**Recycling Irrigation Water on Ornamental Nursery Operations:**

**Will Consumer Premiums Compensate for Growers' Costs?**

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# Recycling Irrigation Water on Ornamental Nursery Operations: Could Consumer Premiums Compensate for Grower Adoption Costs?

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## Background

- The U.S. nursery and greenhouse industry is facing twin challenges of reduced water availability and increased pressure to mitigate pollution from horticultural production.
- Water-recycling technology (WRT) has been adopted by some nursery producers to improve water use efficiency and to enhance water supply security.
- However, the concern about production cost increases associated with WRT and the uncertainty of revenue enhancement discourage many growers from implementing the new technology.
- Consumers are willing to pay premiums for plants labeled and featured as "environmentally friendly" or "eco-friendly" with increased concerns about environmental degradation.

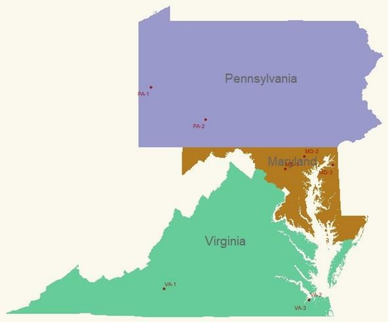
## Objective

- Estimate the economic feasibility of water-recycling technology combined with plant eco-labeling.
- Determine how WRT and consumer premiums would affect greenhouse/nursery production costs, gross revenues and net revenues.
- Research results can help nursery growers and policy makers assess WRT adoption to improve water use efficiency and to reduce pollution of surface waters.

## Study Areas

- The study is conducted with eight varying case nurseries in terms of size, location as well as water supply method.
- Two simulated nurseries (SynSmall and SynLarge) representing characteristics and practices in terms of water source, grower size and water usage are constructed based on previous survey responses of Mid-Atlantic ornamental nurseries.
- Size, geographic location and water source of the eight nursery operations and two simulated nurseries are shown as below:

| Nursery | Acres | Current Water Supply Method |
|---|---|---|
| VA-1 | 2.5 | 34% Recycling, 66% Well |
| VA-2 | 100.0 | 100% Recycling |
| VA-3 | 200.0 | 100% Recycling |
| MD-1 | 16.5 | 50% Recycling, 50% Well |
| MD-2 | 105.0 | 100% Recycling |
| MD-3 | 55.0 | 100% Recycling |
| PA-1 | 5.0 | 20% Recycling, 80% Well |
| PA-2 | 27.0 | 100% Recycling |
| SynSmall | 13.6 | 100% Well Water |
| SynLarge | 88.9 | 100% Well Water |




## Methodology

- Six plants ($i$) for investigating impacts of WRT adoption and consumer premiums on sales including:
  - Annual bedding plants:


Geranium


Petunia


Chrysanthemum

  - Broadleaf evergreen plants:


Azaleas


Holly


Boxwood

- Major assumptions:
  - Average plant death rate with WRT increases from 2% to 3%, leading to yield loss ($\Delta Y_i < 0$);
  - WRT operation practices should be certified by third-party agency;
  - Eco-labels are put on plants produced with WRT after certification;
  - Nurseries are wholesalers who sell all plants directly to retailers, who in turn sell to consumers and return a portion ($R$) of the premium to growers.

### Enterprise Level Costs and Returns from WRT

- Estimate production cost change from WRT for plant $i$, $\Delta PC_i$:

$$\Delta PC_i = \Delta WSC_i + \Delta LC_i + \Delta CC_i \quad (1)$$

where $\Delta WSC_i$ is water supply cost change, $\Delta LC_i$ is labeling cost change and $\Delta CC_i$ is certification cost change.

- Estimate gross revenue change from WRT with premium returned:

$$\Delta GR_i = \Delta Y_i \cdot P_i^w + .97 \cdot Y_i \cdot Premium \cdot R \quad (2)$$

- Eventually, net revenue change from WRT is calculated as:

$$\Delta NR_i = \Delta GR_i - \Delta PC_i \quad (3)$$

### Sensitivity and Break-even Analyses

- Evaluate sensitivities of $\Delta GR_i$ and $\Delta NR_i$ to:
  - Conveyance rate ($R$) when premium estimate fixed at its mean value;
    - Three possible $R$ are selected: 0%, $P_i^w/P_i^r$, and 100%.
  - Premium estimate when $R$ is fixed at $P_i^w/P_i^r$;
    - Three premium estimates are selected: mean, lower and upper bounds for the 90% confidence interval (CI).
- Conduct break-even analyses to balance $\Delta PC_i$ and $\Delta GR_i$ in terms of conveyance rate $R$, premium estimate and plant death rate.

## Results

- Production cost change with WRT:
  - Nurseries VA-1, VA-2, VA-3, MD-1, and MD-2 have lower production costs with WRT compared to well water or municipal water.
- Sensitivity to $R$ when premium estimate is at its mean:
  - When $R = 0\%$:
    - All nurseries have $\Delta GR_i < 0$ for each plant due to the assumed increased plant death rate with WRT;
    - Only VA-2 has $\Delta NR_i > 0$ for all plants due to its large production cost saving from WRT that fully offsets the opportunity cost of yield loss.
  - When $R = 100\%$ & $R = P_i^w/P_i^r$:
    - All nurseries have $\Delta GR_i > 0$ & $\Delta NR_i > 0$ for all six plants;
    - Returned premiums generate enough extra gross revenues to offset the opportunity costs of yield losses as well as the increased production cost with WRT.
- Sensitivity to premium estimate when $R$ is fixed at $P_i^w/P_i^r$:
  - When premium estimates are within 90% CI:
    - $\Delta GR_i > 0$ & $\Delta NR_i > 0$ in all cases except for Holly.
- Break-even analyses:
  - Break-even conveyance rate ($R^*$):
    - For most cases, $R^*$ are well below 50%, indicating growers could cover WRT costs with a relatively small share of the premiums;
    - Two exceptions: Holly on nursery MD-3 ($R^* = 63.9\%$) and SynLarge ($R^* = 64.4\%$).
  - Break-even premium estimates for Holly:
    - \$0.64/pot for MD-3, \$0.44/pot for PA-2, \$0.50/pot for SynSmall and \$0.65/pot for SynLarge;
    - Reasonable since they are within the 90% confidence interval for Holly (\$0.41-\$1.61).
  - Break-even plant death rate:
    - Effective pathogen mitigation practices might reduce plant disease incidence below the level obtained without WRT;
    - For most nurseries, reducing plant disease incidence could offset completely the added WRT production costs.

## Conclusion

- In 50% of the cases examined, growers' net costs increased with recycling.
- Consumer premiums for plants grown with recycled water could offer nursery growers a method to improve their net returns while addressing environmental challenges and improving irrigation water use efficiency.
- Treatment of recycled water with effective pathogen mitigation procedures should always be considered as suggested by scientific researchers.
- A centralized government or industry organization may be better suited to lead the implementation of WRT along with operation standards and certification mechanism.