

Productivity and economics of a diverse temperate silvoarable system



Jo Smith and Martin Wolfe
Organic Research Centre



Productivity: Managing Interactions

Positive interactions

- ✿ Shelter
- ✿ Microclimate
- ✿ Soil OM
- ✿ Nutrients
- ✿ N fixation
- ✿ Pest & disease control
- ✿ Pollination

Negative interactions

Competition for:

- ✿ Light
- ✿ Water
- ✿ Nutrients
- ✿ Space
- ✿ Labour

PRODUCTIVITY

**Varies spatially & temporally
(season/yr/rotation)**

Measuring Productivity

Land Equivalent Ratio (LER)

the ratio of the area needed under sole cropping to the area of intercropping at the same management level to obtain a particular yield

$$\text{LER} = \frac{\text{Tree agroforestry yield}}{\text{Tree monoculture yield}} + \frac{\text{Crop or livestock agroforestry yield}}{\text{Crop or livestock monoculture yield}}$$

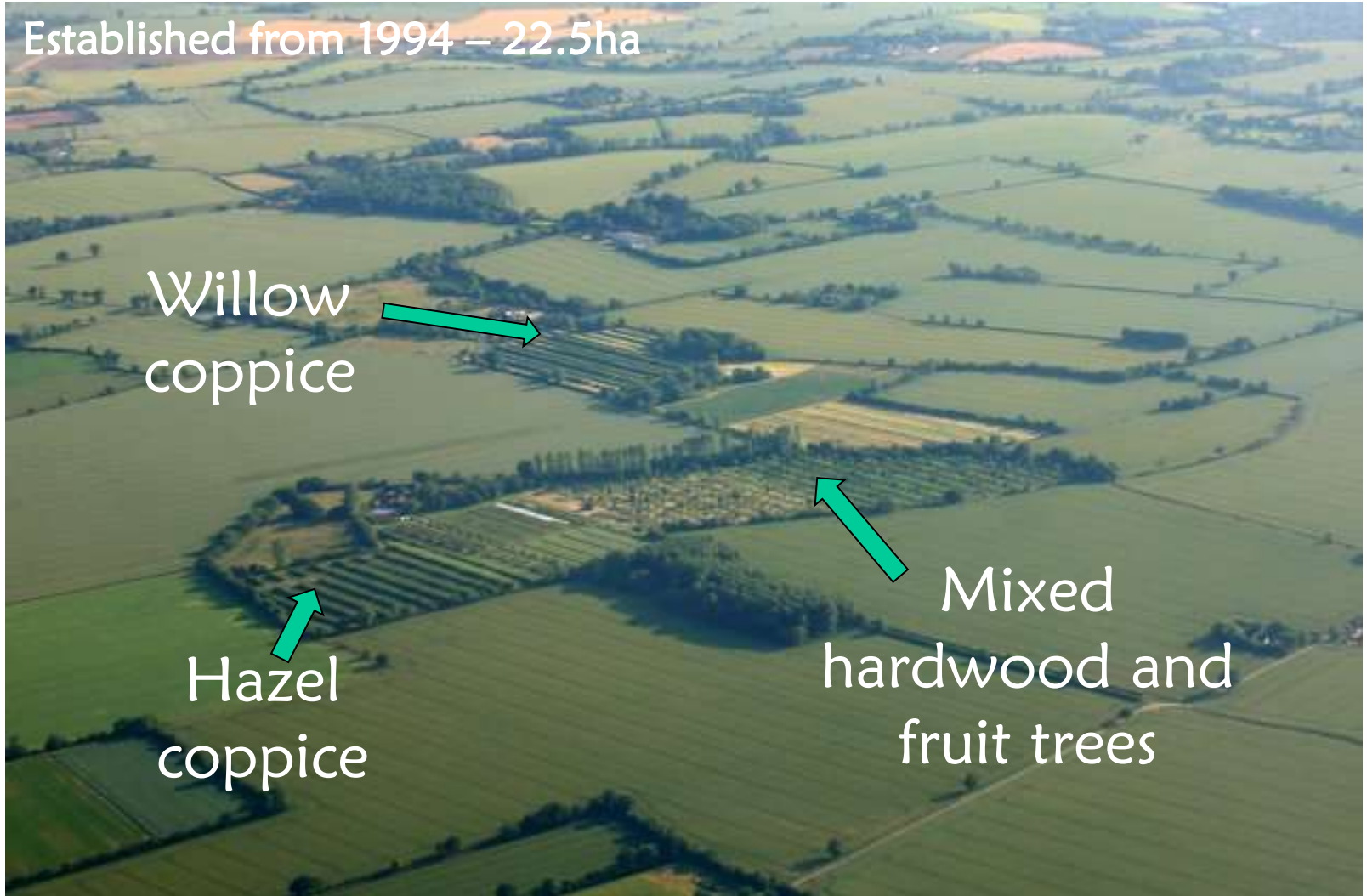
Agroforestry systems LER's:

Annual LER 1.6 in early stages to 1.0 in later stages

Over rotation LER 1.2 i.e. 4ha of AF = 5 ha of sole crops

Wakelyns Agroforestry

Established from 1994 – 22.5ha



Willow
coppice

Hazel
coppice

Mixed
hardwood and
fruit trees

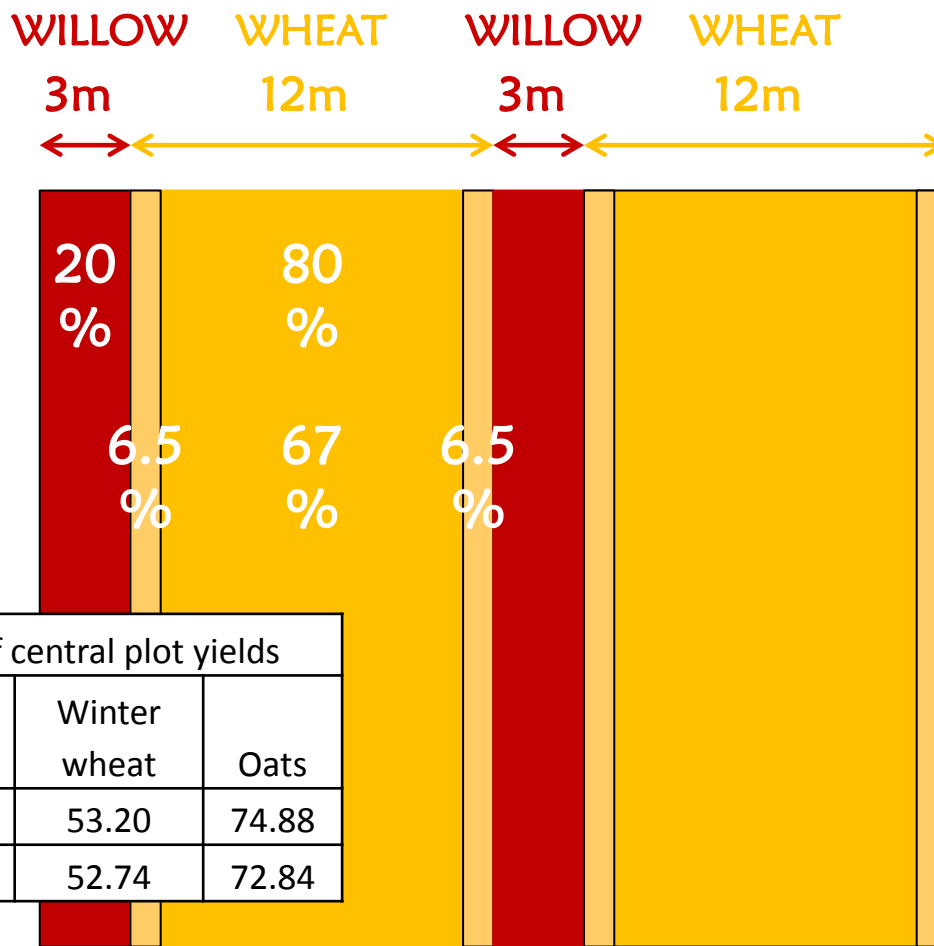
Agroforestry at Wakelyns

- Organic arable rotation and trials
- Products include timber, energy, fruit, nuts, craft materials, cereals, vegetables, soil fertility, pest & disease control, biodiversity.....



Willow alley cropping at Wakelyns





1ha agroforestry = 0.2 willow + 0.67 wheat (@100% yield) + 0.13 wheat (@50% yield)

Land Equivalent Ratio

Caveats:

Uses average figures from Handbooks – no direct comparison on site.

Assumes same management in agroforestry and monocultures.

Willow

SRC Plantation: 25 odt/ha every 3 years = 8.33 odt/ha/year (Nix 2011)

Agroforestry: half of willow strips harvested each year = 2.33 odt/ha/ year

Winter wheat

Monoculture: 5 t/ha (OFMH 2011)

Agroforestry: 2007-2011 average for Claire 6.98 t/ha

0.13 ha @ 50% yield (0.45 t/ha of agroforestry) + 0.67 ha @ 100% yield (4.68 t/ha of agroforestry) = 5.13 t/ha

Land Equivalent Ratio

$$\text{LER} = \frac{\text{Tree agroforestry yield}}{\text{Tree monoculture yield}} + \frac{\text{Crop or livestock agroforestry yield}}{\text{Crop or livestock monoculture yield}}$$

$$\text{LER} = \frac{2.33}{8.33} + \frac{5.13}{5}$$

$$\text{LER} = 0.28 + 1.03$$

$$\text{LER} = 1.31$$

i.e. 31% more land needed under monocultures to produce same total yields.

Economics

Willow woodchip £60/odt (Nix 2011)

Feed wheat £270/t (OFMH 2011)

Willow

Plantation: $8.33 \text{ odt/ha/year} \times £60 = £499.80/\text{ha/yr}$

Agroforestry: $2.33 \text{ odt /ha/year} \times £60 =$
 $£139.80/\text{ha/yr}$

Winter wheat

Monoculture: $5 \text{ t/ha} \times £270 = £1350/\text{ha}$

Agroforestry: $5.13 \text{ t/ha} \times £270 = £1385.10/\text{ha}$

Economics

Willow as woodchip

Output (£) = 139.8 + 1385.10 = *£1524.90/ha*

Monoculture wheat (5 t/ha) = £1350/ha

Willow as bioenergy

Heating oil equivalent = £1200/yr

Output (£) = 1200 + 1385.10 = *£2585.10/ha*

Caveat: doesn't account for inputs e.g. Harvesting and chipping costs for willow

Productivity: design and management

Design:

Species selection:

canopy

roots

allelopathy

N fixers

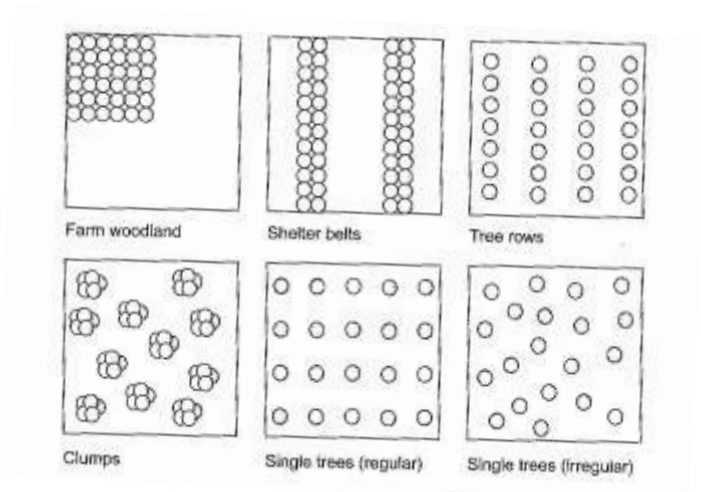
Spatial and temporal arrangement

Management:

Thinning and pruning

Weed control in early years

Protection from animals in early years



Environmental Benefits

Air

- ◆ wind speed
- ◆ GHG
- ◆ Odour



Water

- ◆ 'safety-net' hypothesis
- ◆ flood control



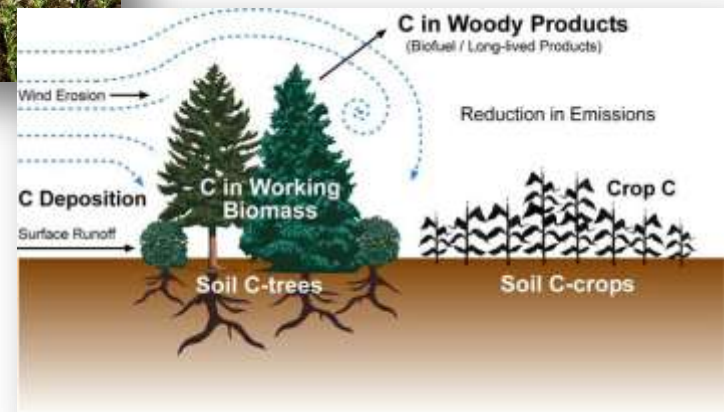
Soil

- ◆ Erosion
- ◆ Structure
- ◆ Fertility



Climate change

- ◆ C sequestration
- ◆ GHG abatement



Biodiversity