Net ecosystem productivity of a grassland in comparison with an arable and a forest ecosystem

P.A. Davis[1], K. Black[1], J. Clifton-Brown[2], G. Lanigan[2], J. Burke[3], A. Fortune[3], M.B. Jones[2] and B. Osborne[1]
[1]Botany Department, University College Dublin, Belfield, Dublin 4, Ireland, Email: Phillipdavis2002@hotmail.com, [2]Botany Department, Trinity College, University of Dublin, Dublin 2, Ireland, [3]Teagasc Oak Park Research Centre, Carlow, Ireland

Keywords: eddy covariance, net ecosystem productivity; carbon sequestration, land use

Introduction Grassland, arable farming and forests are the major land use categories in Ireland and it is, therefore, important to know the carbon-source/sink strengths of these land use types. Forest ecosystems are also an important and fast growing land use category in Ireland. Here we present a comparison of the net ecosystem productivity (NEP) of these three land use categories (grass land, arable and forest) from three sites.

Methods The grassland (*Lolium perenne* dominated) and arable (spring barley) sites are situated at the Oak Park Research Station, Teagasc, Co. Carlow in SE Ireland and the forest site (Sitka spruce plantation) is located 30 km West in Co. Laois. The grassland site was cut for silage in June and grazed by cattle until the autumn. Eddy covariance measurements of CO_2 and H_2O fluxes were made with the EdiSol system, described by Moncrieff *et al.* (1997). The sonic anemometer (soluent R3, Gill Instruments Ltd., Lymington, England) and gas analyser intake were situated at a height of 1.5 – 1.9 m on the arable site 2 m at the grass site and 18 m at the forest site. The CO_2 and H_2O concentrations were measured using a closed path analyser (Li-7000, Li-Cor Inc., Lincon, NE). Carbon export was determined from biomass samples collected at silage cut and during grazing for the grassland and at harvest for the spring barley. Samples were oven dried (80ºC) before mass was determined.

Results All three sites showed the expected seasonal variations in NEP with the major CO_2 uptake occurring in the spring and summer months and less uptake or losses occurring during winter months (Figure 1). Uptake at the arable site stopped in mid July when the Barley ripened and senesced. Fluctuations in summer NEP at the grassland were associated with changes in leaf area index caused by silage cuts and grazing. The arable site showed the greatest losses of carbon during winter months due to the lack of plant cover. Small losses were also observed between November and February at both the grassland and forest sites: this was associated with low temperatures and short day lengths. Differences in the carbon uptake of the three systems were mainly associated with differences in the duration of plant cover (Table 1). Management, carbon export and duration of plant cover also influenced the carbon losses and, therefore, total sequestered carbon.

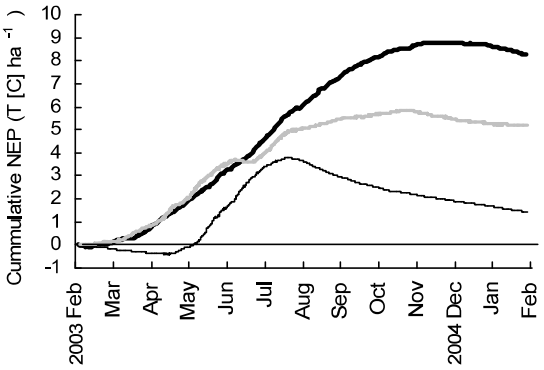

Figure 1 Comparison of cumulative NEP for the three ecosystems. Black = arable; grey = grassland; bold = forest

Table 1 Annual NEP (tC ha^{-1}), carbon export (tC/ha) sequestered carbon (tC ha^{-1}) and period of plant cover (months) for the three ecosystems form Feb 1 2003 to Jan 31 2004. Negative values indicate carbon loss

	Grass land	Arable	Forest
NEP	5.2	1.4	8.2
Carbon export	4.5	3	0
Sequestered carbon*	0.7	-1.6	8.2
Period of plant cover	12	4	12

* *Calculated as, NEP – export. This excludes losses due to run off and leaching.*

Conclusions Forest systems act as the strongest sinks for carbon dioxide and arable systems act as the strongest sources of carbon dioxide. The Grassland was a small sink for carbon dioxide. Carbon export in biomass and other management practices caused the greatest loss of carbon for the arable and grassland. Duration of plant cover and leaf area index appear to have the largest effect on carbon uptake.

References

Moncrieff, J.B., J.M. Massheder, H. de Bruin, J. Elbers, T. Friborg, B. Heusinkveld, P. Kabat, S. Scott, H. Soegaard & A. Verhoef. (1997). A system to measure surface fluxes of momentum, sensible heat, water vapour and carbon dioxide. *Journal of Hydrology,* 188-189, 589-611.