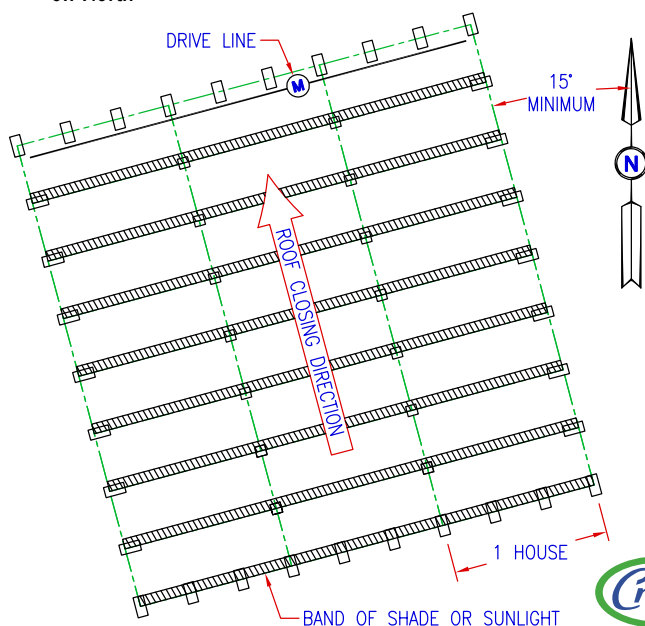
### Optimal house orientation to ensure shadows and sunlight are always moving across the crops:

#### Peaked roof houses (A-Frame, Rafter, X-Frame):

Gutters should always be oriented a minimum of 15 degrees off North

#### Flat roof houses: retracted roof curtains should always

be oriented essentially North-South (Never East-West)

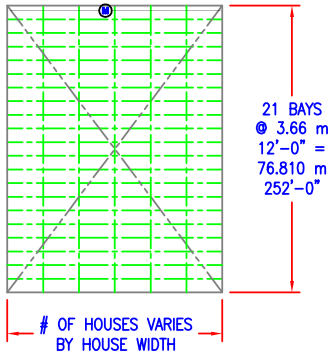




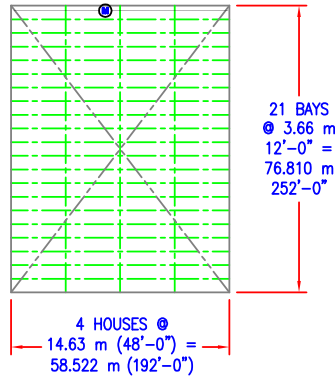
# DESIGN CONSTRAINTS WHEN LAYING OUT A NEW FACILITY

## MAXIMUM ROOF AREA PER PEAKED ROOF MOTOR

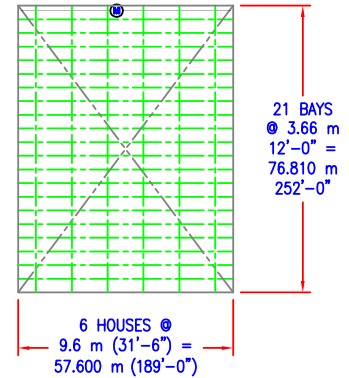
A-FRAME



RAFTER



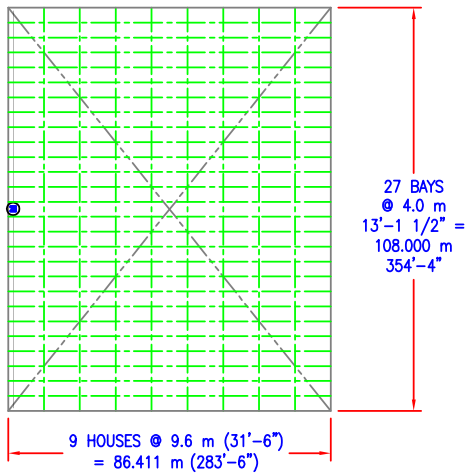
X-FRAME



A-FRAME MAX # OF HOUSES IF 21 BAYS IN ZONE	
WIDTH	# OF HOUSES
7.32 m (24'-0")	6
9.14 m (30'-0")	6
9.6 m (31'-6")	6
10.97 m (36'-0")	5
12.8 m (42'-0")	4
14.63 m (48'-0")	4

MAXIMUM AREA POWERED BY ONE MOTOR: 4,495 m<sup>2</sup> (48,384 ft<sup>2</sup>)

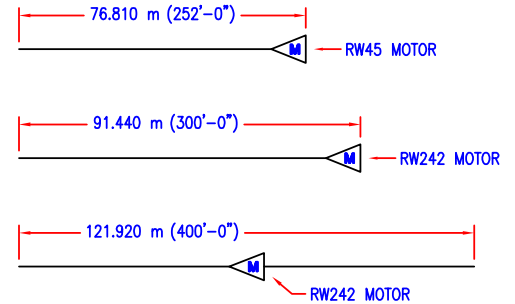
## MAXIMUM ROOF AREA PER FLAT ROOF MOTOR



MAXIMUM AREA POWERED  
 BY ONE MOTOR:  
 9,332 m<sup>2</sup> (100,453 ft<sup>2</sup>)

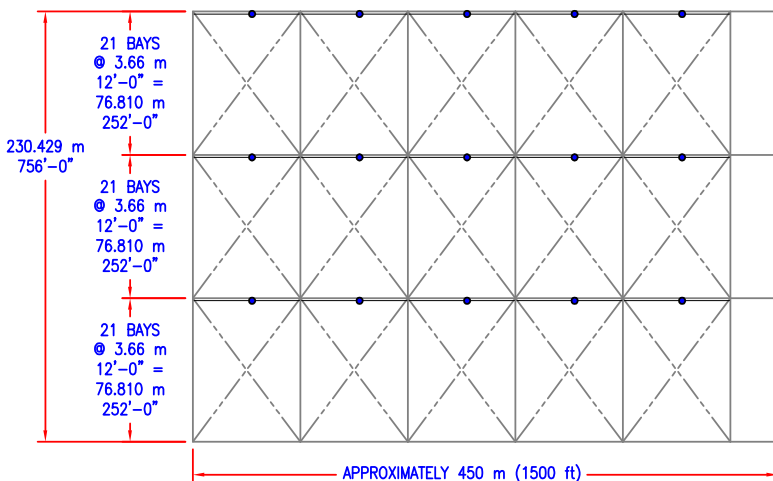
## MAXIMUM LENGTH OF ROLL-UP CURTAIN PER MOTOR

76 m (252 ft) LONG IF USING A RW45 MOTOR, END MOUNTED  
 91 m (300 ft) LONG IF USING A RW242 MOTOR, END MOUNTED  
 121 m (400 ft) LONG IF USING A RW242 MOTOR, CENTER MOUNTED

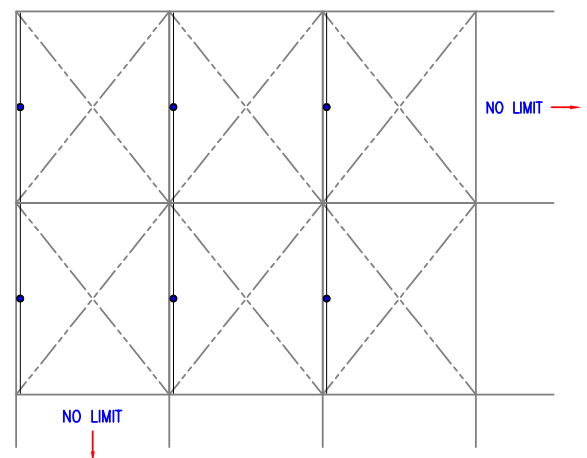


## OVERALL LENGTH AND WIDTH LIMITATIONS

A-FRAME, RAFTER, X-FRAME



FLAT ROOF



## Step 6:

### Decide if additional climate control is required:

- Low-pressure mist or high-pressure fog
- Horizontal airflow fans
- Retractable interior curtain systems for cooling, heat retention, insect control or blackout
- Bird net
- Supplemental heat or light

### If growing crops in arid or tropical climates where temperatures are $>30^{\circ}\text{C}$ ( $86^{\circ}\text{F}$ ) and humidity levels can drop below 50% midday:

Use a low pressure misting system if misting for short durations and there is no risk of foliar disease or salt accumulation on the plants

Use a high pressure fog system if cooling and humidification is critical and there is a risk of foliar disease or salt accumulation.



### If growing crops in temperate climates, typically between latitudes $30^{\circ}$ - $50^{\circ}$

Where winter are cold and summers are hot, use a clear retractable roof covering and a white retractable cooling curtain for summer cooling and winter heat retention

If growing crops between latitudes  $40^{\circ}$ - $50^{\circ}$  where winter temperatures are cold and summers are moderate, use a clear retractable roof covering and a clear internal retractable curtain for additional winter heat retention and summer cooling





**If growing in hot and humid tropical climate** chose a white cooling curtain that is porous to the air, and consider installing horizontal airflow fans. Mist or fog may be beneficial if humidity drops midday

If birds cause damage to crops, install bird net under the retractable roof



**The optimal orientation of the curtain system depends on the direction of the gutters**

If the gutters are at least 15 degrees off North-South, then the interior curtain system should travel from truss to truss closing in the opposite direction from the roof. This creates maximum ventilation with minimum exposure to direct sunlight

If the gutters are oriented North-South on an A-Frame house, then the interior curtain system should travel across the house from gutter to gutter



**Blackout or light deprivation for crops that require photoperiod control**





## Step 7: Choose the perimeter wall design for each of the 4 walls

### The optimal design of the perimeter walls will depend on if:

1. Winter temperatures are too cold
2. Humidity levels are high or low during the summer
3. Crops need to be protected from insects
4. It is desirable to prevent rain and animals from entering inside the house
5. Crops will benefit from exposure to wind
6. Wind will be beneficial to dry soil out after a rain
7. The region is susceptible to hurricanes or cyclones

### Decisions to be made:

1. Choose a wall covering: Stationary insect net, white cooling covering or clear greenhouse covering
2. Is the white or clear wall covering going to be stationary, or installed as a motorized roll-up curtain?
3. Will insect net be installed over the roll-up curtain opening?
4. Will the roll-up curtain extend down to the ground, or to a kneewall?

Install insect net if winter temperatures are warm and humidity is typically high



Install white cooling covering to protect crops from excessive radiation on east and west walls and possibly south and north walls if radiation is high and humidity tends to be low. North wall could be left as insect net for additional ventilation if desired in the Northern Hemisphere and on the southern wall if in the Southern Hemisphere



If winter nighttime temperatures are too cold and summers are hot and dry, cover walls with stationary white or clear plastic covering



Cover the perimeter walls with motorized roll-up curtains if crops would benefit from wind, if wind would help dry out the soil after a rain, or if the house could be hit by a hurricane or cyclone



Roll-up curtains are powered by gear motors which slide on a guide shaft and are balanced using a counterweight



If crops need to be protected from insects when the roll-up curtains are open, then install insect net over the roll-up curtain openings





Install a kneewall below the roll-up curtain if the ground is uneven, or if rain or rodents should be prevented from entering through the walls



Choose standard sliding door or a wider custom width door.  
A truss can be installed under the gutter at roadway locations if wider roadways are required



When insect control is critical, install an exterior vestibule (Sanitary cabin) with double doors





## Step 8:

**Decide if crops will be grown in soil or in containers. If container grown, decide whether the containers should be white or black**

There are many pros and cons to growing in soil or growing hydroponically. When upgrading to a retractable roof house, there are factors which could influence which is best for your specific application. It is best to speak to a Cravo representative to evaluate the pros and cons of each



**If growing plants hydroponically, choose bag or pot color: Choose white if temperatures and radiation levels are excessive year-round and black if increasing soil temperatures is beneficial during colder conditions**

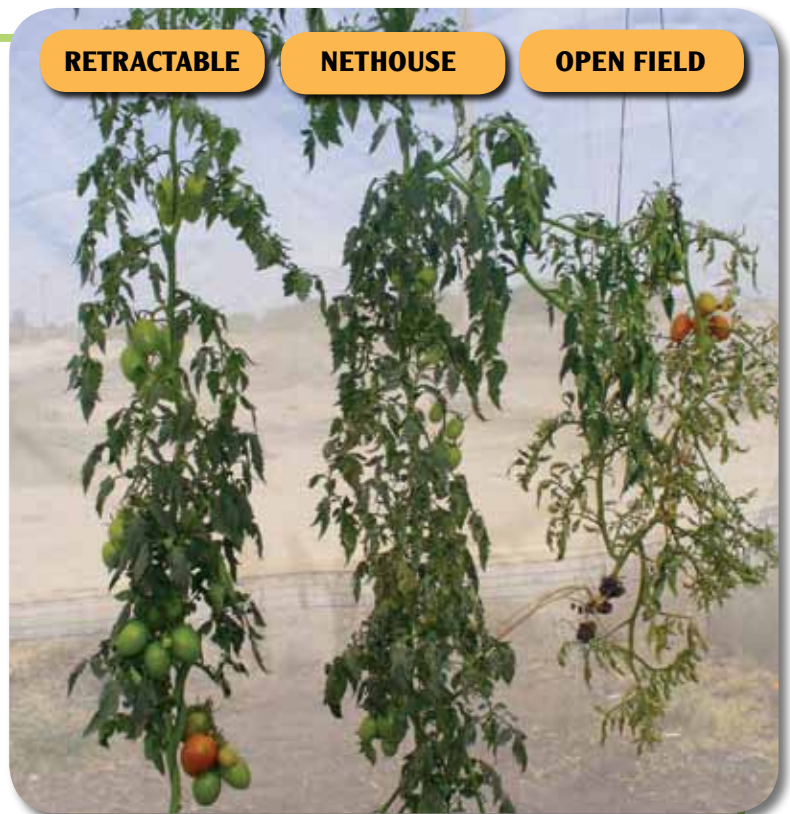
A grower can choose to warm up the soil faster in a black container by retracting the roof to let the sun shine directly on the containers which can be very beneficial on sunny days during the colder times of the year. The roof covering can then be closed partway on the hot sunny days to help prevent overheating of the container and soil media





## Step 9: Determine the optimal plant density

- A retractable roof allows crops to receive maximum full spectrum light, and experience lower humidity levels than to a closed roof house. This influences the plants to become active and initiates a more generative response
- The number of fruit, size of fruit and shelf life can typically be increased in a retractable roof compared to a stationary roof environment and it is also easier to advance or delay the harvest simply by changing how the retractable roof is controlled
- Plant density can possibly be increased, but it is important to choose a variety with the correct attributes, and to determine the optimal plant density in consultation with a crop specialist





**Step 10:** Decide if the climate control computer that will automate control of the roof, walls and misting system will also control internal growing systems like irrigation, fertigation and heat

Over the last 15 years, Cravo has developed special sensors and computer control algorithms to ensure that you can take full advantage of the benefits of both the natural outdoor conditions and a protective greenhouse, shadehouse and nethouse environment

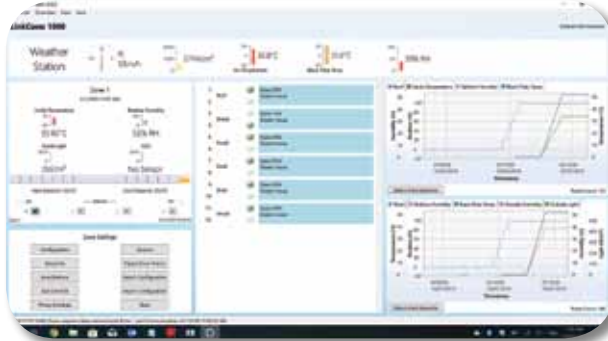


**The control system includes:**

- A weather station that measures surface temperature, wind speed, wind direction, rain and barometric pressure
- Indoor sensors that measure air temperature, humidity, soil wetness and soil temperature



Each crop type should have its own irrigation zone, and indoor air temperature / humidity sensor to allow for optimal control of the roof and misting system



- An interface to connect to a desktop PC for ease of programming, long term data storage, and remote access using a smart phone



Cravo works with most major environmental control computer companies so that they can incorporate the retractable roof control algorithms and best practices into their software



# Summary of your “Retractable Roof Product System” Design Specifications

If you would like to get more information, simply fill out as much of this form as you can, and then scan or take a picture of this form and email it to your Cravo business development person or to sales@cravo.com

Company Name: \_\_\_\_\_ City and Country: \_\_\_\_\_

Contact name \_\_\_\_\_ Telephone: \_\_\_\_\_

General climate conditions: Temperate \_\_\_\_\_ Desert \_\_\_\_\_ Tropical \_\_\_\_\_ Minimum summer humidity % \_\_\_\_\_

Max. windspeed \_\_\_\_\_ kph/ mph Snow load / Hail load \_\_\_\_\_ kg/m<sup>2</sup> or lb/ft<sup>2</sup> Max rainfall duration (hours): \_\_\_\_\_

Maximum slope of land: <2%, 2%-4%, 4%-7%, >7% Land grade: straight plane / rolling

Average summer humidity midday: 20%-40%  40% - 60%  60% - 80%

Number of m<sup>2</sup> or ft<sup>2</sup> to be covered: \_\_\_\_\_ Could house be expanded at a later date? Yes  No

Include sketch or Autocad drawing of available land and indicate north orientation

List the crops to be grown: \_\_\_\_\_ Desired harvest months: \_\_\_\_\_

Number of planting cycles per year: 1 / 2 / 3

Number of different growing zones: 1 / 2 / 3 / 4 / 5 / 6

Growing media: soil / pots / troughs / NFT

Container color: Black  White

SELECT ONE

### House Model

A Frame  Flat roof   
 Rafter  Auto-Dry™   
 X Frame

### Roof Covering

Clear greenhouse roof   
 White cooling roof   
 Rain canopy required: Yes  No

### Additional climate control

Curtain Fabric	Clear Heat retention	White Shading/cooling - closed	White Shading/cooling - open	Blackout	Insect net 10 x 16	Insect net 10 x 20	Bird Net
<b>Retractable</b> secondary curtain system							N/A
<b>Stationary</b> secondary layer	N/A	N/A		N/A			

Humidification / cooling system required: Overhead mist  High pressure fog  Horizontal airflow fans

### Wall coverings design

	Stationary 10 x 20 insect net	Stationary white cooling covering	Motorized roll-up wall with white cooling curtain	Motorized roll-up wall with clear greenhouse curtain	Insect net at roll-up curtain locations
<b>North</b>					
<b>South</b>					
<b>East</b>					
<b>West</b>					

Sanitary cabins required at door locations:  Yes  No



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