EIP-AGRI Focus Group Agroforestry

MINIPAPER: Financial Impact of Agroforestry – 27 April 2017

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Financial Impact of Agroforestry

1. Introduction

1.1. Agroforestry has been concisely described as "farming with trees". The majority of agroforestry systems across Europe are wood pastures including the dehesas and montados in Spain and Portugal and other forms of wood pasture across Europe. Mosquera-Losada et al. (2016) have also highlighted the importance of homegardens within the EU, and many of these will incorporate agroforestry. However this Focus Group is primarily concerned with the introduction of agroforestry within "conventional" arable and livestock systems. Examples of such agroforestry systems include new hedgerow systems, silvoarable agroforestry, and the integration of trees in livestock and poultry systems.

1.2. There are many reasons why farmers may consider agroforestry. Profitability of the system is not the only driver, but it can be important. When 264 farmers across Europe were asked about their perceptions of silvoarable agroforestry, the most positive benefit was perceived to be profitability (27%) followed by improvement of the environment (22%) (Graves et al., 2007).

1.3. Management can be defined as "the process of making informed decisions and allocating resources to achieve one or more objectives". Farmers have access to various forms of resources or capital: natural, social, human, manufactured, and financial (i.e. money). They also have multiple objectives. Financial performance is a measure of the efficiency of different options in terms of the use of money. The analysis can be done from the perspective of an individual farmer (i.e. financial) or a wider societal perspective (i.e. economic). This minipaper focuses on the financial impact of agroforestry from a farmer's perspective.

1.4. The financial performance of a new agroforestry practice is normally completed against a "counterfactual". Depending on the circumstance, this can be a "forestry" and/or the existing arable or livestock system.

1.5. A particular feature of agroforestry is the long-time period required for the trees to complete a rotation. It may take, for example, 60-100 years for an oak tree in Northern Europe to reach a harvestable size. This has two implications. Firstly financial analyses of agroforestry systems tend to require predictions and/or biophysical models of long-term tree growth. Secondly financial analyses need to take account of the general preference for having money now rather than in the future.

1.6. The general preference for having money now rather than in the future can be addressed through the use of a discount rate. When the UK government undertakes a project, they assume a discount rate of 3.5% (HM Treasury, 2011) i.e. £1.00 this year is considered equivalent to £1.035 in 12 months' time. This choice of a discount rate of 3.5% is derived from the sum of three components (HM Treasury, 2011). These are an assumed risk of national catastrophe (e.g. natural disasters, war) of 1.0%, a pure time preference for consumption now, rather than later, assuming no change in income of 0.5%, and 2% attributed to a decline in the marginal "utility" of future consumption because the consumption tends to increase with time (HM Treasury, 2011). Hence if future annual increases in consumption are lower than 2%, then the appropriate discount rate could be lower. Some commentators argue that over the next 50 years as global population growth rates declines below 1% (Worldometers, 2017), economic growth of 2% becomes increasingly unlikely. By contrast, unlike national governments, the discount rates used by individual farmers who are under immediate financial pressure can be substantially higher. For example Duquette et al. (2011) report that the effective discount rate used by some farmers is as high as 28%.

1.7. The implementation of agroforestry on arable and livestock farms within the European Union is strongly affected by the implementation of the subsidies associated with the Common Agricultural Policy. Farmers, with more than a minimal threshold of land, can receive basic and greening payments for agricultural land maintained in good agricultural and environmental condition. Continued receipt of such payments is a critical issue in the financial impact of agroforestry.

2. What do we know? Review of existing financial analyses

2.1. Burgess et al. (2003), working in the UK, completed a financial analysis of a silvoarable poplar system relative to a continued arable rotation and/or a poplar forestry system. They used the results from 11 years of a silvoarable experiment to develop a biophysical model to predict poplar growth and crop yields

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over a tree-rotation of 30 years. Assuming no grants, the sources of revenue were poplar timber and arable crops. It was assumed that the value of the poplar timber increased substantially as the tree became larger (e.g. Hart, 1994). For example, 1 m^3 of poplar was assumed to have a value of £14; a 3 m^3 of poplar was assumed to have a value of about £70. Hence there were benefits in focusing timber production on a smaller number of large trees, rather than a large number of small trees. Based on field measurements, 10 years after tree planting, the crop yield within relatively narrow 10 m alleys was 38-70% of that in control arable areas. Other costs included the side-pruning the trees to improve timber quality and the management of the tree rows. Using these assumptions, Burgess et al. (2003) reported that *in the absence of grants and assuming a discount rate of 5%,* over the 30 year period the net margin of the arable system (£1170 ha^{-1}) was greater than the 10 m x 6.4 m silvoarable system (£396 ha^{-1}) and a 2 m x 4 m poplar system (-£1046 ha^{-1}). By contrast, *assuming no grants and a lower discount rate of 2.5% over 30 years*, the net margin of the silvoarable system (£2098 ha^{-1}) was greater than that of the arable (£1540 ha^{-1}) and the forestry (£593 ha^{-1}) system. Hence the financial performance of agroforestry systems involving tree planting and relying on the harvest of timber are **very sensitive to the choice of discount rate**.

2.2. The net present value of agroforestry relative to an arable and forestry systems is only one measure of financial impact. Another key financial measure is the **effect on cash flow.** Because tree planting requires an upfront cost, and the income from timber is only achieved at some future stage in the tree rotation, the cash flow with an arable system is usually smoother than for an agroforestry system (Figure 1). However if you are looking to establish trees on an arable farm, then a silvoarable system may result in a more even cash flow than forestry.

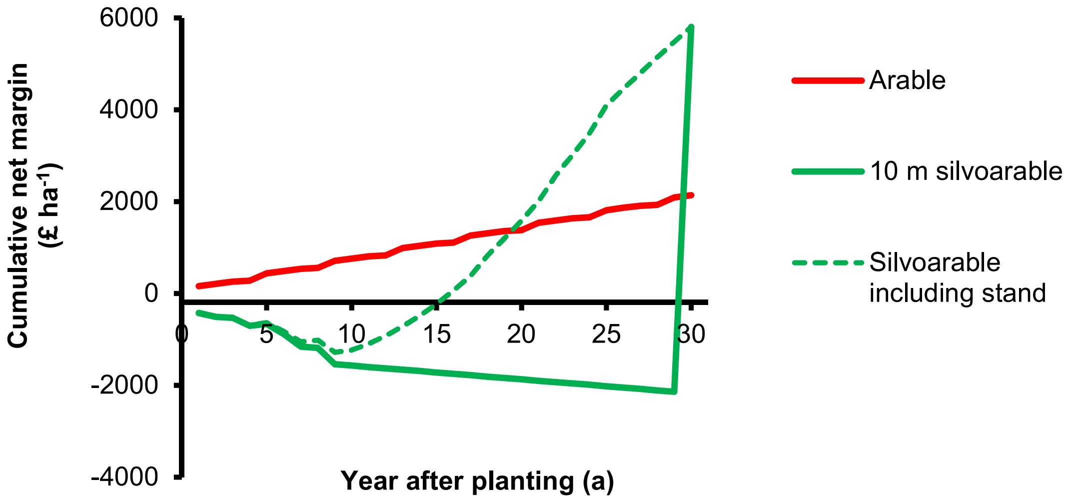

Figure 1. An arable system (indicated in red) usually results in a more even cash flow than the silvoarable system (indicated in green) which may be negative in the initial years. Although the value of the timber in the field accumulates during the 30 year rotation (dashed green line) it is only actualised in year 30 (Burgess et al., 2003). The illustrated values assume a discount rate of 0% and no grants.

2.3. Graves et al. (2007) completed a financial analysis of 42 new silvoarable systems, relative to arable and forestry systems, across France, Spain, and the Netherlands. Timber prices for oak, pine, cherry, walnut and poplar per m^3 were assumed to increase with tree size. The analysis used the Yield-SAFE biophysical model which assumes that greater capture of solar radiation and water by the integrated systems lead to higher yields than growing the trees and crops separately (Figure 2). Financial analysis, in the absence of grants and assuming a discount rate of 4% was completed for the 42 silvoarable systems relative to forestry and arable systems. In 17 cases, the arable system was most profitable, in two cases the forestry system was most profitable. In the remaining 23 cases, silvoarable agroforestry was most profitable; in 12 cases the relative benefit was less than €40 ha^{-1} a^{-1}, in 11 cases the benefit was greater. The systems creating an annual benefit of more than €40 ha^{-1} were all in France and involved the use of cherry, poplar, or walnut as the tree species.

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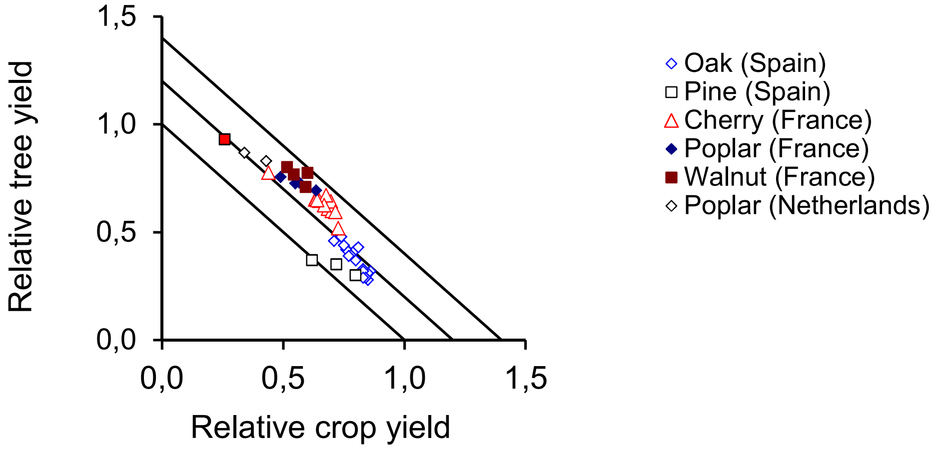

Figure 2. The integration of trees and crops (because of more effective use of solar radiation and water) were predicted to result in higher yields than growing the trees and crops separately. The systems considered were arable crops with walnut and poplar (France and the Netherlands), cherry (France), and oak and pine silvoarable systems (Spain) at 113 trees ha^{-1} (Graves et al. 2007).

2.4. Graves et al. (2007) repeated the analysis with arable and agroforestry grants; the agroforestry grants were assumed to be continued payment of arable area payments on the full areas and 50% of tree planting costs in the first four years. **The inclusion of grants favoured the arable systems**, with the arable system now most profitable in 28 of the 42 cases. There were 14 cases where the silvoarable system remained more profitable, and only eight systems where the equivalent annual value was greater than €50 ha^{-1}. The eight most profitable systems were all based in France with high value walnut or fast growing poplar.

2.5. Burgess et al. (2014) completed an analysis of the financial benefits of planting trees in a free-range egg production system. They reported that whilst consumers were paying up to a £0.15-0.20 premium for six "woodland" eggs, producers were only receiving an additional £0.01 per six eggs. Hence it was clear that there could be **a large difference between the premium paid by the consumer and that received by the farmer**. It was assumed that the agroforestry system comprised the planting of trees on 20% of one hectare, and there were 2,000 birds per hectare each laying 280 eggs per year. After making a number of assumptions (e.g. improvement in egg quality, an increased loss of eggs in the field, and a one-off reduction in land value), the analysis suggested that woodland planting was profitable for the farmer.

3. What is lacking? Critical review of limitations

3.1. Whilst Graves et al. (2007) demonstrated that silvoarable systems with poplar and walnut in France were more profitable than arable and forestry systems, the slow uptake of such systems suggests that either Graves et al. made some incorrect assumptions or there is a non-financial constraint on uptake.

3.2. A potential error in the assumptions of Burgess et al. (2003) and Graves et al. (2007) is that **the value of the wood per m^3 does not always increase with tree size**. Whilst such increases are observed with high value timber, in some cases the trees will only be used for firewood and the price received will not increase with tree size. For example at the walnut-arable system on Claude Jollet at Les Eduts in Western France, recent thinnings of walnut were sold for firewood rather than timber (AGFORWARD, 2016).

3.3. A second potential error is that the **predicted yields of wood do not occur in practice**. On the basis of measurements of tree growth after seven years, Burgess et al. (2005), using UK forestry tables, predicted a yield class (i.e. maximum mean annual increment) for poplar in the continuously-cultivated treatments of 14-20 m^3. With 11 years of data, Burgess et al. (2003) reduced the maximum yield class to 14 m^3. Subsequently measurements taken in 2011 (19 years after planting) indicated that the actual maximum mean annual increment had decreased to 9 m^3 ha^{-1} (Upson, 2014). Upson proposed that the initially high growth rates observed at the site were not maintained because of the relatively low rainfall at the site (about 600 mm) and disease pressure.

3.4. A third potential error is that the financial analysis **is the choice of an inappropriate discount rate and underestimates of the labour and administrative costs** associated with new systems. Neither Burgess et al. (2003) or Graves et al. (2007) considered the administrative costs associated with planning and administrating an agroforestry system. Such costs could quickly remove the assumed annual financial benefits of €50 ha^{-1}. In a review of the key negative perceptions of agroforestry, complexity and administrative costs rank highly (Graves et al, 2009). Lack of knowledge about potential labour costs and availability of labour can be a considerable non-financial constraint. Over-estimating the discount rate (perhaps because of current overestimates regarding long-term economic growth) may deter initial investment; under-estimating the discount rate may lead to inappropriate investment.

3.5. The fourth potential error is **the choice of the correct counterfactual.** The walnut-arable system of Claude Jollet at Les Eduts in Western France has often been highlighted as an example of growing walnut on arable land. However during our visit in November 2016, Claude Jollet explained that the land was previous forest land which he had cleared without the necessary permission (AGFORWARD, 2016). He was therefore obliged to reforest the area, and the most profitable way of doing this was to plant a silvoarable system with widely-spaced walnut, where he was also able to claim single farm payments. Hence in this example, the appropriate financial comparison is between agroforestry and a forestry system rather than an arable system.

3.6. A fifth potential issue that is not widely considered is **catastrophic risk**. Whereas livestock breeders can be aware of catastrophic risk (e.g. complete removal of breeding herd due to disease), arable farmers who face the complete destruction of an annual crop can simply replant a new crop in the next season. The value of a stand of trees may reduce to zero in a short period of time by storm damage vandalism, fire, pests or a disease. This risk may be moderated by planting mixed species and addressed through insurance.

3.7. A sixth issue rarely considered is financial analyses of agroforestry is the **effect of taxation.** Taxation, like subsidies and grants, is a governmental intervention that seeks to achieve societal goals. Taxation regimes are largely determined by at a national level and as there can be different tax regimes for 'agriculture' and 'forestry', national definitions can be important. For example, the definition of "agriculture" in the UK is quite broad (UK Government, 1995; Erwood, 2015) and it includes "the use of land for woodlands where that use is ancillary to the farming of land for other agricultural purposes". Hence revenue from farmland trees in the UK is susceptible for income tax (Strutt and Parker, 2015) and such areas can be eligible for agricultural property relief which minimises inheritance tax. By contrast the tax regime for trees grown in commercial UK forests is different. In this case, there is no income tax on timber income and no capital gains tax payable on asset appreciation of timber, but there may be capital gain tax related to the "land" component of forest land. Interestingly different EU grants can also have different tax implications. For example income tax may not be payable on some grants, but it may be payable on income compensation payments (Scottish Woodlands, 2015). Such differences highlight that there is the potential for a nation's taxation regime to have differential impacts on the financial value of trees in agricultural or forestry systems.

3.8. A seventh issue to consider is the interaction between agroforestry, **land ownership**, and **land prices**. In France, about 75% of the agricultural area in 2010 was tenanted (Eurostat 2012a), whereas in the UK about 70% of the land is farmed by the people who owned it (Eurostat 2012b). As a general rule, the establishment and management of trees is less complicated on owner-managed farms. Sandars (1999) argued that in the UK the positive effect of trees on farm prices was likely to be least where the market was limited to those with an interest in arable farming, and greatest where the trees offered shelter, shooting/recreation or landscape benefits to farmers or "lifestyle" buyers.

4. What is needed? Conclusions

4.1. There is a balance to be achieved by agroforestry economists when they are asked to both "promote" agroforestry and determine the profitability of agroforestry. As indicated above, some of the assumptions made in agroforestry modelling may need refinement.

4.2. A conclusion of Graves et al. (2007) was that silvoarable agroforestry was likely to be of greatest interest where the profitability of the tree system was similar to that of the arable system; otherwise the owner would be best advised to focus on either the more profitable arable or forestry system. However many of the practical examples of where agroforestry seem to be implemented on a conventional arable or livestock farm, is **to make the main enterprise more sustainable.** An example of this is "woodland eggs". Similarly, Stephen Briggs has planted a silvoarable system in order to reduce soil erosion on his peatland arable farm in Eastern England.

4.3. Some agroforestry promotion is focused on the improvement of grants. However in the absence of progress, some farmers are particularly adept at finding agroforestry combinations that do not invalidate single-farm or basic payments. For example planting agricultural crops such as apple trees allow the farmer to retain his land as "agricultural land" whilst increasing tree cover. In a similar way, tree strips can be designated as "wildflower strips" to benefit from agri-environment payments. It can be argued that the key component of any successful agroforestry system is the farmer (Burgess, 2017).

4.4. There remains a dearth of information for farmers about the value of wood. In preparing this report, we tried to find an updated value for poplar timber values in the UK and it was difficult find any recent values. An efficient wood market would benefit from greater transparency in timber and wood prices for small producers.

4.5. There remains a need to firstly account for the additional complexity and administrative costs associated with agroforestry in financial analyses. In addition, on-going maintenance costs and other non-financial on-going commitments are unknown, unclear and hence are a barrier at planting. Secondly, in view of the substantial wider societal benefits of agroforestry, ways should be sought to minimise the unnecessary administrative burden. It is clear than the current system of "complex rules" has tended to lead to a more "simplified landscape". Is it possible to deliver a system of "simple rules" that creates a more "complex and diverse landscape"?

4.6. This analysis focuses solely on the financial analysis of the marketable components of the system. A wider economic analysis would consider wider societal benefits and the impacts of grants and subsidies.

5. References

AGFORWARD (2016). First Meeting of the EIP European Focus Group on Agroforestry. http://www.agforward.eu/index.php/en/news-reader/id-30-november-1-december-2016.html

Burgess, P.J., Incoll, L.D., Hart, B.J., Beaton, A., Piper, R.W., Seymour, I., Reynolds, F.H., Wright, C., Pilbeam & Graves, A.R.. (2003). The Impact of Silvoarable Agroforestry with Poplar on Farm Profitability and Biological Diversity. Final Report to DEFRA. Project Code: AF0105. Silsoe, Bedfordshire: Cranfield University. 63 pp.

Burgess, P.J., Incoll, L.D., Corry, D.T., Beaton, A. & Hart, B.J. (2005). Poplar growth and crop yields within a silvoarable agroforestry system at three lowland sites in England. Agroforestry Systems 63(2): 157-169.

Burgess, P.J., Belot, V., Buachie, E., Cuartero de Frias, F., Nedved, K., Rodriguez Arquero, E. (2014). The economics of woodland eggs in the UK. In: 2nd European Agroforestry Conference 4-6 June 2014, Cottbus, Germany Book of Abstracts. 67-70.

Burgess, P.J. (2017). Agroforestry in the UK. Quarterly Journal of the Royal Forestry Society 111(2): 111-116.

Duquette, E., Higgins, N., Horowitz, J. (2011). Farmer discount rates: experimental evidence. American Journal of Agricultural Economics 94(2): 451-456.

Erwood, C. (2015). Essentials of a successful claim to agricultural property relief. **https://www.taxation.co.uk/Articles/2015/03/24/332840/real-life-farming**

Eurostat (2012a). Agricultural census in France. **http://ec.europa.eu/eurostat/statistics-explained/index.php/Agricultural_census_in_France**

Eurostat (2012b). Agricultural census in the United Kingdom **http://ec.europa.eu/eurostat/statistics-explained/index.php/Agricultural_census_in_the_United_Kingdom**

Graves AR, Burgess PJ, Palma JHN, Herzog F, Moreno G, Bertomeu M, Dupraz C, Liagre F, Keesman K, van der Werf W Koeffeman de Nooy A, van den Briel JP (2007). Development and application of bio-economic modelling to compare silvoarable, arable and forestry systems in three European countries. Ecological Engineering 29: 434-449.

Graves, A.R., Burgess, P.J., Liagre, F., Pisanelli, A., Paris, P., Moreno, G.M., Bellido, M., Mayus, M., Postma, M., Schlindler, B., Mantzanas, K., Papanastasis, V.P. & Dupraz, C. (2009). Farmer perceptions of silvoarable systems in seven European countries. In: Advances in Agroforestry Vol 6: Agroforestry in

Europe: Current Status and Future Prospects 67-86. (Eds. A. Rigueiro-Rodríguez, J.H. McAdam, and M.R. Mosquera-Losada). Springer.

Hart, C. (1994). Practical Forestry for the Agent and Surveyor. Third Edition. Stroud, Gloucestershire: Alan Sutton Publishing Ltd. pp 428-430.

HM Treasury (2011). The Green Book. Appraisal and Evaluation in Central Government. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf

Mosquera Losada, M.R., Santiago Freijanes, J.J., Pisanelli, A., Rois, M., Smith, J., den Herder, M., Moreno, G., Malignier, N., Mirazo, J.R., Lamersdorf, N., Ferreiro Domínguez, N., Balaguer, F., Pantera, A., Rigueiro-Rodríguez, A., Gonzalez-Hernández, P., Fernández-Lorenzo J.L., Romero-Franco, R., Chalmin, A., Garcia de Jalon, S., Garnett, K., Graves, A., Burgess, P.J. (2016). Extent and success of current policy measures to promote agroforestry across Europe. Deliverable 8.23 for EU FP7 Research Project: AGFORWARD 613520. (8 December 2016). 95 pp. http://www.agforward.eu/index.php/en/extent-and-success-of-current-policy-measures-to-promote-agroforestry-across-europe.html

Sandars, N.D.H, (1999). The effect of woodlands on farm valuation. In: (Ed. P.J. Burgess, E.D.R. Brierley, J. Morris and J. Evans) Farm Woodlands for the Future 115-121. Oxford: Bios Scientific Publishers.

Scottish Woodlands (2015). A Brief Guide to Forestry Taxation. http://www.scottishwoodlands.co.uk/assets/pdf/forestry_taxation_summary.pdf

Strutt and Parker (2015). What are the tax implications for the commercial occupation of woodland? http://www.struttandparker.com/knowledge-and-research/what-are-tax-implications-commercial-occupation-woodland

UK Government (1995). Agricultural Tenancies Act 1995, s 38(1). http://www.legislation.gov.uk/ukpga/1995/8/contents

Upson, M.A (2014). The Carbon Storage Benefits of Agroforestry and Farm Woodlands. Unpublished PhD thesis. Cranfield University. 319 pp.

Worldometers (2017). Online real-time population update http://www.worldometers.info/world-population/#growthrate [accessed March 2017].

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