Forest Research
The Research Agency of the Forestry Commission

Selection index weights for Sitka spruce. A Report by Prof. Bruce Greaves (Tasmania)

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Forest Research

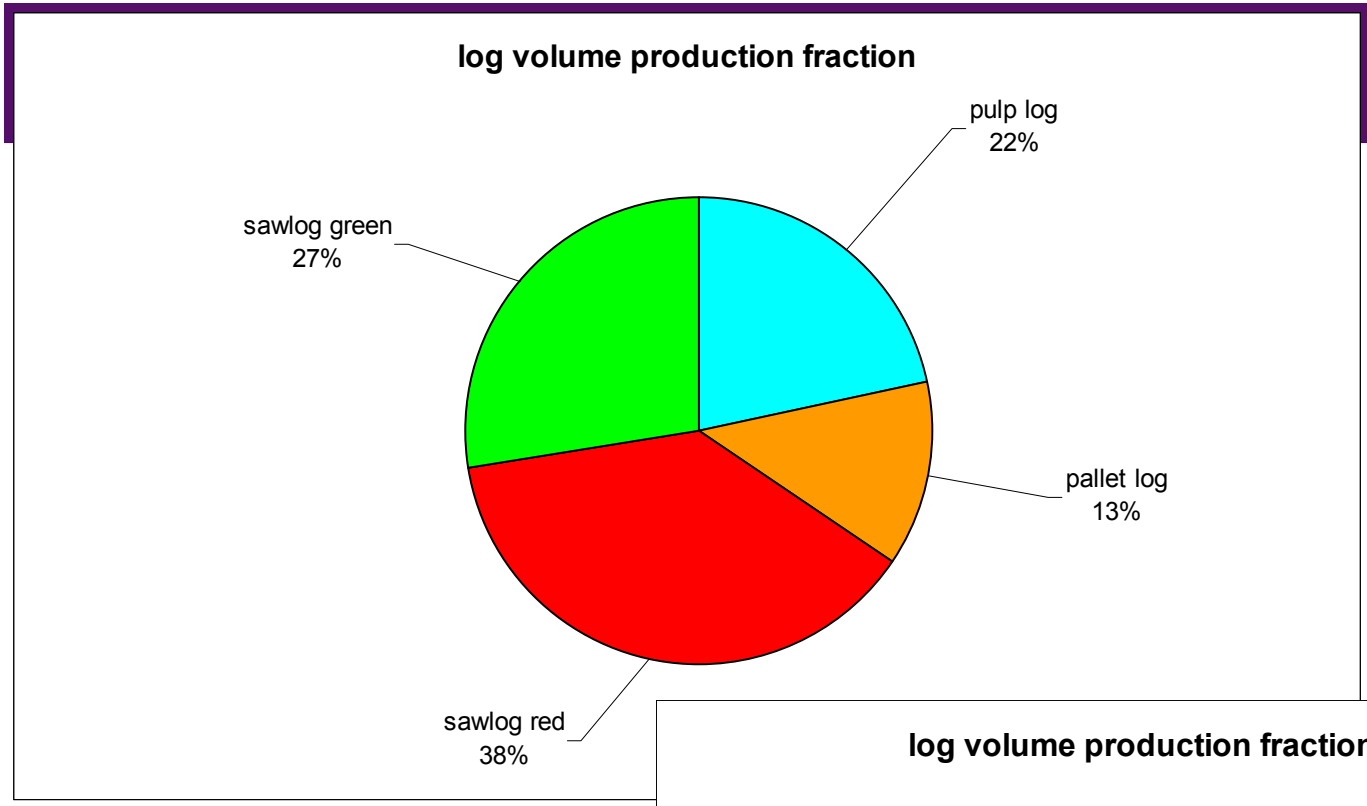
Analysis from the original report commission by Scottish Forestry Trust

Introduction

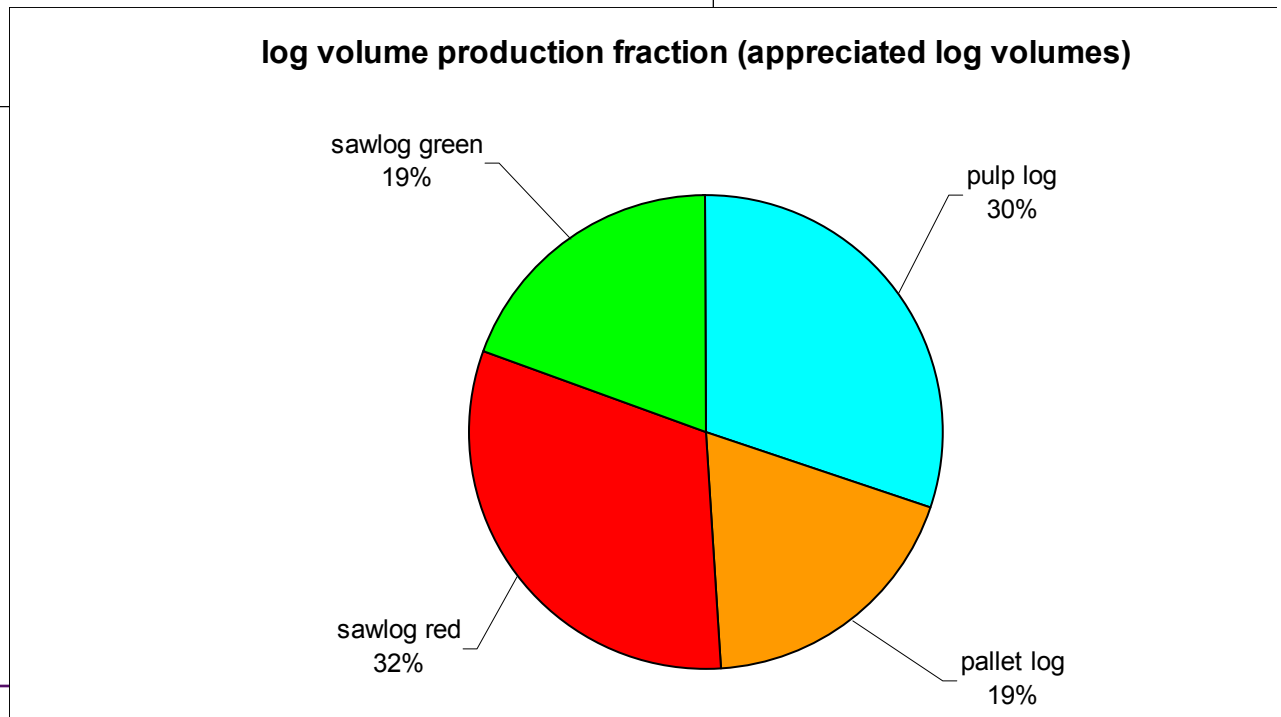
- A complete look at the Sitka spruce wood chain from planted plant to plank;
- Does *not* included the cost of tree breeding
- A look at the profitability of Sitka spruce for UK plc
- Alter all the many variables in the model
- Variables impact on the profitability - some more than others
- Try to identify the most important traits
- Similar studies carried out with *Pinus radiata* in South Australia.
- SFT - it was their idea ! They paid for it.

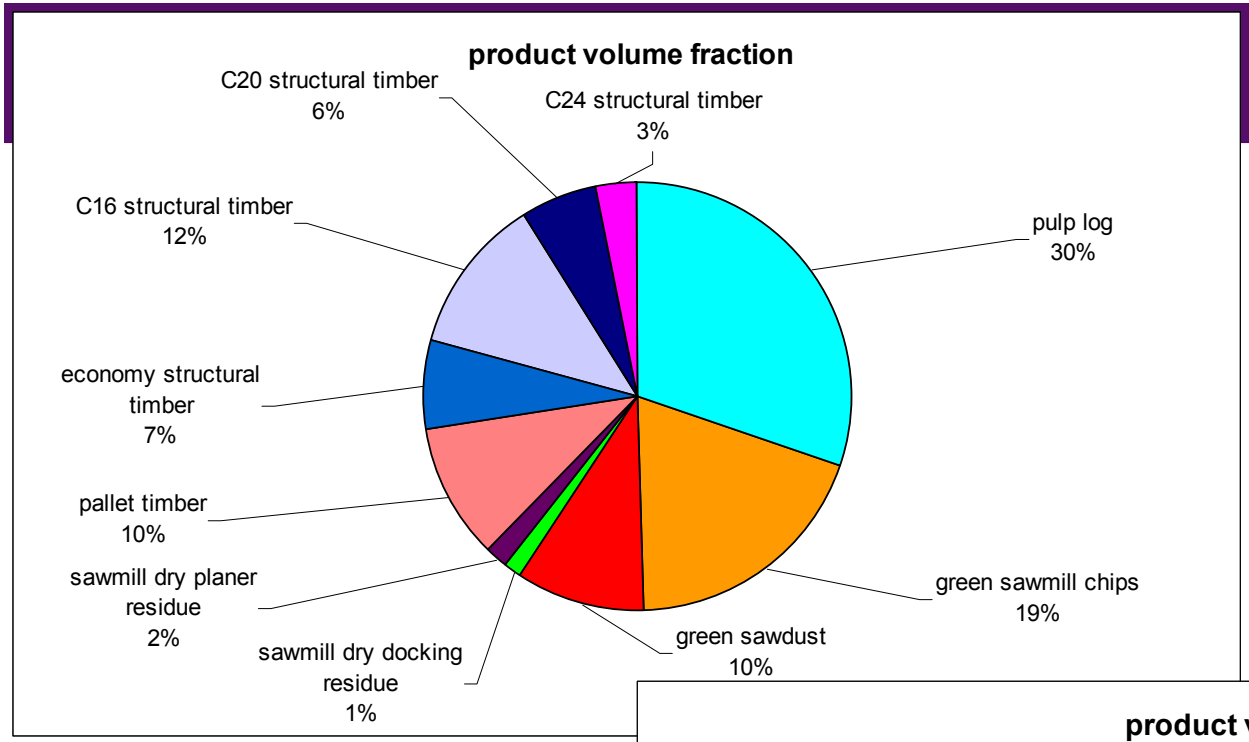
Looks at Expenditure and Income in the forest and sawmill

- A complex *Excel* spreadsheet with many elements - costs and income in the forest; in the mills; transport costs; waste;
- Ratio of Income and Cost is the profitability index (*PI*).
- If the establishment costs are fixed, *PI* will vary according to the proportion and value of the products in the forest and sawmill;
- Volumes and Values appreciated to end of rotation
- This puts a seemingly higher value on products of earlier thinnings (pulp + pallet wood).

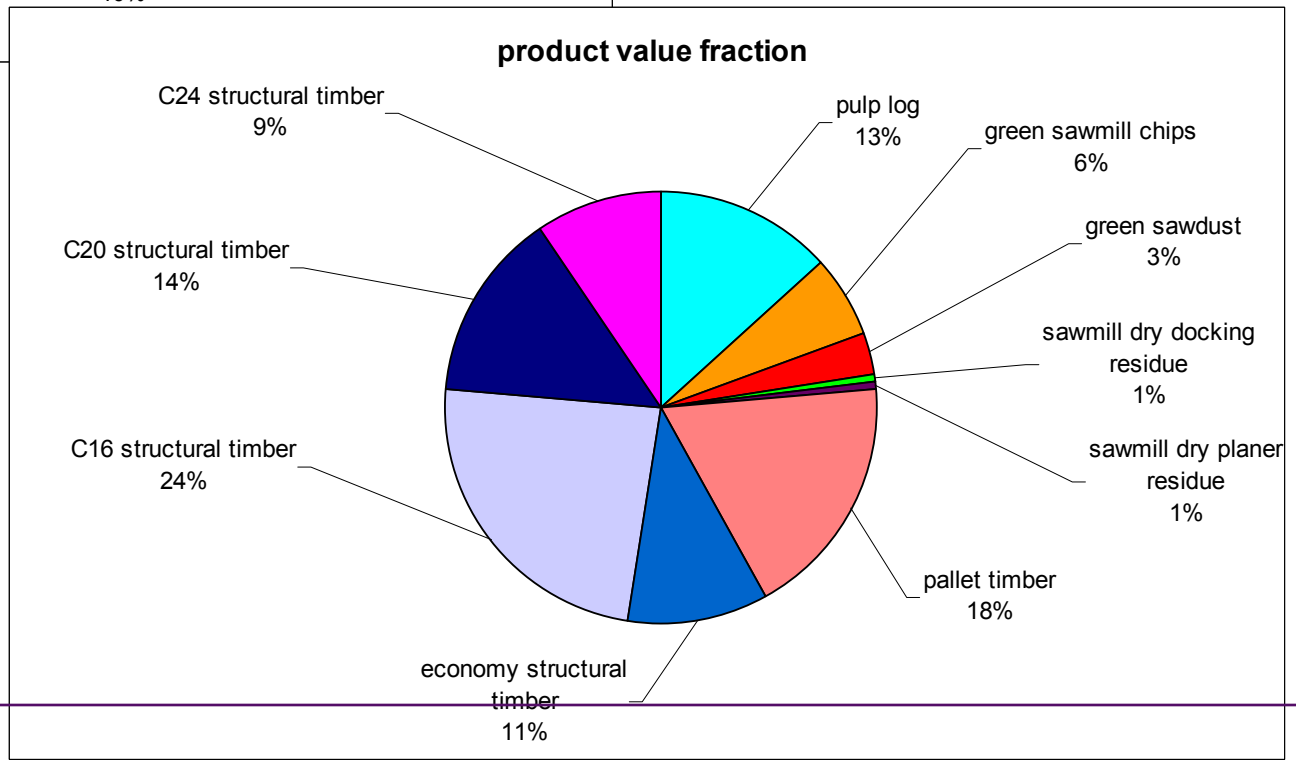


In the Forest




product volume fraction
C20 structural timber 6%
C24 structural timber 3%
C16 structural timber 12%
pulp log 30%
economy structural timber 7%
pallet timber 10%
sawmill dry planer residue 2%
green sawmill chips 19%
sawmill dry docking residue 1%
green sawdust 10%

At the Mills


product value fraction
C24 structural timber 9%
pulp log 13%
green sawmill chips 6%
green sawdust 3%
C20 structural timber 14%
sawmill dry docking residue 1%
C16 structural timber 24%
sawmill dry planer residue 1%
pallet timber 18%
economy structural timber 11%

Economic weights

- Defined as the change in £ of end product due to an increase in the trait mean by one unit.
- This means 500m^3 to 501m^3
- Or Stem Score 3 to Stem Score 2
- But 0.5 kg/m3 to 1.5 kg/m3
- *Value weights* are estimated which represent the change in overall profitability associated with an increase of 10% for each trait independently:
- So 500 to 550; 3 to 3.3; 0.5 to 0.55

Assumed genetic correlations between selection traits

	dbh10	pilodyn	stem score	branch score	stress wave velocity
dbh10	1	0.7	-0.2	0.2	-0.5
pilodyn	0.7	1	0.1	0.1	-0.5
stem score	-0.2	0.1	1	0.3	-0.1
branch score	0.2	0.1	0.3	1	0
stress wave velo	-0.5	-0.5	-0.1	0	1

Assumed genetic correlations between selection traits (at selection age) and objective traits (at rotation age).

	MAI	RIN-39 stem form	basic density	MOE	branch size
dbh10	0.7	0	-0.5	-0.4	0.1
pilodyn	0.4	0	-0.7	-0.4	0
stem score	0	-0.7	0	0	0.2
branch score	0	0	0	0	0.7
stress wave velo	-0.4	0	0.3	0.6	0

Selection index coefficients for various combinations of traits, 9 combinations depicted

selection trait	weight unit	weight set								
		1	2	3	4	5	6	7	8	9
dbh10	PI per [cm]	4.6%	3.6%	3.2%					4.4%	3.5%
pilodyn	PI per [mm]	-1.1%			1.3%				-1.1%	
stem score	PI per [1-6 score]	-0.7%	-1.5%			-4.5%			-0.9%	-1.6%
branch score	PI per [1-6 score]	-6.8%	-6.4%				-5.3%		-6.7%	-6.3%
stress wave velocity	PI per [km/s]							-3.8%	-0.8%	-0.5%
standard deviation of multi-trait gain		6.86%	6.74%	4.84%	2.44%	3.53%	3.51%	2.87%	6.88%	6.75%

SFT asked me to investigate various extremes to test out the model

- Option 1 all sawlogs to grade out at C16 in the sawmill;
- Option 2 all sawlogs to grade out at C24 in the sawmill;
- Option 3 no regard for quality at the mill - just grow for pallet wood;
- Option 4 assume a greater proportion of green logs will be cut but still for the C16 market.
- Table of weights

Table of weights to be applied according to assumption variations

3.5 % interest rate

selection t	weight set									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
dbh10	1	1	1	0	0	0	0	1	1	1
pilodyn	1	0	0	1	0	0	0	1	0	0
stem scor	1	1	0	0	1	0	0	1	1	0
branch sc	1	1	0	0	0	1	0	1	1	1
stress wa	0	0	0	0	0	0	1	1	1	0

Profit Index

	5.26%	**5.16%**	**3.50%**	**1.62%**	**2.96%**	**2.86%**	**2.15%**	**5.29%**	**5.17%**	**5.04%**	**YC 20 all C16**
29%	1.00	0.98	0.67	0.31	0.56	0.54	0.41	1.00	0.98	0.96	**Default log mix**
	5.48%	**5.38%**	**3.74%**	**1.78%**	**3.01%**	**2.89%**	**2.29%**	**5.51%**	**5.39%**	**5.27%**	**YC 18 all C16**
25%	1.00	0.98	0.68	0.33	0.55	0.53	0.42	1.00	0.98	0.96	**Default log mix**
	5.71%	**5.61%**	**4.00%**	**1.95%**	**3.06%**	**2.92%**	**2.44%**	**5.74%**	**5.62%**	**5.52%**	**YC 16 all C16**
21%	1.00	0.98	0.70	0.34	0.53	0.51	0.43	1.00	0.98	0.97	**Default log mix**

	1	2	3	4	5	6	7	8	9	10
dbh10	1	1	1	0	0	0	0	1	1	1
pilodyn	1	0	0	1	0	0	0	1	0	0
stem scor	1	1	0	0	1	0	0	1	1	0
branch sc	1	1	0	0	0	1	0	1	1	1
stress wa	0	0	0	0	0	0	1	1	1	0

Profit Index

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21%	1.00	0.98	0.70	0.34	0.53	0.51	0.43	1.00	0.98	0.97	**Default log mix**
	16%	**16%**	**3%**	**2%**	**10%**	**14%**	**2%**	**16%**	**16%**	**15%**	**YC 20 all C24**
71%	1.00	1.00	0.17	0.11	0.63	0.88	0.10	1.00	1.00	0.95	**Veg prop**
	16%	**16%**	**3%**	**2%**	**10%**	**14%**	**2%**	**16%**	**16%**	**15%**	**YC 18 all C24**
66%	1.00	1.00	0.20	0.12	0.63	0.88	0.12	1.00	1.00	0.96	**Veg prop**
	16%	**16%**	**3%**	**2%**	**10%**	**14%**	**2%**	**16%**	**16%**	**15%**	**YC 16 all C24**
60%	1.00	1.00	0.22	0.14	0.63	0.87	0.14	1.00	1.00	0.96	**Veg prop**

	1	2	3	4	5	6	7	8	9	10
dbh10	1	1	1	0	0	0	0	1	1	1
pilodyn	1	0	0	1	0	0	0	1	0	0
stem scor	1	1	0	0	1	0	0	1	1	0
branch sc	1	1	0	0	0	1	0	1	1	1
stress wa	0	0	0	0	0	0	1	1	1	0

Profit Index

	5.26%	5.16%	3.50%	1.62%	2.96%	2.86%	2.15%	5.29%	5.17%	5.04%	YC 20 all C16
29%	1.00	0.98	0.67	0.31	0.56	0.54	0.41	1.00	0.98	0.96	Default log mix
	5.48%	5.38%	3.74%	1.78%	3.01%	2.89%	2.29%	5.51%	5.39%	5.27%	YC 18 all C16
25%	1.00	0.98	0.68	0.33	0.55	0.53	0.42	1.00	0.98	0.96	Default log mix
	5.71%	5.61%	4.00%	1.95%	3.06%	2.92%	2.44%	5.74%	5.62%	5.52%	YC 16 all C16
21%	1.00	0.98	0.70	0.34	0.53	0.51	0.43	1.00	0.98	0.97	Default log mix
	16%	16%	3%	2%	10%	14%	2%	16%	16%	15%	YC 20 all C24
71%	1.00	1.00	0.17	0.11	0.63	0.88	0.10	1.00	1.00	0.95	Veg prop
	16%	16%	3%	2%	10%	14%	2%	16%	16%	15%	YC 18 all C24
66%	1.00	1.00	0.20	0.12	0.63	0.88	0.12	1.00	1.00	0.96	Veg prop
	16%	16%	3%	2%	10%	14%	2%	16%	16%	15%	YC 16 all C24
60%	1.00	1.00	0.22	0.14	0.63	0.87	0.14	1.00	1.00	0.96	Veg prop
	4.68%	4.39%	4.09%	1.76%	1.68%	0.71%	2.37%	4.71%	4.40%	4.37%	YC 20 all Pallet
33%	1.00	0.94	0.87	0.38	0.36	0.15	0.51	1.01	0.94	0.93	Veg prop
	4.93%	4.64%	4.33%	1.92%	1.73%	0.74%	2.52%	4.96%	4.66%	4.63%	YC 18 all Pallet
29%	1.00	0.94	0.88	0.39	0.35	0.15	0.51	1.01	0.94	0.94	Veg prop
	5.20%	4.92%	4.60%	2.09%	1.78%	0.76%	2.67%	5.23%	4.93%	4.91%	YC 16 all Pallet
25%	1.00	0.95	0.88	0.40	0.34	0.15	0.51	1.01	0.95	0.94	Veg prop
	4.82%	4.53%	4.22%	1.85%	1.71%	0.73%	2.45%	4.85%	4.54%	4.52%	YC 18 all Pallet
31%	1.00	0.94	0.88	0.38	0.35	0.15	0.51	1.01	0.94	0.94	Seed Orchard
	5.72%	5.65%	3.56%	1.71%	3.37%	3.39%	2.22%	5.75%	5.67%	5.50%	YC 20 all C16
28%	1.00	0.99	0.62	0.30	0.59	0.59	0.39	1.00	0.99	0.96	More green logs
											Veg prop
	5.58%	5.51%	3.40%	1.60%	3.33%	3.36%	2.12%	5.60%	5.52%	5.34%	YC 20 all C16
31%	1.00	0.99	0.61	0.29	0.60	0.60	0.38	1.00	0.99	0.96	More green logs
											35-yr rotation
											Veg prop
	6.10%	6.07%	3.45%	1.79%	3.75%	3.97%	2.20%	6.13%	6.09%	5.87%	YC 20 all C16
30%	1.00	1.00	0.57	0.29	0.62	0.65	0.36	1.00	1.00	0.96	Even more green logs
											Veg prop
	5.95%	5.93%	3.29%	1.68%	3.70%	3.92%	2.10%	5.98%	5.94%	5.72%	YC 20 all C16
33%	1.00	1.00	0.55	0.28	0.62	0.66	0.35	1.00	1.00	0.96	Even more green logs
											35-yr rotation
											Veg prop

Conclusions

- The model is a tool for investigating different breeding and production options.
- Dependent on the accuracy of input variables and inter-relationship between traits
- Only breeding for C24 makes a real difference to PI;
- DBH is the main driver;
- Quality traits more important as quality products are screened out in the forest and sawmill.
- The *status quo* should be retained in terms of traits we select for + emphasis placed on those traits.