NPP & Agriculture

Andy Whitmore
Lianhai Wu
Rothamsted Research
G's, 10 December 2013

Jean-Baptiste Van Helmont 1580-1644

Start:			Add water 5 years		End:	
Weight willow	5lb	->		->	Weight willow	169lb
Weight soil	200lb				Weight soil	199lb 14oz

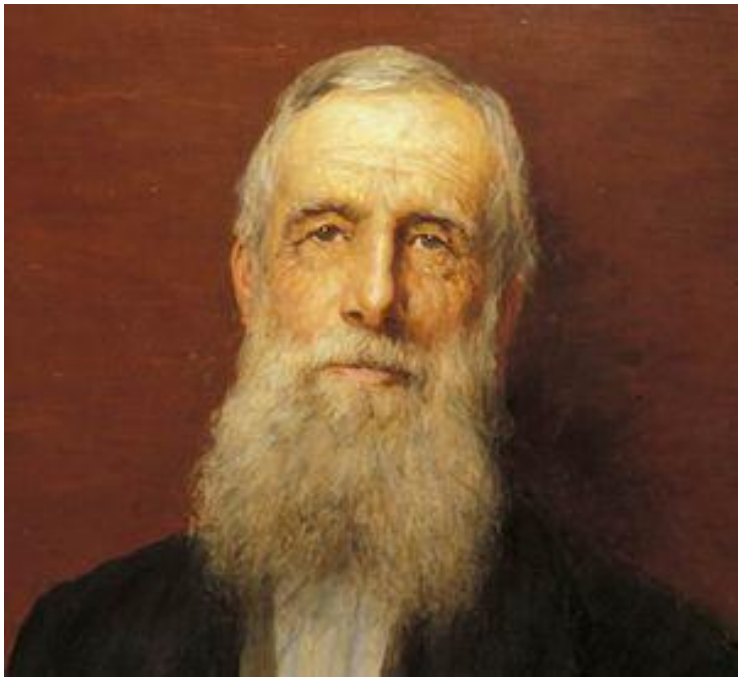
Nutrients and Soil

Justus von Liebig 1803 - 1873

Plants obtains carbon from the CO_2 in the air
CO_2 is <1% of the air, N_2 is 80% so…

Law of the minimum

Helped develop ‘Oxo’ and ‘Marmite’



John Bennet Lawes 1814 - 1900

Disputed atmosphere as source of N
Set up Broadbalk experiment & others at
Rothamsted to prove most plants got N from the soil

Made fortune from superphosphate fertiliser

The Classical Experiments at Rothamsted

Broadbalk Wheat, started 1843

Park Grass. From 1856

Hoosfield Spring Barley. From 1852

Long-term Experiments

Broadbalk: Mean yields of wheat grain, cultivars and major changes

eg Goulding et al 2008

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CALCULATING NET PRIMARY PRODUCTION AND ANNUAL INPUT OF ORGANIC MATTER TO SOIL FROM THE AMOUNT AND RADIOCARBON CONTENT OF SOIL ORGANIC MATTER

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RothC model

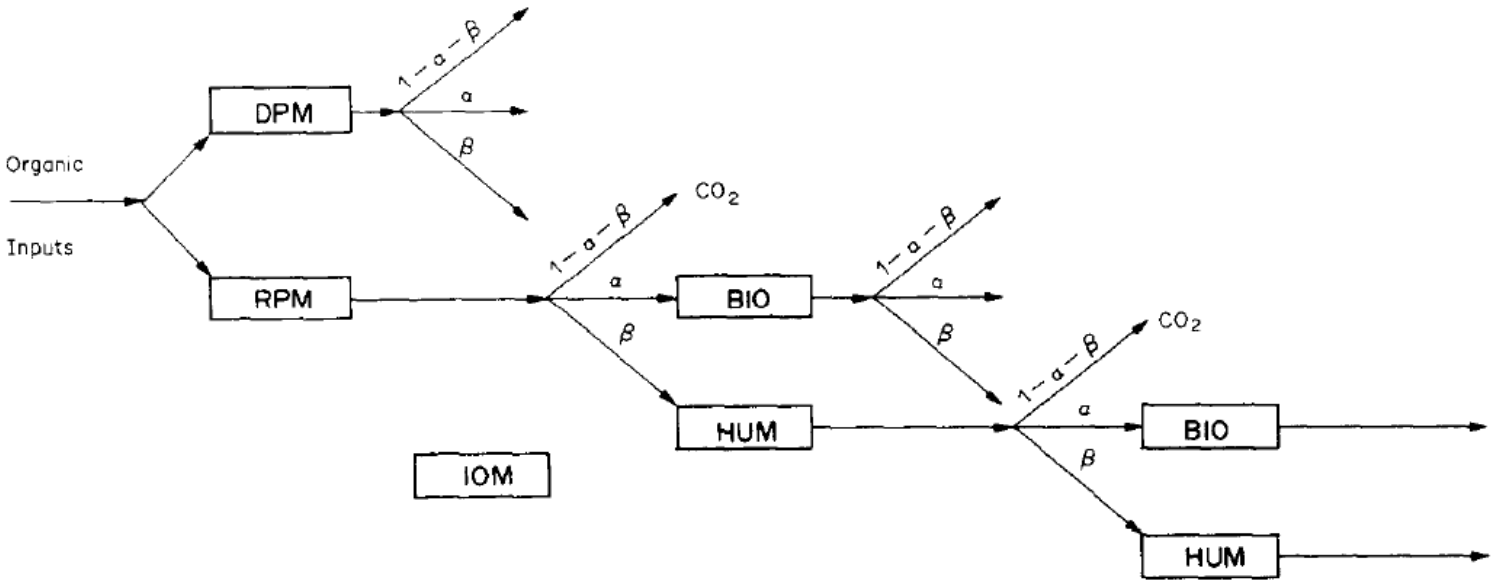

Fig. 1. Flow of C through the compartments of the model: decomposable plant material (DPM), resistant plant material (RPM), soil microbial biomass (BIO), humus (HUM) and inert organic matter (IOM). When substrate C is metabolised by the biomass, a fraction α is incorporated into the microbial biomass compartment, a fraction β enters the humus compartment and the rest is liberated as CO_2.

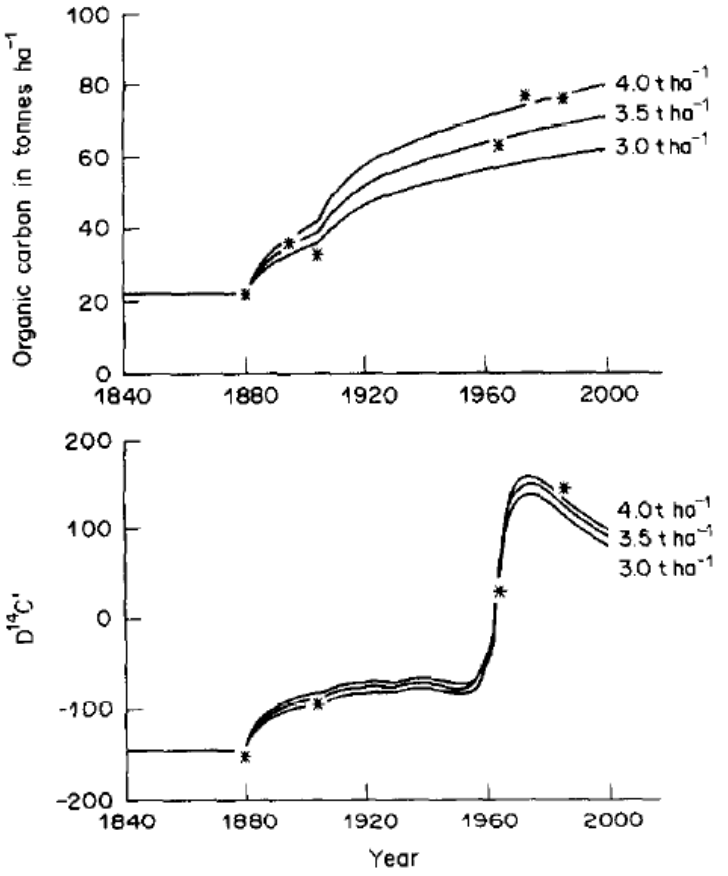

Fig. 3. The accumulation of organic C (and the radiocarbon content of this C, expressed as $D^{14}C'‰$) in topsoil (to a depth that contains the same weight of ignited "fine soil" as when sampled to a depth of 22.9 cm in 1985) from the wooded section of Broadbalk Wilderness. In this and succeeding Figures the asterisks show the data: the lines the model predictions, for (in this case) annual inputs of 3.0, 3.5 and 4.0 t C ha^{-1}yr^{-1}.

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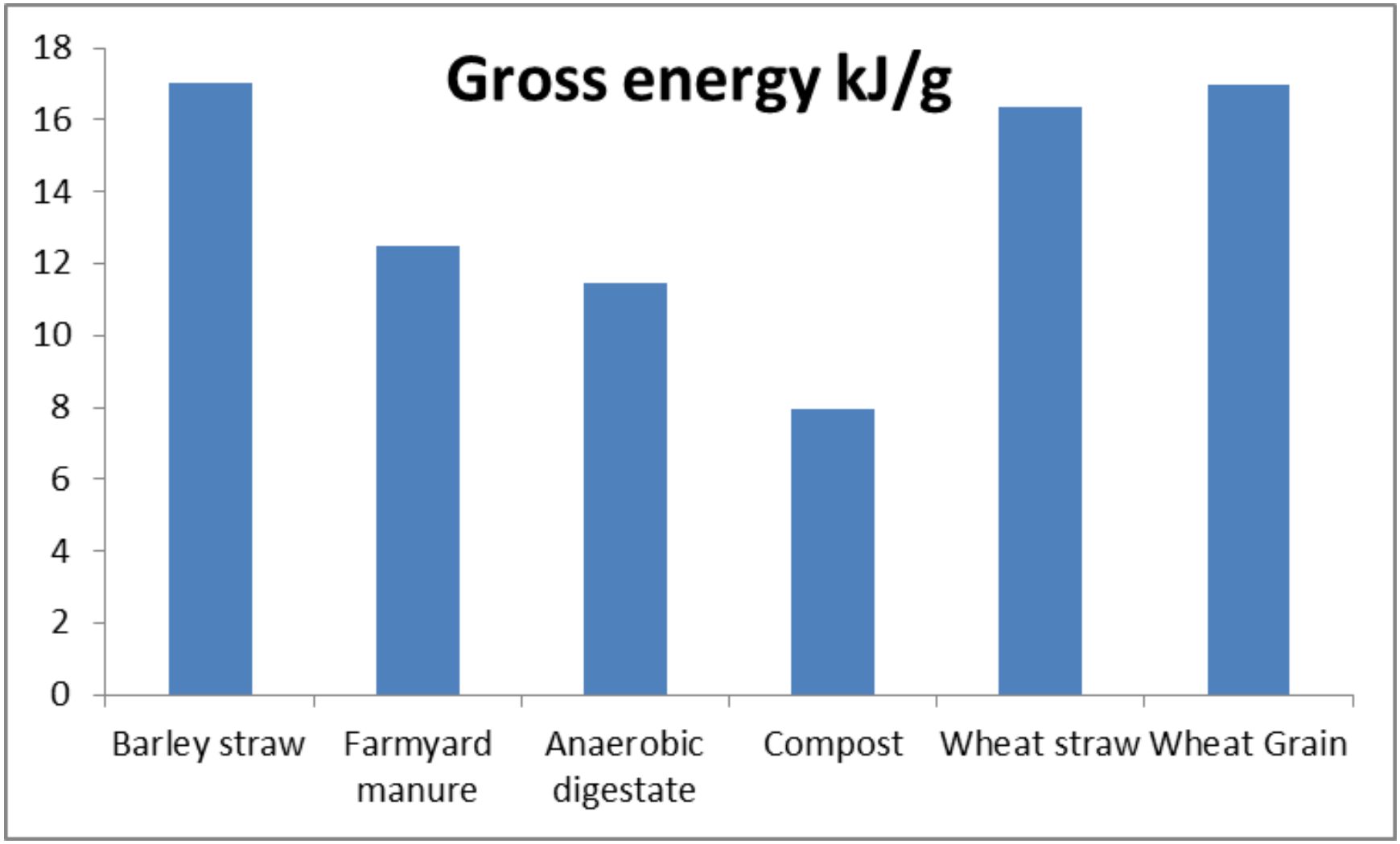
Table 5. NPP in the four sites

Site	Return of organic C to soil (t C $ha^{-1}yr^{-1}$)[a]	Removal in harvest (t C $ha^{-1}yr^{-1}$)[b]	Accumulating in standing crop (t C $ha^{-1}yr^{-1}$)[b,c]	NPP (t C $ha^{-1}yr^{-1}$)
Broadbalk Wilderness	3.5	0	1.27	4.8
Geescroft Wilderness	2.5	0	0.84	3.3
Park Grass, plot 3d, unmanured	3.0	0.97[d]	0	4.0
Broadbalk wheat, plot 03, unmanured	1.3	0.93[e]	0	2.2
Broadbalk wheat, plot 08, NPK	1.7	3.51[e]	0	5.2

[a]Return to topsoil, as modelled.
[b]Assuming that plant dry matter contains 40%C.
[c]Mean annual accumulation in trees, 1883–1969 (Jenkinson, 1971).
[d]Mean annual removal in 2 cuts of hay, 1970–1985 (from Numerical Results of the Field Experiments, Rothamsted).
[e]Mean annual removal in grain plus straw, continuous wheat, 1970–1985 (from Numerical Results of the Field Experiments, Rothamsted).

BBSRC bioscience for the future



Energy Density Gasoline 46 MJ/kg
(Wheat grain 17 MJ/kg)