An Economic Analysis of Fumigation Alternatives, the Methyl Bromide Ban, and its Implication: Evidence from the Florida Tomato Industry

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Methyl bromide (bromomethane, CH3Br), which has been by far the most effective pre-plant fumigant used to control nematodes, soil-borne pests, weeds and plant diseases in agriculture, is being phased out in the U.S. under Montreal Protocol due to its destructive effect on ozone depletion. It is now only permitted under the Critical Use Exemptions (CUEs) in a very limited scale under close government scrutiny. Scientific research up to now hasn’t found such feasible fumigant alternatives with consistent, high technical effectiveness and low cost as methyl bromide (MBr).

The technological shock, coupled with intense competition from Mexico, a developing country still allowed to use methyl bromide under Montreal Protocol, has caused significant economic damage (increasing production cost and decreasing yield) to the Florida tomato industry, the largest fresh tomato supplier in the nation. Florida fresh tomato production decreased from 45 thousand acres in 2001 to 29 thousand acres in 2012. The farm gate value of the industry slumped from $620 million in 2010 to $270 million in 2012 (NASS/USDA, 2013).

**Background**

Table 1: Total negative effects (added costs and reduced returns), total positive effects (reduced costs and added returns), and total effects of the selected alternative soil treatments relative to MBr:Pic (67:33) in the tomato production system.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Rate</th>
<th>Cost/Acre</th>
<th>Applied</th>
<th>Added costs of the alternative treatment ($/acre)</th>
<th>Reduced returns of the alternative treatment ($/acre)</th>
<th>Total negative effects of the alternative treatment ($/acre)</th>
<th>Reduced costs of the alternative treatment ($/acre)</th>
<th>Added returns of the alternative treatment ($/acre)</th>
<th>Total positive effects of the alternative treatment ($/acre)</th>
<th>Total effects of the alternative treatment relative to MBr:Pic (67:33) ($/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-fumigated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>MBr:Pic (67:33)</td>
<td>67%</td>
<td>2947.24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PicChlor 60</td>
<td>60</td>
<td>1898.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MBr:Pic (50:50)</td>
<td>50%</td>
<td>1911.55</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FL-3</td>
<td></td>
<td>2543.41</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Objectives**

- Compare cost-effectiveness of MBr:Pic (67:33) and alternative fumigation strategies.
- Analyze risk efficiency of MBr:Pic (67:33) and alternative fumigation strategies.

**Results**

Partial budget analysis is to estimate and analyze the economic effectiveness of MBr:Pic (67:33) and its alternatives. It compares the negative effects of applying a new treatment relative to a base or standard treatment to the positive effects associated with the new treatment relative to the base or standard treatment. In this study, fumigation cost, harvest cost and average yield with change different treatments were specified. Other costs which were fixed across treatments are excluded of the analysis.

**Second-order stochastic dominance (SSD) and stochastic efficiency with respect to a function (SERF)** is to identify and rank different fumigation strategies in the field trials based on risk efficiency of yield and gross return under given risk aversion. The Constant Relative Risk Aversion (CRRA) utility function is used to calculate the Certainty Equivalent (CE) of the average yields and gross returns of all six treatments under given risk averseness coefficient.

\[
U(c) = \frac{(1+r)^{-1}}{1-r} \ln(c) \quad \text{if } r > 0, r \neq 1 \quad \text{and} \quad U(CE) = E(U(c))
\]

where \( r \) is relative risk aversive coefficient (RRAC). In this study, \( r \) is assumed from 1 to 4.

**Table 2: Estimated fumigation costs for MBr:Pic (67:33) and selected alternative soil treatments and the fumigation costs of the alternative treatments relative to MBr:Pic (67:33) in tomato production.**

<table>
<thead>
<tr>
<th>MBr and selected alternative treatment</th>
<th>Fumigation labor costs ($/acre)</th>
<th>Fumigation materials costs ($/acre)</th>
<th>Total fumigation costs ($/acre)</th>
<th>Fumigation cost relative to MBr:Pic (67:33) ($/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-fumigated</td>
<td>70.04</td>
<td>48.77</td>
<td>118.81</td>
<td>-118.81</td>
</tr>
<tr>
<td>MBr:Pic (67:33)</td>
<td>84.70</td>
<td>46.15</td>
<td>130.85</td>
<td>-130.85</td>
</tr>
<tr>
<td>TE-3</td>
<td>15.45</td>
<td>32.93</td>
<td>48.38</td>
<td>-48.38</td>
</tr>
<tr>
<td>FL-3 way</td>
<td>30.58</td>
<td>46.15</td>
<td>76.73</td>
<td>-76.73</td>
</tr>
</tbody>
</table>

**Results cont.**

Table 3: Marketable tomato yields, the harvest costs, including labor and materials, gross returns for MBr:Pic (67:33) and selected alternative fumigant treatments, and the difference in the harvest costs and gross returns relative to MBr:Pic (67:33).

**Conclusions**

MBr:Pic (67:33) produces the highest average yield and gross return, followed by MBr:Pic (50:50), TE-3, PicChlor 60, FL-3 way and non-fumigated treatment. Though fumigation costs of MBr:Pic (67:33) treatments are higher than other treatments, its outstanding yield performance still makes it the most cost effective fumigation, producing more positive effects than other treatments. SERF analysis indicates MBr:Pic (67:33) is the most preferred fumigation under given risk aversion. As for yield performance, SERF shows that MBr:Pic (67:33) is the most risk efficient followed by MBr:Pic (50:50) and TE-3; for gross return, MBr:Pic (67:33) is surpassed by MBr:Pic (50:50) at the breakeven RAC (2.62), but both are more risk efficient than other treatments.

In general, the MBr:Pic (67:33) is the most cost effective and risk efficient of all treatments studied.