Appendix

GLOSSARY OF TERMS

In a **closed system**, all nutrient feedwater is captured for reuse. This includes the collection of irrigation, leachate and nutrient rich feedwater under all production areas and benches and subsurface drainage.

In an **open system**, leached or irrigated nutrient feedwater is not captured for reuse. Soil based production systems are generally open systems, unless sub-surface drainage has been installed to intercept any leachate that may get below the crop rooting zone.

Wastewater

All water to be disposed of that is generated on the operation. It includes: greenhouse nutrient feedwater, drip gutter water, shipping drench water, boiler water and condensate, cut flower pail water, tray and trough wash water, filter backwash, planting line water, drip–line wash water, roof white-wash rinsate, and any tanks, pond or cistern water that contains any of these wastewaters.

Nutrient feed water

Any water in your greenhouse operation that contains nutrients. This can include: fertilizer stock tanks, mixing tank water, irrigation water, leachate from pots, baskets, flats and planters, nutrient rich water from flood floors, trays and troughs, and any treatment tanks or storages that have any water contaminated by nutrients in it. This water can be recirculated, can be land applied and must be treated before discharge to the natural environment. Permits may be required, check with your local MOECP district office or OMAFRA environmental specialist.

Leachate

Any water that comes out the bottom of a pot, basket or other growing container. This water is likely to carry nutrients and must be managed as greenhouse nutrient feed water.

Rainwater

Water that does not touch the ground and is not contaminated with nutrients that is collected and stored for use in the greenhouse.

Stormwater

All water that would have touched the ground outside the greenhouse before it existed. Note that this includes water that touches the roof of the greenhouse. If collected for use in the production cycle, it must be managed in accordance with appropriate regulations. Check with your local MOECP district office.

Top-irrigation

Water and nutrients are delivered to the top of the container (i.e. hand, sprinklers, mist, boom, drip emitters and tape). Also referred to as overhead irrigation.

Sub-irrigation

Water and nutrients are delivered through the bottom of the container (i.e. trays, troughs and flood floors).

WORKSHEET 1: TOTAL MAXIMUM DAILY WATER APPLIED

This worksheet explains how to estimate peak water use to irrigate your entire production area in one day. A peak use day is a day with a high solar radiation, in a low relative humidity greenhouse, under high temperatures. The same calculation can be used to determine the average amount of water applied daily.

It is important to know the total maximum daily water use when:

- designing an irrigation system
- designing an irrigation/stormwater recycling pond
- recording and estimating daily water use for reporting

To calculate the maximum water applied per day through the whole operation, consider:

- The volume of water emitted in each production area during one irrigation event
- The number of irrigation events per day
- Total area in production to be irrigated on peak use day

Tips

Use a water meter to track output in each production area over the course of one irrigation event.

Specific crops may be irrigated several times per day, while others are not. It may be helpful to calculate irrigation volumes and events based on different production areas or crops with different requirements (i.e. overhead irrigated potted container crops, sub-irrigated potted container crops or propagation benches).

Example calculation

Total Maximum Daily Water Applied =

Propagation Production Area [(Volume per irrigation event) x (Number of irrigation events)]
+
Stock Plant Production Area [(Volume per irrigation event) x (Number of irrigation events)]
+
Production Area [(Volume per irrigation event) x (Number of irrigation events)]
+
Finishing Area [(Volume per irrigation event) x (Number of irrigation events)]

Note: All operations will be different — consider the areas present in your operation. Other production areas may also be present and production space in use and crop needs may change depending on the season or crop stage.

Note: When calculating the volume required for an irrigation/stormwater collection pond, take into consideration the average annual precipitation and historical storm events in your area.

**This worksheet has been adapted from the Best Management Practices and Self-Assessment for Water and Fertilizer Use for Outdoor Container Production.*

WORKSHEET 2:
LEACHING FRACTION FOR POTTED CONTAINER CROPS

Leaching fraction (LF) is commonly used to assess the irrigation efficiency of container crop production. It helps to measure whether too much, or not enough irrigation water is being applied to the crop. The lower the number, the lower the volume of water being lost out the bottom of the container.

Periodically, growers may need to leach their crops (e.g. to remove an accumulation of fertilizer salts in the media). However, on average, growers are working towards minimizing percent leaching fraction.

Several unrelated factors can affect the leaching fraction data. For instance, media that is not evenly or regularly moistened tends to have dry “cracks” that channel irrigation water rapidly through the container, exaggerating the leachate volume. Potted container crops with dense or relatively tall canopies can deflect overhead irrigation water, preventing it from landing on the surface of the media of some of the pots container within the irrigation zone. Drip lines and emitters can be clogged and pressures unregulated, creating a scenario where plants are watered until the driest plant is wet.

By knowing and paying attention to these limitations, growers can use % leaching fraction to help make decisions about irrigation method, timing and duration in order to help conserve water and nutrients lost through leaching.

Example

For this exercise, choose overhead, hand-watered, or drip irrigated production areas that have crops that are similar in age, size and canopy shape.

You will need the following for each area tested:

- 40–60 clean, empty containers identical to those used to grow the crops
- 40–60 small plastic bags (e.g. small garbage bags)
- 40–60 large elastic bands
- 20–30 medium-sized stones (5–10 cm in diameter)
- wide-mouth 1–2 L jug, graduated cylinder, flags, notebook and writing utensil

Step 1:
Place 10–20 empty containers lined with an impermeable barrier (e.g. plastic bag) randomly throughout the area being tested. Try to have some containers from the outer edges and middle of the area. These empty, lined containers are the “interception” containers. Only use containers identical to those used in the crop you are testing. The “interception” container approximates how much of the overhead irrigation water actually makes it onto the surface of the media. (Tip: Use elastic bands to secure the impermeable barrier to the top rim of the container.)

Step 2:
Place 10–20 empty, bag-lined containers directly underneath the same number of crop plant containers. Place a 5 cm stone inside to give room for drainage. These containers are the “leachate” containers, and will catch the volume of water that drains from the crop containers. The “leachate” containers are identical to the crop containers and fit tightly under the crop container. Place these crop plant + “leachate” containers beside the empty “interception” containers. (Tip: Flag the plants so you can find them more easily after the irrigation event.)

Step 3:
After an average irrigation event, collect and measure all "leachate" and "interception" container water volumes, and record them in a chart so you can refer back to individual container volumes. (Tip: Collect water into a wide-mouthed vessel before pouring into the graduated cylinder for measurement.)

Step 4:
Use the water volumes collected to calculate percent leaching fraction (%LF).

Individual Container % Leaching Fraction = ("leachate" container volume / "interception" container volume) x 100

Average % Leaching Fraction for the Production Area =
("Total leachate" container volumes) / ("Total interception" container volumes) x 100

Interpreting the results:
Review the individual %LF for various containers throughout the production area. Do they differ in relation to their location? Do specific crops, spacing or container sizes affect the results?

Guidelines for Interpreting Average Leaching Fraction

%LF = 0–15% Very Good	%LF = 16–25% Good	%LF = 26-40% Inefficient	%LF = >40% Excessive
This indicates a conservative use of irrigation water	Review crop quality, wetness of the media and any other factors that could be exaggerating %LF. Then consider reducing the length of the irrigation cycle.	Review crop quality, wetness of the media and any other factors that could be exaggerating %LF. Then consider reducing the length of the irrigation cycle.	Review crop quality, wetness of the media and any other factors that could be exaggerating %LF. Strongly consider reducing the length of the irrigation cycle.

**This worksheet has been adapted from the Best Management Practices and Self-Assessment for Water and Fertilizer Use for Outdoor Container Production.*

WORKSHEET 3: INTERCEPTION EFFICIENCY

Percent interception efficiency (%IE) is commonly used to describe the spacing and configuration of container crops. It indicates the container surface area in relation to the area of production space they are growing on. However, the true value of this measurement is to quantify the effective use of the production area and the efficient use of overhead-applied irrigation water. The higher the %IE, the lower the volume of water being lost between containers. %IE is a simple calculation based on container spacing in two directions. Container crop spacing will depend on key management factors.

Container crops with tall or wide canopies will deflect irrigation water and prevent it from landing on the surface of the media, and may require containers to be placed farther away from each other to achieve adequate wetting of the media. Some floral crops are susceptible to foliar diseases that can be reduced by using wider container spacing patterns. Container and flat spacing may need to be adjusted several times throughout the crop cycle as plants mature, get transplanted and are shipped, leaving production areas with low interception efficiencies.

By measuring %IE throughout the growing season for various crops, growers can use the data to help make decisions about irrigation types and timing, both of which will help conserve water and nutrients lost through run-off.

What you will need:

- measuring tape
- a notebook

Step 1. Pick your sites

For this exercise, choose top- irrigated container crops that are similar in container size, and growth stage. By organizing %IE data into groups, growers can gain more meaningful data to help manage their different crops.

Step 2. Calculate your areas

Start by envisioning a rectangle or square that includes one quarter of each of 4 containers (see Pg. 42). Measure the length and width of the rectangle that intersects with the centres of the 4 containers and record it as ground area. In staggered container spacing, you will need to draw an imaginary vertical line to make the parallelogram into a rectangle and measure length and width. These length and width dimensions will be used to calculate the area of the rectangle that reaches the centre of 4 containers. There are 4 quarters of a container surface in each rectangle, which adds up to one full container surface area. Calculate surface area (A) of one container by measuring the diameter of the container and then dividing it in half to determine the radius. The radius is used to calculate the container surface area using the formula:

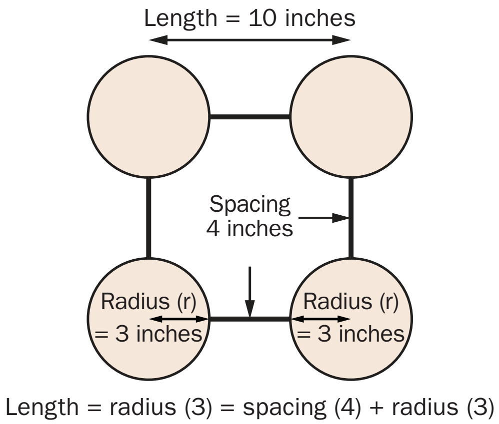
$A = \pi r^2$
where A = surface area
$\pi = 3.14$
r = radius

If the container is square or a rectangle, simply calculate the area of the container using length x width.

Step 3. Do the calculations

%IE = Surface area of 1 container / Rectangle area x 100

Sample calculation:



Because pots are round, there is already a significant loss in interception, even when the crop is grown using 'pot-to-pot' tight spacing.

6 inch (15.24 cm) diameter containers spaced at 4 inches (10.16 cm) in each direction

r = one half the diameter = 1/2 6 inch (15.24 cm)
= 3 inches (7.62 cm)

Container surface area: $A = \pi r^2 = \pi (3)^2$
= 3.14 x 9
= 28.26 sq. inches (182.41 cm^2)

Rectangle area = Length x Width
= 10 inches x 10 inches
= 100 sq. inches (645.16 cm^2)

%IE = Surface area of 1 container / Rectangle area x 100
= 28.26 sq. inches / 100 sq. inches x 100
= 28.26%

Maximum % Interception Efficiency Possible for Typical Containers used in Commercial Production			
Container Size (Diameter)	**Container Surface Area**	**Rectangle Area (pot–pot tight)**	**Maximum Potential %IE**
Flats	—	—	100%
4″ (10.16 cm)	12.56 sq. inches (81.03 cm^2)	4″ x 4″ = 16 sq. inches (103.23 cm^2)	78.5%
6″ (15.24 cm)	28.26 sq. inches (182.41 cm^2)	6″ x 6″ = 36 sq. inches (232.26 cm^2)	78.5%

Note the drop in interception efficiency as plants are spaced out from propagation flats to larger containers.

Step 4. Complete this several times during the growing season for several different production zones and crops

Use the data to optimize irrigation interception efficiency.

WORKSHEET 4: TRACKING YOUR PROGRESS

Keeping track of your self-assessment scores each year is a great way to see where improvements can or have been made over time. Scoring in the chart below has been broken down into pre-production, production and post-production areas which can be totalled to give an overall score.

You may wish to indicate years in which major upgrades to production systems took place as well as any changes to the type of crops grown in the greenhouse.

Progress chart					
Year	*e.g. 2018*				
Notes on production year	*e.g. Installed new flood floor in Range 3*				
GENERAL ENVIRONMENTAL ASSESSMENT FOR FLORICULTURE GREENHOUSES					
1					
2					
3					
4					
5					
6					
7					
Total section score					
A. PRE-PRODUCTION WATER AND NUTRIENT MANAGEMENT					
A.1					
A.2					
A.3					
A.4					
A.5					
A.6					
A.7					
A.8					
Total section score					

Year					
B. PRODUCTION WATER AND NUTRIENT MANAGEMENT					
B.1					
B.2					
B.3					
B.4					
B.5					
B.6					
B.7					
B.8					
B.9					
B.10					
B.11					
B.12					
B.13					
B.14					
B.15					
B.16					
B.17					
B.18					
B.19					
B.20					
B.21					
B.22					
Total section score					
C. POST PRODUCTION WATER AND NUTRIENT MANAGEMENT					
C.1					
C.2					
C.3					
C.4					
C.5					
Total section score					
Total overall score					