Economics of silvoarable agroforestry

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Aston University

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Content

Agroforestry encompasses a very wide range of systems, but this talk is focused solely on the profitability of silvoarable alley-cropping systems to the farmer.

It ignores wider societal benefits and is primarily focused on two studies.

2003: Financial appraisal of silvoarable systems with poplar in UK based on Burgess et al. (2003)

2007: Financial appraisal of silvoarable systems in Spain and France based on Graves et al. (2007)

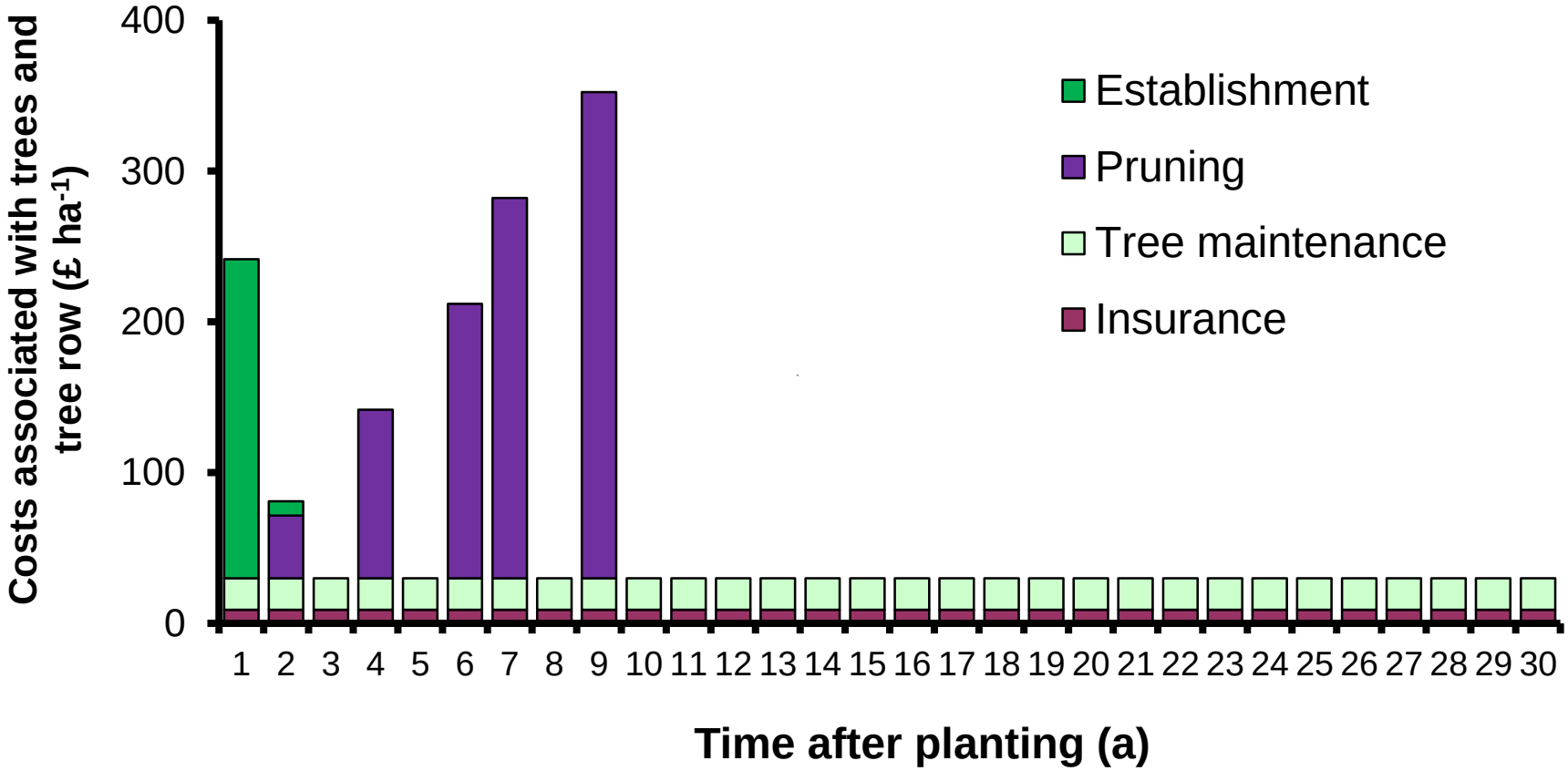
It concludes with some current thoughts in 2017

Silvoarable agroforestry with poplar

The response of poplar at 10 m spacing was measured.

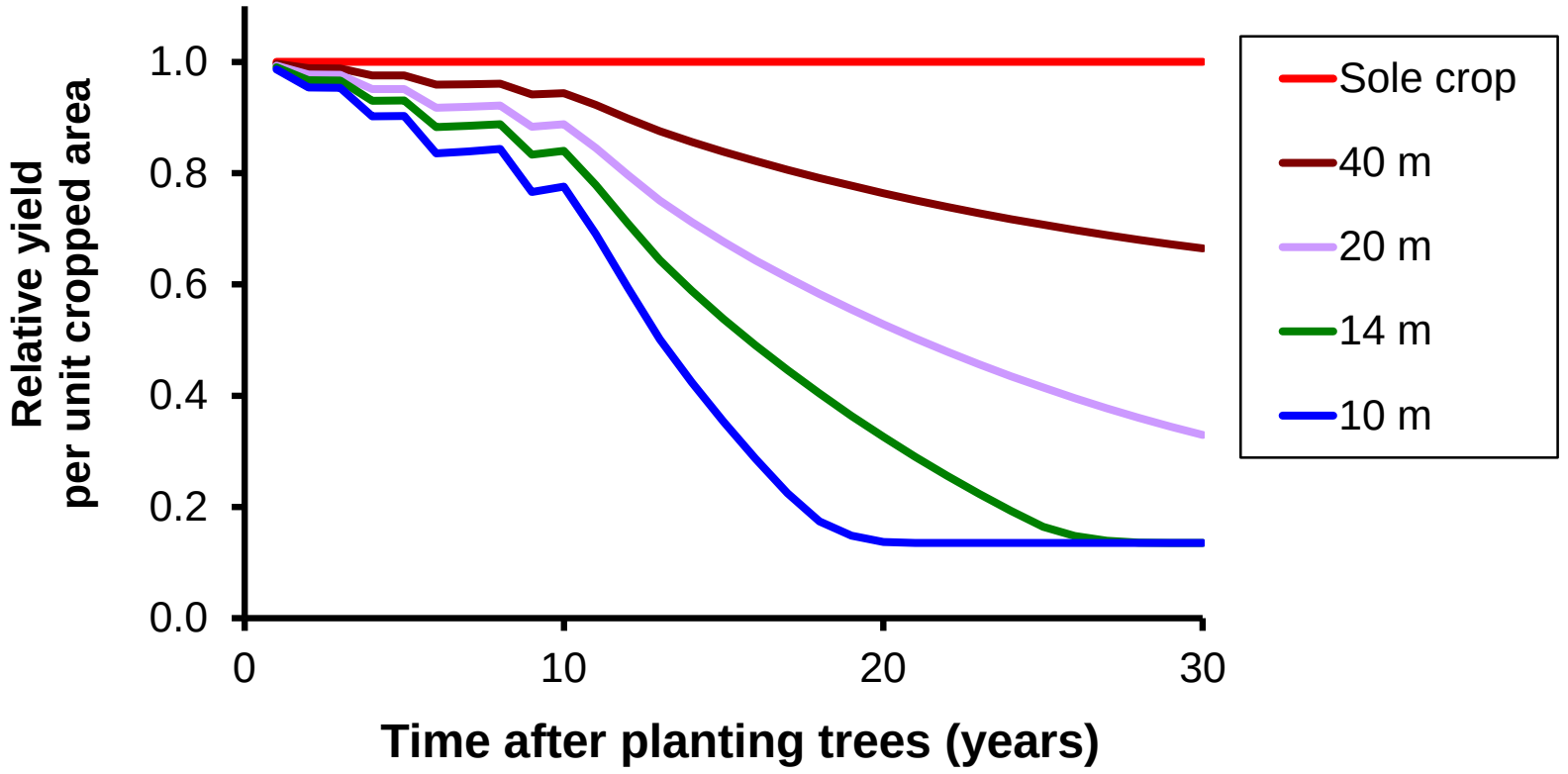
The profitability of silvoarable agroforestry with poplar at four different spacings (10, 14, 20 and 40 m) were modelled and compared with an arable rotation and two forestry systems (poplar planted at spacings of 8 m x 8 m or 4 m x 2 m).

Costs of tree management



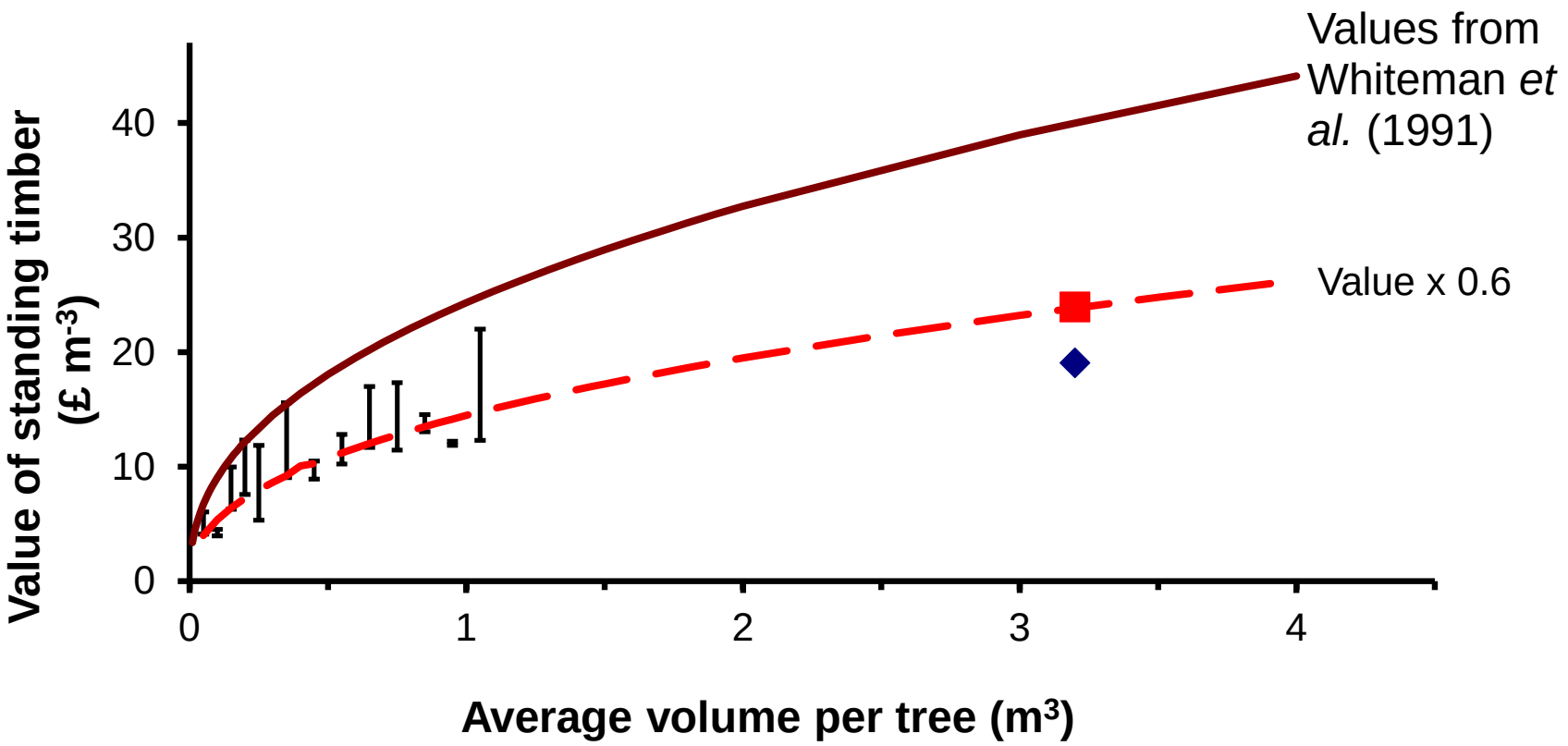
Assumptions: the costs of establishing and maintaining a 156 tree ha^{-1} silvoarable system with poplar; understorey management costs of the tree row were an additional £30-70 ha^{-1} per year during cropping (from Burgess et al., 2003).

Predicted relative crop yield during the rotation of the tree crop depends on the alley width



Assumptions: 10 m results based on field measurements; other results based on modelling; study based on 30 year tree rotation and poplar of yield class 14 (Burgess et al. 2003)

Assumed value of timber



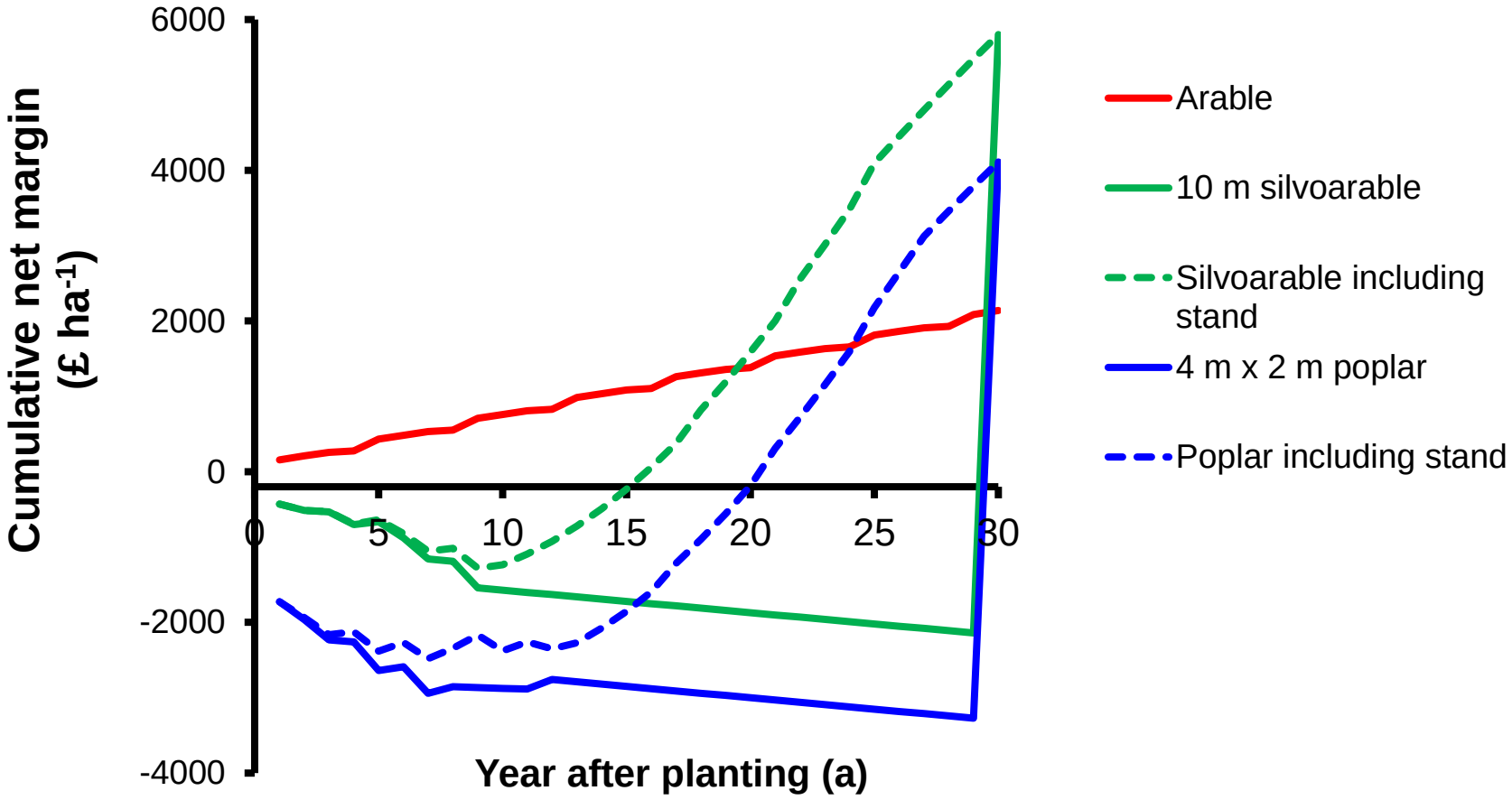
Predicted long-term price curve for the standing value of hardwood (Hart 1994, quoting Whiteman et al. (1991) and estimates for poplar based on calculation from Davenport (1995) ■ and prices in 2003: ◆. The bars show the highest and lowest mean prices received for standing softwood sales in 2000 and 2001 (Forestry Commission, 2003) (From Burgess et al., 2003)

Length of profitable cropping (years) depends on alley width and cereal price

Tree-row	Price of feed wheat (£ t^{-1})							
spacing	-20%	-10%	Base	+10%	+20%	+30%	+40%	+50%
	£50	£57	£63	£69	£76	£82	£88	£95
10-m	1 year	1	5	9	10	11	11	13
14-m	1	1	5	10	13	13	13	13
20-m	1	1	9	13	13	14	17	17
40-m	1	1	13	17	21	26	30	30

Cereal prices were lower in 2003 than 2017. Assumptions: based on 2003 prices and costs assuming no grants. Rotation is based on a rotation of wheat (9.61 t ha^{-1} at £63 t^{-1}), wheat (8.17 t ha^{-1} at £63 t^{-1}), barley (7.77 t ha^{-1} at £60 t^{-1}) and oilseed rape (3.2 t ha^{-1} at £135 t^{-1}). Maximum cropping period of 30 years set by tree rotation (Burgess et al., 2003)

Predicted cumulative cash flows assuming no grants (0% discount rate)



More even cash flow with the arable system (in red) than the silvoarable or forest system in the absence of grants (Burgess et al., 2003).

Choice of discount rate

HM Treasury assumes a discount rate of 3.5% for government projects

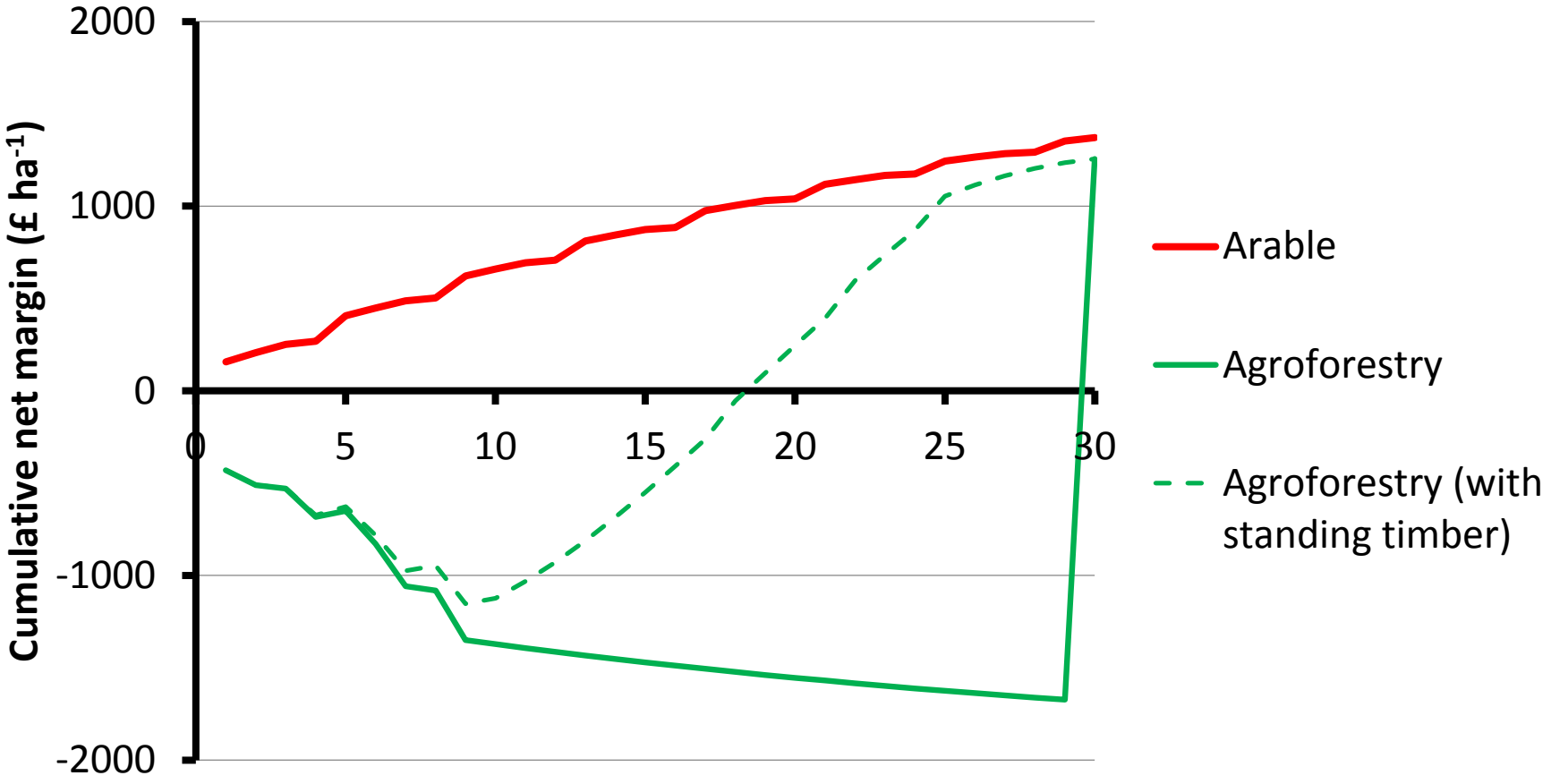
The choice of discount rate *r* comprises:

$r = L + \delta + \mu.g$

- Catastrophe risk (*L*) (e.g. natural disasters, war) (Assumed value by HM Treasury = 1.0)
- Pure time preference (δ) (individuals' preference for consumption now, rather than later, with an unchanging level of consumption per capita over time) (0.5)
- A decline in the marginal "utility" of future values as the individual gains more resources (*μ.g*) (2.0)

Duquette et al. (2011) in a study of America farmers reported actual discount rates of at least 28%

Predicted cumulative cash flows assuming no grants (3.5% discount rate)



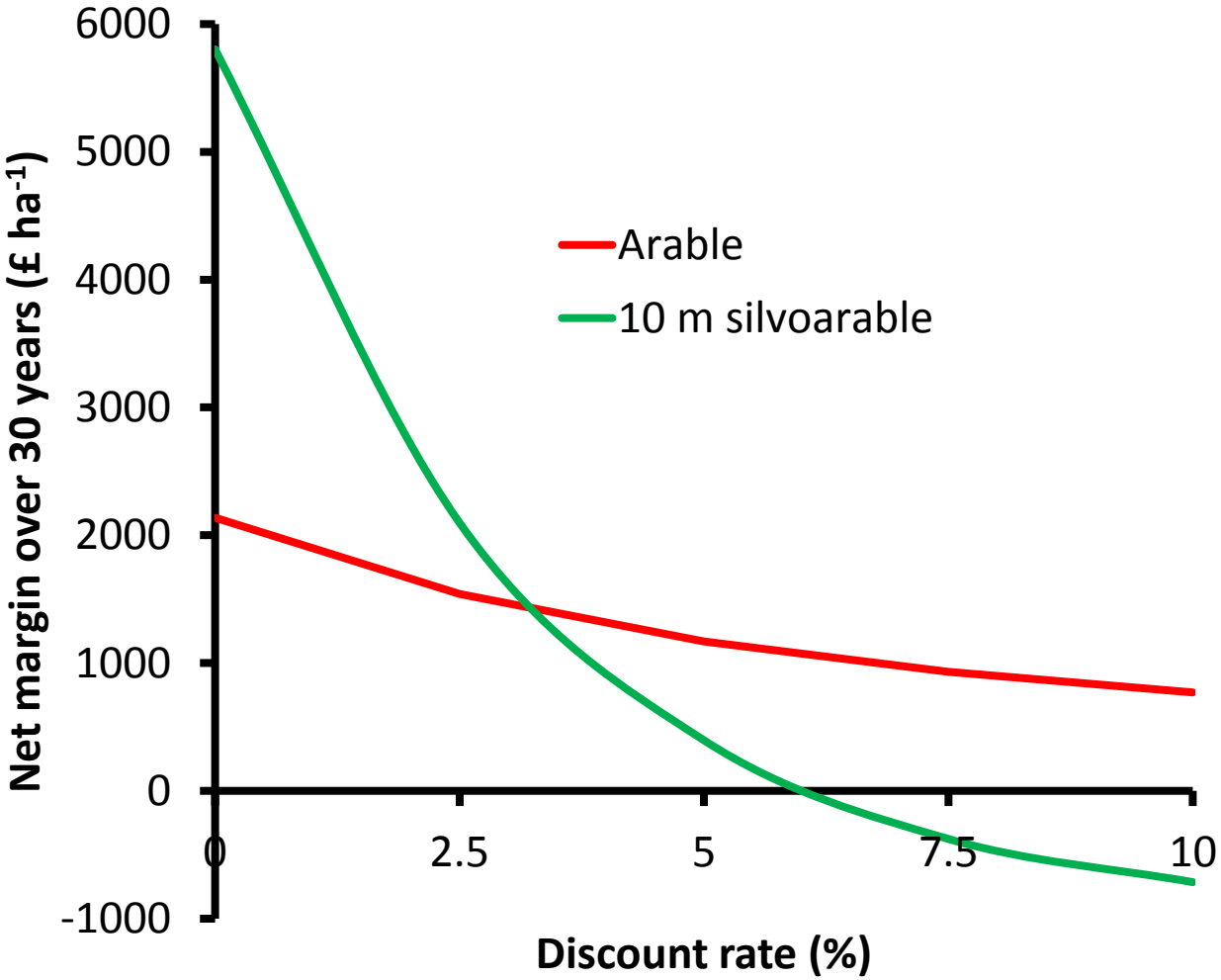
After 30 years at 3.5% discount rate, the net margin of the arable system (£1372 ha^{-1}) was greater than that of the silvoarable (£1255 ha^{-1}) (Burgess et al., 2003)

Predicted net revenue (£ ha^{-1}) from agriculture, four silvoarable systems and two forestry systems assuming no grants

	Arable crop	Silvoarable				Poplar	Poplar
		40 m x 6.4 m	20 m x 6.4 m	14 m x 6.4 m	10 m x 6.4 m	8 m x 8 m	4 m x 2 m
Crop period		**13 year**	**9 year**	**5 year**	**5 year**		
Crop income	15,249	6,028	3,943	2,155	1,976	0	0
Crop costs	13,111	5,392	3,540	1,878	1,753	0	0
Timber income	0	1,993	3,986	5,723	7,972	7,972	7,891
Cost (woodland)	0	833	1,352	1,795	2,394	2,377	3,781
Net margin at discount rate of:							
0.0%	2,138	1,795	3,036	4,205	**5,801**	5,595	4,110
2.5%	1,540	870	1,203	1,540	**2,098**	1,905	593
5.0%	**1,170**	435	359	350	396	213	(1,046)
7.5%	**932**	227	(26)	(200)	(376)	(552)	(1,809)
10.0%	**771**	126	(197)	(440)	(714)	(884)	(2,157)

The yield class of the poplar was assumed to be 14.
Values from Burgess et al. (2003)
Note: Silvoarable calculations are based on cropping until specified year and then grazing at no net charge; negative values are shown in brackets.

Effect of discount rate on net margin assuming no grants and subsidies



At low discount rates, the value of the timber in 30 years dominates; at high discount rate the value of timber in 30 years is minimal

Grants in 2003

Arable

- Arable area payment of £227 ha^{-1} for cereals and set-aside and £261 ha^{-1} for oilseed rape

Poplar

- In 2003, under the Government's Woodland Grant Scheme (WGS), farmers could receive a planting grant of up £1,950 ha^{-1}, when establishing poplar at 1,100 trees per hectare.
- Farm Woodland Premium Scheme (£300 ha^{-1} a^{-1}) for 10 years

Silvoarable

- 276 ha^{-1} a^{-1} planting grant
- No eligibility for Farm Woodland Premium Scheme
- Pro-rata arable area payment available as long as cropping take place

Predicted net revenue (£ ha^{-1}) from agriculture, four silvoarable systems and two forestry systems assuming grants (as of 2003)

	Agriculture	Silvoarable	Silvoarable	Silvoarable	Silvoarable	Poplar	Poplar
		40 m x 6.4 m	20 m x 6.4 m	14 m x 6.4 m	10 m x 6.4 m	8 m x 8 m	4 m x 2 m
		YC=14	YC=14	YC=14	YC=14	YC=14	YC=14
		30 years	25 years	17 years	13 years[1]		
Crop income	15249	12118	8416	5826	4321	0	0
Grant income (crop)	**6810**	**6470**	**5108**	**3308**	**2361**	0	0
Crop costs	13111	12455	9814	6359	2141	0	0
Timber income	0	1993	3986	5723	7972	7972	7891
Tree grants	**0**	**67**	**134**	**198**	**276**	**3791**	**4950**
Cost (woodland)	0	926	1531	1958	2635	2377	3781
0% discount	8947	7267	6299	6738	7854	**9386**	9059
2.5%	**6410**	4954	3941	3788	3954	5382	5197
5%	**4834**	3623	2703	2329	2089	3426	3264
7.5	**3814**	2814	2016	1579	1180	2438	2253
10.0	**3125**	2293	1611	1176	728	1917	1693

Assumptions: comparison assuming grant arrangements in 2003 (where set-aside was not an option)

[1]: Silvoarable calculations based on cropping until year 13, and arable area placed to pasture until year 30.

Conclusions in 2003

- **Estimate of timber value is critical but difficult to estimate**
- **Duration of profitable crop rotation increases with alley width and higher crop prices**
- **Arable provides a more even cash flow than forestry.**
- **Silvoarable systems improve cash flow compared to forestry.**
- **Choice of discount rate is critical**

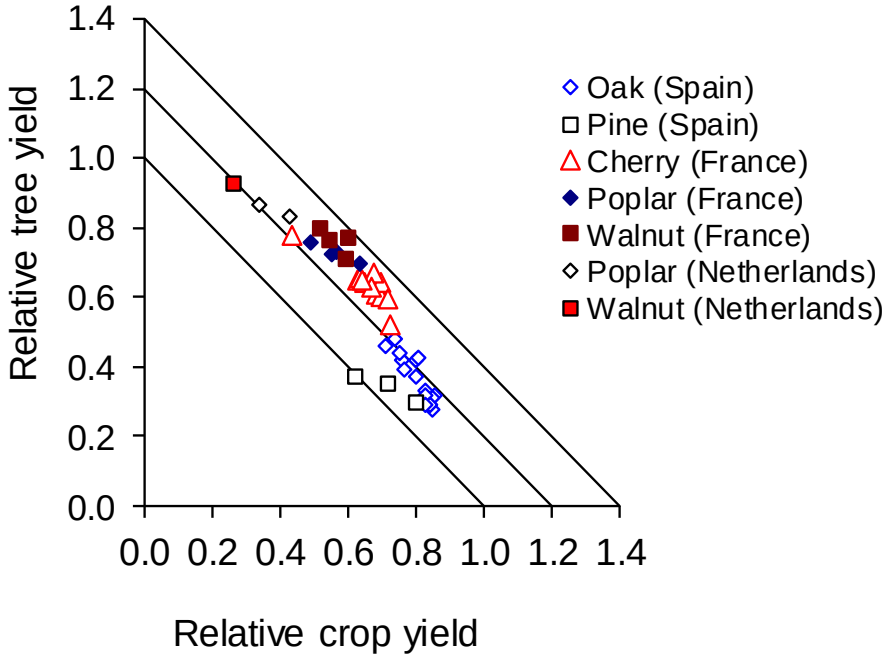
  Without grants, at 0% you would choose silvoarable;
  at 4% an arable system

- **Impact of grants**

  Grants in 2003 favoured high density tree planting or continued cropping, and penalised mixed cropping

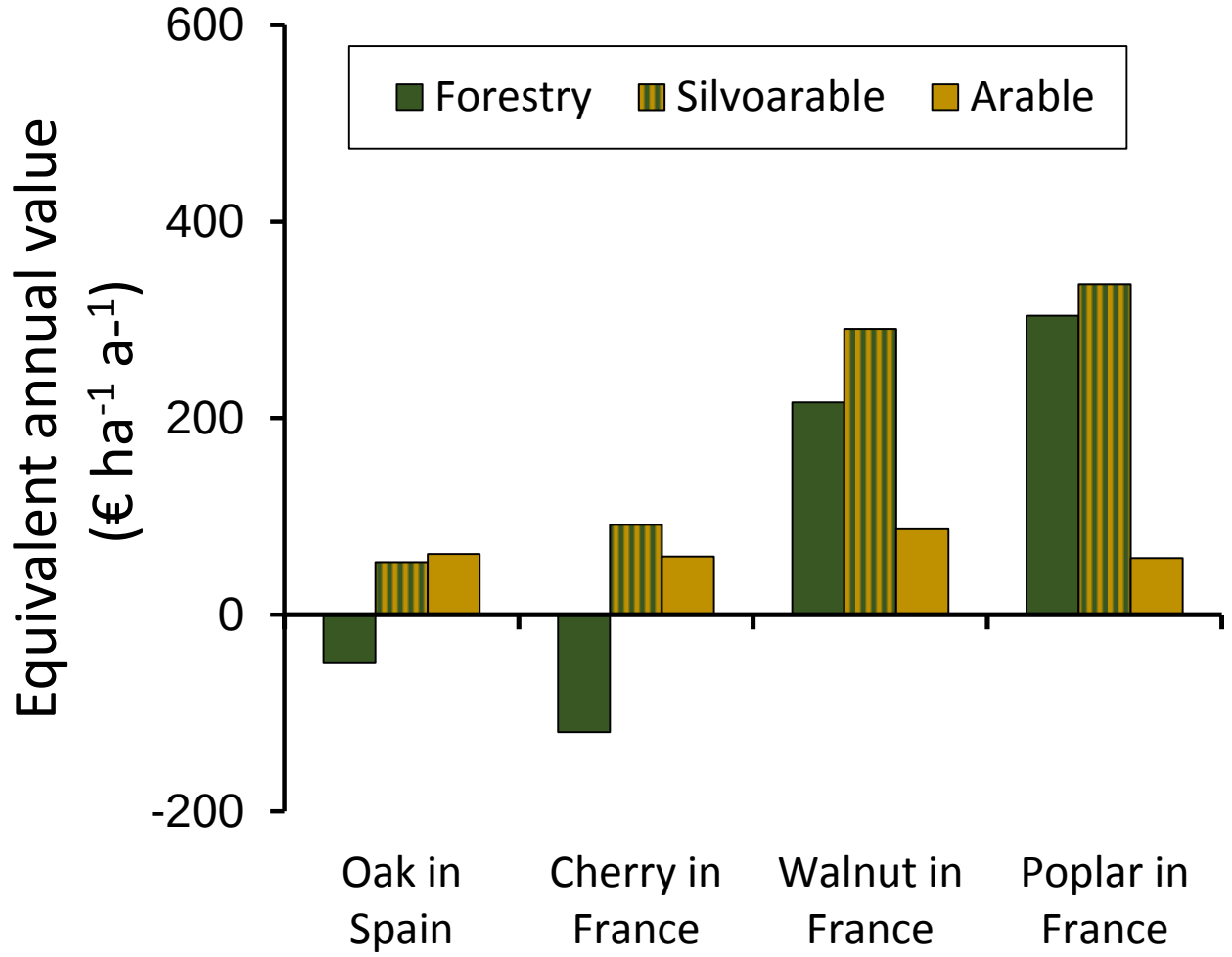
Production and financial benefits


Wheat and walnut agroforestry (copyright Agroof)



Whilst agroforestry rarely results in a higher tree yield than forestry or a greater crop yield than arable systems, Graves et al (2007) reported that intercropping widely-spaced high-value walnut trees in France can increase production

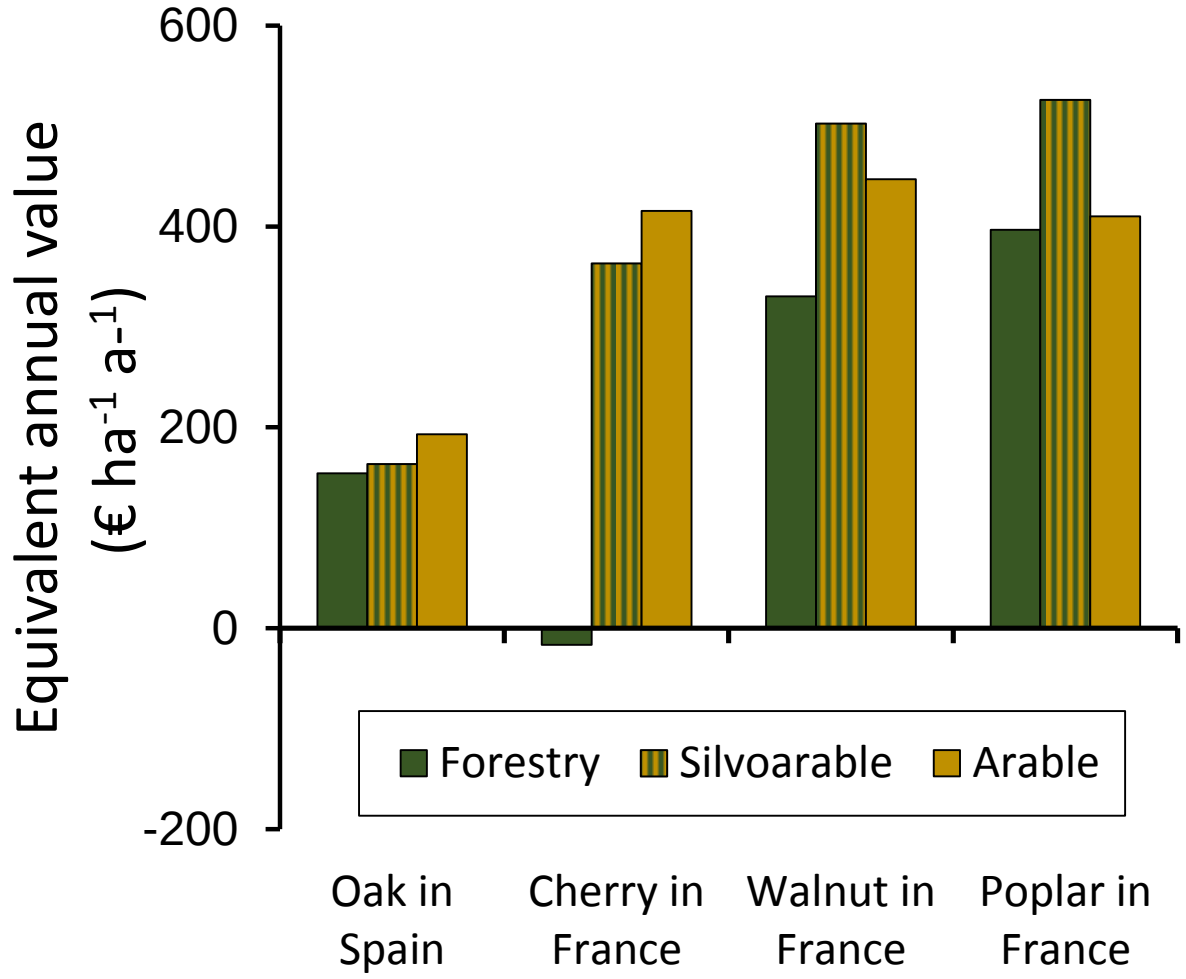
No grants: comparison of profitability of forestry, silvoarable and arable



The fast growth of poplar in France, and the high value of walnut timber meant that silvoarable systems in France were competitive with forestry systems and arable systems (for specific details see Graves et al. 2007);

Assumptions: discount rate of 4% without grants

With grants: comparison of profitability of forestry, silvoarable and arable



The grant systems favoured the arable systems. However silvoarable systems with walnut and poplar still appeared beneficial (Graves et al. 2007)

An annual benefit of €55 to €116 ha^{-1} reported for walnut and poplar in France

Is this sufficient to compensate for the complexity and risk?

Assumptions: discount rate of 4%; grants as of 2005; single farm payments on cropped area.

2017: Silvoarable agroforestry providing a financial benefit

The European Agroforestry Focus Group visited the walnut silvoarable system at Les Eduts in December 2016

The financial rationale has been reported to be based on the high value of walnut timber, but the system has also been designed to ensure receipt of basic payments

40-year-old walnut-cereal silvoarable system at Les Eduts in Charente-Maritime, France, with barley being harvested on 5 July 2016 (Photograph by Philippe Van Lerberghe)

2017: Silvoarable agroforestry providing a financial benefit

This biodiverse organic system is well-adapted to the current grant system including apple trees (an agricultural crop) and wildflower rows (eligible for agri-environment payments)

Stephen Briggs of Whitehall Farm, near Peterborough, has planted apple trees and wildflower strips at a 24 m spacing to provide an additional crop, protect the soil, and enhance biodiversity within an organic cereal system (Photo credit: Stephen Briggs)

2017: Silvoarable agroforestry providing a financial benefit

Some farmers are planting mixed species of trees to improve the environmental conditions for organic vegetable crops i.e. reduced wind speeds; improved functional biodiversity; rotation management within field.

Silvoarable system with 20 m rows at Tolhurst Organics June 2015 (Smith and Venor, 2015)

Conclusions

- The profitability of a timber-based silvoarable system is very sensitive to the discount rate and the value of the timber.
- Silvoarable systems can be an cost-effective way of establishing trees, particularly if basic payments can be maintained.
- Bio-economic models predict that silvoarable system are more profitable than the comparable forestry or arable systems, because of the increased land productivity.
- However this modelling may underestimate the costs associated with complexity and administration.
- There are options to maximise grants such as planting fruit tree species and integrating wildflower mixes
- Whilst the benefits of producing two crops (i.e. a tree and an arable crop) can be attractive, the critical argument for integrating trees on most farms will be that it improves the sustainability of the main enterprise.

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