Perfecting pawpaw production in Ohio

Quantity and quality
Acknowledgements

Funding, helpers (Thom, etc. + UGs
Overview

Woodland production
• Yield
• Economic returns
• Stand management

Orchard production
• Establishment
• Yield
• Fruit quality
• Economic returns
Introduction
Patch of pawpaw trees

Pawpaw fruit
• Pawpaw Beer – Jackie O’s Brewery (Athens, OH)
• Pawpaw Pulp – Integration Acres (Athens, OH)
Part I.

Woodland pawpaw production
Part I.
Woodland pawpaw production

• Yield
• Economic returns
• Stand management
Wild patch monitoring

[Map of Ohio with locations marked: OSU Wetlands, OSU Piketon, Waterman Farm, Integration Acres, Fox Paw Farm]
Mean number of pawpaw per tree

- WA
- Ol
- RP
- IA
- Pi

2015 2016 2017 2018
What controls yield?

- Tree size
- Canopy openness

Probability of producing a fruit

Diameter of Tree (cm)

- 1.5”
- 3”

Open canopy
Closed canopy
Potential Economic Return

- Woodland stand yields: ca. 900 fruit/acre trees*
- Wild fruit weight: ca. 0.2 lb
- Wild fruit pulp yield: ca. 0.1 lb/fruit
- Approx. crop value:
  Wholesale: $1/lb – Market: $3/lb – Pulp (processed) $8/lb

*Not necessarily an acre in area – an acre of trees would consist of ca. 530 trees at spacings we observed
## Potential Economic Return

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Market Value</th>
<th>Net Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholesale to processor</td>
<td>$183</td>
<td>- $294</td>
</tr>
<tr>
<td>Farmers Market</td>
<td>$549</td>
<td>$72</td>
</tr>
<tr>
<td>Processed pulp*</td>
<td>$732</td>
<td>- $111</td>
</tr>
</tbody>
</table>

*Values and returns per acre of pawpaw patch*

*Excludes infrastructure and equipment*
Enhancing patch productivity
Pollination experiment

Objective – do pollination limitation and self-unfruitfulness control fruit-set?
Pollination experiment

Objective – do pollination limitation and self-unfruitfulness control fruit-set?
Objective – do pollination limitation and self-unfruitfulness control fruit-set?

![Bar chart showing the number of fruit in different sites, plots, and trees.](chart.png)
Improving patch production

Before management

Removing understory competition

After management
Orchard establishment and production

Part II.
Part II.

Orchard establishment and production

1. Orchard establishment
2. Varietal performance
   - Yield
   - Quality
3. Economics
Experimental orchards

Map showing the location of Waterman Farm and OSU Piketon.
Experimental orchards

- Percentage tree survival by stock type and system

<table>
<thead>
<tr>
<th>Stock</th>
<th>Input System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Seedling*</td>
<td>81</td>
</tr>
<tr>
<td>Bare root</td>
<td>65</td>
</tr>
<tr>
<td>Container</td>
<td>80</td>
</tr>
</tbody>
</table>

*Also bare root but not grafted
Varietal yield and quality
Assessing yield
Assessing yield
## Assessing yield

<table>
<thead>
<tr>
<th>Genetic Group</th>
<th>Wabash</th>
<th>Overleese</th>
<th>Susquehanna</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Fruit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Fruit Mass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulp Mass</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assessing yield

• Number of fruit affected by cultivar, tree size and flowering effort
• Fruit mass affected by group, tree size and flowering effort
• Pulp mass NOT affected by group or cultivar
• Lots of fruit v. bigger fruit? Know your market

• Site identity BY FAR the most important effect
Assessing fruit quality
<table>
<thead>
<tr>
<th>Quality Metric</th>
<th>Description</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit Moisture</td>
<td>% of water in pulp</td>
<td>Oven Drying</td>
</tr>
<tr>
<td>Length to Width ratio</td>
<td>Measurement of size (%)</td>
<td>Measured</td>
</tr>
<tr>
<td>Weight of Pulp</td>
<td>Pulp weighed after skin and seeds removed</td>
<td>Measured</td>
</tr>
<tr>
<td>Seed to Pulp ratio</td>
<td>Weight of seed to weight of pulp (%)</td>
<td>Measured</td>
</tr>
<tr>
<td>Fruit <em>Phyllostica</em> Abundance</td>
<td>% of skin covered</td>
<td>Photographic</td>
</tr>
<tr>
<td>Skin Hardness</td>
<td>Force to break skin (N)</td>
<td>Force gauge</td>
</tr>
<tr>
<td>Flesh Hardness</td>
<td>Resistance to flesh puncture (N)</td>
<td>Force gauge</td>
</tr>
<tr>
<td>Brix</td>
<td>Sugar Content (°)</td>
<td>Refractometer</td>
</tr>
<tr>
<td>L Average Flesh</td>
<td>Light to dark for flesh</td>
<td>Colorimeter</td>
</tr>
<tr>
<td>L Average Skin</td>
<td>Light to dark for skin</td>
<td>Colorimeter</td>
</tr>
<tr>
<td>pH</td>
<td>Acidity level</td>
<td>Meter</td>
</tr>
<tr>
<td>DeltaE</td>
<td>Browning potential</td>
<td>Colorimeter</td>
</tr>
<tr>
<td>Phenolics</td>
<td>Total Phenolic (browning) compounds present</td>
<td>Colorimetric</td>
</tr>
<tr>
<td>Volume</td>
<td>Prolate Elliposiod</td>
<td>Calculated</td>
</tr>
</tbody>
</table>
Differences between varieties

- Harder fruit
- Sweeter fruit
- Heavier fruit
- Paler colour
- Lots of *Phyllostica*
- More seeds
Differences between varieties

- Lots of *Phyllostica*
- More seeds

- Harder fruit
- Sweeter fruit

- Allegheny
- Shenandoah
- Potomac
- Susquehanna

- Heavier fruit
- Paler colour
Differences between varieties

- Harder fruit
- Sweeter fruit
- Lots of *Phyllostica*
- More seeds
- Heavier fruit
- Paler colour

NC-1

Overleese
Differences between sites

- Harder fruit
- Sweeter fruit
- Heavier fruit
- Paler colour
- Lots of *Phyllostica*
- More seeds
### Potential Economic Return

Assumes 233 trees / acre of single variety

Excluded infrastructure, equipment and start-up costs

<table>
<thead>
<tr>
<th>Site</th>
<th>Variety</th>
<th>Fruit/tree</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>PA-Golden</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Lynn's F</td>
<td>133</td>
</tr>
<tr>
<td>2</td>
<td>Overleese</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Potomac</td>
<td>42</td>
</tr>
<tr>
<td>3</td>
<td>Quaker's D</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Wells</td>
<td>131</td>
</tr>
<tr>
<td>4</td>
<td>Susquehanna</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Wilson</td>
<td>146</td>
</tr>
<tr>
<td>5</td>
<td>Susquehanna</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Quaker's D</td>
<td>46</td>
</tr>
<tr>
<td>6</td>
<td>NC-1-6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Rappanhannock</td>
<td>99</td>
</tr>
</tbody>
</table>
Conclusions

1. Economically viable production from wild stands will require management to improve productivity
   • Thinning, grafting, supplemental planting

2. High input systems and minimally stressed stock maximize orchard establishment
   • Use container stock or graft in-situ

3. Fruit yield, quality and economic returns are highly dependent upon cultural practices and varietal selections
   • Choose high yielding, consistent varieties matched to your chosen market.
   • Maintain diverse pollination partner trees