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**The many ways that  
Retractable Roof Greenhouse  
systems can positively impact  
on the balance sheet and income  
statement.**

**Retractable roof greenhouses are proving to increase overall profitability four ways by helping the balance sheet and almost every line on the income statement:**

### **BALANCE SHEET**

1. Reducing the total capital investment in land, the greenhouse structure and related equipment

### **INCOME STATEMENT**

1. Increasing revenues
2. Reducing the risk of a catastrophic loss
3. Reducing operating costs

The amount by which you can improve revenues, and reduce costs will depend on what crop you are growing, where you are growing, your current production practices, and your **imagination, desire and willingness to reinvent your production practices.**

### **IMPROVING THE BALANCE SHEET BY REDUCING THE TOTAL CAPITAL INVESTMENT**

The flexibility in creating different environments using retractable roof greenhouses provide opportunities to locate in different climates, reduce the investment in the greenhouse structure itself, and possibly avoid the purchase and installation of equipment that is normally required.

### **REDUCING THE COST OF USABLE LAND AND LAND PREPARATION**

1. Future greenhouses could be built in warmer climates where land costs could be cheaper since cooling is no longer a limiting factor when using a retractable roof greenhouse.
2. Land utilization can be maximized since larger gutter connected greenhouses can be built without compromising on cooling and ventilation. With traditionally ventilated greenhouses, greenhouses had to be split up into smaller sizes to allow for adequate cooling and ventilation. The space in-between the greenhouse ranges becomes wasted space.
3. There could be a reduction in the amount of money that needs to be invested to comply with regulations concerning emission of leachates. The reduction in water usage combined with the reduction in fertilizer will reduce the amount of nutrients leached into the ground.
4. Costs to grade the land could be reduced if crops could be grown in the ground instead of using a hydroponic or NFT system since land preparation and leveling is more critical when using these systems.

5. The expense of storm water studies and the investment in expensive studies, water drainage and water retention ponds could possibly be avoided if a flat retractable roof greenhouse using a water porous covering is built since the rain is not diverted by the roof covering and gutter system.
6. Building permits may not be necessary if building a flat roof greenhouse since local authorities may treat it as a shadehouse.

## **REDUCING THE TOTAL INVESTMENT IN THE GREENHOUSE ITSELF**

1. Building larger greenhouse ranges which reduces the investment in sidewall coverings, and doors.
2. Building flat roof greenhouses where it is not a must to keep rain off the plants.
3. Minimizing the cost of electrical wiring by minimizing the number of motors required to operate the greenhouse.

## **REDUCING THE TOTAL INVESTMENT IN GREENHOUSE EQUIPMENT**

### **1. Horizontal airflow fans**

- It may not be necessary to install HAF fans to circulate the air since opening the walls and roofs allows the wind to circulate the air more effectively and economically than horizontal airflow fans. However, if the greenhouse roof is closed for long periods of time during the winter, then they may still be beneficial.

### **2. Curtain system for shading, cooling/ heat retention**

- The purchase of a curtain system or black shade cloth could possibly be avoided. While the curtain system still may be beneficial to provide more options on managing the growing environment, it may more of a benefit than a necessity.
- It is no longer necessary to install curtain systems above greenhouses for shading and cooling to compensate for the lack of ventilation capacity.

### **3. Hydroponic or NFT system, fertigation system and reverse osmosis system**

- A hydroponic or NFT system can improve production yields and quality, but they are frequently required to manage water stress and to compensate for the increased salinity levels which tend to build up in the soil media due to the excessive use of fertilizers, or from using irrigation water that has a high salinity. These systems can create a higher risk system for farmers who have not had extensive experience using such a system. Retracting the roof could naturally accomplish some of the same objectives as retracting the roof since water stress is increased by increasing transpiration. Retracting the roof occasionally during rain is a simple strategy that growers could use to reduce the salinity of the growing media and help compensate for a high salinity in the irrigation water, which may be sufficient to avoid having to install a hydroponic system.

### **4. Fog system**

- When plants are grown in a retractable roof greenhouse, a fog system may not be required since plants can tolerate a higher level of stress since they are not grown soft and the ventilation capacity of an RRG prevents to overheating during the middle of the day. Fog systems may be beneficial for a very short time to boost humidity levels especially when growing young plants.

## **IMPROVING THE INCOME STATEMENT**

The income statement can be improved using retractable roof greenhouses by both increasing revenues and reducing operating expenses.

### **INCREASING REVENUES**

Retractable roof greenhouses can be used to increase your revenues by increasing the quality and /or quantity of salable product compared to what is normally produced outside, or in a traditional shadehouse or greenhouse. This increase comes mainly from growers being able to provide a better growing environment and eliminating or reducing many of the undesirable stresses which limit growth, or quality compared to growing either outside or in a traditional greenhouse. Growers can increase revenues by:

1. Increasing the **quantity** of product that the grower actually gets paid for.
2. Improving the **quality** so that a higher price can be charged.
3. Improving the **timing** of when the crop is ready to hit the market when prices are best.
4. Finding varieties that may reap higher prices when grown in a retractable roof compared to the current varieties that grown in traditional greenhouses.

#### **1. INCREASING THE QUANTITY OF PRODUCT THAT THE GROWER ACTUALLY GETS PAID FOR**

The increased flexibility in managing the growing environment can increase the quantity of product produced per square meter or foot.

- Growers have achieved increases the overall rate of growth by up to 30% compared to a traditional greenhouse simply by:
  - retracting the roof when outside conditions permit.
  - extending the growing season since dormancy can be quickly induced.
  - increasing plant density.
- Seasonal outdoor growers have increased growth rates by up to 100% simply by preventing crops from being exposed to excessive cold or hot temperatures.
- Both outdoor and greenhouse growers have been able to reduce the amount of product that is not salable due poor quality or timing.

#### **2. IMPROVED QUALITY SO THAT A HIGHER PRICE CAN BE CHARGED**

The quality of the plants grown in n retractable roof greenhouse can be significantly higher than those grown in traditional greenhouses allowing top prices to be charged for the product. These include:

- chemical residues are reduced or eliminated.
- brighter flower colors.
- longer shelf life.
- plants are grown tougher and are well acclimated to outdoor conditions.

#### **3. SUPPLYING PRODUCT WHEN PRICES ARE BEST**

The ability to open and close the roof provides an improved ability to speed up or slow down production to allow the managers to time their peak production to be ready so as to reap the best prices. The best prices could be during the winter, being the first to market in the spring, being able to supply good quality through the heat of summer, or being able to supply product in the fall after the cold

weather has limited the field production. It all depends on your crop and the market that you are competing in.

#### **4. GROW MORE PROFITABLE VARIETIES**

When new varieties come out that appear to meet a customer demand, growers do trials to determine if it can be profitably grown. Many varieties that met customer expectations did not perform well when tried in a traditional greenhouse. Many varieties that did not perform well in the commercial trials may do well in a retractable roof greenhouse since most of the challenges of growing in a traditional greenhouse can be prevented. Consequently many of the varieties that were tried and discontinued, could possibly be grown very profitably in a greenhouse with a retractable roof. Those growers that take the initiative to pursue these opportunities are the ones who will be able to provide products in demand at qualities and costs not available to growers using traditional greenhouses

### **REDUCING EXPENSES**

There are many areas where expenses can be reduced by growing plants in a retractable roof greenhouse. The degree to which the cost reductions apply will vary by crop, geographic location and the market being served.

#### **CHEMICAL FUNGICIDES, GROWTH REGULATORS AND PESTICIDES**

Chemical usage can be significantly reduced when growing in a retractable roof greenhouse. Growers have experienced the following:

- 50%- 100% reduction in fungicide usage.
- 50%- 100% reduction in growth regulator usage.
- 10% - 100% reduction in pesticide usage.
- 50%-100% reductions in herbicide usage.

When calculating the total savings in reducing chemical usage, one must consider:

- Reduced cost to purchase chemicals
- Reduced cost of labor to apply chemicals
- Reduced labor inefficiency resulting from workers being unable to enter a greenhouse that has been sprayed
- Reduced paperwork associated with recording of chemical applications
- Increased life of poly roof coverings since many chemicals used in the greenhouse are harmful to polyethylene

#### **WIDER CHOICES OF SPRAY APPLICATION**

Growers can use electrostatic sprayers rather than conventional sprayers and take advantage of the lower cost to operate because they can close the greenhouse roof to block the wind which helps improves the uniformity of the fine mist spray.

#### **FERTILIZER**

Reductions in fertilizer usage or improvements in fertilizer usage should be achieved regardless of whether crops are normally grown outside or in a greenhouse.

Fertilizer usage on outdoor crops can improved since closing the roof midday helps prevent an excessive fertilizer release of slow release fertilizer by reducing the temperature of the soil media and fertilizer pellet and also helps reduce water loss due to evaporation and transpiration. The reduced

water loss reduces the irrigation frequency which can reduce the amount of fertilizer that is leached out of the bottom of the container.

For crops grown in traditional greenhouses, fertilizer rates can usually be lowered since retracting the roof restores transpiration levels to normal levels allowing plants to more easily absorb and distribute the nutrients that are available to the root system.

## **WATER**

Growers of outdoor containerized grown plants have experienced up to **50% reductions in water usage** during the summer simply by closing the greenhouse roof partway to reduce the radiant energy that plants are exposed to.

Changes in daily water usage will depend on what environment the retractable roof is being compared to. Water usage on a daily basis will tend to increase compared to a traditionally ventilated greenhouse due to the higher transpiration and evaporation rates when the roof is retracted. However, if the rate of plant growth increases due to the ability to optimize the growing environment, then the total amount of water used per finished plant may actually decrease.

Retracting the roof and using rain to irrigate the plants can further reduce water usage. In addition to saving water, rain:

- is free.
- has a low PH.
- has a lower salinity than most irrigation water.
- cleans off the leaves.
- helps leach salt out of the soil media.

## **HEATING**

Heating costs can be reduced by:

- building the greenhouse in a location where average temperatures are warmer.
- not having to turn on the heating system in the morning to dry off the plants for disease control if the roof is going to be retracted shortly after sunrise.
- not having to heat the greenhouse in the winter to melt snow off the roof since the roof can be retracted to allow the snow to fall harmlessly to the ground.
- building larger houses that are more efficient to heat than many smaller one (ie. hoop houses).
- installing shading/cooling **and heat retention** curtains. Growers can now choose a closed curtain fabric that offers maximum heat retention without compromising on the cooling and ventilation capacity. In traditionally ventilated greenhouses, growers sometimes had to choose a porous curtain fabric to get sufficient cooling and then missed out on the potential heat savings.

## **ELECTRICITY**

Electrical costs can be reduced since:

- fans are not required for ventilation.
- the motors that power the roofs only run intermittently. It takes only minutes for one motor to power anywhere from 2,000 sq m (20,000 sq ft) to 10,000 sq m (108,000 sq ft) depending on the roof design.
- horizontal airflow fans do not need to run when the roof is retracted partway or completely.

## **GROWERS**

Having the ability to work with both an outdoor and greenhouse environment allows growers to proactively influence the plant to naturally develop in the desired manner without the use of chemicals, or sophisticated crop management strategies. With this approach, growers tend not to have as many problems that they need to solve. This allows them to change their focus to being a **fire preventer instead of a fire fighter** which has proven to be a catalyst for ambitious growers because they now can learn how to use retractable roof greenhouses as a tool to make their job easier while at the same time delivering better quality plants. Retractable roofs also could allow less experienced growers used since crop management is easier.

## **GENERAL LABOR**

Retractable roof greenhouses reduce labor costs in many ways:

- Materials handling is more efficient when larger greenhouse ranges are built
- Employee supervision is easier in large ranges
- There is usually no need to move crops from a growing greenhouse to a hardening area
- Picking of plants for shipping tends to be more efficient since crops tend to be more uniform reducing the need for workers to have to pick through plants. Being able to ship all plants from one area also allows the area to be quickly replanted.
- Reduced labor cost for spraying of chemicals
- Possibly faster re entry a greenhouse or outdoor environment can be created.

## **EMPLOYEE SATISFACTION**

When the roof and walls are positioned to make create the best working environment for the plants, the workers will tend to be more comfortable as well which will help make them more productive.

Workers will be happier when they are protected from cold, snow, rain or excessive heat, and able to be outside when conditions are ideal. They will also be pleased to work in an environment that has fewer chemicals. The improved plant quality will also have a positive effect since most employees like to see that their company is producing and shipping top quality products.

## **MAINTENANCE**

Maintenance costs with a retractable roof greenhouse can be reduced by reducing or eliminating labor to:

- spray on and scrub off whitewash is eliminated since roofs are never whitewashed.
- seasonally install and remove black shade cloth can usually be eliminated.
- repair damage to the roofs from the wind since the reinforced poly roof coverings are more resistant to wind damage.
- change the roof covering by changing the roof covering less frequently since reinforced poly roofs typically last 6 – 8 years instead of 1 to 4 years for regular greenhouse film.
- clean the roofs since retracting the roof allows plants to receive higher light levels.
- repair hail damage since reinforced poly roof coverings are very resistant to hail damage.
- maintain ventilation fans or cooling pads since they are not required with a retractable roof.
- maintain roof vent motors since fewer motors may be used.

## **MANAGEMENT AND MOTIVATION OF WORKERS**

It is easier to manage and motivate workers when their working conditions are improved and many of the tasks that they dislike are reduced or eliminated.

## **PRODUCTION PLANNING**

Production planning is one of the most difficult functions at a greenhouse operation. Some of the challenges are:

- it can be difficult to forecast the timing of when the peak demand will occur.
- erratic weather conditions also affects the speed at which plants grow in the greenhouse
- some crops tend to grow better in one style of conventional greenhouse than another.
- it can be difficult to schedule when plants are to be moved from the greenhouse to outside or to a shade house in order to acclimate them.

Retractable roofs can help the production planning process by:

- allowing the space inside a retractable roof to used as greenhouse, shadehouse or outdoor growing areas, simply by positioning the roof, which can eliminate the need to schedule and move plants to different growing areas.
- making it easier to speed up or slow down the plants to react to changes in market demand.
- making it easier to produce top quality product during erratic changes in the weather or during the heat of the summer.
- allowing a wider variety of plants can be grown at the same time in the same zone.

## **TRAINING**

Training of growers, maintenance personnel and workers is simplified for operations with one or multiple locations.

### **TRAINING AT ONE LOCATION**

Retractable roof greenhouses can frequently be used for the entire growing process, from propagation to hardening. Having one style of house simplifies the training since employees do not have to learn the subtle and not so subtle differences between growing in different types of traditional greenhouses, like a sawtooth, gutter vent, single ridge vent, double ridge vent, pad and fan, or side vent and fan.

### **MULTIPLE LOCATIONS**

Since retractable roof greenhouses perform well in many different climates, the same type of house can be built at different locations. This simplifies training of growers and maintenance personnel since they can be moved from one location to another without the need for extensive training on how to use this style of greenhouse.

### **REDUCES TURNOVER OF WORKERS**

The improved work environment can reduce turnover which reduces both the cost of training and the cost due to mistakes resulting from the inexperienced workforce.

## **REDUCE THE RISK OF A CATASTROPHIC LOSS**

Retractable roof greenhouses can be used to reduce the risk to the owner in the following ways:

- reduced risk of crop loss due to losing a poly roof due to the wind since suspended retractable roofs have never blown off during a strong wind, even during wind speeds up to 160kph (100mph)
- reduced risk of major structural damage to the greenhouse due to hurricanes since the roof and walls can be quickly and automatically retracted.
- greenhouse roofs can be retracted during a fire to limit the spread of fire.
- reduced risk of major crop loss due to a major disease outbreak.
- reduce the risk fines due to excess emissions of chemicals or nutrients.

## **COST OF INSURANCE (or make it easier to get insurance)**

Insurance costs may be reduced or insurance companies may be willing to provide insurance since retractable roofs can reduce the risk of loss due to fire, hurricanes, or crop failures.

## **RESALE VALUE**

The resale value of a greenhouse is can be highest if the greenhouses have a retractable roof since virtually every crop can be profitably grown, making it more attractive to buyers.

## **BANK FINANCING**

Banks should be more interested in financing retractable roof greenhouses since:

- The improved profitability should make loan repayments easier
- There should be a reduced risk of a catastrophic loss
- The greenhouse should have a higher resale value since virtually any crop can be grown in it especially since curtain systems for insect protection, extra shade, cooling, heat retention, or blackout can be added at a later date, provided that the clearance has be maintained.

## SUMMARIZING THE POTENTIAL INCREASE IN PROFITABILITY AND PAYBACK

### POTENTIAL REDUCTIONS IN CAPITAL COST

	Cost factor	Savings /sq m or ft	Total savings
	<b>LAND</b>		
	Improved land utilization since larger greenhouse ranges can be built, eliminating space in-between greenhouse ranges.		
	Reduced land cost from building in a warmer location.		
	Reduced investment in equipment or facilities to control chemical or nutrient emissions.		
	Reduced grading costs if crops can be grown in the ground.		
	Reduced investment in storm water management systems if a flat roof house can be built.		
	<b>GREENHOUSE STRUCTURE, ROOF COVERING AND VENTILATION SYSTEM</b>		
	The cost to buy and build a traditional greenhouse \$ /sq m or ft		XXXXX
	The cost to build a retractable roof greenhouse \$ sq m or ft		XXXXX
	The difference in cost.		
	<b>OTHER GREENHOUSE EQUIPMENT</b>		
	Eliminate cost to buy and install horizontal airflow fans.		
	Eliminate cost to buy black shade cloth.		
	Eliminate cost to buy and install retractable shading system.		
	Eliminate the cost to install a hydroponic or NFT system.		
	<b>Total Savings on capital</b>		

## POTENTIAL INCREASES TO REVENUE

Current revenue per sq ft or m :\$

	Revenue factor	Significance			% increase
		Low	medium	high	
<b>Increase price per unit</b>	Improved quality, ie taste, shelf life, chemical free.				
	Time crops to hit the market when prices are best.				
	Grow more profitable varieties that may not perform well in traditional greenhouses.				
<b>Increase quantity of product sold</b>	Increasing yield per sq. meter or foot due to increased yields.				
	Reduce growing time by up to 30% if crops are normally grown in a greenhouse or up to 100% if crops are normally grown seasonally outside.				
	Increased production since plants could be spaced closer together.				
	Faster time to replanting if crops are uniform and can be picked at once.				
	Reduced losses due to fungal diseases, insect damage or viruses.				
	Reduced losses due to cultural problems like flower and fruit drop, blossom end rot.				
	Reduced losses due to crops being overgrown.				
	Reduced losses due to a late or early freeze.				
	<b>TOTAL estimated percent increase in revenue</b>	XX	XX	XX	
	<b>Current Revenue per sq ft or m</b>	XX	XX	XX	
	<b>TOTAL ESTIMATED INCREASE IN REVENUE PER SQ M. OR FT.</b>	XX	XX	XX	

## REDUCTIONS IN OPERATING COSTS

	<b>Cost factor</b>	<b>Cost per sq m or ft per year</b>	<b>Est'd % savings</b>	<b>Savings per sq m or ft</b>
	<b>Purchased Supplies</b>			
<b>Chemicals</b>	Reduction in chemical growth regulators.			
	Reduction in chemical fungicides.			
	Reduction in insecticides.			
	Reduction in herbicides.			
<b>Fertilizer</b>	Reduction in fertilizer usage			
<b>Water</b>	Reduction in water usage to grow a finished crop or using rain to irrigate			
<b>Heating</b>	Reduction in heating costs by locating in a warmer winter climate			
	Reduction in heating costs by building larger gutter connected greenhouses			
	Reduction in heating costs from being able to use a closed curtain fabric which offers better heat retention			
<b>Electricity</b>	Not running fans for ventilation			
	Not running horizontal airflow fans at all or when the roof is retracted			
	<b>Labor costs</b>			
<b>Grower</b>	<ul style="list-style-type: none"> <li>• Does not have to schedule movement and timing of crops to provide for hardening</li> <li>• Easier to plan production since virtually every crop can be grown in an RRG</li> <li>• Grower can possibly manage a larger growing area or have less experience since it is easier to prevent problems</li> </ul>			
<b>General Labor</b>	<ul style="list-style-type: none"> <li>• Improved labor productivity due to increased overall satisfaction and working in more comfortable environments</li> <li>• Improved materials handling due to the large open growing areas</li> <li>• Improved crop uniformity causes plants to be ready at the same time allowing for more efficient picking of vegetables, flowers or plants.</li> <li>• More effective labor supervision in larger ranges</li> <li>• If spraying is required, re- entry times could possibly be reduced</li> <li>• Elimination of moving plants from inside a greenhouse to an outside area for hardening</li> <li>• Reduced training time for chemical applications</li> <li>• Reduced training due to reduced turnover</li> </ul>			

	<ul style="list-style-type: none"> <li>Easier training of new employees since growing processes are more standardized.</li> </ul>			
<b>Maintenance costs</b>	Whitewash does not have to be applied or removed.			
	Black shade cloth does not have to be installed or removed.			
	Poly roofs do not have to be installed or removed every season.			
	No cooling pads or fans to maintain.			
<b>Reduction of risks</b>	Reduced risk of crop loss due to power outage since roof can be operated manually.			
	Reduce risk of crop loss due from losing the roof since suspended roofs are more wind resistant.			
	Reduce risk of damage due to hurricanes since roof can be retracted.			
	Reduce risk of damage due to fire since roof can be retracted.			
	Reduce risk of chemical or nutrient emissions.			
	Increased ability to handle changes in crop mix .			
<b>Resale value</b>	Increased resale value since greenhouse is suitable to grow other crops.			
<b>Financing</b>	Impact on availability of financing			
	Cost of interest payments due to improved borrowing terms or reduction in overall capital investment			
<b>Insurance</b>	Reduction in insurance costs from due to reduced risks.			
	<b>TOTAL ANNUAL COST SAVINGS PER SQ FT OR M</b>			

**YEARLY INCREASE IN PROFITABILITY FROM GROWING IN A RETRACTABLE ROOF GREENHOUSE**

Yearly potential increase in revenue per sq. m or ft	
Yearly potential reduction in operating costs	+
Yearly estimated increase in profits per year	=

**PAYBACK ON THE INCREASED INVESTMENT TO BUILD A RETRACTABLE ROOF**

Estimated increase in total capital cost to build a retractable roof	
Estimated increase in profits per year	Divided by:
Payback on the incremental cost to build a retractable roof	=