SILVOPASTORAL AGROFORESTRY - AN OPTION TO SUPPORT SUSTAINABLE GRASSLAND INTENSIFICATION

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Abstract

Intensive and semi-intensive temperate grassland systems often revolve around landscapes which have poor ecosystem services delivery. This work demonstrates that the introduction of wide spaced trees in silvopastoral agroforestry systems can make these grassland landscapes more sustainable, deliver a wide range of ecosystem services and align with a sustainable grassland management strategy. The longer animals can remain on pasture in climates with high, unpredictable rainfall, the less ammonia will be emitted from the system. Silvopasture is shown to extend the grazing season to help higher grass utilisation and give resilience to grazing during extreme rainfall, while increasing short-term carbon storage and long term carbon sequestration.

Keywords: soil trafficability; water infiltration; carbon sequestration; reduced ammonia

Introduction

Agroforestry can be defined as the integration of agriculture and forestry on the same land unit. The interactions between the two components can be managed to produce a stream of production and environmental benefits over time. In silvopasture, a form of agroforestry, stock graze pasture between widely spaced trees. As such, agroforestry can be considered as a means of introducing trees into the farmed landscape while delivering objectives for sustainable grassland intensification. Agroforestry systems have been shown to be a welfare-friendly livestock system which delivers a wide range of ecosystem services (McAdam 2000) and economic predictions have been favourable (McAdam et al. 1999). To accelerate the pathway to a carbon neutral livestock system, a recent report (DAERA 2017) recommends that farmers should consider the benefits of establishing an agroforestry system on a proportion of their land to suit individual farm locations and catchments to add resilience to their grazing system in wet weather and allow earlier and later seasonal grazing. This paper reports the supporting evidence for this.

In Northern Ireland, current levels of grassland utilisation are low (in the order of 5t DM /ha/ yr DAERA 2017) in beef systems and most grassland systems are net carbon sources. It is also clear that, given the uncertain seasonal rainfall profile, grassland utilisation can be seriously impaired by soil trafficability. The longer animals need to be taken off pasture and housed, the greater will be the amount of ammonia emitted. Sustainable grassland intensification could be considerably facilitated by increasing the length of the grazing season through improved soil trafficability. Given predicted climate change for the region, the establishment of trees on pasture can reduce the flooding risk by significantly increasing the rate at which water can enter the soil, thus decreasing the flow of water into rivers and streams as well as creating drier grazing pastures for livestock.

Although the results reported here are from a large scale, long term silvopastoral trial, the objective of the study reported in this paper was to demonstrate that silvopastoral systems can increase the length of the livestock grazing season, a key feature towards sustainable grassland utilisation.

Materials and methods

A long-term silvopastoral agroforestry site was established in Northern Ireland at Loughgall, Co Armagh in 1989 (Sibbald et al. 2001) to compare three land use types - (1) a silvopastoral system with ash trees (*Fraxinus excelsior* L.) planted at 400 stems/ha, (2) planted woodland with ash trees (2,500/ha), and (3) permanent grassland. Soils at Loughgall are Brown Earth on Red Limestone Till with a soil pH range7.0 - 8.3, and clay content between 30 and 45%. There were 3 replicates of each treatment in a randomised block design, plots were approx. 1ha each and individually fenced. The trial has been consistently managed and documented since planting with some intensive periods of measurement. The trial was a unique resource to assess the long term impact of silvopastoral systems on a range of ecosystem services. Soil carbon storage was investigated by soil sampling to 20 cm and analysing carbon content by soil fraction size (Fornara et al. 2017). To estimate total carbon content in the tree component of the system, eight trees were completely excavated, soil washed off the stumps, the whole tree separated into leaves, twigs, small branches, large branches, trunk and roots (Olave et al. 2016) and carbon content assessed. Soil moisture content was measured weekly from 1st August 2016 until May 2017 (mean of 10 values per plot over 3 replicate plots per treatment) and soil resistance to penetration (a measure of infiltration potential) measured through the soil profile (to approx. 80cm) using a penetrologger weekly over Sept to Nov 2017.

Results and discussion

Carbon. 26 years after the conversion of permanent grassland to either silvopastoral or woodland systems, while tree planting on permanent grassland may not contribute to greater soil C stocks it may, in the long-term, increase the C pool of more stable (recalcitrant) soil micro-aggregate and silt and clay fractions, which could be more resilient to environmental change (Fornara et al. 2017). The mean carbon content of each tree was estimated at 336 kg and total C per unit area (at a tree density of 230 stems/ha) as 77.38 t/ha (Olave et al. 2016). Over the life of the crop this was an accumulation rate of 3.68 tC/ha/yr. Given that accumulation rates of C in permanent grassland are in the order of 1t/ha/yr and the nature of the carbon sequestered in the silvopasture, agroforestry has the potential to deliver a carbon neutral livestock system.

Soil trafficability. If a soil moisture content of 40% is taken as a notional limit for soil poaching to occur, between August 2016 and May 2017, the soil moisture content was below 40% for 17 weeks more in the agroforestry than the grassland (Figure 1).

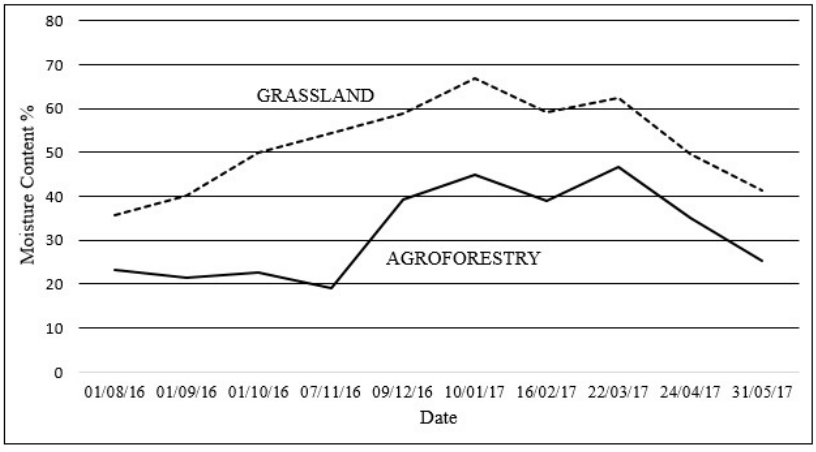

Figure 1: Soil Moisture from August 2016 to May 2017 from grassland and agroforestry in a long term (26yrs) grazing experiment at Loughgall, Co Armagh. ($P<0.05$ ese 3.506).

This represents a potentially substantial increase in grazing season length. As part of a rotational grazing strategy, agroforestry paddocks could be saved for grazing at the beginning or end of the grazing season and thus greatly increase grass utilisation.

Soil infiltration. The resistance to soil penetration (and hence infiltration) was greater in the agroforestry than the grassland to 76cm depth (Figure 2). Hence agroforestry has created a soil profile under grassland which will be much more resilient to potential flooding and predicted climate change and greatly increase the sustainability of grazed pasture.

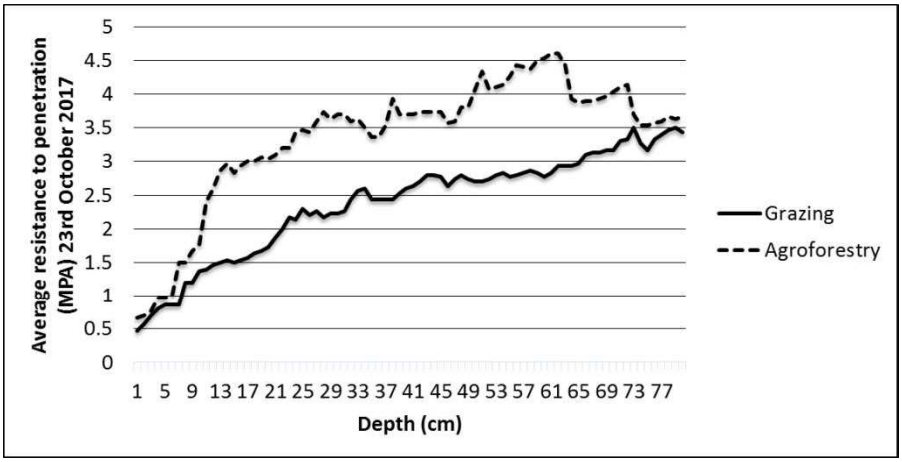

Figure 2: The average resistance to soil penetration (from Sept-Nov 2017) from grassland and agroforestry in a long term (26yrs) grazing experiment at Loughgall ($P<0.001$ ese 0.24).

Policy uptake. Economic predictions (McAdam et al. 1999) and farmer surveys of agroforestry have been favourable but it is when agroforestry is accepted for state support that on-farm planting is likely to increase. In 2015 agroforestry was included as an option in forestry measures in Ireland and in 2017 as an option in the DAERA Environmental Farming Scheme in Northern Ireland. In the latter, the planting and management specification stipulated was based on the research findings from the trial reported above. Uptake has been encouraging and these farmers will form the nucleus of a group of examples in practice which hopefully will encourage other applicants.

Conclusion

Silvopastoralism can reduce soil moisture, increase soil trafficability and thus significantly extend the grazing season to improve grass utilisation and sustainability.

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