Notes taken during NB Greenhouse Consultations
July 26-29, 2016

These notes are not intended to be recommendations to growers; they are simply a summary of the information that was discussed during the greenhouse visits. Care must be taken before growers apply any of the information contained in this document. Furthermore, it is the grower's responsibility to follow all pest control product labels. Also, organic growers must make sure the products they intend to use meet the Canadian Organic Standards and that their use is allowed by their organic certification agency.

<u>Rainbow Harvest Acres</u> (Bob and Jolene Giesbrecht): July 25, 2016

- For proper natural venting with roll-up sides, the roll-up opening must be at least 25% of the greenhouse width (ie. a 32 foot wide greenhouse should have at least 8 ft of unobstructed roll-up side opening). Insect exclusion netting often restricts the natural air movement and can cause excessive heating.
- 100,000-110,000 BTU per furnace. Consultant did a few calculations.
  Typically, 24 BTU/hr per m^2 of greenhouse for 1 $^{\circ}$C difference in temperature is required.
- Plant density recommended
  2-3 plants/m2 for beef steak type tomato plants
  2.5-3.5 plants/m2 for cluster types
  Up to 3-5 plants/m2 for cherry types
  Ideal plant densities will depend on grower experience and greenhouse technology used.
- When grafted plants are used, the top part of the plant (scion) should not be allowed to set roots as the disease resistance of root stock will be lost.
- Temperature sensors in greenhouses should be at the height of the top fruit cluster (near growing point), therefore the sensor should be raised as the season progresses.
- Since the smallest greenhouse can be heated better, cherry tomatoes should be grown in it.
- It is possible to split the clusters of cherry type tomatoes by dropping the greenhouse temperature. Some Quebec growers use this technique.
- To reduce the humidity in the greenhouse, growers can consider at least 2 heating cycles per day (sunset and sunrise, should be automated). This should keep the air drier and should help control diseases (such as botrytis and leaf mould). Morning heat is important but it is also important to vent the greenhouse to exhaust the cool and moist air.
- Minimum temperature in the greenhouse should be set at 17.5 °C (depending on time of year and climatic conditions).
- To reduce risk of fruit cracking, the crop should be growing actively before the 1st morning watering.
- During harvest time and during hot and sunny days, up to 5 liter/m2 of water may be required for tomato production. Less for cucumber and peppers.
- Drip lines can be anchored to the soil to hold them in place with "U" shape hooks or staples.
- Some growers fertilize one side of the row at one time. On the second application, they will fertilize the other side. This facilitates the work involved with split applications.
- Target: The crop should produce 8-10 fruit per week/m2.

- Bottom leaf pruning can be done up to 2nd unpicked fruit cluster. The unhealthy and diseased bottom leaves should be removed and disposed of appropriately. Some of those leaves can become a burden to the plant as the energy and nutrients may be diverted towards the leaves instead of toward the growing point and fruit development.
- In general, cherry and cocktail type tomatoes only yield 60% of the beef steak types and they require more bees, more pruning, and more work, so growers need to charge more money for them.
- 3 new varieties were suggested: Makari (pink cultivar, a good substitute for Tomimaru Mucho), Tomimaru Mucho and Toranjina (cherry orange, with good resistance package, including leaf mould).
- Some Quebec growers are producing more lunch type peppers instead of large globe peppers. Some markets are looking for small to medium size peppers.
- Some growers are using dormant oil (Greenspray oil) to control aphids. This treatment may be used before the release of beneficials.
- The "Les serres Tessier" control system may be affordable but other systems will provide more options. The client may want to consider " igrow" controllers.
- Fertilization program. Client should reduce the original fertilization program by at least 25%. The original recommendations made earlier in the season were for a long season and a high productivity system.
- Consultant was not worried about the purple colours of the bottom leaves. May be a sign of Mg deficiency but the consultant is not worried about it. In this case, the fertilization program is probably not as important as other crop management practices at this point in the growing cycle.

Strawberry Hill Farm (Tim and Kirsten Livingstone)

- May want to consider new cultivars:
  1) Toronjina: highly resistant and vibrant orange cheery type tomato
  http://www.dominion-seed-house.com/en/10041-hyb-toronjina.html
  2) Sweet treats: pink cherry type (a little larger than cocktail good against leaf mould), http://parkseed.com/sweet-treats-hybrid-tomato-seeds/p/52525-PK-P1/
- To avoid fruit splitting, avoid excessive watering after a period of dryness. With dryer soils or if growers prefers dryer growing condition, select cultivars that are resistant to splitting. Avoid heavy watering in early morning and late in the days.
- In drier growing condition systems, less nutrient leaching occurs so nutrients may remain available to the crop (less fertilization may be required).
- Tip burn occurs when the humidity and temperature fluctuate too much.
- It is possible and easier to pinch above the 2nd true leaf to obtain two uniform heads (plant stressing). Pinching should ensure a cluster after 6-7 leaves instead of 8 to 11 leaves without pinching. This year, the 1st clusters (beef type) at SHF are very late, too late.
- Why should growers grow cluster type tomatoes (ie. climstar) when they don't have much taste? However, they do store well.
- Growdena is sensitive to powdery mildew but tastes better than Bigdena. It has more ribs and is a bit smaller than Bigdena.
- Need to improve pollination. This will increase the number of fruit per cluster and fruit size. It will also allow better plant balance (vegetative vs fruiting).

- A 30 ft wide greenhouse will require at least 7.5 ft of roll-up side opening to ensure enough natural ventilation.
- A mature plant should not have more than 45-55 leaves/m2 when the leaf is 45 cm long. If more, deleafing should be done.
- It is important to prune the bottom leaves before they start using the energy at the expense of the growing point and fruit development.
- To help control powdery mildew, start by deleafing up to the 2nd unpicked cluster. Then start using the milstop and microscopic sulfur.
- Many growers in Quebec apply the microscopic sulfur by dusting. This is an off label use. Tomatoes can take a lot of sulfur but other crops are sensitive. Cucumbers are sensitive so no dry sulfur should be used on cucumbers. Bartlett Microscopic sulfur is OK for organic. Make sure you know how to apply the powder as the static charge of the material can cause explosions. Make sure the applicator's ground line or chain is used on the dusters. Cherry type tomatoes are more sensitive to the powdery mildew (PM). Favorita is very sensitive.
- Sulfur also controls spider mites.
- Magnesium sulfate (Epsom salts) is added to the sulfur and water mixture so the product runs off the fruit. This will reduce the risk of having any product residue on the bottom of the fruit once the fruit dries off (20-30 g of Epsom salt/liter of water)
- Greenhouse cucumbers will benefit from soil heating and misting. Some cultivars are adapted to cold weather.
- Growers should keep better track of yield. It could be lbs per row or per m2 or per plant, it could be number of box. Growers need to know their yields so they can determine the profitability of the greenhouses.
- In Ontario, many growers are producing large beef type tomatoes for the US market.
- At the farm, the peppers have lots of leaves and lots of future fruit. Some growers use rebars and strings to weave and support the plants to avoid lodging.

Jemseg River Farm (Micheal Carr)

- For proper natural venting with roll-up sides, the roll-up opening must be at least 25% of the greenhouse width (ie. a 32 foot wide greenhouse should have at least 8 ft of unobstructed roll-up side opening). Insect exclusion netting often restricts the natural air movement and can cause excessive heating.
- By inflating the double layer of plastic, there will be less plastic movement (less beating and wearing).
- Always use the AC plastic (anti condensation) for single or double layer of plastic.
- No powdery mildew but some botrytis.
- Prestop (biological fungi) can be used. Heating the structure would remove the excessive humidity in the air.
  http://pr-rp.hc-sc.gc.ca/1_1/view_label?p_ukid=73206676
- Grower should look at plant density and row spacing. 1.6 m is often used between row centers. Rows are strung in a V-shape with two top wires. The distance between the top wires of approx. 60 cm and the distance between the top wirea in the alley is approx. 1 meter at 3 m of height.
- Should consider two new varieties: Toronjina and Sweet Treats
  1) Toronjina: highly resistant and vibrant orange cherry type tomato

2) Sweet Treats: pink cherry type (a little larger than cocktail, good resistance to leaf mould),

- For powdery mildew control use milstop and Sulfur (wet or dry) possibly every 7 days.
- There are a lot of propane heaters used in the industry as the propane is relatively cheap at the moment. Some dual (oil and propane) furnaces are on the market.
- igrow is a good greenhouse controller option.
- To remove botrytis infected tomato leaves or plants with a plastic bag; the growers can pull the plastic bag inside out to avoid the dissemination of spores or pathogenic material (ie. dog shit trick).

Walker Produce Farm (Linda and Brian Walker)

- A 30 ft wide greenhouse will require at least 7.5 to 8 ft of roll-up side opening to ensure enough natural ventilation.
- Plant densities and row spacing need to be adjusted. No more than 5 or 6 rows should be used in this greenhouse. The farm is currently using a plant density of 1.5 plant/m2.
- Cucumbers should be grown at 1.5 to 2.5 plants/m2.
- Grower needs to use "real" greenhouse cultivars. Find other cultivars than Early Girl and Big Beef.
- Pollination needs to be improved. Bumble bees can be used. In mid-day (between 2 and 3 o'clock), the grower could also vibrate or shake the top wires and springs. These strategies must be used during the entire season, including the early part.
- Remove bottom leaves so that no leaves are under the bottom 2 unpicked clusters.
- If cucumbers are grown, insect exclusion screens can be used provided the screens do not restrict the air flow. Select nets that prevent entry of tarnished plant bugs and cucumber beetles. Avoid the fine nets and screens.
- Keep 3 to 4 tomatoes per cluster (beef type only), and prune the others early as heavy clusters are hard on the crop. The crop will have a difficult time to balance itself (lack of vigor in the top of the plant).
- Large English cucumber plants need to be pruned. Bottom suckers should be removed and every second fruit or blossom should be removed. Always leave the top young suckers on the cucumber plants in case the tarnished plant bugs damages and destroys the growing point. One of the young suckers can be kept and used as a new growing point. If all suckers are removed and the growing point is destroyed, the plant will never recover.
- For medium size cucumber varieties, leave one fruit at every node.
- For Lebanese cucumber varieties, leave up to two fruits at every node.
- On this farm, during hot and sunny weather, irrigate for 2 hrs per day with the cycles (one at 9:00 am and one at noon). Do not irrigate before 9:00am and after 2:00pm.
- Should fertigate at every watering.
- The grower should intervene with a registered spider mite control product on the cucumbers.
- If predators or parasitoids are used to suppress the spider mites, misting will be required. Misting tends to lower mite pressure and encourage biologicals. Misting will be important in the future if the grower wants to continue growing cucumbers.
- Deheading tomato plants is important: Dehead 8-10 weeks before the beef steak tomato plants are terminated. Dehead 6-8 weeks before the cherry tomato plants are terminated.

Ferme Pouce Vert (Roger et Carmelle Richard)

- The 7.2 mil anti condensation (AC) plastic can also be used on multi-bay high tunnels. AC is very good for two year.
- Eiffel 7.2 mil may be the best.
- The plastic should be installed in the summer when the conditions allow the grower to stretch the plastic. During that time, the anti-condensation (AC) properties of the plastic will be maximized. Some suppliers will require that the plastic be replaced or installed in mid-season for full product warranty.
- Suppliers: Excalibur (Ontario) and Hol-Serre.
  http://www.excaliburplastics.com/plastics/products_view.php?id=5
- Colour options for plastic mulch is not very important for tomatoes when the crop canopy is so dense. There is very little light that reaches the mulch.
- In Quebec, the organic greenhouse tomato seedlings are grown in 6 in. pots (seedlings are approximately 7 weeks old at planting, when they have up to 1 flower cluster). If seedlings are more mature, watering will be extremely important.
- In Quebec, the conventional tomato seedlings are grown in 4 in. pots.
- From a tiny fruit to fully ripened cherry type fruit it takes approximately 7 weeks.
- On the farm, some fruit abortion was observed.
- Some botrytis was observed. Highly diseased plants should be carefully removed from the greenhouse and tunnels. These plants should be bagged on site (near the area where the plant was taken) and removed from the structure. Small botryis lesions may be cut out of the stem; however, organic growers may want to use a spray of vinegar on the lesion before handling the plant to avoid the dissemination of the pathogenic organism. If part of the plant is removed because it is infected, make sure to include at least 1 inch of extra plant material (healthy material) as the infection is often present on some of the healthy parts of the plant..
- Higher yields of cucumbers can be achieved by pruning and growing them on strings but there are additional costs involved. In unheated, short season and low tunnels situations, cucumber may be grown more cost effectively on the ground.
- Raspberries grown in high tunnels have better shelf-life. Wholesalers are now looking for tunnel grown raspberries.
- Some of the pepper varieties grown on the farm are more productive than others. Basic pepper pruning would include, removing all flowers or fruits below the 1st branching. Weaker varieties and plants that have a large fruit at the branching point often are unable to support more fruit production or development. These plants will provide one large king fruit but few other fruit.
- Silver plastic mulch tends to deter aphids and is less hot than the black mulch.
- Chesapeake pepper plants have smaller fruit (very nice fruit). http://www.stokeseeds.com/category.aspx?CategoryID=116&checkCookies=1
  Very early, smooth, blocky fruit that changes color from dark green to red rapidly. This variety can support a king fruit and many other fruit. Same can be said about Carmen.
- Emerite is a very interesting pole bean. Stays tender. 53 days. Medium green completely stringless long filet bean. Pod averages 20 cm, very straight and smooth with excellent bean flavor.
- Romano is another pole bean but it is not as nice looking for the market.

Codiac Organic Ltd. (Mark and Fran Day)

- 120,000 BTU propane heater. Good enough for three season production.
  Typically, 24 BTU/hr for m2 of greenhouse for one degree difference is required.
- Cherry type tomatoes produce 60 % of beef steak tomato types.
- Pepper need 8-10 weeks before turning in colour.
- Pollination is a problem. The growers need to add bumble bees or need to vibrate top wires and tomato strings.
- Current exclusion screens are not porous enough to allow adequate natural ventilation. Screens are more useful when growing cucumbers because coarse screens can control tarnished plant bugs and cucumber beetles.
- Bottom leaf pruning up to the 2nd unpicked cluster (on a mature plant),
- Need to irrigate a little more without saturating the subsoil.
- Continue to foliar feed with fish fertilizer.
- Based on the detailed greenhouse soil report, the soluble salts level of the soil is very high. This is due to the very high sulfate level. This situation should be fine.
- May need more nitrogen later in the season. Plants remain a little too pale, especially at the back end of the greenhouse.
- Liquid fish fertilizers may contain high levels of sodium (Na).

Nature's Route farm (Kent Coates)

- The temperature sensor should be at the same height as the top clusters or growing point.
- Pollination issue observed. Plants may appear OK but not enough pollinators. Bumble bees will ensure better pollination, more fruit and bigger fruit.
- Powdery mildew observed. Milstop and microscopic sulfur are the two best control options. Sulfur can be applied as a liquid through a water dilution or can be dusted on tomatoes (only). Not on cucumbers.
- Chapin Duster can also be used to dust the crop. https://chapinmfg.com/Product/slug/chapin-5000-16-ounce-hand-rose-and-plant-duster
- Microscopic sulfur in water can also be mixed with Epsom salt. The Epsom salt will make sure no dry deposits accumulate at the tip and bottom of leaves and fruits.
- 1st beef steak type tomato clusters should be pruned to 3 to 4 fruit so the plant can support and grow more leaves (better balance).

Diddley Squash Farm (Susan Linkletter)

- Anti-condensation plastic should be used on all structures (single and double layer system). Water droplets (condensation) intercept some of the sun light.
- Insect exclusion screens can be used but should be UV treated to prevent sun degradation. Do not select the screens that are too tight as it will reduce air movement and cause over heating situations. Select screens or nets that control tarnished plant bugs and cucumber beetles.

- Plant density. Make sure the rows are not too tight. Single row set-up in a V-shape string system is best.
- Grower should make sure the new containers used for production meet the Canadian Organic Standards:
  "The following conditions apply to containerized, staked crops (for example, tomatoes, sweet peppers, cucumbers, eggplant):
  at the start of production, the total volume of soil shall consist of at least 10% compost; compost shall be included in the fertility program; containers shall be at least 30 cm (12 in.) high; and the soil volume shall be at least 70 L/m² (15.4 gal./10.8 ft^2), based on the total growing area."
- Greenspray oil can be used to control aphids before the predators or parasitoids are released.
- Bio controls for aphids and spider mites are very effective. Misting will help the biocontrol agent and will suppress the spider mite population.
- Bunker crops may be useful for some bio controls as they will harbor the beneficial until the pest population becomes more of a problem. No bunker crop and no insect pest = no beneficials.
- The lights used in the old greenhouse should have some reflectors. May need to add twice as many lights to support high production. The grower should have an expert do the lighting requirement calculations.

Take home messages for all NB greenhouse vegetable growers:

- Better pollination:
  Avoid excessively cold and hot conditions. Ideal temperature: 16 to 25 C.
  Non-pollinated cluster will have few fruit and irregular size fruit.
  Bumble bees may be useful. Growers may want to vibrate or shake the top wires and string between noon and 2:00pm. Good pollination ensures good fruit size and uniformity.

- Basic tomato, pepper and cucumber plant pruning information:
  Keep 3 to 4 tomatoes per clusters (beef type only), and prune the others early as heavy clusters are hard on the crop. The crop will have a difficult time to balance itself (lack of vigor in the top of the plant). Bottom leaf pruning can be done up to 2nd unpicked fruit cluster. The unhealthy and diseased bottom leaves should be removed and disposed of appropriately. Some of those leaves can become a burden to the plant as the energy and nutrients may be diverted towards the leaves instead of toward the growing point and fruit development.
  When grown on strings large English cucumber plants need to be pruned. Bottom suckers should be removed and every second fruit or blossom should be removed. Always leave a few suckers at the top of the plants, in case the tarnished plant bugs damage and destroy the growing point. Later, one of the young suckers can be kept and used as a new growing point. If all suckers are removed and the growing point is destroyed, the plant will never recover.
  For medium size cucumber varieties, leave one fruit at every node.
  For Lebanese cucumber (small fruit) varieties, leave up to two fruit at every node.
- Some of the pepper varieties are more productive than others. Basic pepper pruning would include, the removal of all flowers or fruits below the 1st branching. Weaker varieties that have a large fruit at the branching point often are unable to support more fruit production or development. These plants will provide one large king fruit but few other fruits. Quebec growers

are producing more lunch type peppers instead of large globe peppers. Many growers in Quebec use rebars and strings to weave and support the plants to avoid lodging.

- Tomato plant density and row spacing:
  Row spacing of 1.6 m is often used (between row centers).
  Simple rows are easier to manage than staggered rows if growers plan to add organic fertilizers. Tomatoes are strung in a V-shape with two top metal wires. The distance between the top wires of approx. 60 + cm and the distance between the top wires in the alley is approx. 1 meter at 3 m of height.
  2-3 plants/m2 for beef steak type tomato plants
  2.5-3.5 plants/m2 for cluster types
  Up to 3-5 plants/m2 for cherry types
  Ideal densities will depend on grower experience and greenhouse technology.

- Microscopic sulfur: Sulfur and Milstop are good control options to control powdery mildew. No additives should be used with MilStop. Typically, sulfur is applied with water (750g/1000 liters). Some Quebec growers use higher rates of sulfur. Some Quebec growers will apply the sulfur dry with dusters (gas powered or with Chapin type dusters). This dry application is an off label use. Tomatoes can take a lot of sulfur but other crops are sensitive. Cucumbers are sensitive so no dry sulfur should be used on cucumbers. Bartlett Microscopic sulfur is OK for organic. Make sure you know how to apply the powder as the static charge of the material and applicator can cause explosions. Make sure the applicator's ground line or chain is used on the dusters. Cherry type tomatoes are more sensitive to the powdery mildew (PM). Favorita is very sensitive. Sulfur also controls spider mites and other diseases. Microscopic sulfur in water can also be mixed with Epsom salt. The Epsom salt will make sure no dry deposits accumulate at the tip and bottom of leaves and fruits. 20-30 g of Epsom salt per liter of water can be used.

- Spider mites and predators for cucumber production. If predators or parasitoids are used to suppress the spider mite population, misting will be required. The misting will increase humidity and will help lower mite pressure and encourage biologicals. The misting is not to wet the plants but rather to increase the humidity in the air. Sulfur can suppress mite populations. Some organic growers in Quebec use "Greenspray" oil to suppress the aphid population. The oil is typically used before the predator and parasitoids are released.

- New cultivars:
  1) Toronjina: highly resistant and vibrant orange cherry type tomato.
  http://www.enzazaden.com/binaries/tomato%20brochure%202012_english_lr_tcm13-18709.pdf
  2) Sweet Treats: pink cherry type (a little larger than cocktail good against leaf mould),
  http://www.sakatavegetables.com/_ccLib/attachments/pages/SweetTreatsBrochure.pdf
  3) Makari (pink cultivar, a good substitute for Tomimaru Mucho),
  4) Chesapeake pepper plants have smaller fruit (very nice fruit).
  Very early, smooth, blocky fruit that changes color from dark green to red rapidly. This variety can support a king fruit and many other fruits. Same can be said about Carmen.
  5) Emerite is a very interesting pole bean. Stays tender. 53 days. Medium green completely stringless long filet bean. Pod averages 20 cm, very straight and smooth with excellent bean flavor.

6) Romano is another pole bean but it is not as nice looking for the market.

- Basic irrigation information:
  At least three irrigation lines should be used. White over black plastic is useful to reduce evaporation and encourage surface mineralization. Growers should always avoid heavy watering events. It is much better to use multiple short cycles per day. Never water before 10:00am and after 2:00pm. During harvest, when conditions are sunny and hot, up to 4 liters/m2 of water may be needed for tomato production.

- Anti-condensation (AC) plastic: Always use AC greenhouse plastic for single and double layer plastic for greenhouses and tunnels.

- Natural ventilation and insect exclusion screens: Unless you plan to grow cucumbers, exclusion nets or screens are generally not needed. If growers want exclusion screens, they should not select fine screens as they will restrict air movement and cause excessive heating. The screen should only exclude larger insect such as cucumber beetles and tarnished plant bugs. For proper natural venting with roll-up sides, the roll-up opening must be at least 25% of the greenhouse width (ie. a 32 foot wide greenhouse should have at least 8 ft of unobstructed roll-up side opening). Insect exclusion netting often restricts the natural air movement and can cause excessive heating.

- Greenhouse controller systems: igrow by Link4. Temperature sensors in greenhouses should be at the height of the top clusters.

- The scion part of the grafted plants should not be allowed to set root as the disease resistance of root stock will be lost.

- It is possible and easier to pinch above the 2nd true leaf to obtain two uniform heads (plant stressing). Pinching should ensure a 1st cluster after 6-7 leaves instead of 8 to 11 leaves without pinching. This allows earlier harvest.

- Productivity and profitability: In general, growers need to do a better job keeping track of yield. Yield information is critical to determine profitability and for the development of adequate crop fertilization plan. To obtain high yields, growers need to fertilize the tomato crop at higher rates.

- In Quebec, the organic greenhouse tomato seedlings are grown in 6 in. pots (seedlings are approximately 7 weeks old at planting, when they have up to 1 flower cluster). If seedlings are more mature, watering will be extremely important. The conventional tomato seedlings are grown in 4 in. pots.