Straw and living mulches compared with herbicide for under-vine weed control in a Public-Private Benefit Framework

Tom Nordblom ¹,⁵  
Melanie Weckert ³  
Chris Penfold ²  
Mark Norton ¹,⁴

1. Graham Centre for Agricultural Innovation (alliance of Charles Sturt University and NSW DPI), Albert Pugsley Place, Wagga Wagga, NSW 2650 Australia  
2. School of Agriculture, Food and Wine, University of Adelaide, Roseworthy Campus,  
3. Plant Pathology/Soil Microbiology, NSW DPI, National Wine & Grape Industry Centre (alliance of Charles Sturt University and NSW DPI), Wagga Wagga, NSW, Australia  
4. Pasture Systems, DPI Agriculture, NSW DPI, WWAI  
5. School of Agricultural & Wine Science, Charles Sturt University, Wagga Wagga, NSW

NSW DPI = NSW Dept of Primary Industries, New South Wales, Australia  
WWAI = Wagga Wagga Agricultural Institute, Pine Gully Road, Wagga Wagga, NSW 2650 Australia

Selected Paper, 61st AARES Annual Conf., Brisbane, QLD, 8-10 Feb 2017
Straw and living mulches compared with herbicide for under-vine weed control in a Public-Private Benefit Framework

Tom Nordblom ¹,⁵  Chris Penfold ²
Melanie Weckert ³  Mark Norton ⁴

Chris Penfold photo: Replicated under-vine treatments, Barossa Valley, Sept 2015
Chart source: Wine Australia. 2016 South Australian Winegrape Crush Survey

Chris Penfold photo: Medic and Ryegrass under vines, Langhorne Creek, Nov 2016.
Figure 1. District fruit prices and yields, 2006-16

Data source: Wine Australia. 2016 South Australian Winegrape Crush Survey
Fruit Prices, $K/t

$r = 0.29$

Barossa Shiraz

Langhorne Creek Cab-Sav

Simulated price / yield seasons
Fruit Yield, t/ha

$r = 0.69$

Langhorne Creek Cab-Sav

Barossa Shiraz

Simulated price / yield seasons
c. Gross Revenue, Price x Yield, ($K/ha)

- Barossa Shiraz
- Lang Ck Cab Sav

\[ r = 0.58 \]

\[ \text{avg Barossa Shiraz ($7,516/ha)} \]
\[ \text{($7,397/ha)} \text{ avg Lang Ck Cab-Sav} \]

Simulated price / yield seasons
Cumulative frequency (%)

Annual gross revenue = price x yield

- Barossa Shiraz $K/ha/yr
- Lang Ck Cab Sav $K/ha/yr
Chris Penfold photo: Replicated under-vine treatments, Barossa Valley, Sept 2015
Table 3. Vineyard Annual Operational Costs, fixed and variable with fruit yield

<table>
<thead>
<tr>
<th>COST CATEGORIES:</th>
<th>Annual fixed costs</th>
<th>Variable costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Barossa Shiraz fixed costs ($/ha)</td>
<td>Lang Ck Cab Sav fixed costs ($/ha)</td>
</tr>
<tr>
<td>Under-vine weed control Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Under-vine HERBICIDE sprays</td>
<td>75</td>
<td>80</td>
</tr>
<tr>
<td>Living mulches established &amp; maintained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. COCKSFOOT perennial grass</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>3. Ryegrass &amp; BURR MEDIC</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Straw mulch purchase, apply &amp; maintain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Triticale STRAW mulch</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Other fixed costs per hectare, such as:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultivation; Sowing, slashing inter-row areas; Pruning; Fertilizers; Insecticides; Fungicides; Repairs and maintenance; Electricity; Water; Leases; Labour (50 hrs per ha at $25/hr); Harvesting costs, other.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Other Fixed costs ($/ha)</td>
<td>4,591</td>
<td>4,936</td>
</tr>
</tbody>
</table>

Variable costs depending on fruit yield ($/t)

<table>
<thead>
<tr>
<th></th>
<th>Barossa Shiraz</th>
<th>Lang Ck Cab Sav</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvesting</td>
<td>+ 30</td>
<td>+ 30</td>
</tr>
<tr>
<td>Freight</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Levies</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Extra Labour/wage ($25/hr, 2 hrs/t)</td>
<td>+ 50</td>
<td>50</td>
</tr>
<tr>
<td>Variable Costs ($/t)</td>
<td>105</td>
<td>105</td>
</tr>
</tbody>
</table>
10 to 20m plots are harvested mechanically into the weigh-bin trailer - a quick and accurate operation!
2016 yield indices of alternative mulches relative to the HERBICIDE treatment at two locations

<table>
<thead>
<tr>
<th>TREATMENT: HERBICIDE</th>
<th>no mulch</th>
<th>--sown living mulches --</th>
<th>applied mulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td></td>
<td>Perennial COCKSFOOT GRASS</td>
<td>Triticale STRAW mulch</td>
</tr>
<tr>
<td>Ryegrass with BURR MEDIC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triticale STRAW</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FIELD TRIAL LOCATION**

<table>
<thead>
<tr>
<th></th>
<th>Barossa yield index</th>
<th>Langhorne Ck yield index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Plot yield (t/ha)</td>
<td>8.82</td>
<td>19.95</td>
</tr>
<tr>
<td></td>
<td>0.881</td>
<td>0.754</td>
</tr>
<tr>
<td></td>
<td>1.033</td>
<td>1.083</td>
</tr>
<tr>
<td></td>
<td>1.104</td>
<td>1.092</td>
</tr>
<tr>
<td></td>
<td>9.74</td>
<td>21.79</td>
</tr>
</tbody>
</table>
Gross revenues vary year to year with yields and prices; Operational costs also vary with yields.

Gross Margin = Gross revenue – Operational costs

We assume yields under the different treatments differ every year while keeping their same yield ratios relative to the herbicide treatment as in their 2016 yield indices.
Subtracting annual overheads, drawings, interest and taxes from Gross Margins over 10-year (decadal) periods of simulated price & yield variations = Decadal cash flow

Barossa $80K overhead

50 hectare vineyard
Simulated price / yield seasons

Barossa $80K overhead

50 hectare vineyard
Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard
Simulated price / yield seasons

Barossa $80K overhead

50 hectare vineyard
Decadal cash flow

Barossa $80K overhead
50 hectare vineyard
Decadal cash flow
$ Million

<table>
<thead>
<tr>
<th>Decade</th>
<th>HERBICIDE</th>
<th>COCKSFOOT</th>
<th>BURR MEDIC</th>
<th>STRAW</th>
</tr>
</thead>
<tbody>
<tr>
<td>117</td>
<td>$0.47</td>
<td>$0.36</td>
<td>$0.75</td>
<td>$0.77</td>
</tr>
<tr>
<td>118</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>119</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>121</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>122</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>123</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>124</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>125</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>126</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard
Simulated price / yield seasons

Barossa $80K overhead

50 hectare vineyard

Decadal cash flow

<table>
<thead>
<tr>
<th>Decade</th>
<th>HERBICIDE</th>
<th>COCKSFOOT</th>
<th>BURR MEDIC</th>
<th>STRAW</th>
</tr>
</thead>
<tbody>
<tr>
<td>230</td>
<td>$1.17</td>
<td>$0.10</td>
<td>$1.41</td>
<td>$1.54</td>
</tr>
<tr>
<td>231</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>232</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>233</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>234</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>235</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>236</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>237</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>238</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>239</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Decadal cash flow
$ Million
$0.59
$0.30
$0.83
$0.94
$2.0
$1.5
$1.0
$0.5
$0.0
$0.5
$1.0
$1.5
$2.0

67 68 69 70 71 72 73 74 75 76

Decade 67
HERBICIDE
FESCUE
CLOVER
STRAW

Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard
Barossa Shiraz, $80K overhead

Decadal cash margin (millions)

50 hectare vineyard

Cumulative probability

HERBICIDE
COCKSFOOT GRASS
BURR MEDIC
TRITICALE STRAW

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

-$3.0 -$2.0 -$1.0 $0.0 $1.0 $2.0 $3.0

18% 88% 95%
Barossa Shiraz, $120K overhead

Cumulative probability

Decadal cash margin (millions)

50 hectare vineyard

HERBICIDE
COCKSFOOT GRASS
BURR MEDIC CLOVER
TRITICALE STRAW

22%
35%
Langhorne Creek Cab-Sav, $120K overhead

Decadal cash margin (millions)

50 hectare vineyard

Cumulative probability

HERBICIDE
COCKSFOOT GRASS
BURR MEDIC CLOVER
TRITICALE STRAW

10%
26%
HERBICIDE

Private Benefits

Public Benefits

Public Losses

Private Losses

Dream result, pride of District, State & Nation

Good result, costs of research well justified

Poor Result, Private Benefit lowered more than increase in Public Benefits
Where herbicide resistance is not (yet) in evidence, the rise of herbicide resistance implies the prudent course is to explore such options.

If there are private economic benefits from integrated weed management using different control measures over time to maintain the efficacy of herbicides, most will go to vineyard owners over time, justifying research levies they pay.

Specific recommendations on plant species giving the best results from under-vine mulching are likely to differ among districts as weed populations, soils, climates, input costs and output prices differ. Weed suppression is a key.

At stake in the world marketplace is the fact that premiums are often paid for products guaranteed to be ‘clean and green’. It is particularly important to the image of Australian agricultural exports to maintain the verifiable reality of the claim of taste, safety and wholesomeness.
Things to do in the coming seasons

• Further seasons of field trial results at a larger sample of locations are needed to improve and correct our initial inferences;

• Review of our cost assumptions, which include higher costs for mulch options than the herbicide option; i.e., is re-sowing a living mulch required every year?

• Review our assumption of identical grape quality and prices across all under-vine treatments at a location. Recent taste-panel results for samples from the treatments indicate differences, and quality is key for winemakers.

• Prepare a more comprehensive economic analysis, covering a greater diversity of locations with corrected cost, price and yield assumptions.
Acknowledgements

• To Prof. Jim Pratley, Graham Centre for Agricultural Innovation, Charles Sturt University, for discussions and references on herbicide resistance in weeds;

• To Dr John D. Finlayson, Whangaraei, New Zealand, for assistance in computing the extended jointly correlated random (stochastic) series of yields and prices for our risk analyses based on the statistical characteristics of a shorter historical series;

• To Dr Tim Hutchings, Meridian Agricultural Consulting, for help in the adaptation of his ‘sequential multivariate analysis’ (SMA) model with @RISK software. This was used by the first author to generate the long-term, whole-farm financial risk profiles needed for the present analysis.