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

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

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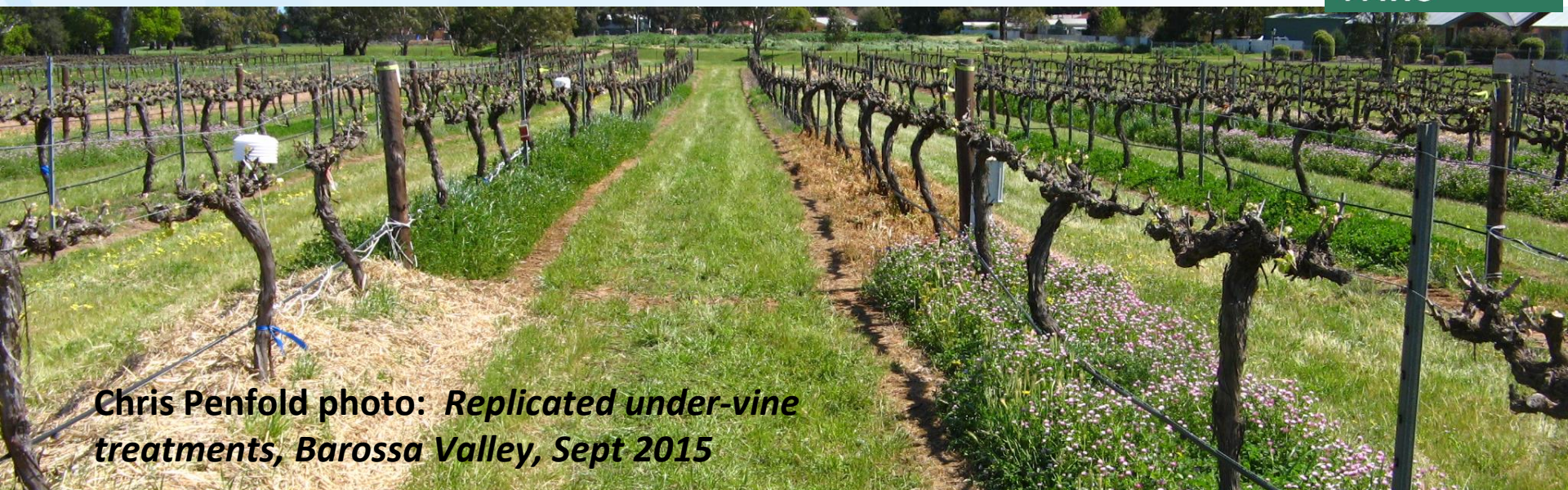
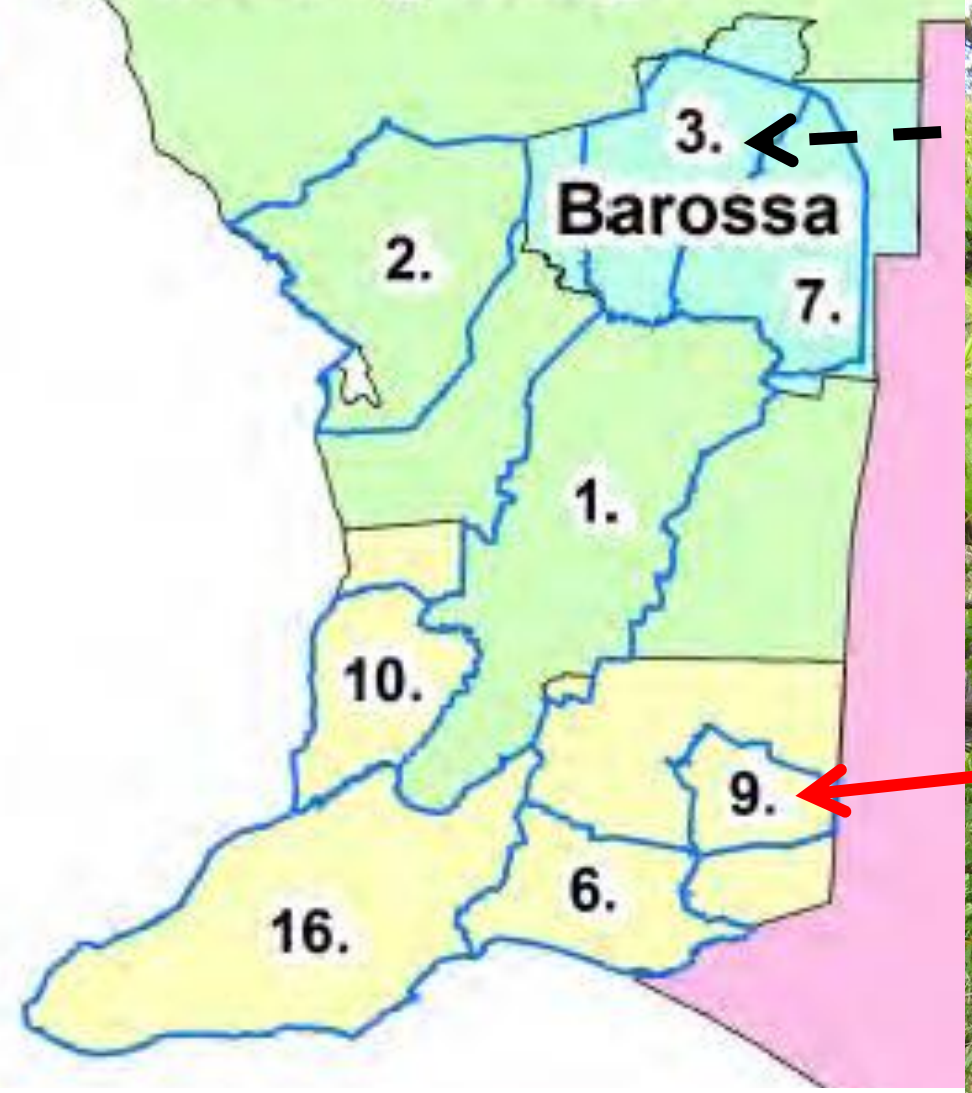


Chris Penfold photo: *Replicated under-vine treatments, Barossa Valley, Sept 2015*



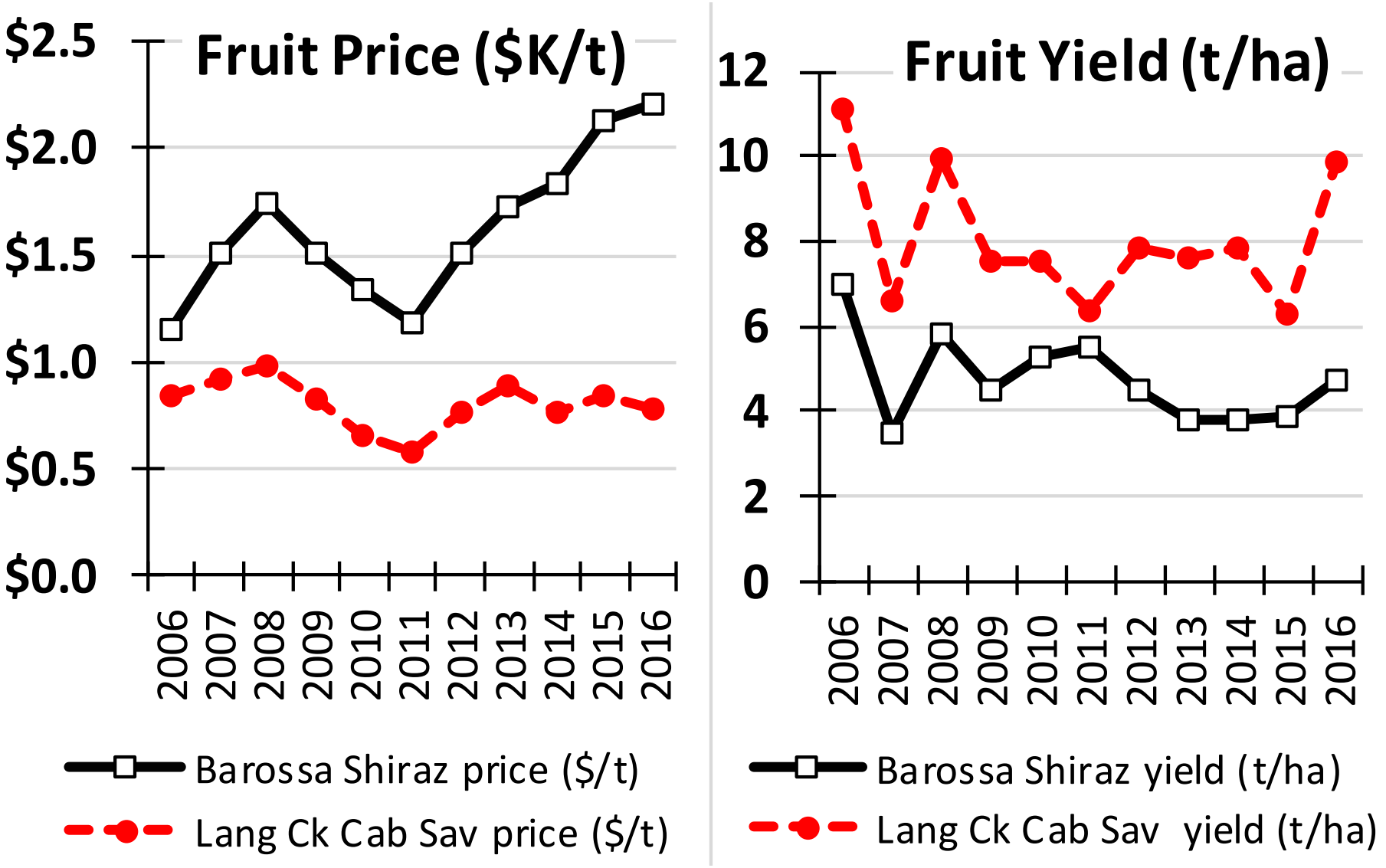
Barossa

Langhorne Creek

Chart source: Wine Australia. 2016 *South Australian Winegrape Crush Survey*

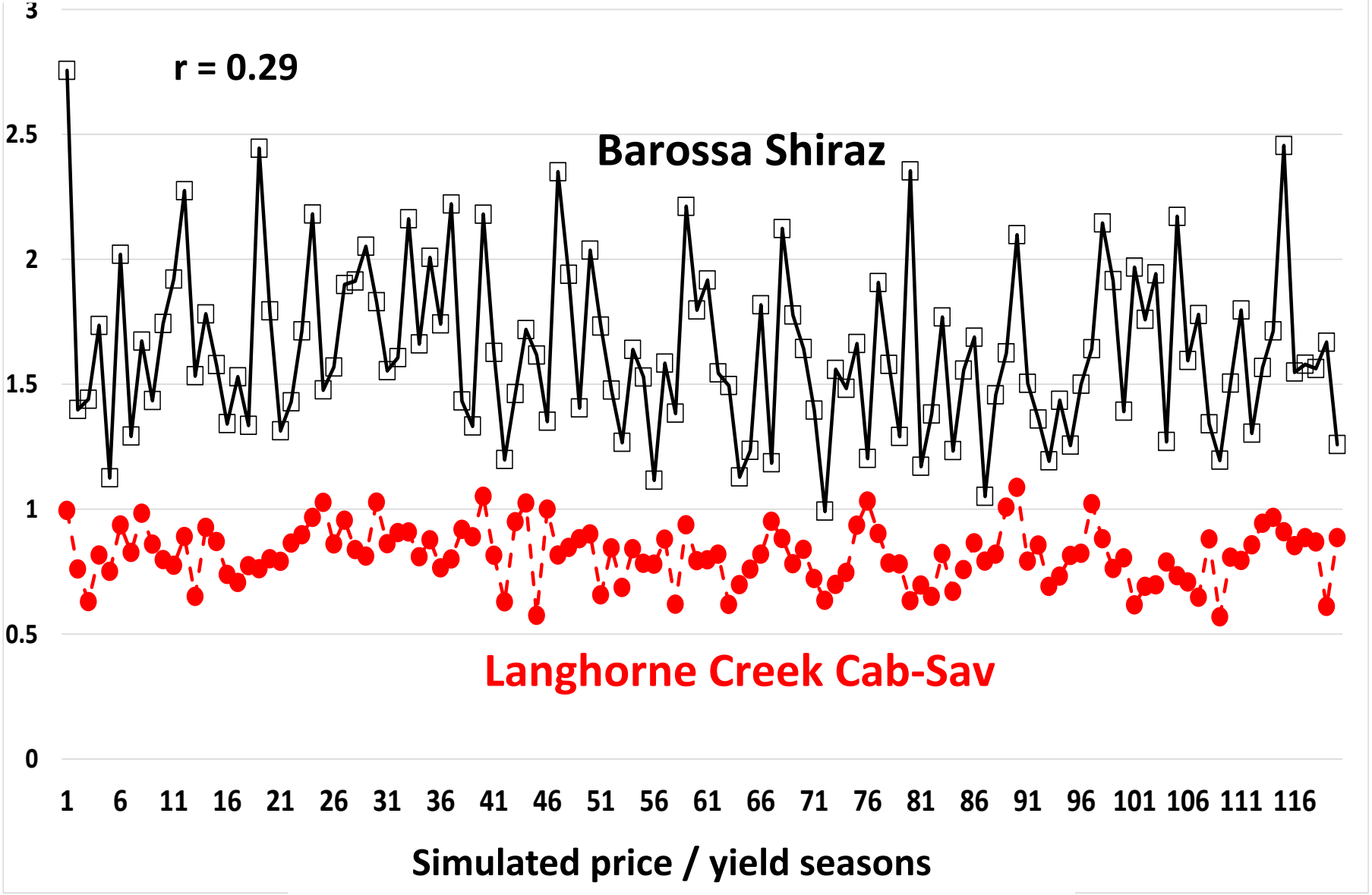
Chris Penfold photo: *Medic and Ryegrass under vines, Langhorne Creek, Nov 2016.*

Figure 1. District fruit prices and yields, 2006-16

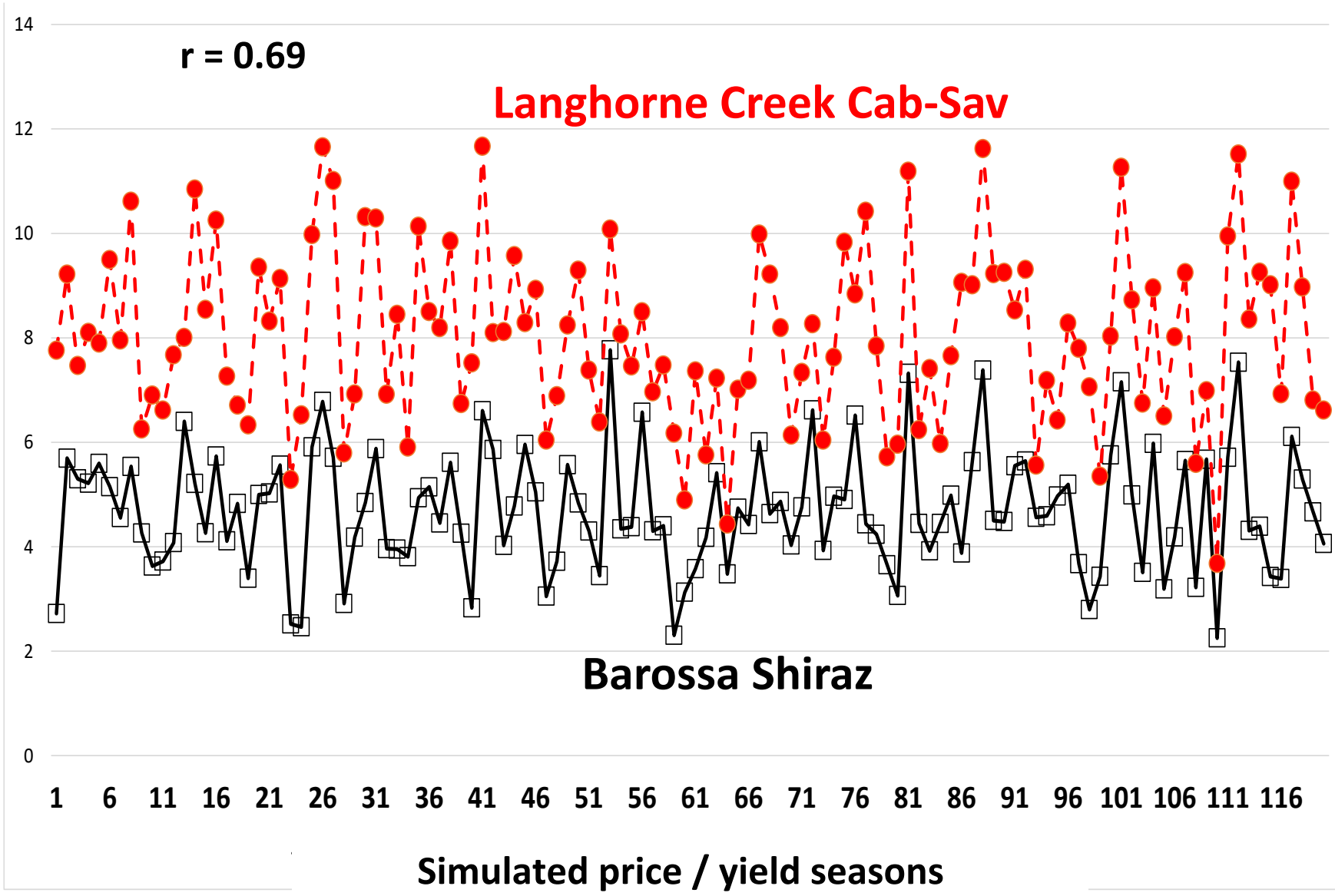


Data source: **Wine Australia.** ***2016 South Australian Winegrape Crush Survey***

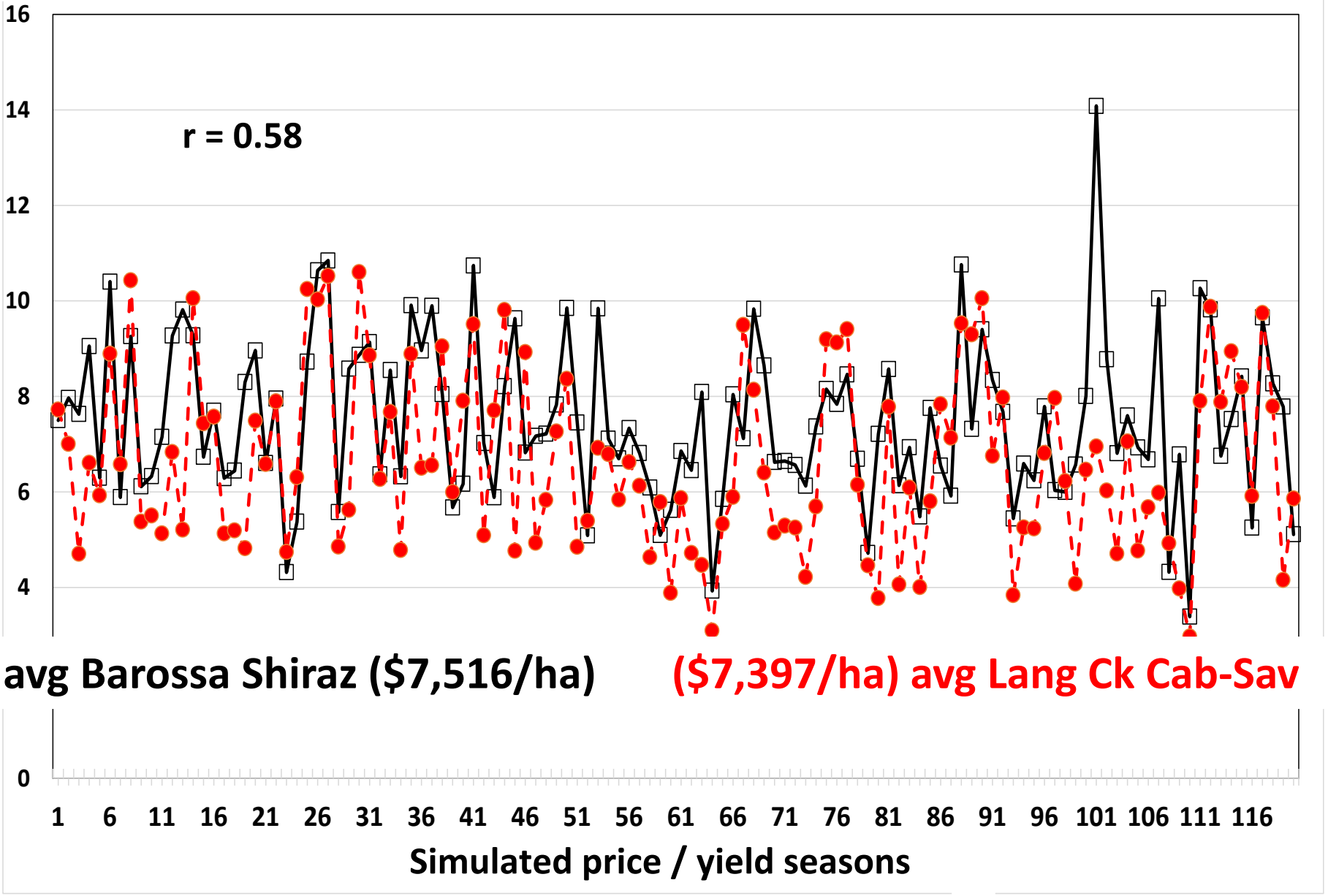
Fruit Prices, $K/t

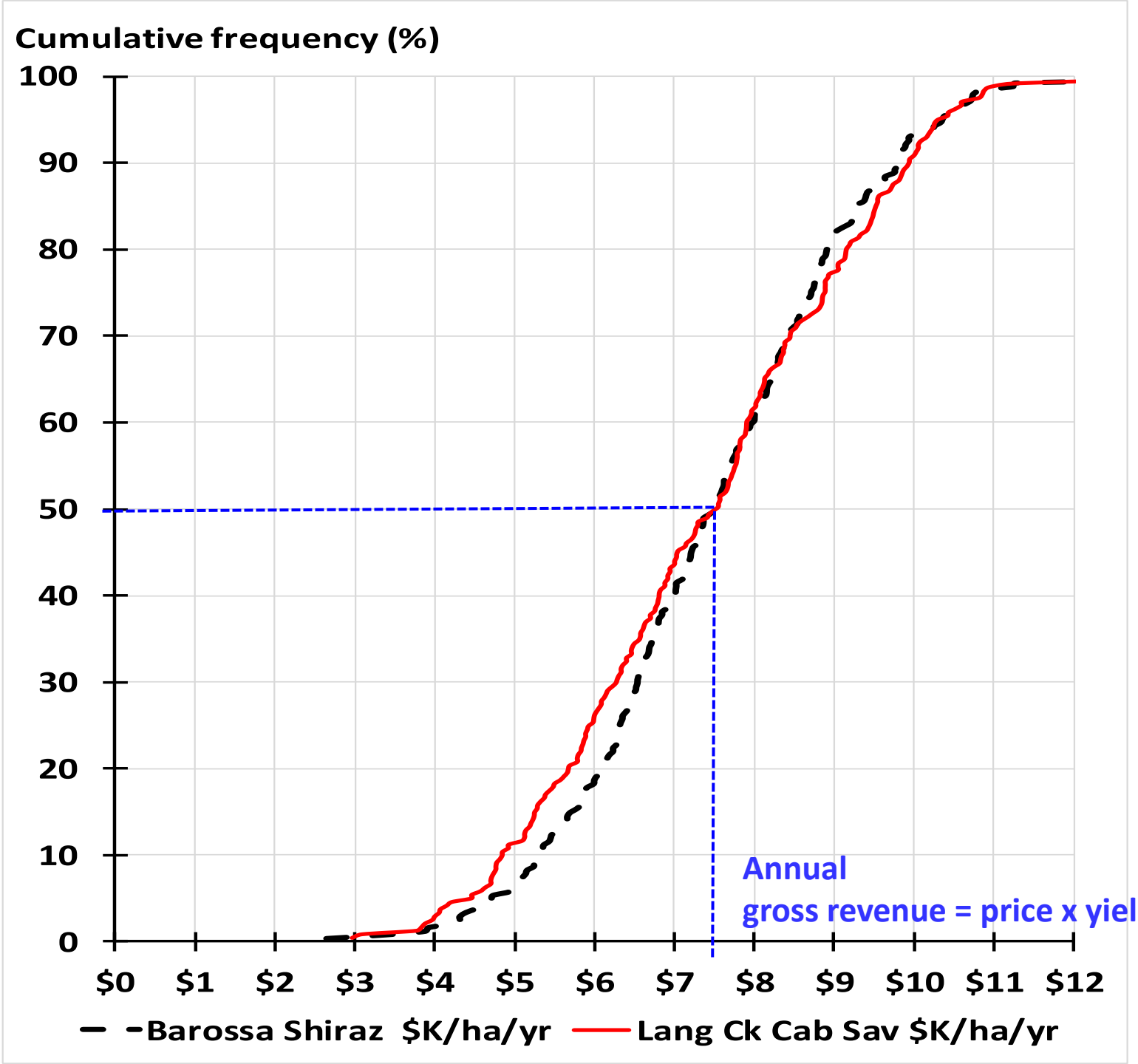


Fruit Yield, t/ha



$K/ha Gross Revenues,




Cumulative frequency (%)
100
90
80
70
60
50
40
30
20
10
0
$0
$1
$2
$3
$4
$5
$6
$7
$8
$9
$10
$11
$12
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

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

Variable costs depending on fruit yield ($/t)			
Harvesting	+	**30**	**30**
Freight		**15**	**15**
Levies		**10**	**10**
Extra Labour/wage ($25/hr, 2 hrs/t)	+	**50**	**50**
Variable Costs ($/t)		**105**	**105**

10 to 20m plots are harvested mechanically into the weigh-bin trailer - a quick and accurate operation!

Chris Penfold photo

2016 yield indices of alternative mulches relative to the HERBICIDE treatment at two locations

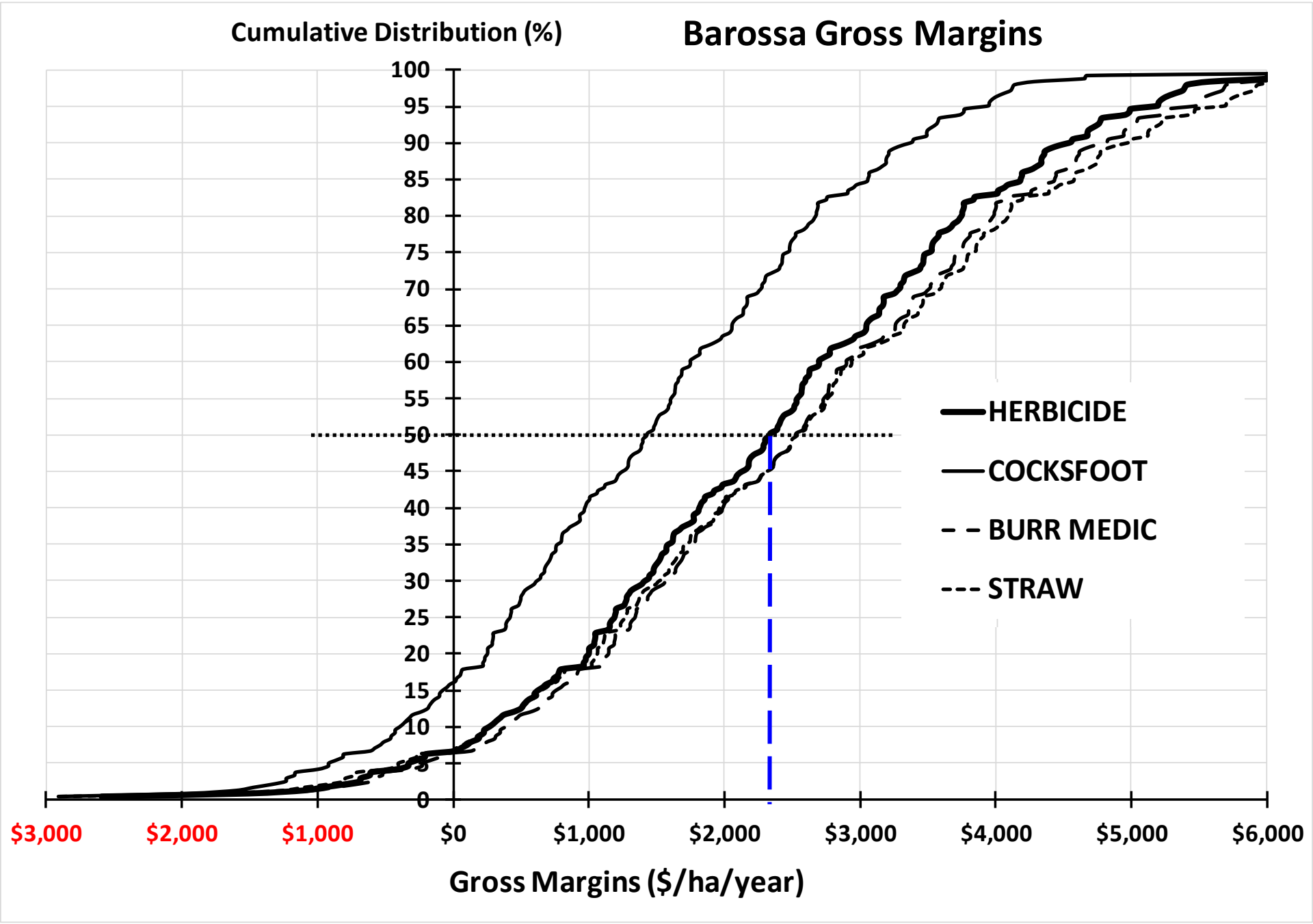
	no mulch	---sown living mulches ---		applied mulch
TREATMENT:	**HERBICIDE** control	Perennial **COCKSFOOT GRASS**	Ryegrass with **BURR MEDIC**	Triticale **STRAW** mulch
FIELD TRIAL LOCATION				
Barossa yield index	**1**	**0.881**	**1.033**	**1.104**
Plot yield (t/ha)	8.82	7.77	9.11	9.74
Langhorne Ck yield index	**1**	**0.754**	**1.083**	**1.092**
Plot yield (t/ha)	19.95	15.05	21.61	21.79

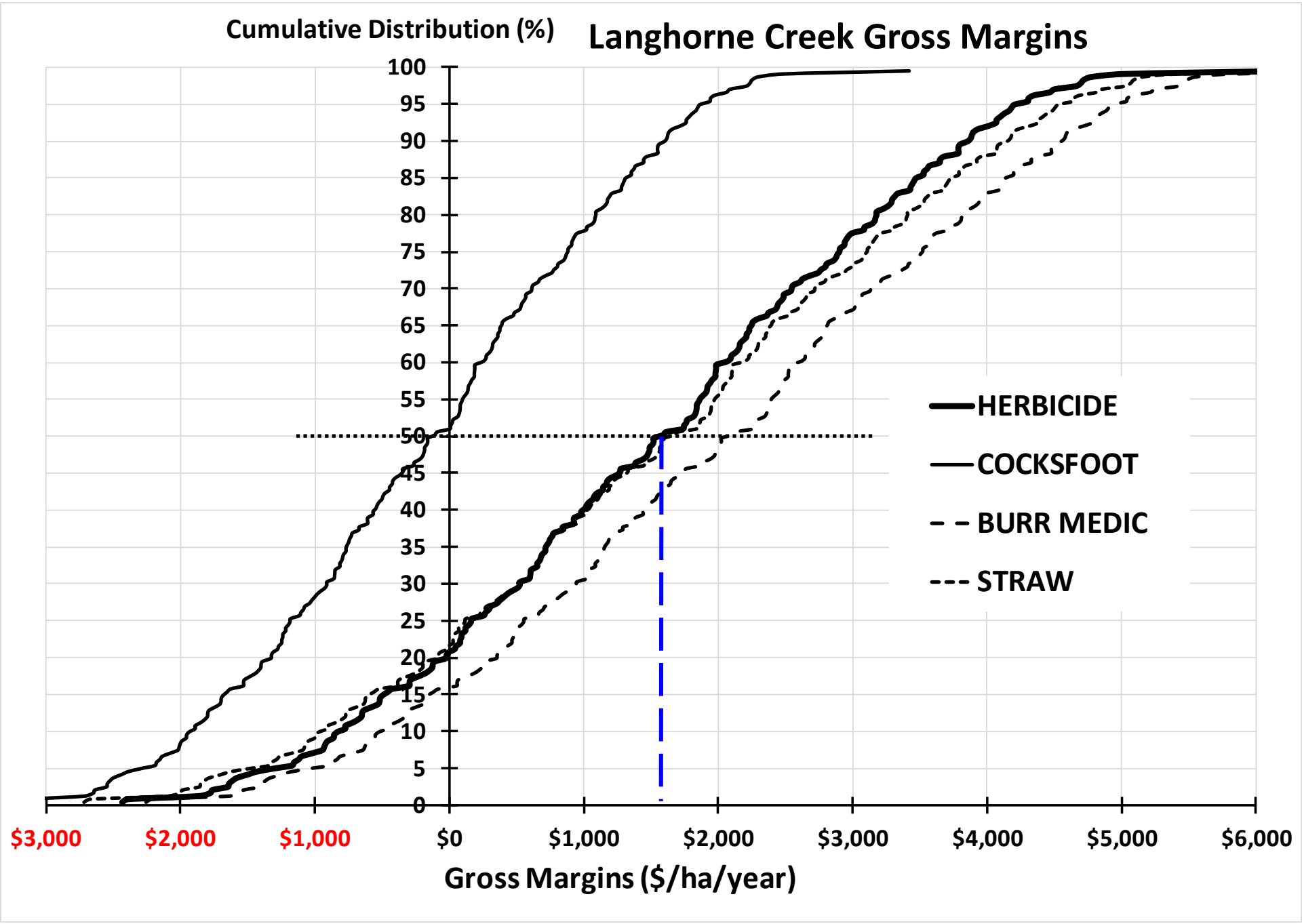
Gross revenues vary year to year with yields and prices;
Operational costs also vary with yields

Gross Margin = Gross revenue – Operational costs

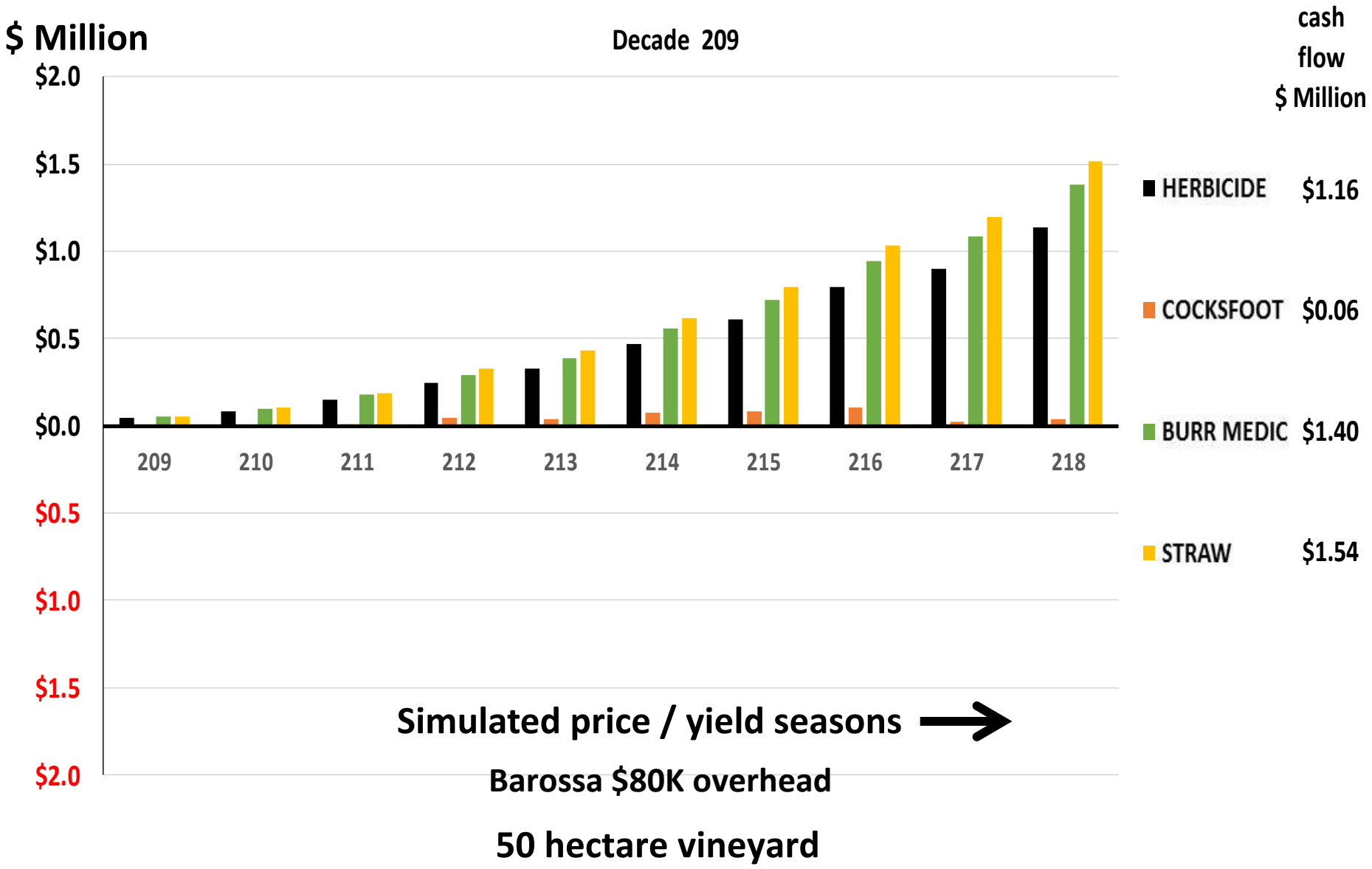
We assume yields under the different treatments differ every year while keeping their same yield ratios relative to the herbicide treatment as in their 2016 yield indices

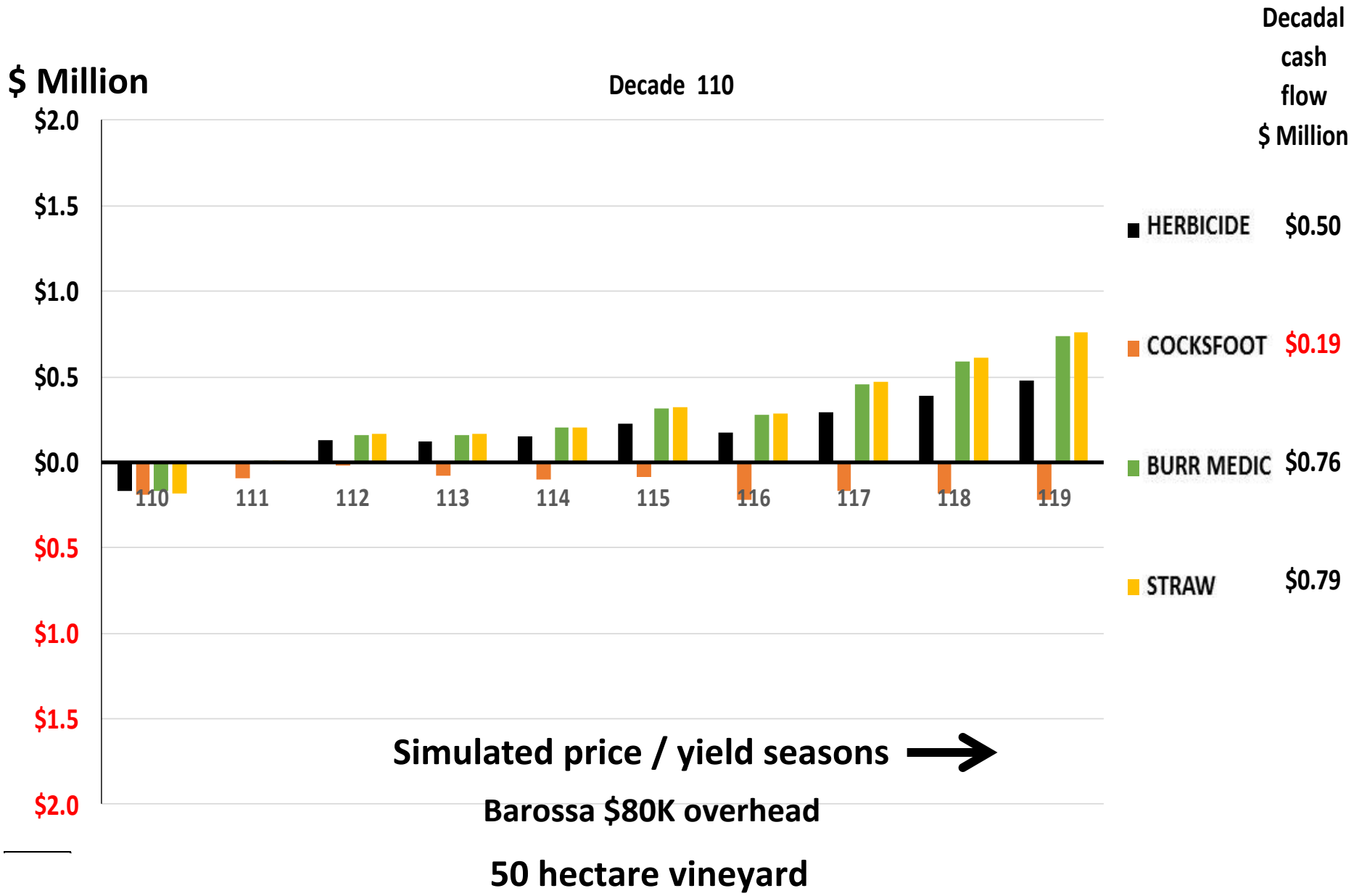
Chris Penfold photo: Strawberry clover and sheep fescue, Langhorne Creek, Nov 2016

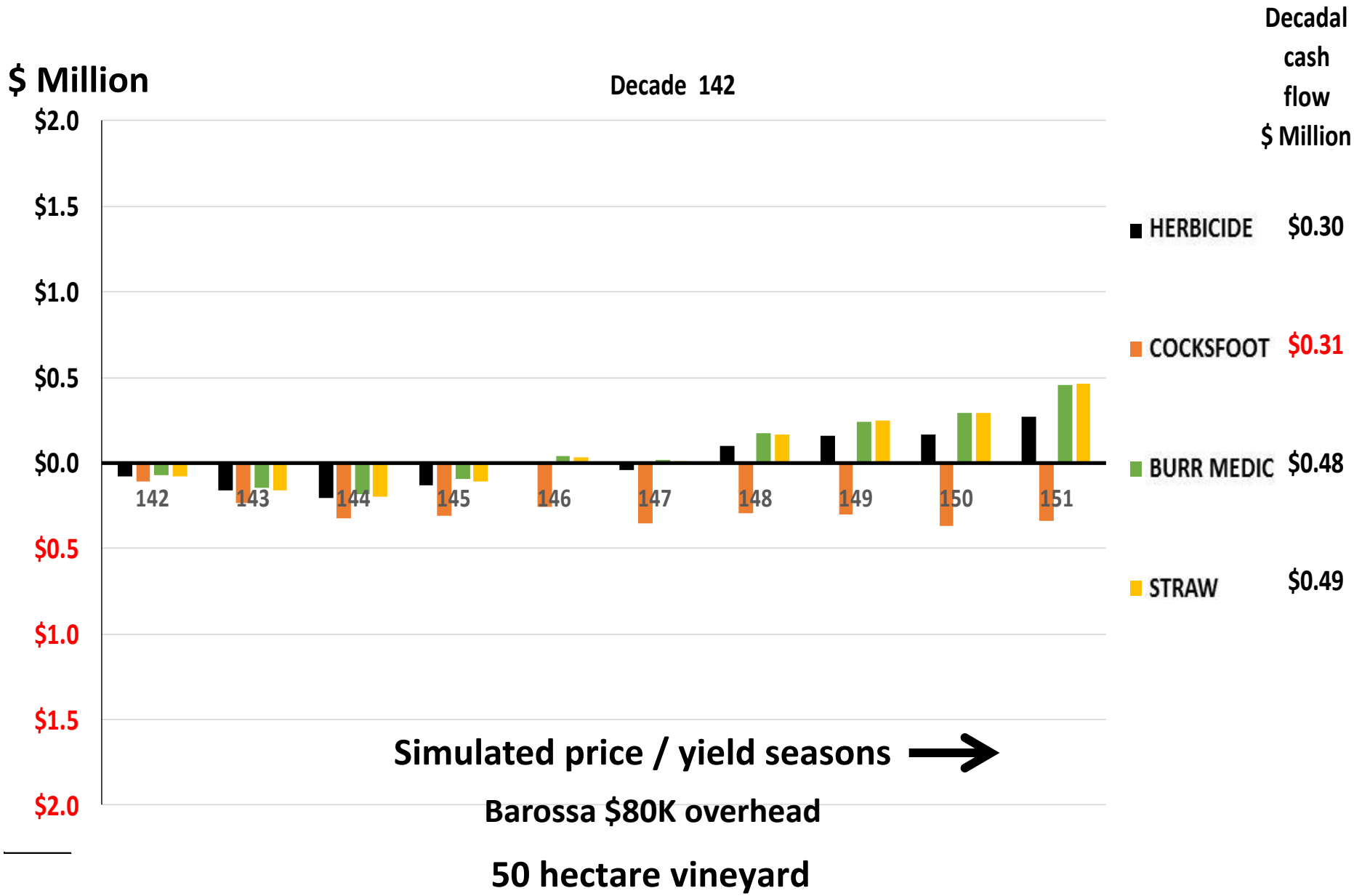

Barossa Gross Margins
Cumulative Distribution (%)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
HERBICIDE
COCKSFOOT
BURR MEDIC
STRAW
$3,000
$2,000
$1,000
$0
$1,000
$2,000
$3,000
$4,000
$5,000
$6,000
Gross Margins ($/ha/year)

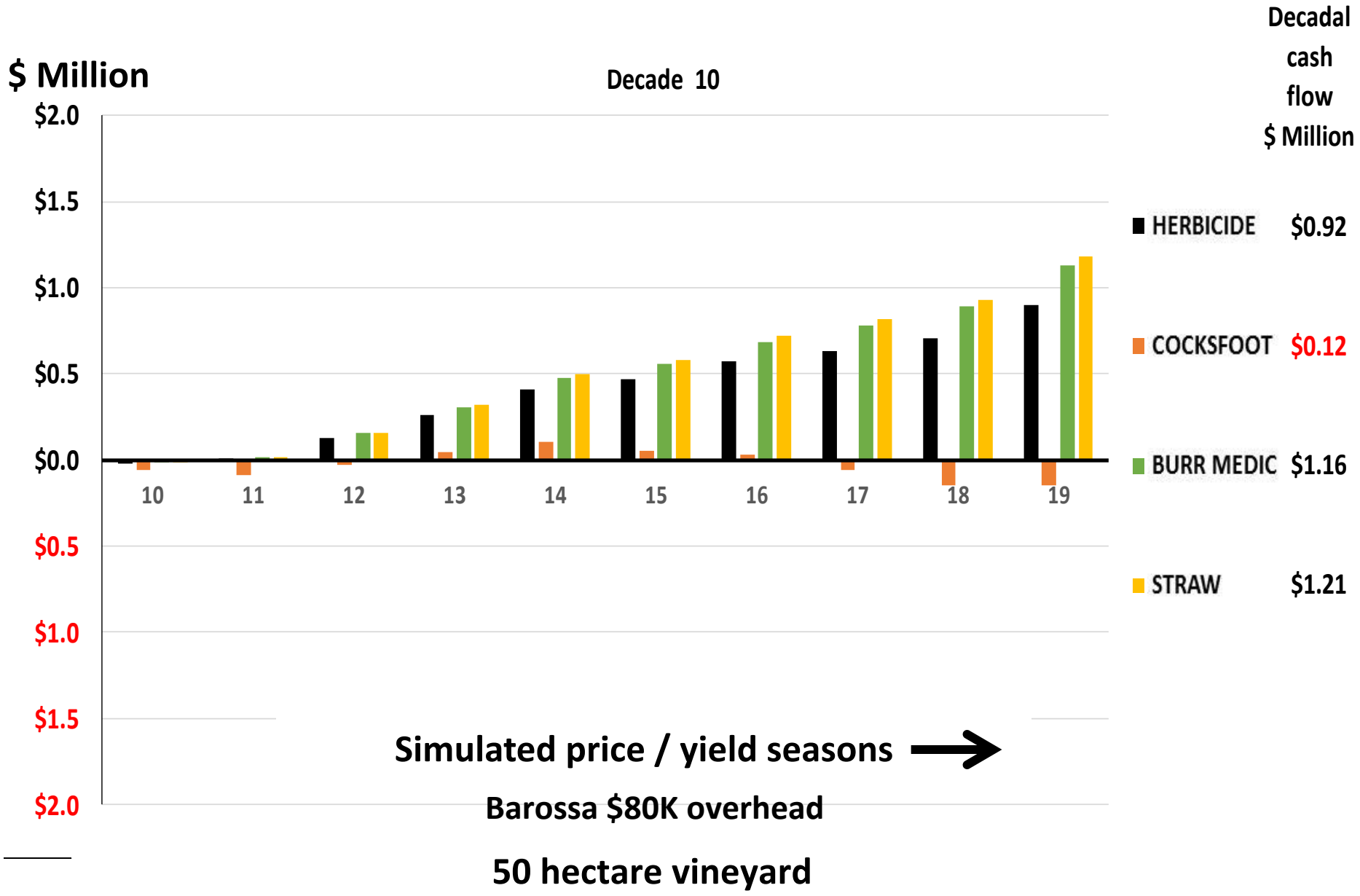

Cumulative Distribution (%)
Langhorne Creek Gross Margins
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
HERBICIDE
COCKSFOOT
BURR MEDIC
STRAW
$3,000
$2,000
$1,000
$0
$1,000
$2,000
$3,000
$4,000
$5,000
$6,000
Gross Margins ($/ha/year)

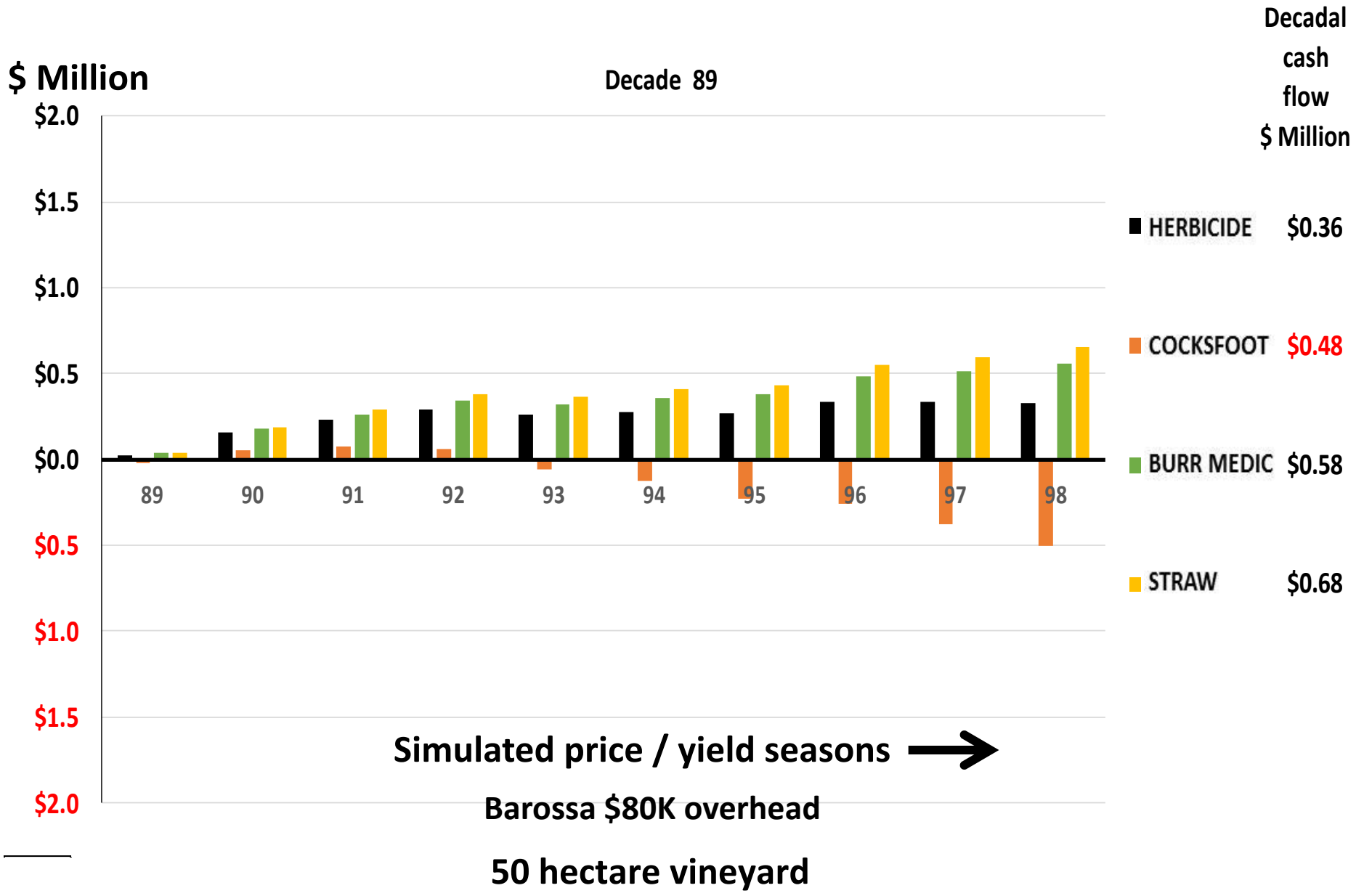
Subtracting annual overheads, drawings, interest and taxes from Gross Margins over 10-year (decadal) periods of simulated price & yield variations =

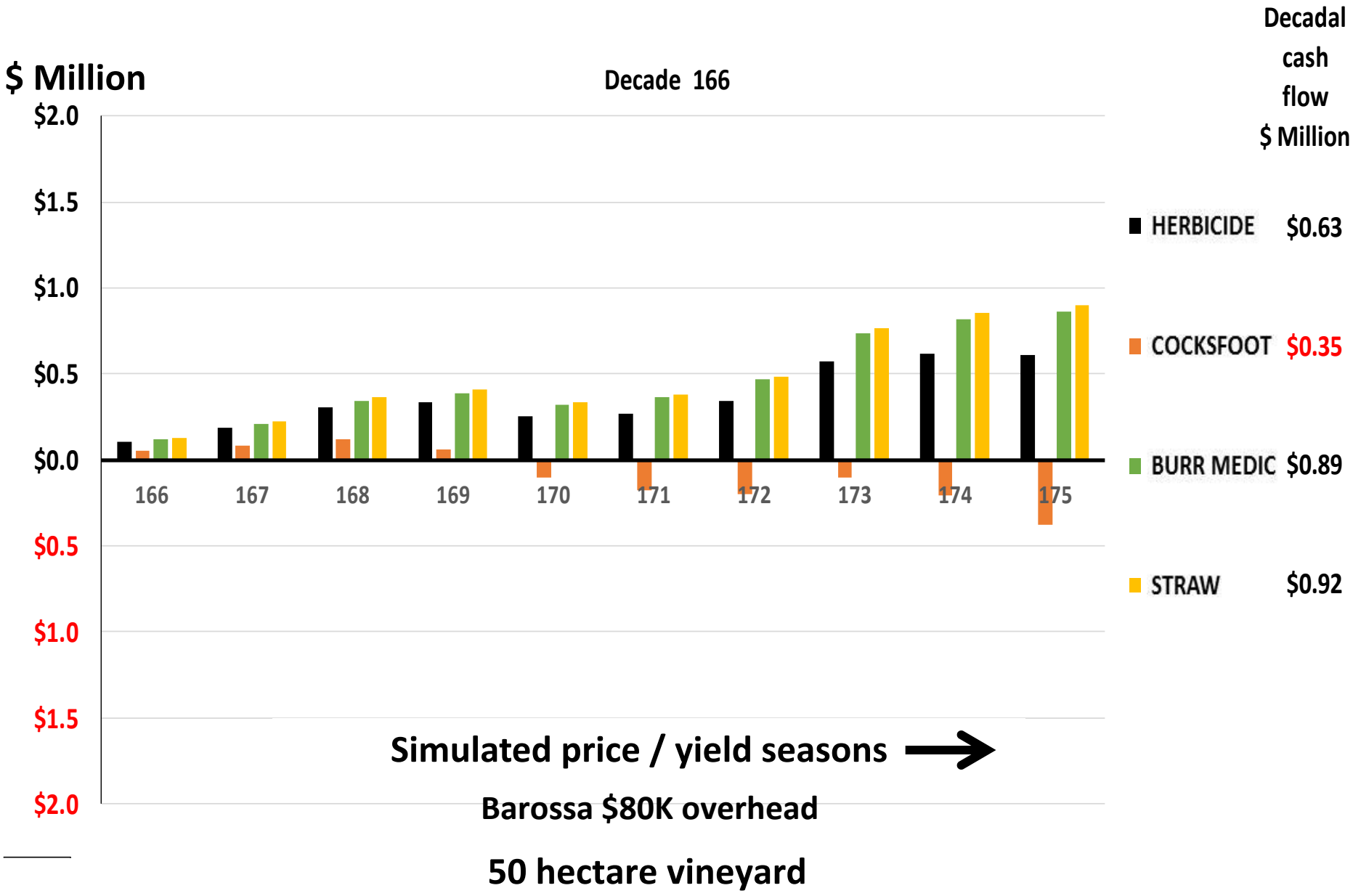


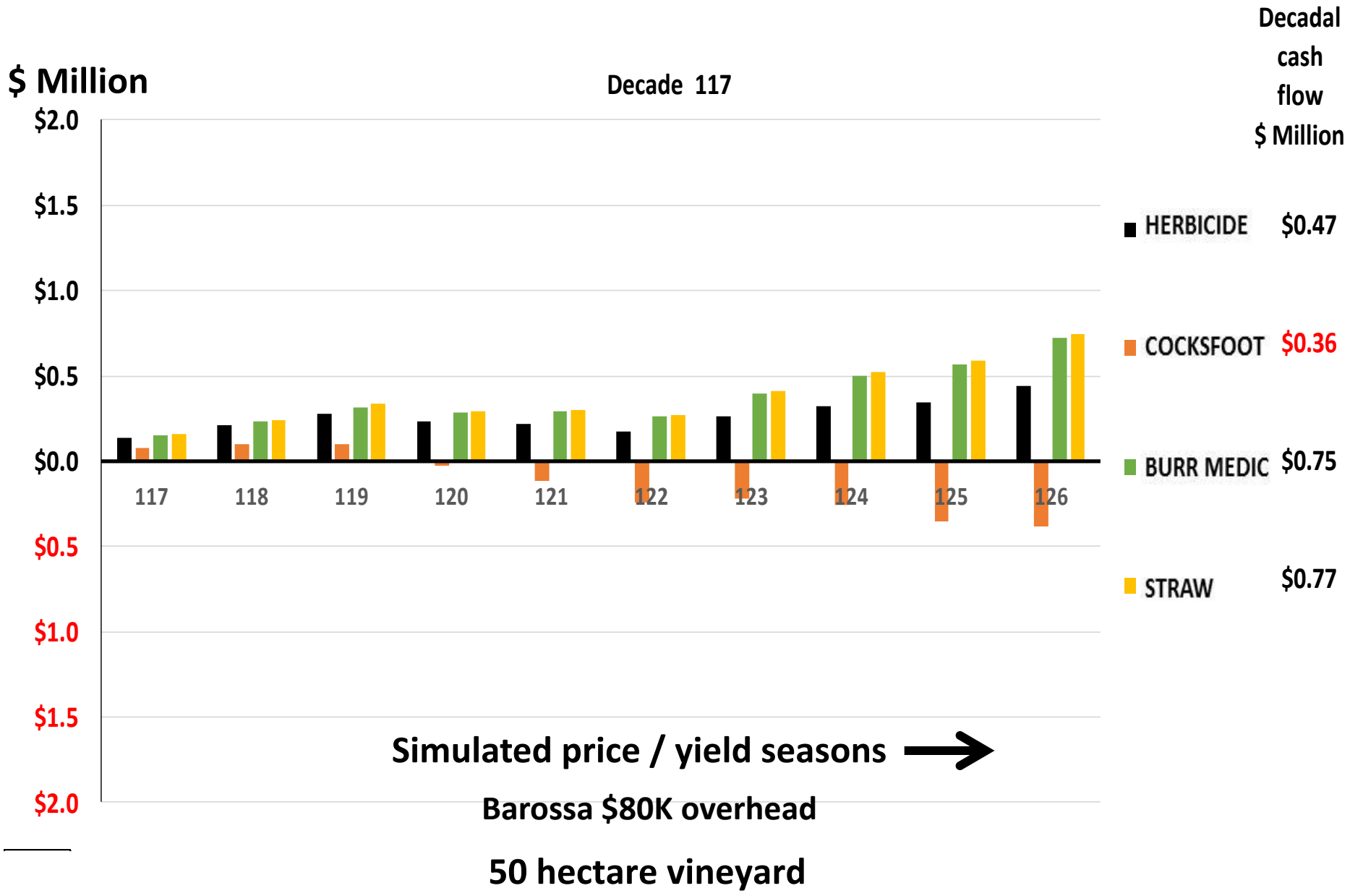

$ Million
Decade 110
$2.0
$1.5
$1.0
$0.5
$0.0
$0.5
$1.0
$1.5
$2.0
110
111
112
113
114
115
116
117
118
119
Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard
Decadal cash flow $ Million
HERBICIDE $0.50
COCKSFOOT $0.19
BURR MEDIC $0.76
STRAW $0.79

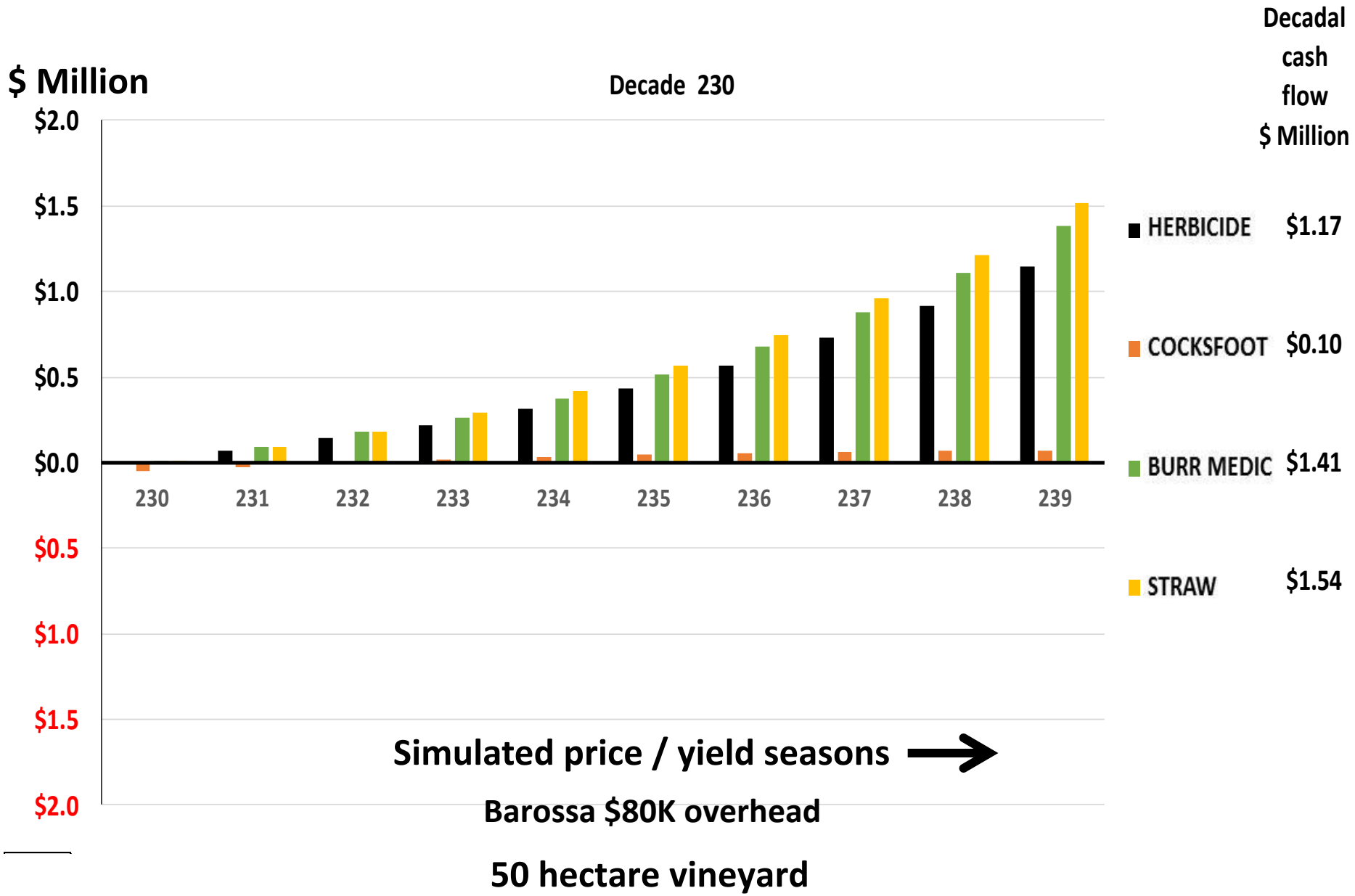

$ Million
Decade 142
$2.0
$1.5
$1.0
$0.5
$0.0
$0.5
$1.0
$1.5
$2.0
142
143
144
145
146
147
148
149
150
151
Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard
Decadal cash flow $ Million
HERBICIDE $0.30
COCKSFOOT $0.31
BURR MEDIC $0.48
STRAW $0.49

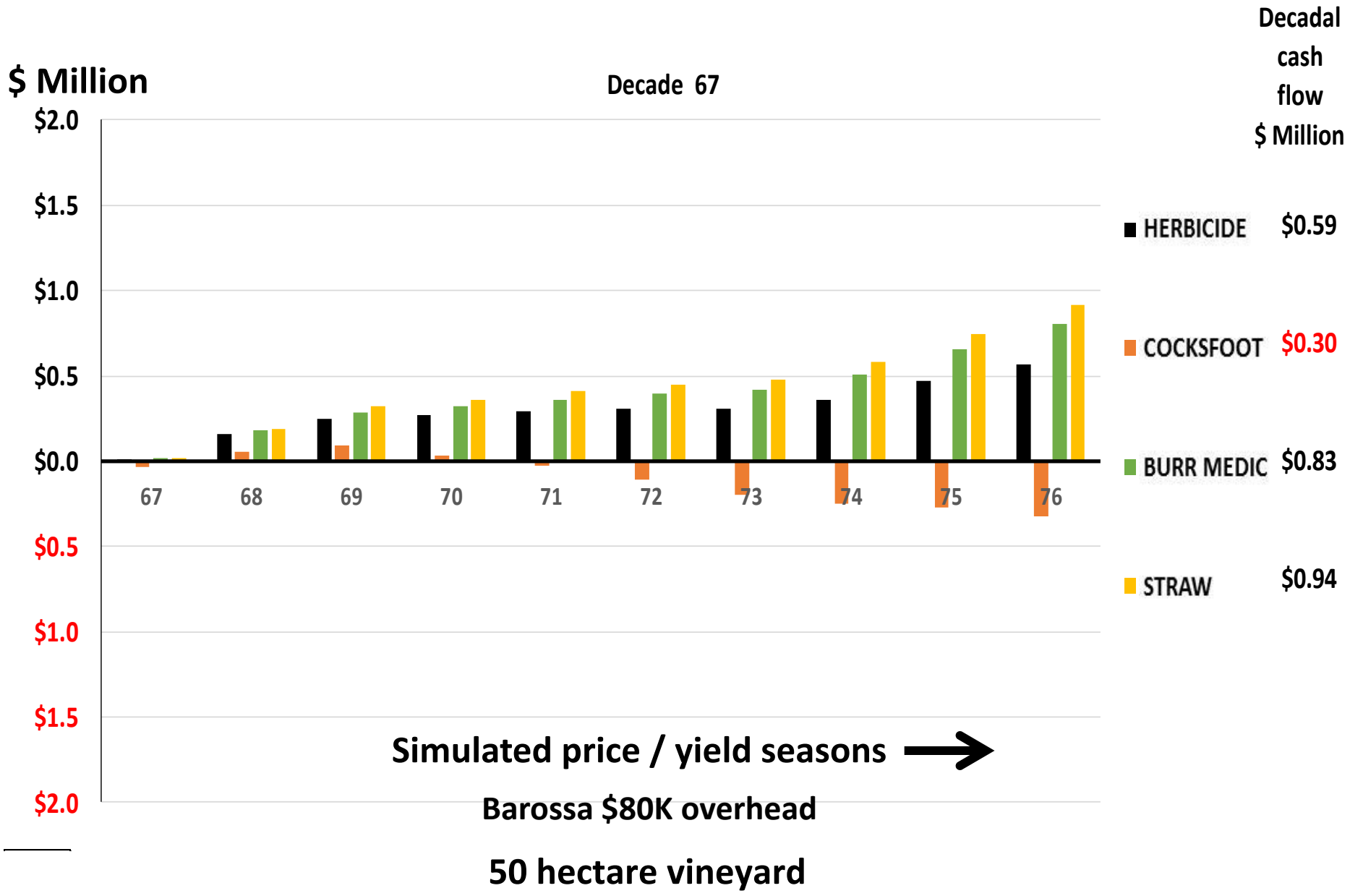

$ Million
Decade 10
$2.0
$1.5
$1.0
$0.5
$0.0
$0.5
$1.0
$1.5
$2.0
10
11
12
13
14
15
16
17
18
19
Decadal cash flow $ Million
HERBICIDE $0.92
COCKSFOOT $0.12
BURR MEDIC $1.16
STRAW $1.21
Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard

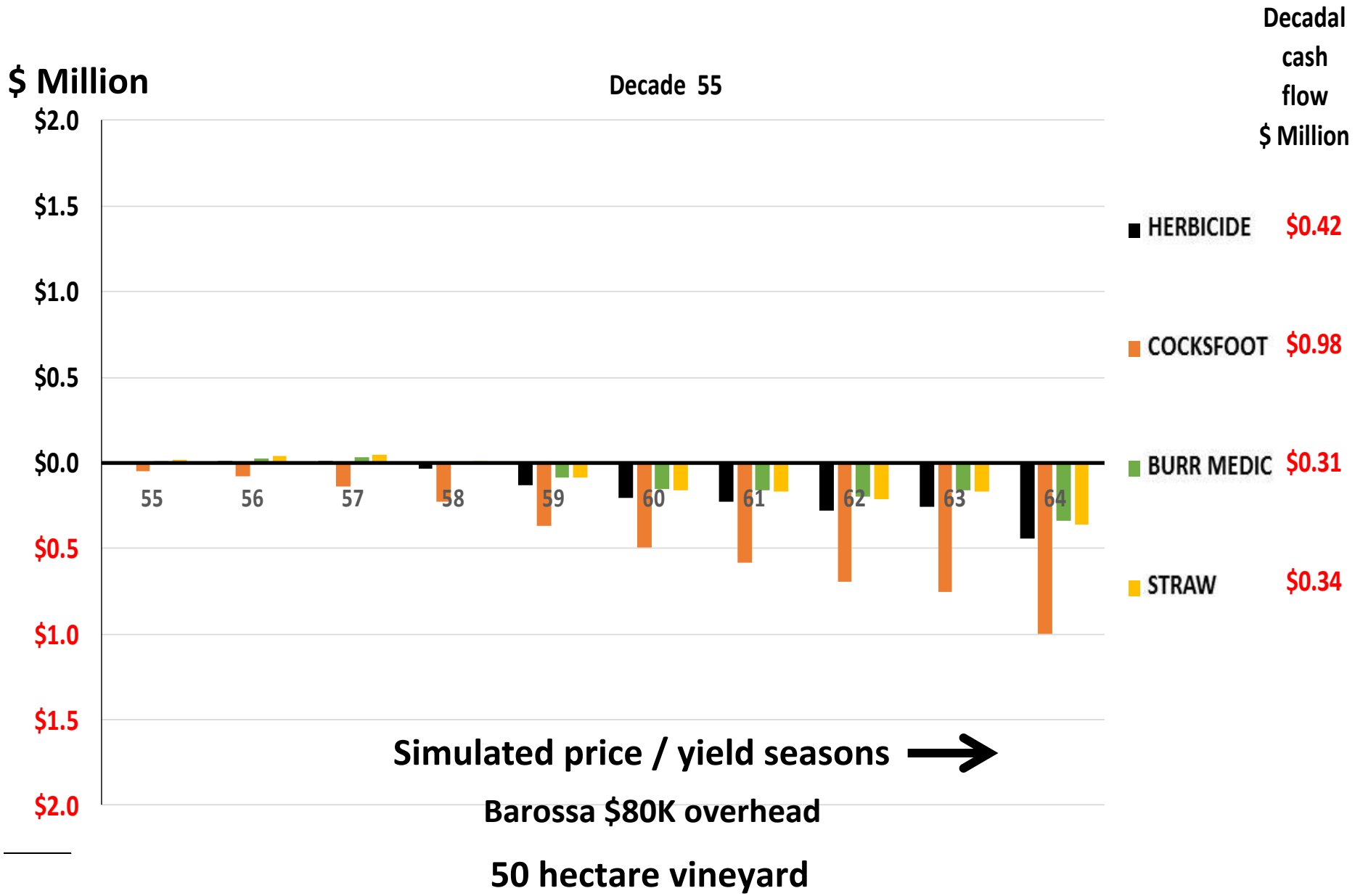

$ Million
Decade 89
$2.0
$1.5
$1.0
$0.5
$0.0
$0.5
$1.0
$1.5
$2.0
89
90
91
92
93
94
95
96
97
98
Decadal cash flow $ Million
HERBICIDE $0.36
COCKSFOOT $0.48
BURR MEDIC $0.58
STRAW $0.68
Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard

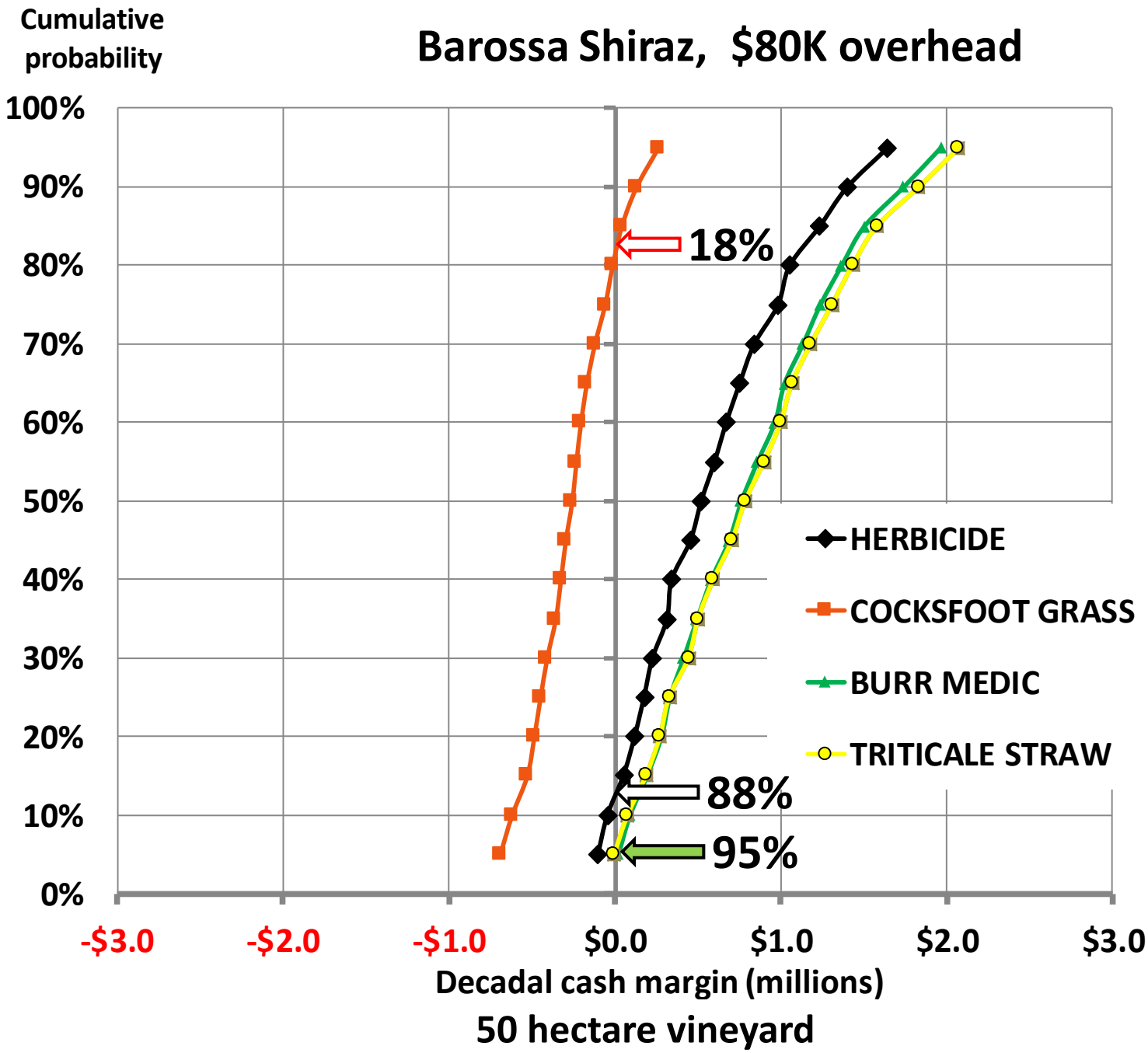

$ Million
Decade 166
$2.0
$1.5
$1.0
$0.5
$0.0
$0.5
$1.0
$1.5
$2.0
166
167
168
169
170
171
172
173
174
175
Decadal cash flow $ Million
HERBICIDE $0.63
COCKSFOOT $0.35
BURR MEDIC $0.89
STRAW $0.92
Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard

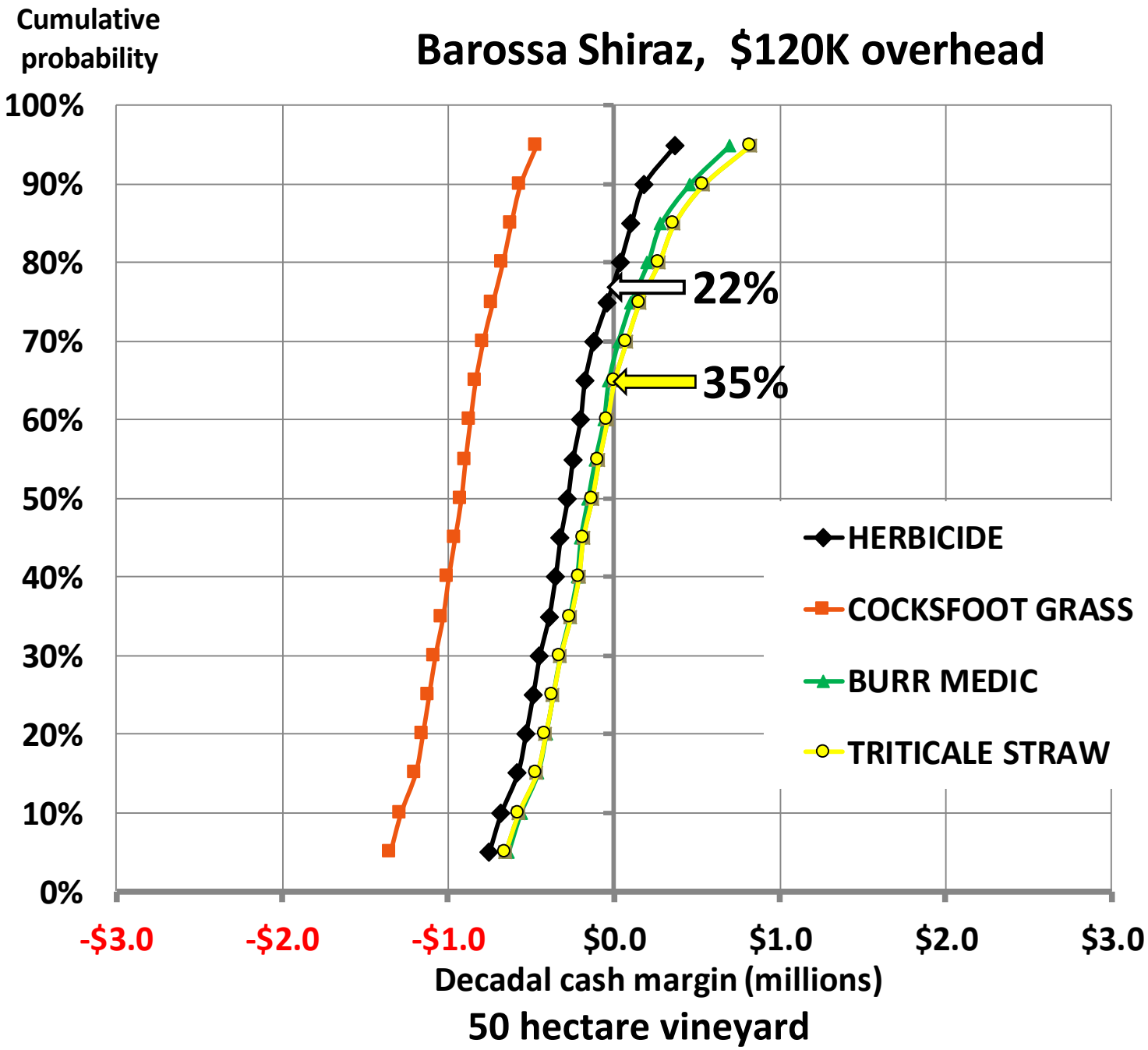

$ Million
Decade 117
$2.0
$1.5
$1.0
$0.5
$0.0
$0.5
$1.0
$1.5
$2.0
117
118
119
120
121
122
123
124
125
126
Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard
Decadal cash flow $ Million
HERBICIDE $0.47
COCKSFOOT $0.36
BURR MEDIC $0.75
STRAW $0.77

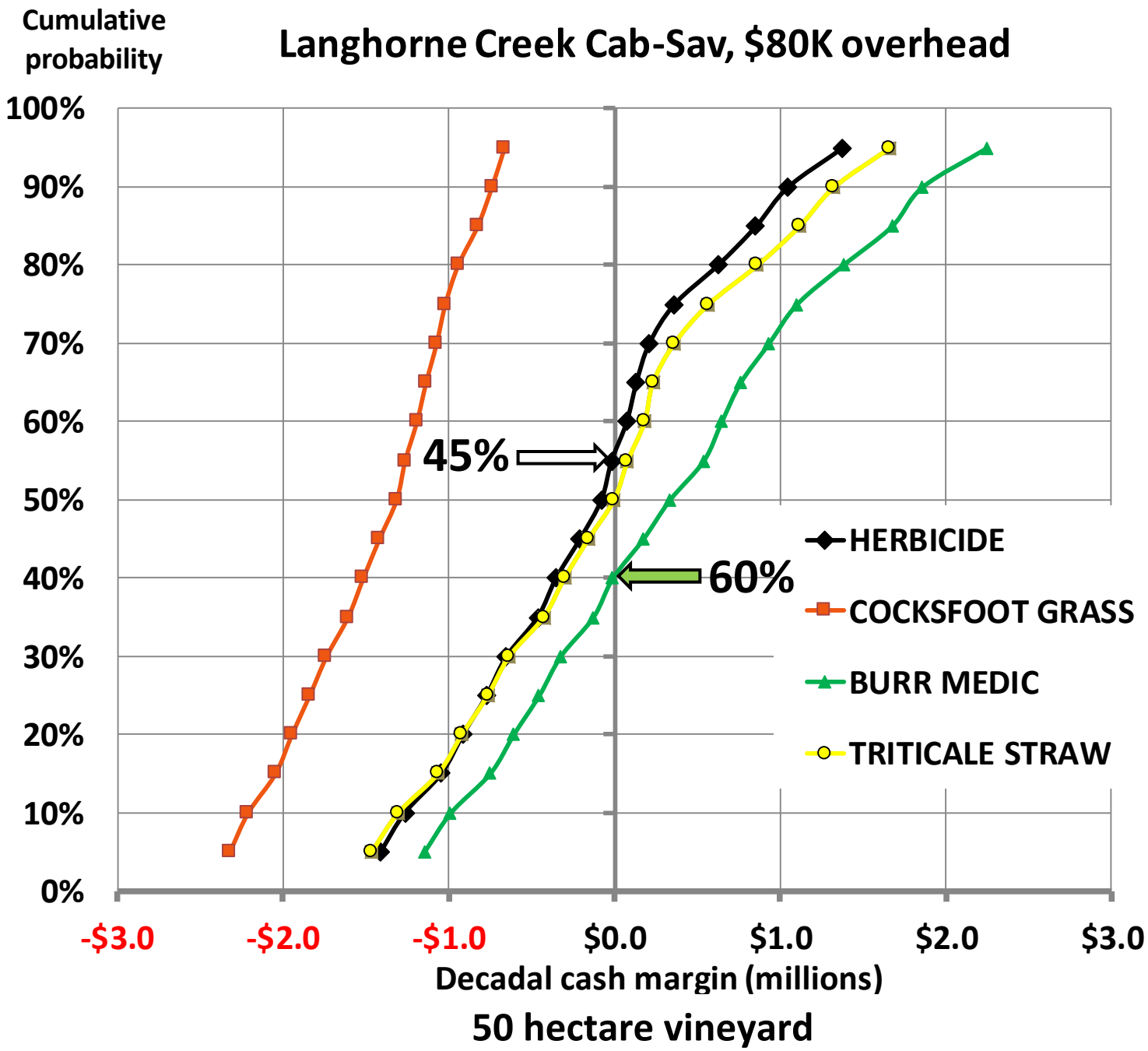

$ Million
Decade 230
$2.0
$1.5
$1.0
$0.5
$0.0
$0.5
$1.0
$1.5
$2.0
230
231
232
233
234
235
236
237
238
239
Decadal cash flow $ Million
HERBICIDE $1.17
COCKSFOOT $0.10
BURR MEDIC $1.41
STRAW $1.54
Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard

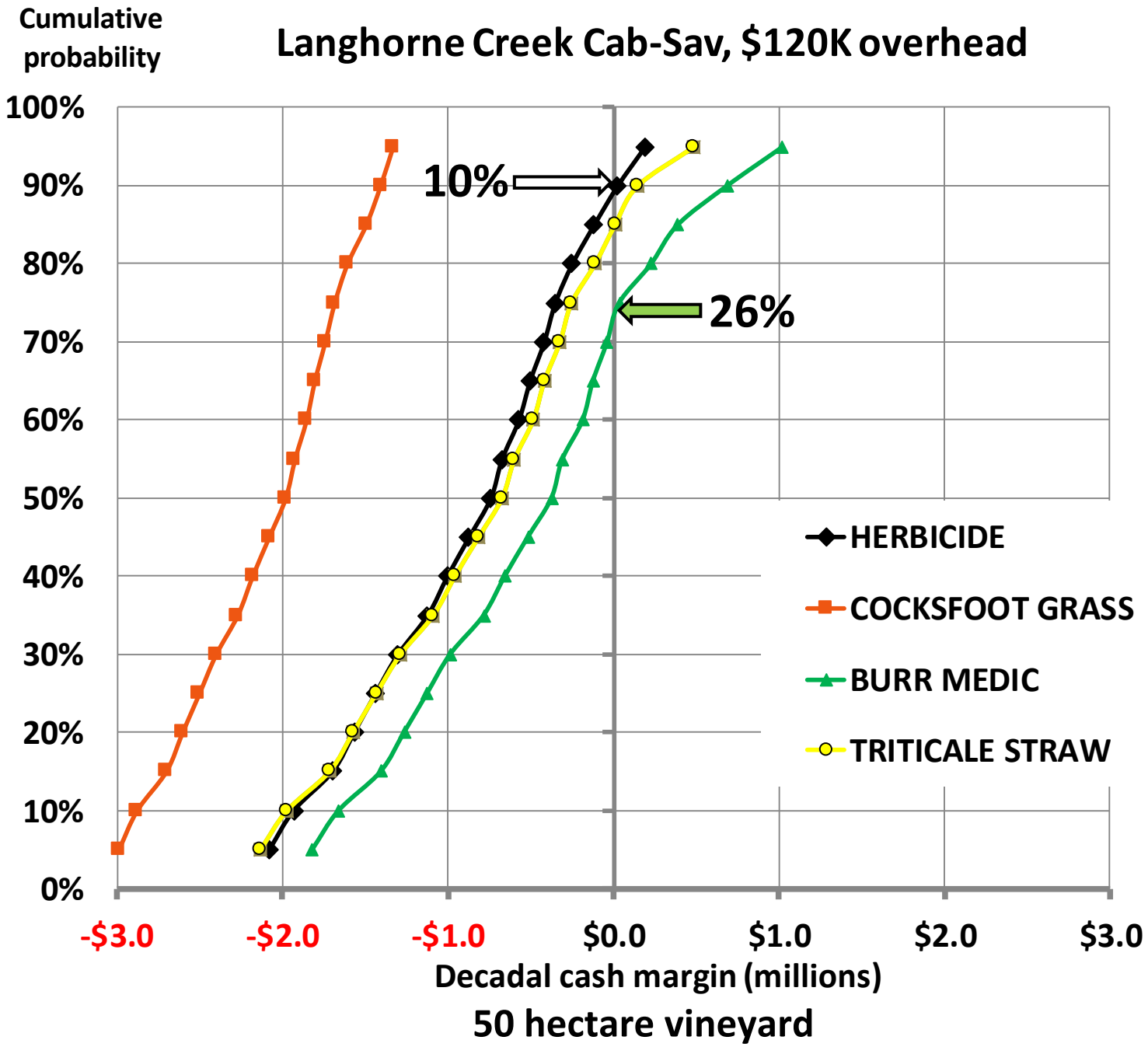

$ Million
Decade 67
$2.0
$1.5
$1.0
$0.5
$0.0
$0.5
$1.0
$1.5
$2.0
67
68
69
70
71
72
73
74
75
76
Decadal cash flow $ Million
HERBICIDE $0.59
COCKSFOOT $0.30
BURR MEDIC $0.83
STRAW $0.94
Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard

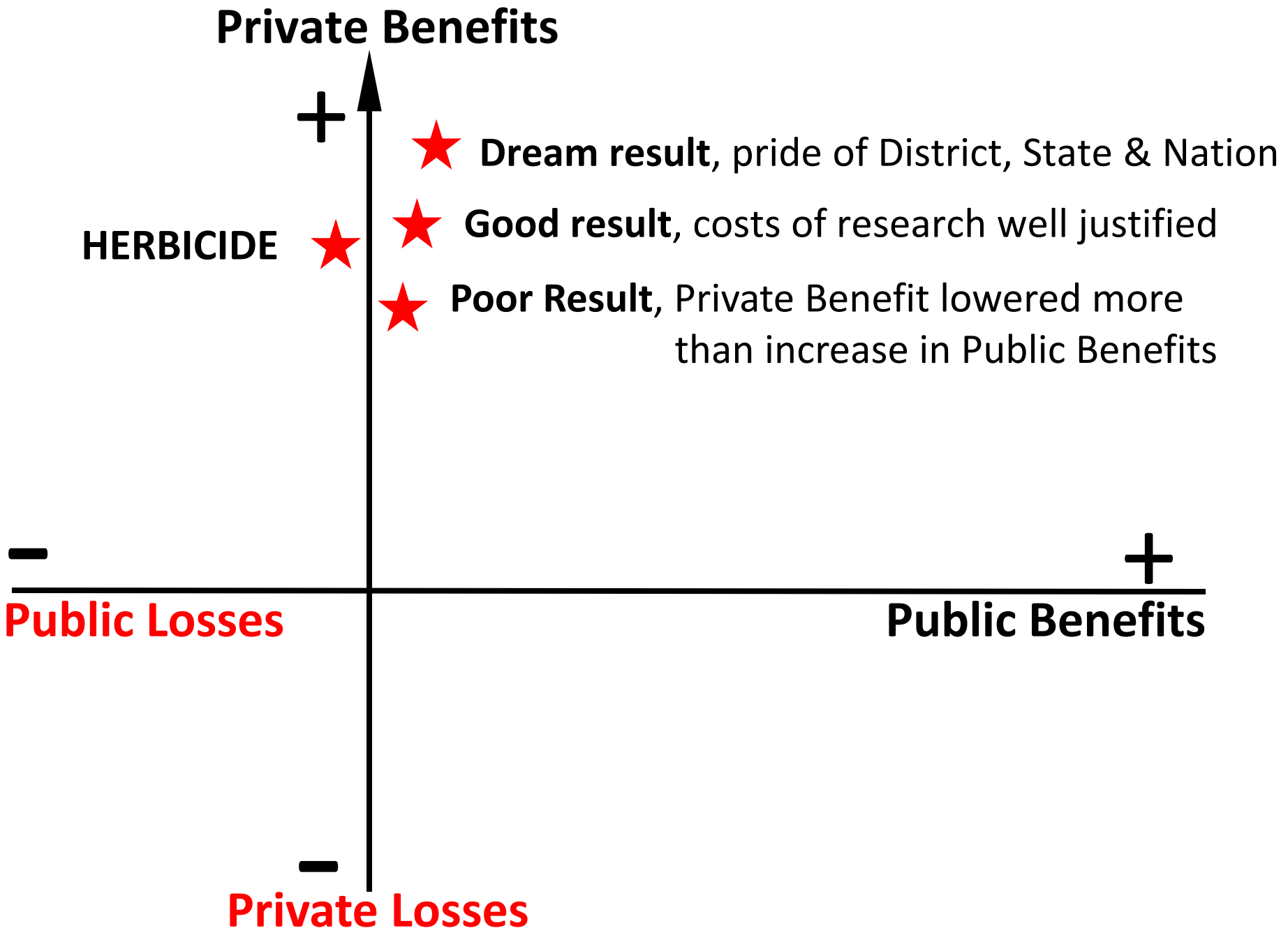

$ Million
Decade 55
Decadal cash flow $ Million
$2.0
$1.5
$1.0
$0.5
$0.0
$0.5
$1.0
$1.5
$2.0
55
56
57
58
59
60
61
62
63
64
HERBICIDE $0.42
COCKSFOOT $0.98
BURR MEDIC $0.31
STRAW $0.34
Simulated price / yield seasons
Barossa $80K overhead
50 hectare vineyard


Cumulative probability
Barossa Shiraz, $80K overhead
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
18%
88%
95%
HERBICIDE
COCKSFOOT GRASS
BURR MEDIC
TRITICALE STRAW
-$3.0
-$2.0
-$1.0
$0.0
$1.0
$2.0
$3.0
Decadal cash margin (millions)
50 hectare vineyard


Cumulative probability
Barossa Shiraz, $120K overhead
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
22%
35%
HERBICIDE
COCKSFOOT GRASS
BURR MEDIC
TRITICALE STRAW
-$3.0
-$2.0
-$1.0
$0.0
$1.0
$2.0
$3.0
Decadal cash margin (millions)
50 hectare vineyard


Cumulative probability
Langhorne Creek Cab-Sav, $80K overhead
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
45%
60%
HERBICIDE
COCKSFOOT GRASS
BURR MEDIC
TRITICALE STRAW
-$3.0
-$2.0
-$1.0
$0.0
$1.0
$2.0
$3.0
Decadal cash margin (millions)
50 hectare vineyard


Cumulative probability
Langhorne Creek Cab-Sav, $120K overhead
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
10%
26%
HERBICIDE
COCKSFOOT GRASS
BURR MEDIC
TRITICALE STRAW
-$3.0
-$2.0
-$1.0
$0.0
$1.0
$2.0
$3.0
Decadal cash margin (millions)
50 hectare vineyard


Private Benefits
+
Dream result, pride of District, State & Nation
Good result, costs of research well justified
HERBICIDE
Poor Result, Private Benefit lowered more
than increase in Public Benefits
−
+
Public Losses
Public Benefits
−
Private Losses

Conclusions

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.