

# Evaluating the Sustainability of Agroforestry systems in five different countries of Europe using Emergy evaluation

Adrian Gliga<sup>1</sup>, Mignon Sandor<sup>1\*</sup>, Jo Smith<sup>2</sup>, Bhim Bahadur Ghaley<sup>4</sup>, Andrea Pisanelli<sup>5</sup>, Angela Augusti<sup>5</sup>, Rafal Wawer<sup>6</sup>, Robert Borek<sup>6</sup>, Laurence Smith<sup>2,3</sup>

**1** University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Department of Environment and Plant protection, 400372, Romania;

**2** The Organic Research Centre, Hamstead Marshall, Newbury, Berkshire RG20 0HR, UK;

**3** The Royal Agricultural University, Cirencester, Gloucestershire GL7 6JS, UK;

**4** University of Copenhagen, Department of Plant and Environmental Sciences, 2630 Taastrup, Denmark;

**5** National Research Council, Research Institute on Terrestrial Ecosystems, 05018, Porano, Italy;

**6** Institute of Soil Science and Plant Cultivation –State Research Institute, Department of Soil Science Erosion Control and Land Protection, ul. Czartoryskich 8, 24-100 Puławy, Poland

\* Author to whom correspondence should be addressed; E-Mail: [sandor.mignon@usamvcluj.ro](mailto:sandor.mignon@usamvcluj.ro)

**Abstract:** Resource use and environmental impacts of six different agroforestry systems from five European countries were assessed using emergy evaluation (Table 1). Emergy is a widely used method for the assessment of energy efficiency and sustainability within agroforestry systems that expresses and accounts for different forms of energy on a common physical basis. Each system consisted of a farm with an integrated food and non-food production system. The on-farm resource use, production and inputs of different types like sunlight, fuel, machinery, human labour and economic services were converted into a common unit of solar equivalent Joules (seJ). After accounting for emergy in each system we used emergy indices to compare different systems in terms of ecological and economic efficiencies to assess sustainability. Emergy-based indices calculated in this study are: output (Y), total emergy use (U), solar transformity (U/Y), fraction of local renewable resource use, emergy yield ratio (EYR), environmental loading ratio (ELR), and emergy sustainability index (ESI). Compared to conventional systems more than 90% of resources (seJ) were used for supporting labor and service, less than 50% of resources are used in agroforestry systems for the same purpose.

**Table 1.**

## Studied farms, location and size

No.	Agroforestry farm	Study location	Size
1	Livestock silvopastoral system with wooded semi-natural grasslands	Petrova Municipality Romania	94 ha
2	Organic farm with willow and hazel alley cropping system, mixed species timber and apple system, hedgerows	Wakelyns Farm, Suffolk, UK	22 ha
3	Experimental Combined Food and Energy system, integrating food and fodder crops with mixed stands of willow, alder and hazelnut.	Taastrup, Denmark	11 ha
4	Organic farm comprised of olive orchard with natural weed between the tree rows	Orvieto Municipality, Italy	7 ha
5	Conventional farm, of which 22 ha are managed as olive orchards with periodical soil harrowing	Orvieto Municipality, Italy	207 ha
6	Livestock farm with wooded grasslands, hedgerows and forest	Beskid Mountains, Poland	200 ha

## References :

Ghaley & Porter, 2013, *Ecol. Indic.*, pp. 534-542.