

Agroforestry mellangrodor & mob grazing

7-8 December 2017 Stockholm

Stephen Briggs



INNOVATION *for* AGRICULTURE

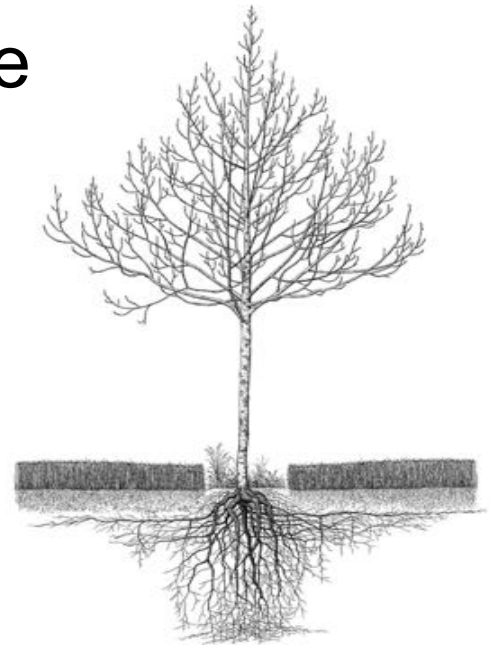


NUFFIELD
FARMING
SCHOLARSHIPS
TRUST

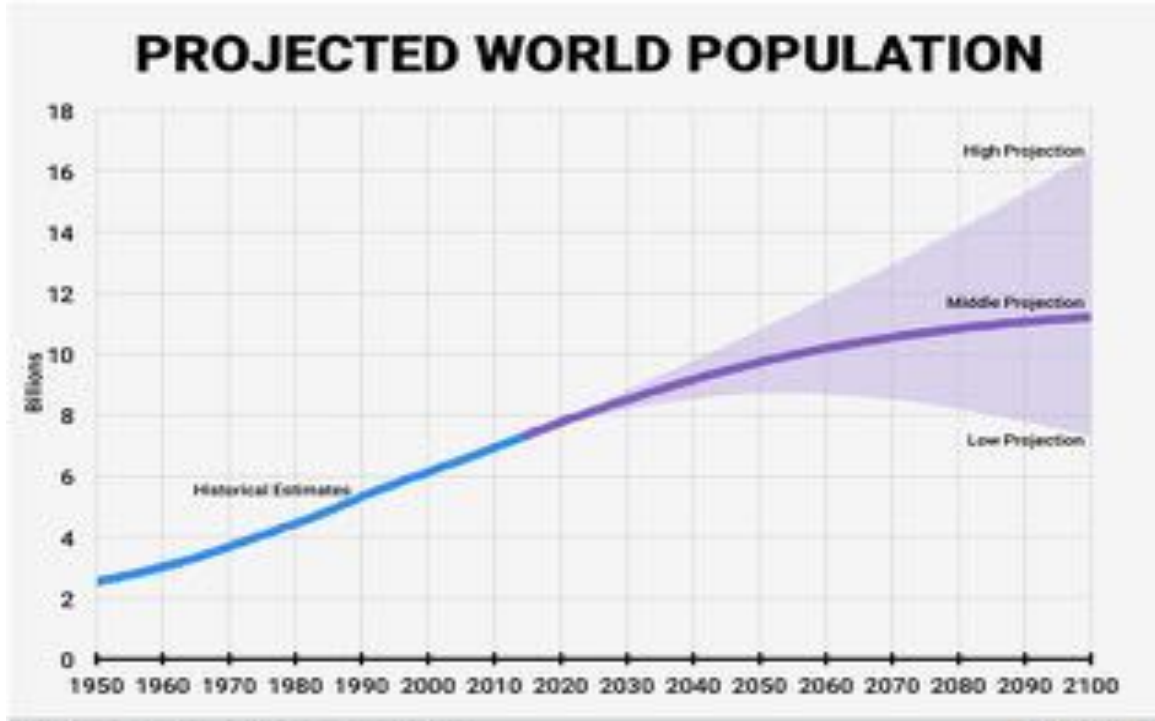


ABACUS
AGRICULTURE

1. Why is agroforestry different ?
2. Impact on farm soils, resource use, biodiversity, productivity ?
3. Silvopasture & Silvoarable opportunities
4. Bluebell Farms Ltd – our experience



Competition for land



SOURCE: United Nations, "World Population Prospects: 2015 Revision"



Resource degradation

'Adapting farming to climate change'



Agricultural challenges ahead.....

High input monoculture

- is it yesterdays approach?

Inputs more expensive & less available ?

Increase productivity ?

Better resource use ?

Protect & enhance biodiversity ?

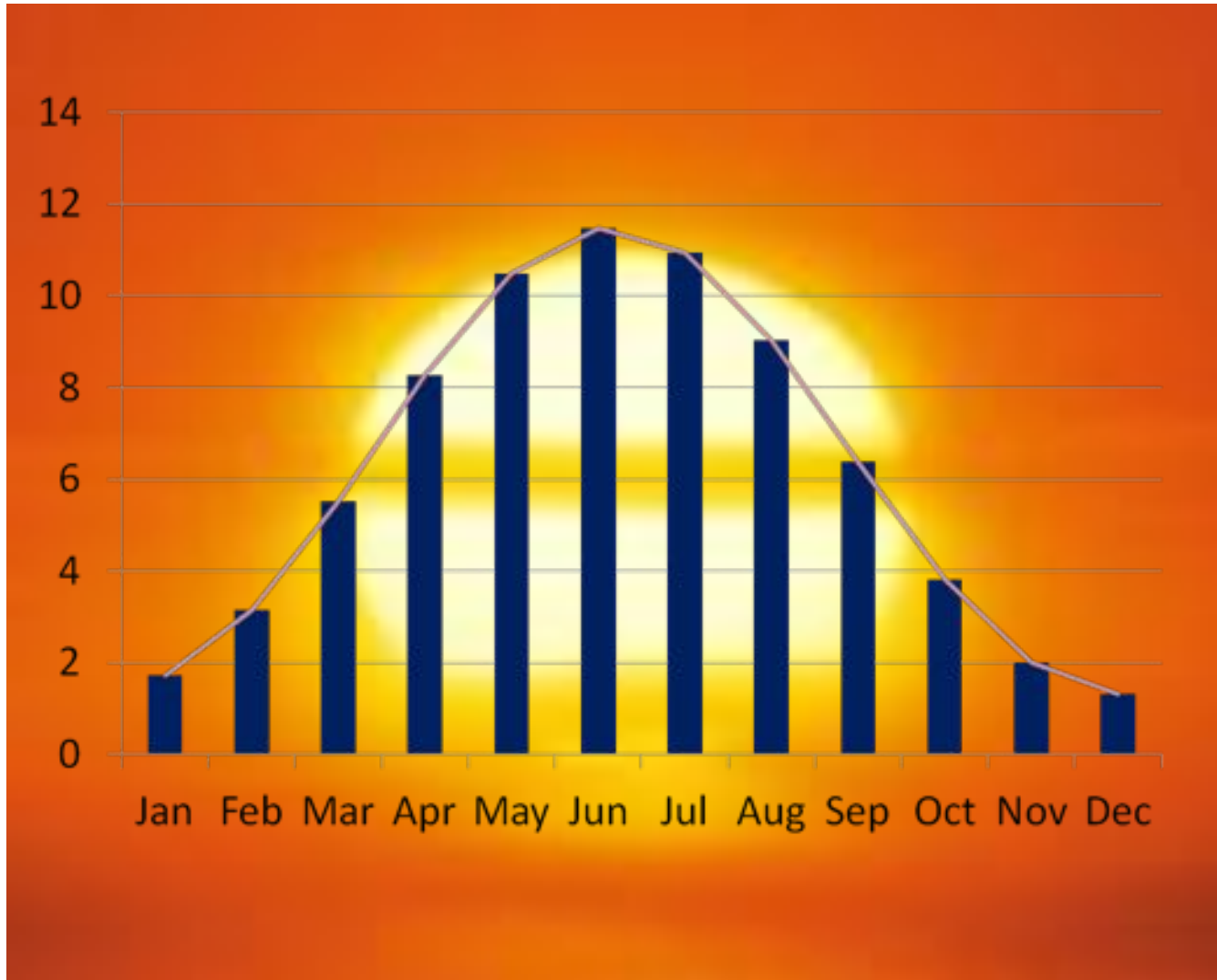
What is a farmers job.....



.....to capture the sun

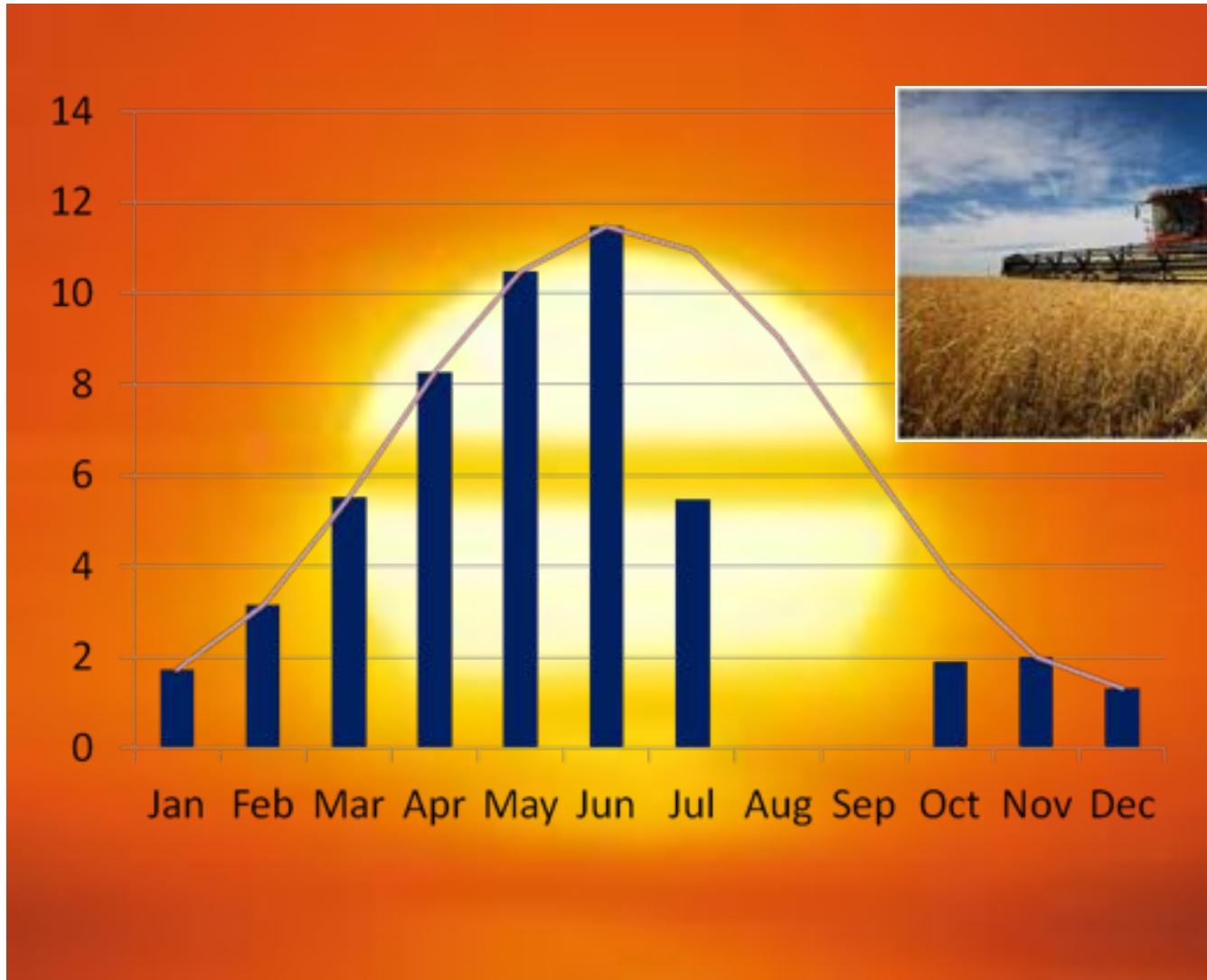
& turn it into carbon (*crops, animal feed etc*)

Capturing the sun



Potential daily sun hours

Capturing the sun



Potential daily sun utilisation by combinable crops



Trees important for climate change adaptation ✓

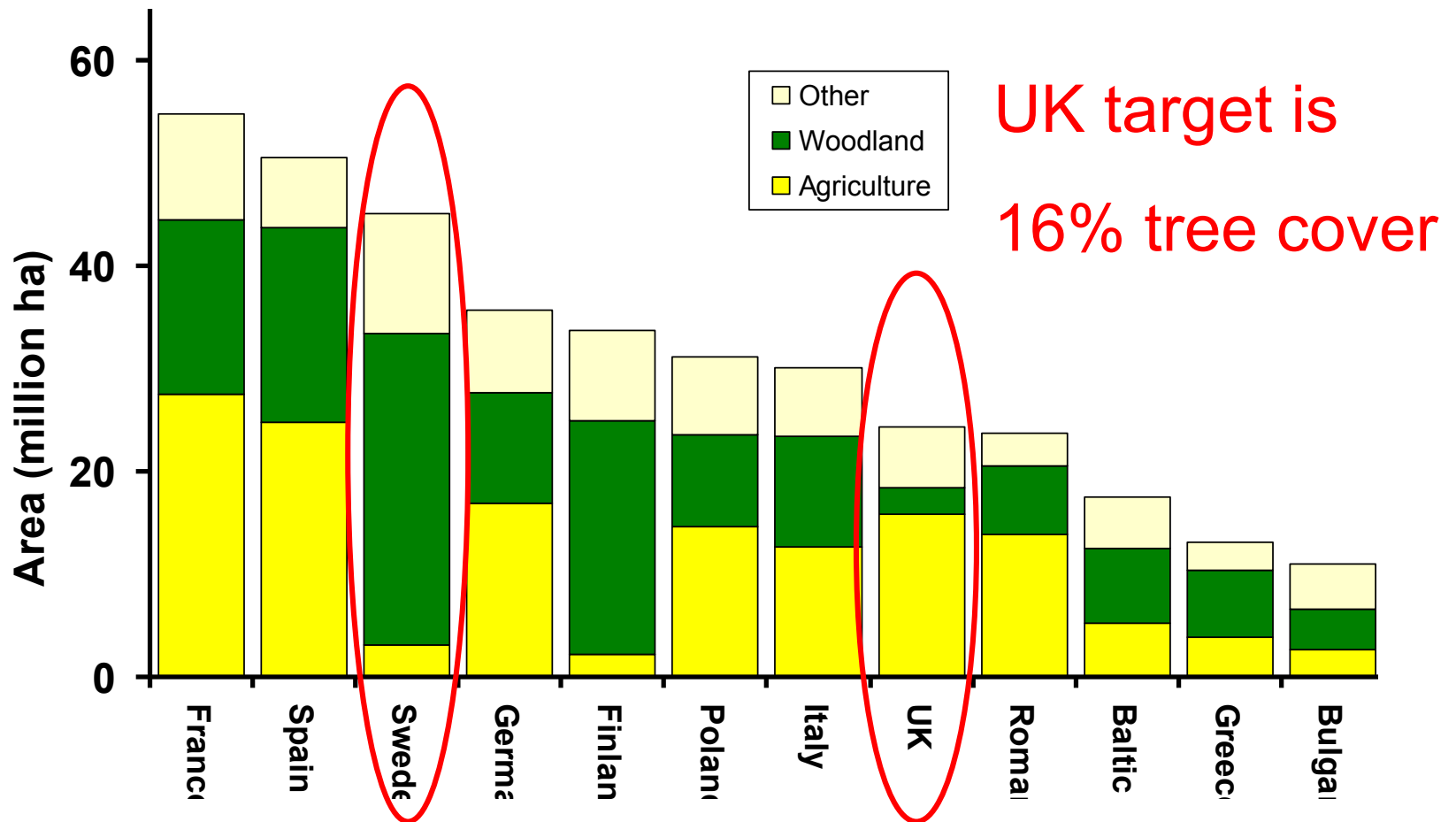
Could trees have an important role in agriculture ?

Agroforestry– an alternative approach ?

Agriculture or forestry ?



UK : 66% agriculture; 11% Tree cover



Agroforestry could make a significant contribution to tree planting targets

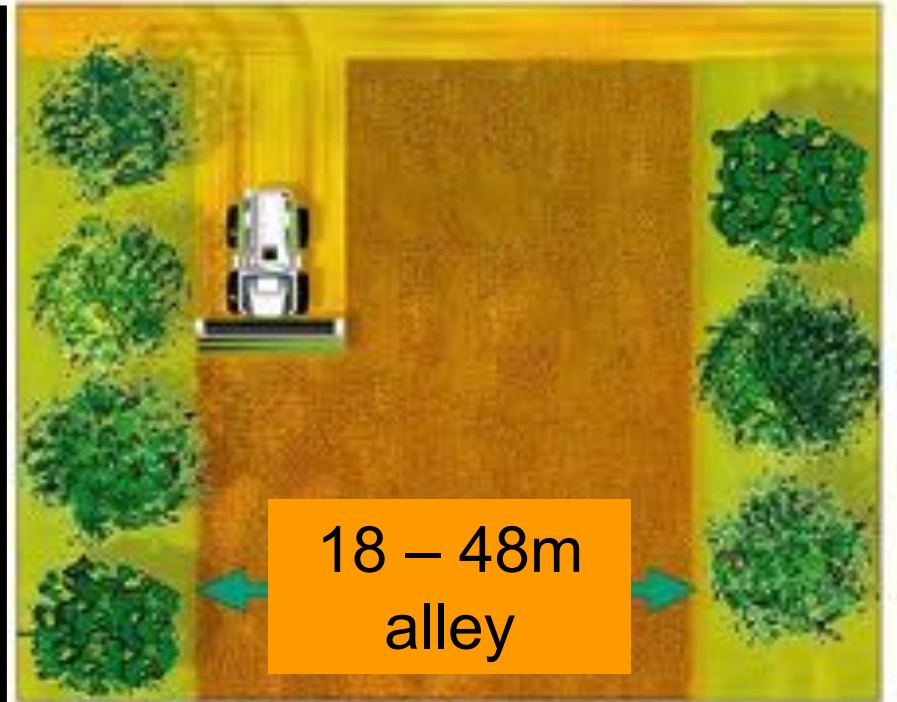
Nr Le Mans France early 20th C



Le bocage dans le Perche, près de Nogent-le-Rotrou (Eure-et-Loir). - Cl. L.P.V.A.

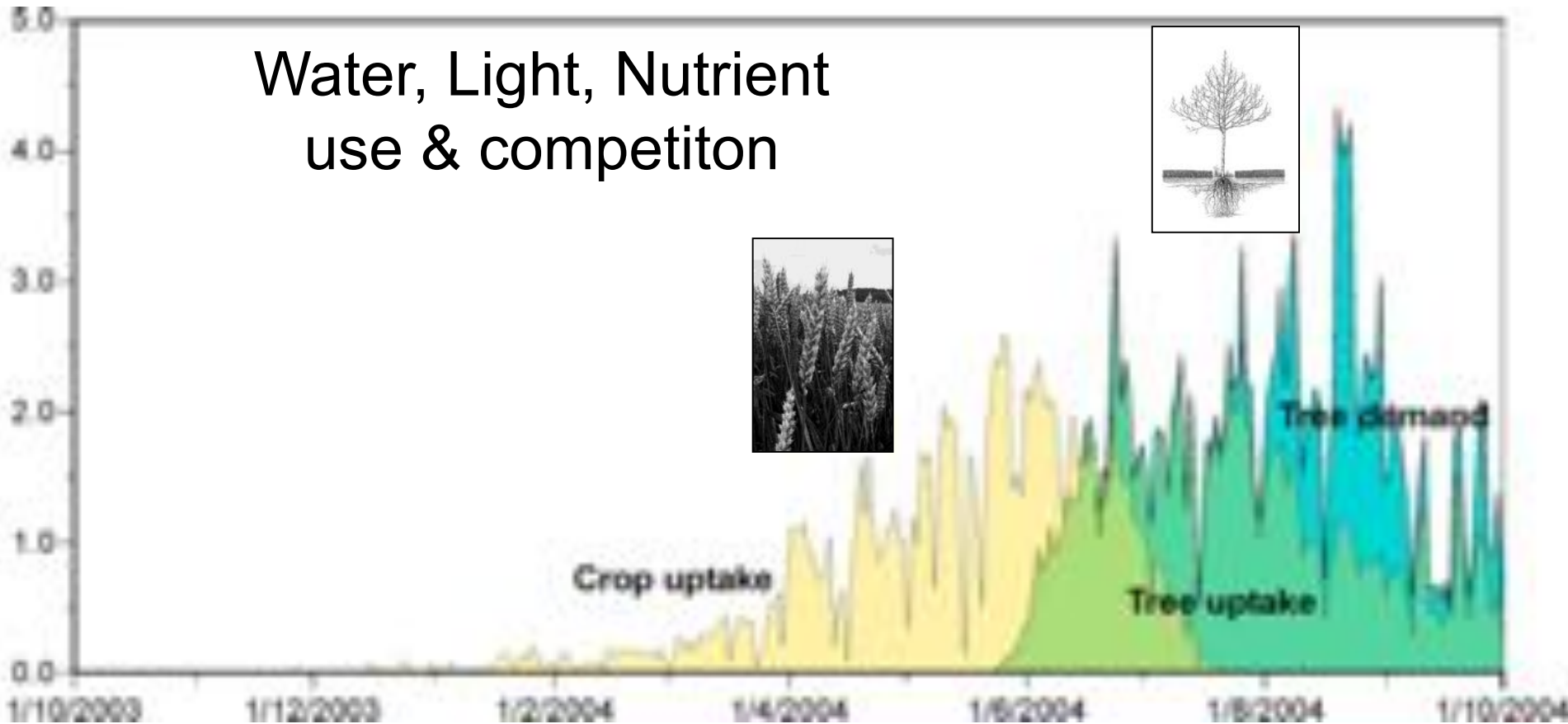
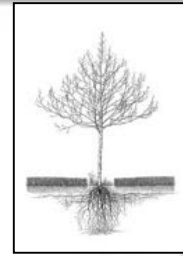
Agroforestry is not a mixture of agriculture and forestry : it's a *hybrid* farming system

'modern systems adapted to modern agriculture'



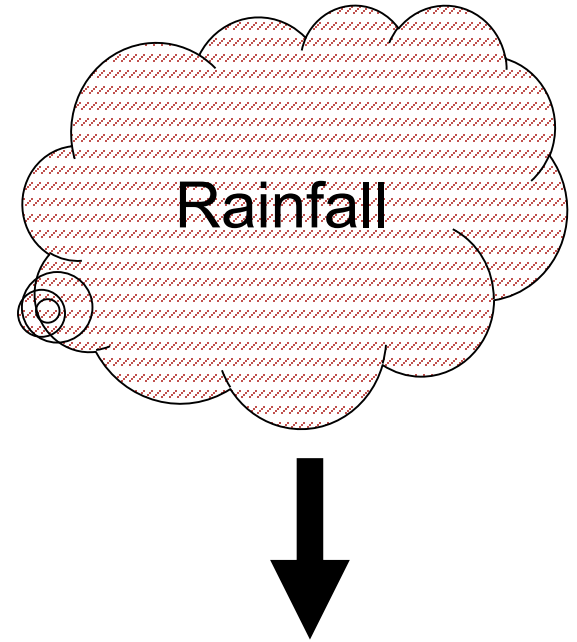
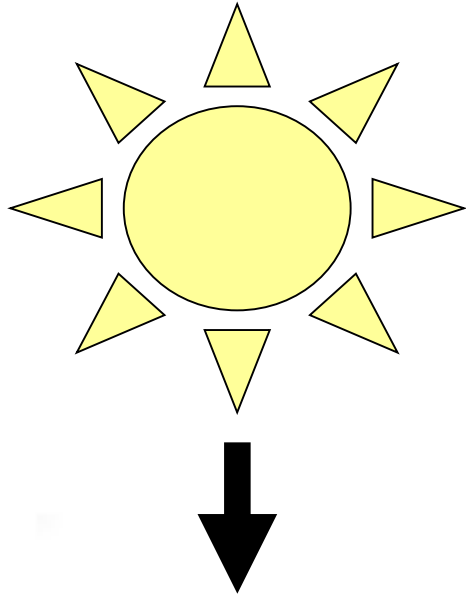
Complementary Combinations are Key

Water, Light, Nutrient use & competition



Crops & trees use water, light, nutrients from different 'spaces' and at '***different periods***' during the season

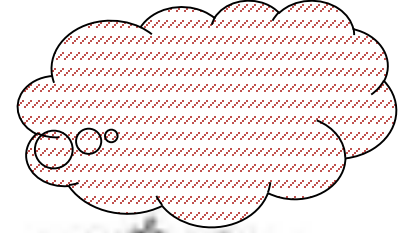
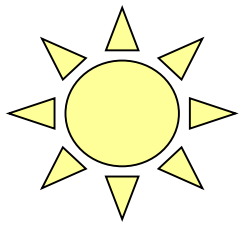




Monoculture Crops grow 0 -1 m above ground only

Monoculture roots grow 0 -1 m below ground only

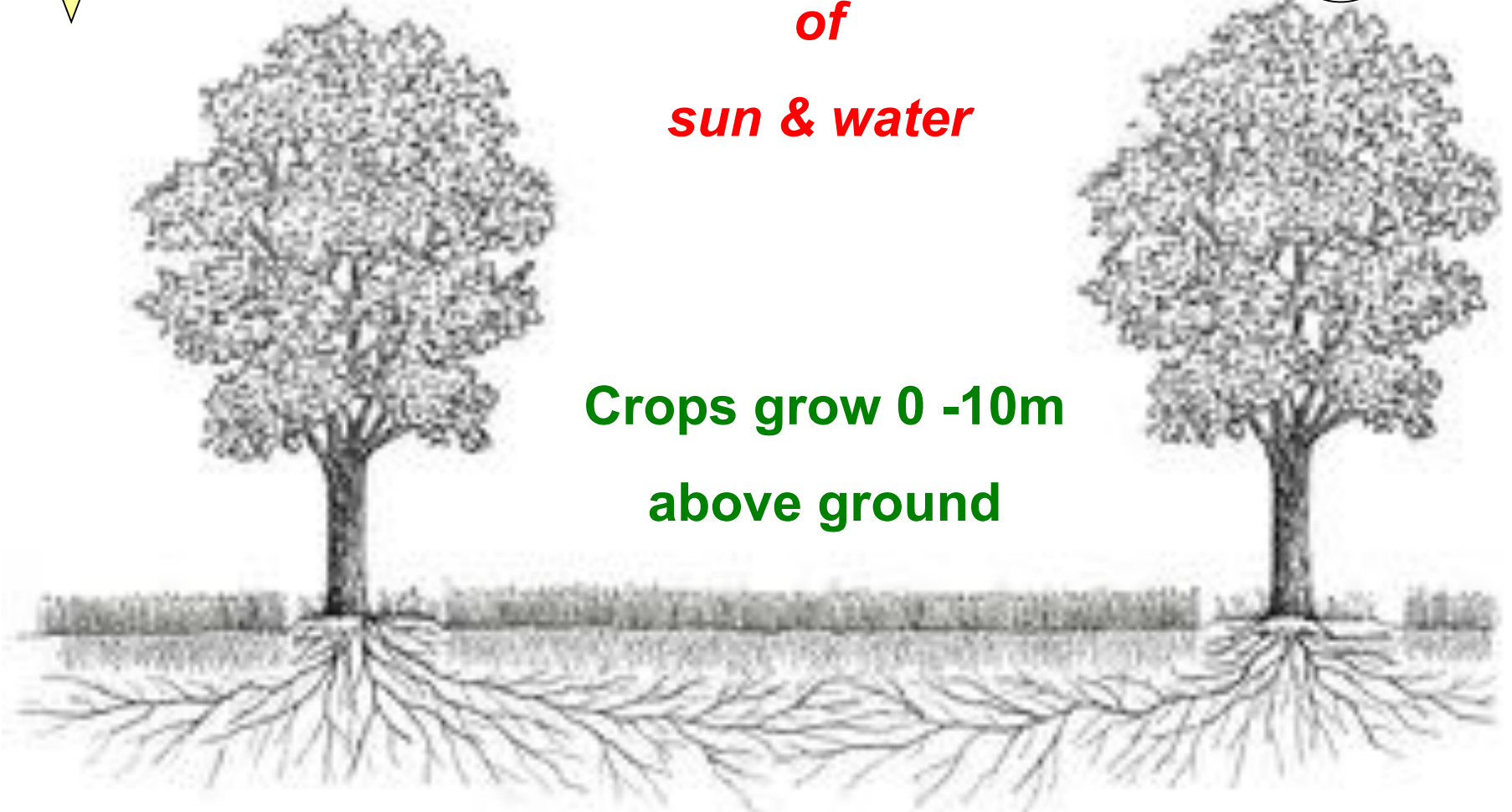




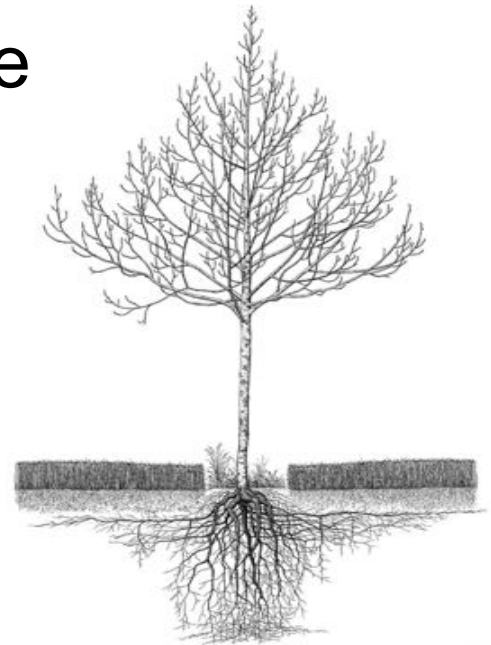
***Improved use
of
sun & water***

**Crops grow 0 -10m
above ground**

**Improved root spread,
nutrient use & reduced leaching**



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Soil Research





Forest tree roots

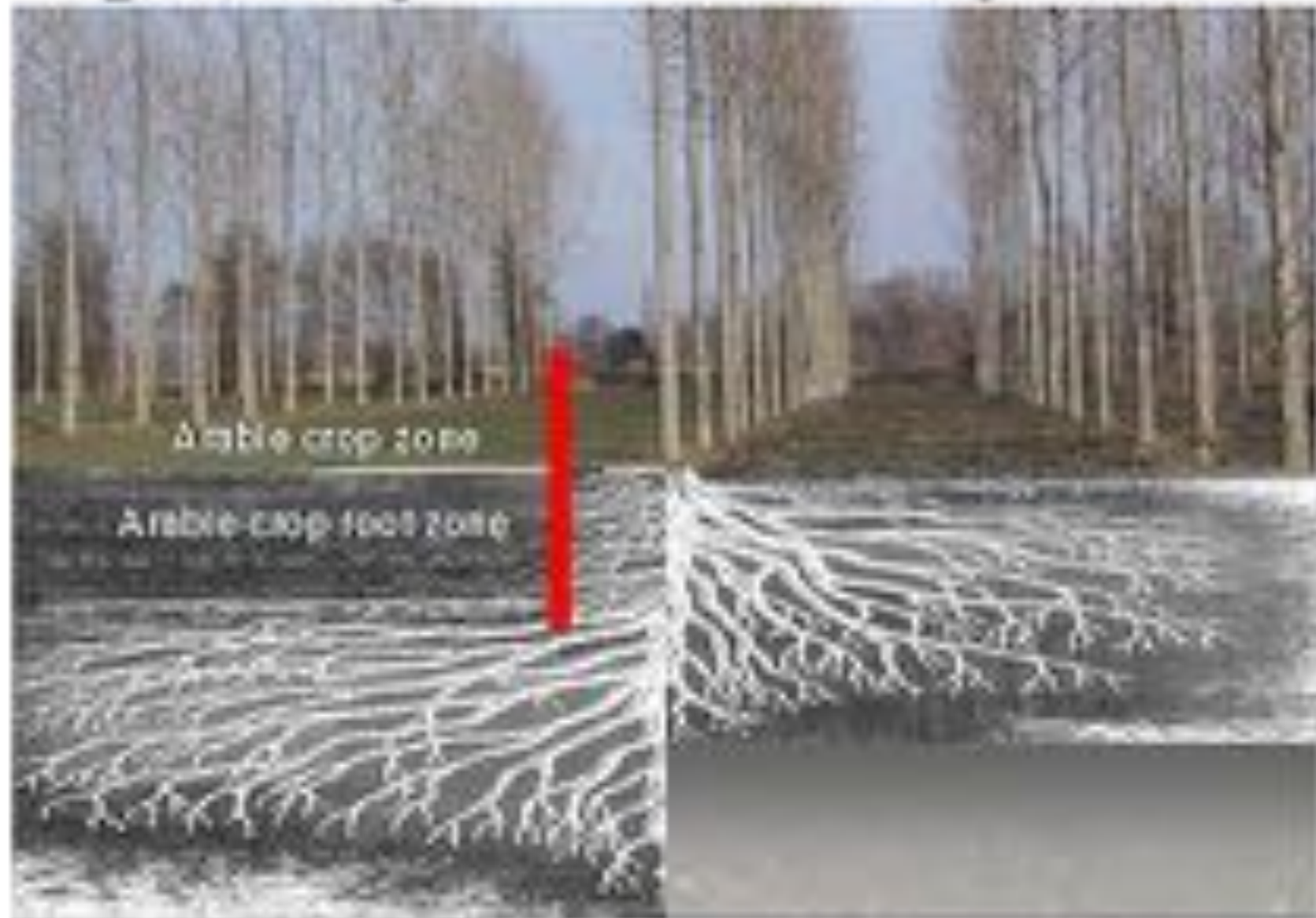


Agroforestry tree roots

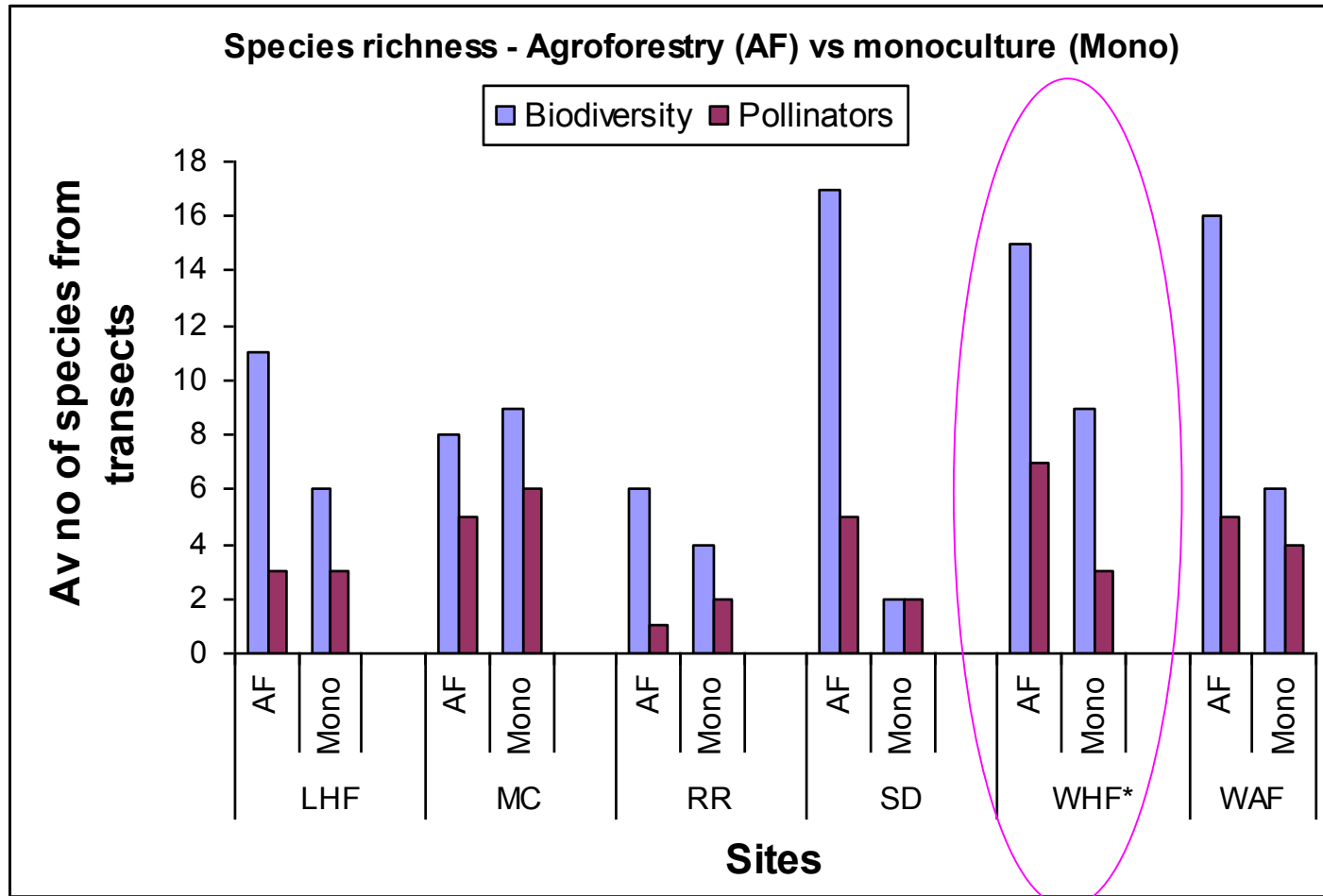


Agroforestry

Forest plantation



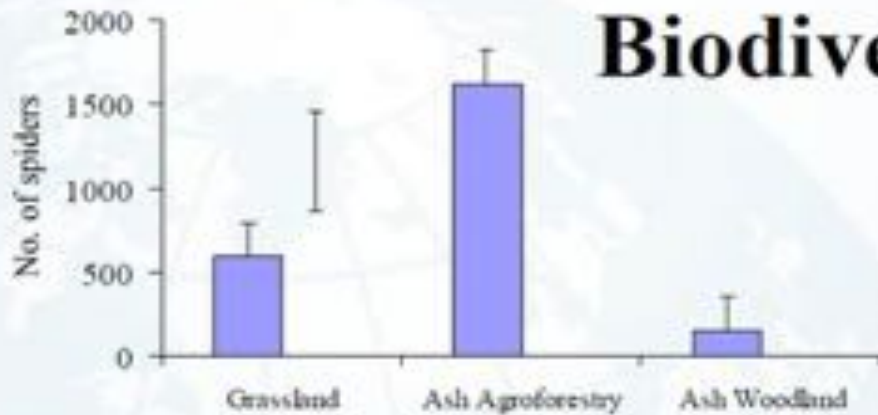
Biodiversity & Ecosystems services research



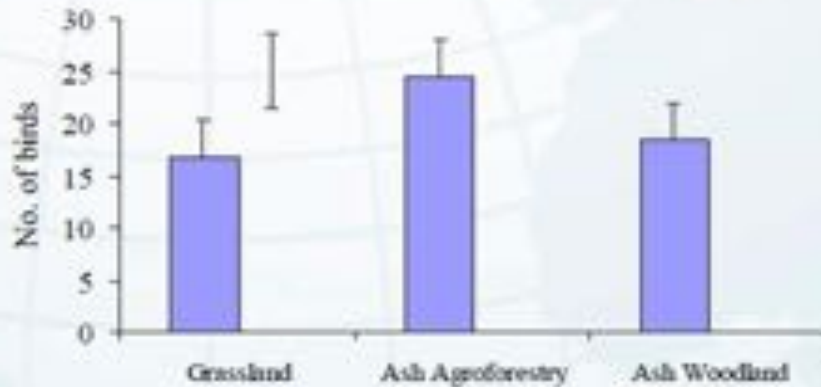
Comparison of species richness between agroforestry (AF) and monoculture (mono) at 6 farms in England 2009-2011.

Source : A Varah Reading University

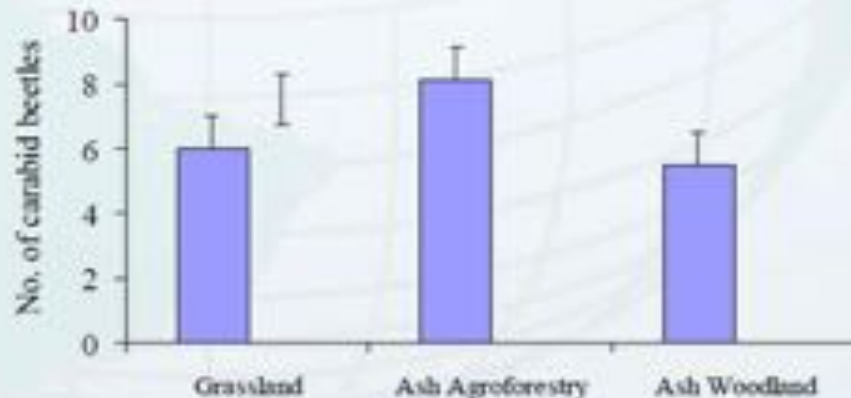
Biodiversity Benefits



Spiders



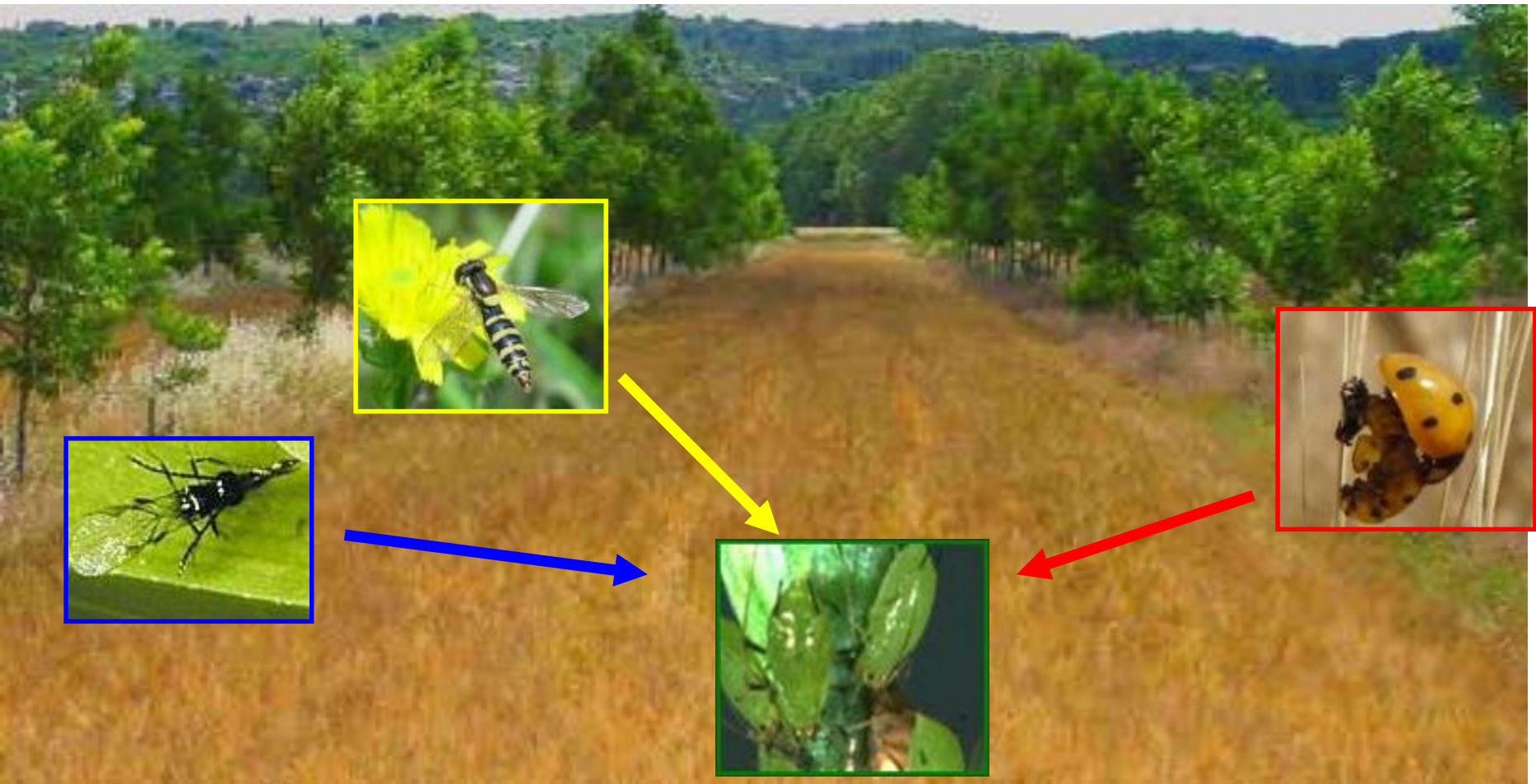
Birds



Beetles



Agroforestry has enhanced biodiversity



i.e biological control of aphids in wheat
Reduced pesticide use?

Environmental protection



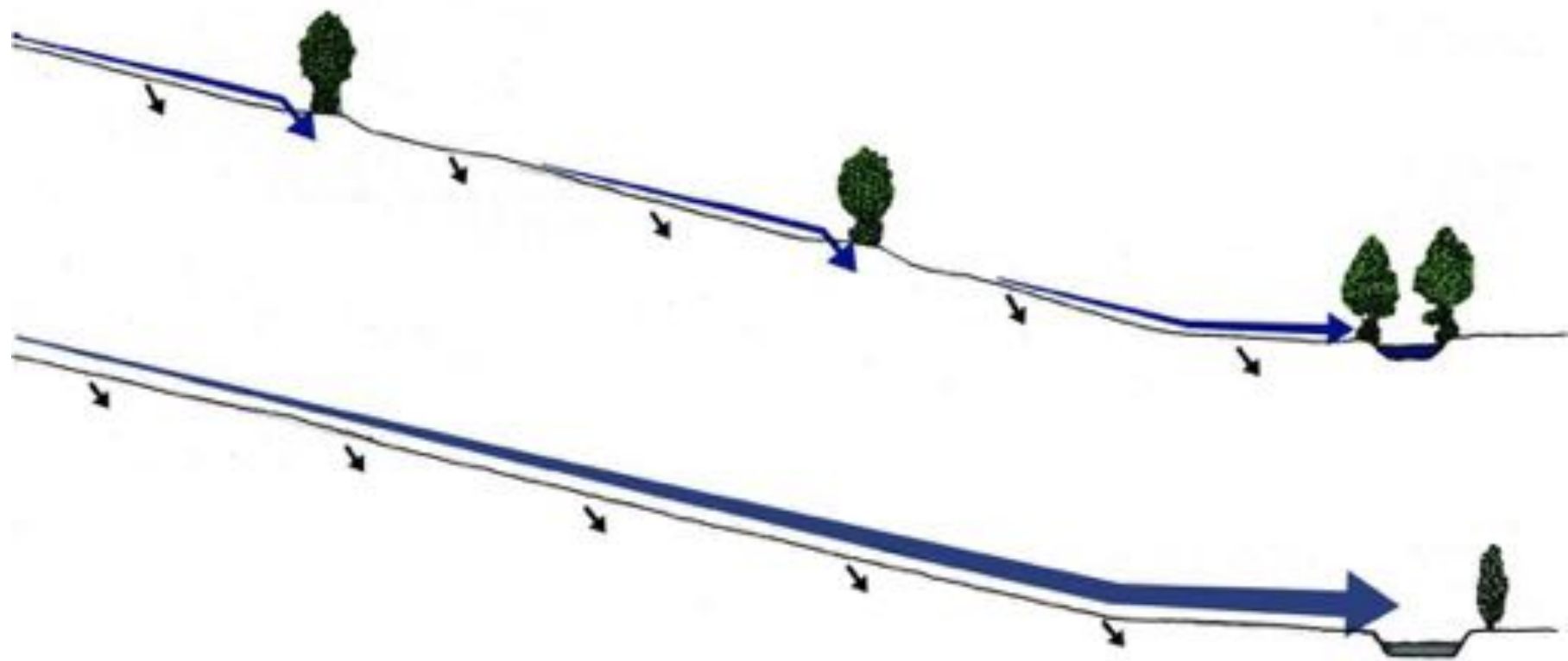


Riparian Buffers



Surface run off

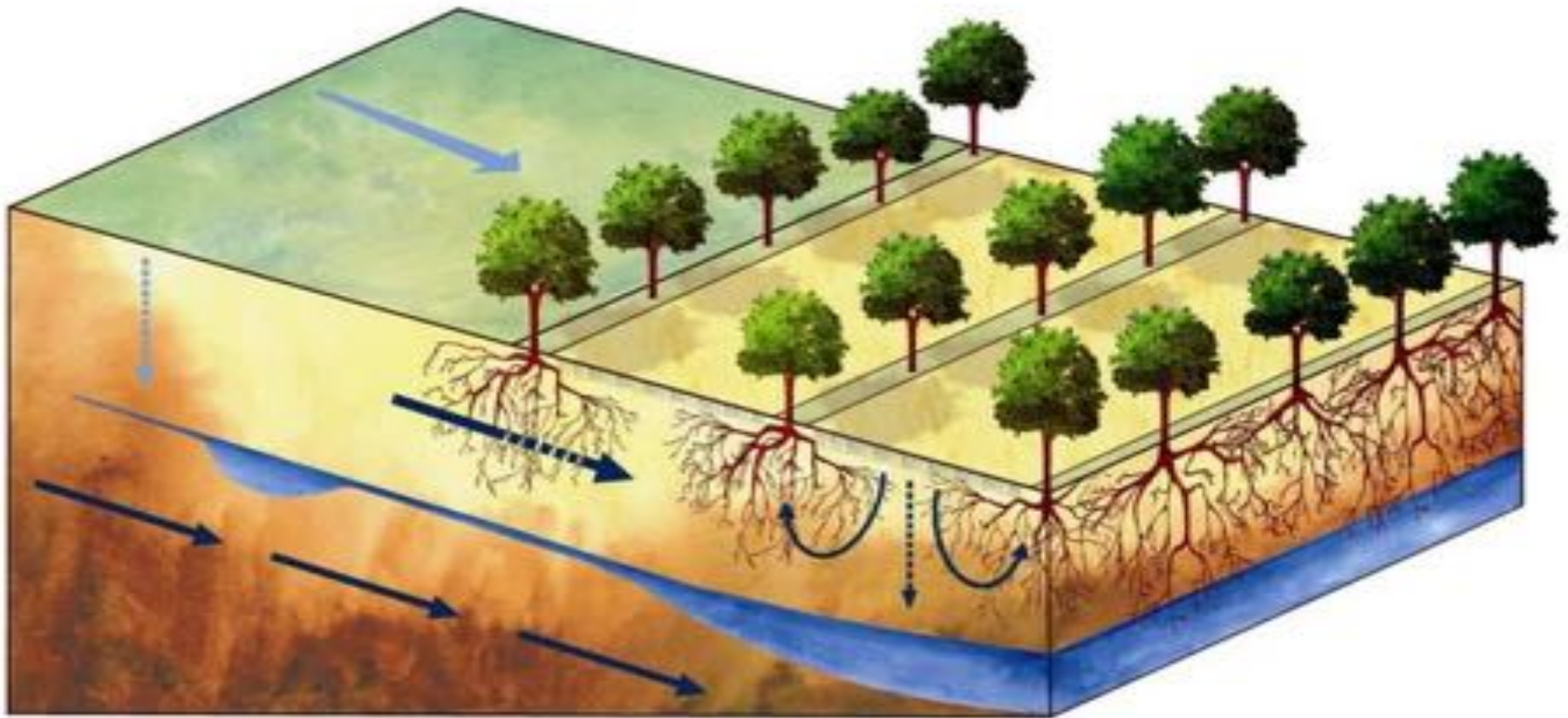






What about resource utilisation
&
Competition for resources ?

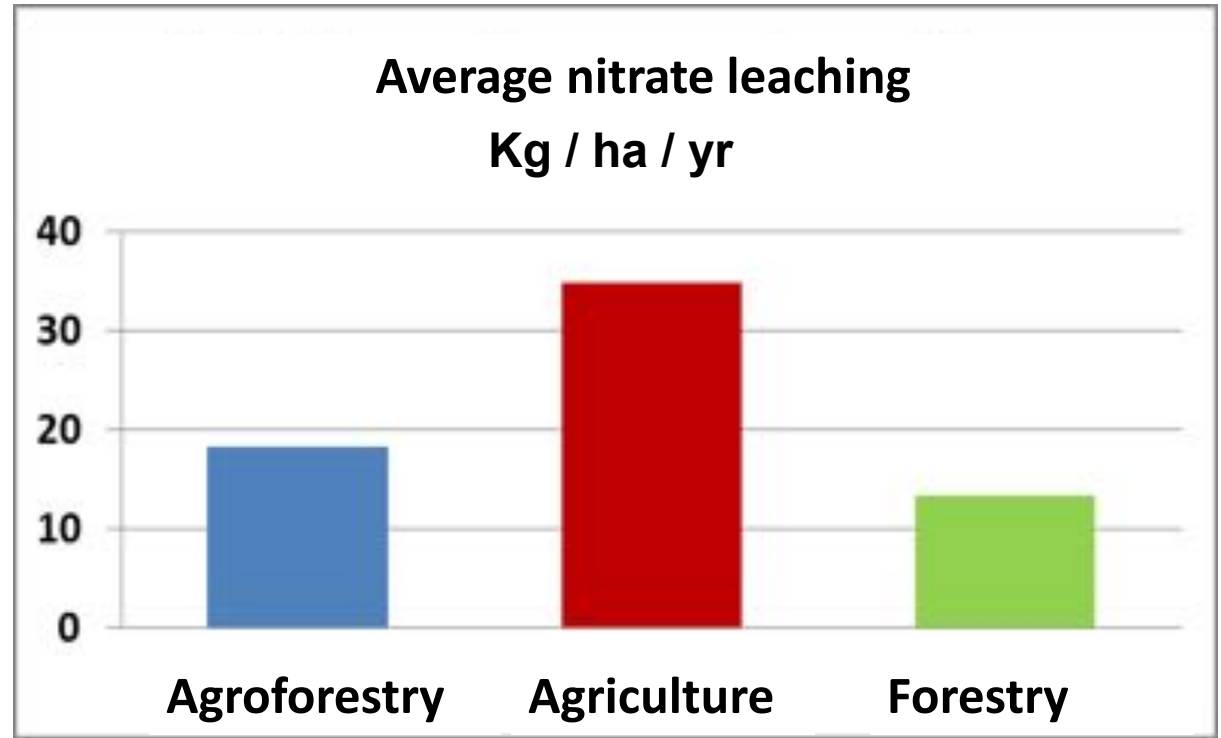
- Improved soil & water quality protection
- Wind speeds reduced
- Reduced evaporation and water loss from crops
- Microclimate modified



Reduced Nitrogen leaching

**Up to 50% less
N lost under
Agroforestry
than arable**

**Trees capture N
not used by
crops**



Source : Research by INRA Restinclières, France



Monoculture

Agroforestry

How can we compare productivity?

Land equivalent ratio of productivity

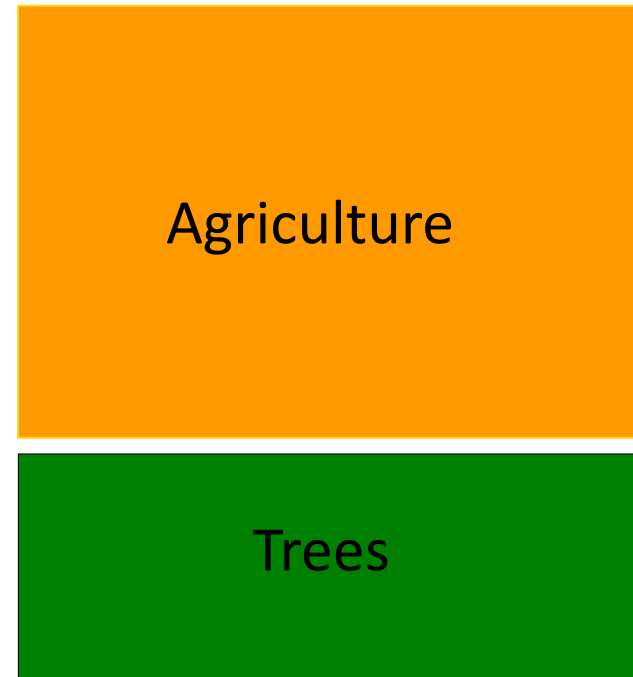
Mixture

1 ha



=
LER = 1.4

Grown separately



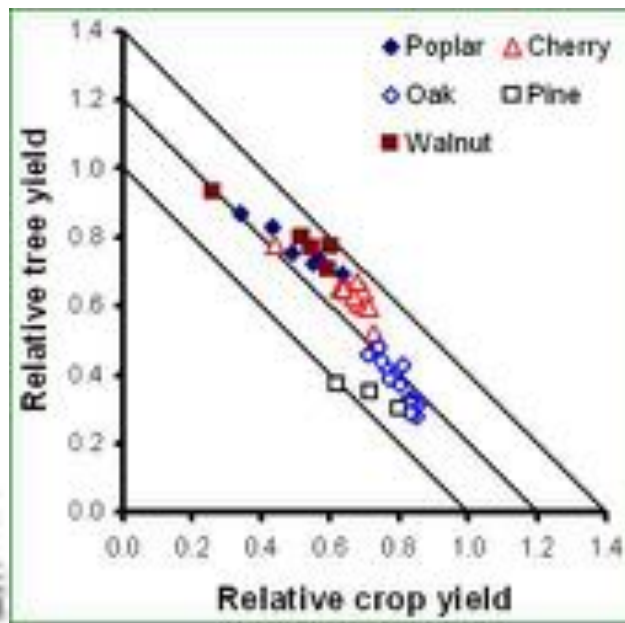
0.8 ha

0.6 ha

An LER of 1.4 means 100 ha of agroforestry produces as much crop & tree products as 140 ha farmland where trees and crops are separated

Balancing productivity with environment management

Tree and crop yields for 42 tree-crop combinations



LER's
1.1 to 1.4

Improved sun & water utilisation

Greater overall productivity



Is agroforestry scalable to mainstream agriculture?


China



**The People's
Republic of China**
Zhonghua Renmin Gongheguo

UK – 4.7 million ha arable land

Henan Province 3.2 million ha

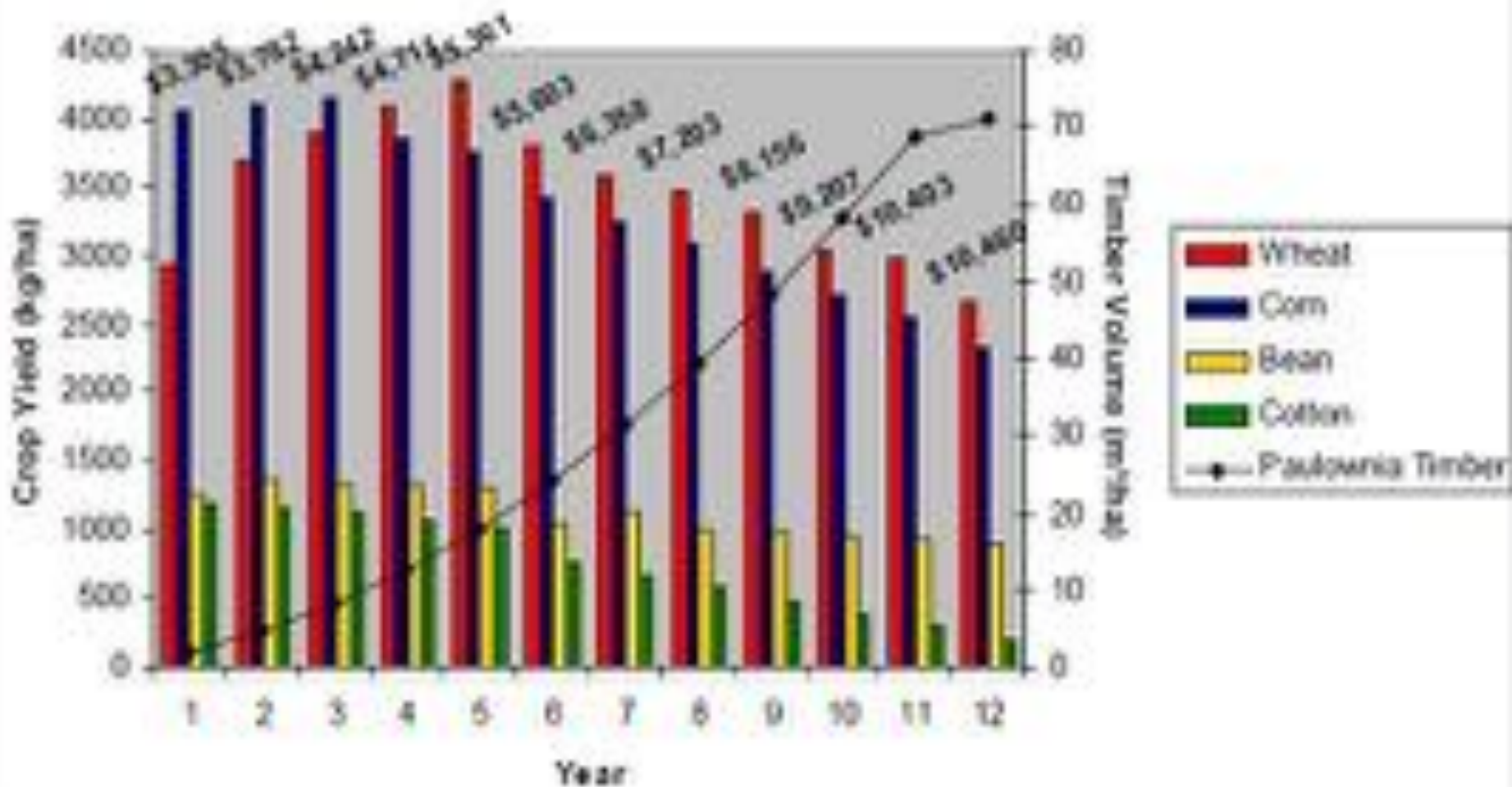


China - Henan province
3.2 million ha of Paulownia tree / wheat intercrop
Crop land is scarce in China!

As the trees mature - arable crop output decreases

Combined value of arable crop + timber increases with time

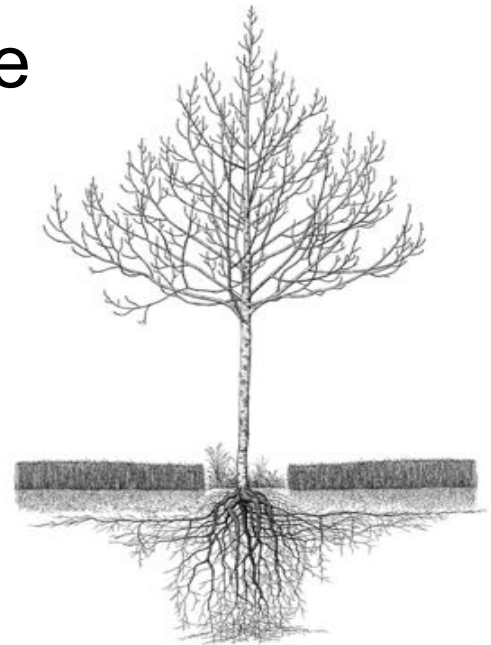
Agroforestry Yields on the North China Plain



Source Yin & He



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Silvo-pastoral: trees and livestock



Tree forage – increasing interest

- Trace minerals
- Protein rich leaves
- Medicinal benefits
- Diet supplementation
- Willow & poplar browse?

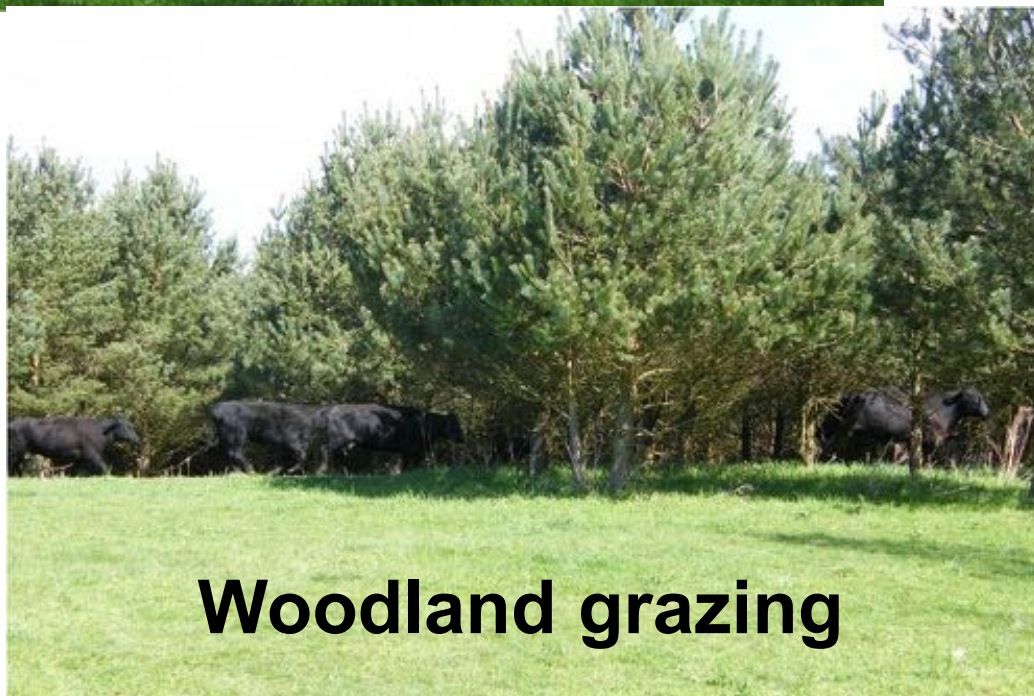




Orchards



Tree Forage



Woodland grazing

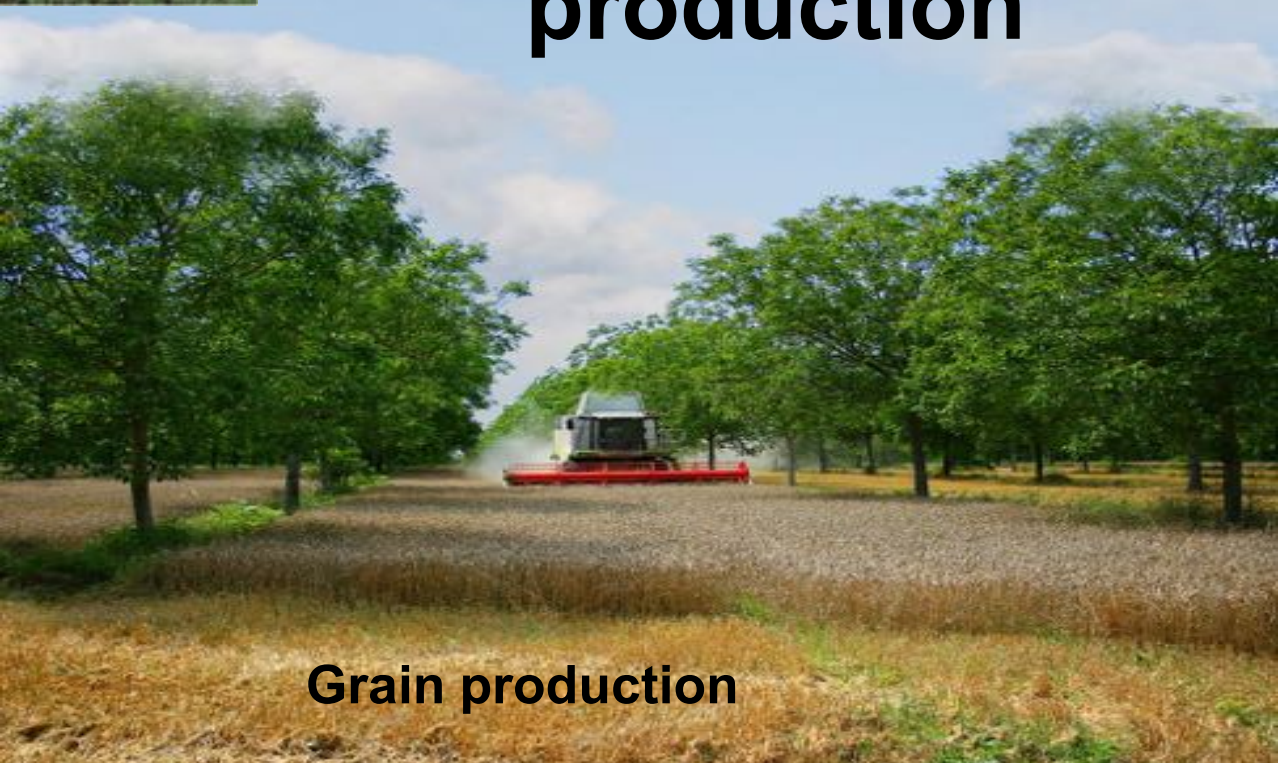


**Fruit
&
Nuts**



Biomass

Agroforestry & crop production



Grain production

Silvo-arable : crops & trees




Using field scale machinery

Silvo- Arable Alley Cropping



Crop rotation & timescales longer



A photograph of a field with trees in the background. The foreground is a field of brown, fallen leaves. In the background, there is a line of trees with green foliage. The sky is overcast and grey. The text is overlaid on the bottom right of the image.

Trees bring up nutrients from deep
Leaf fall provides fertiliser
Nutrients available to crops



Windbreaks



Shelter Belts

Riparian systems



Upland agriculture



lowland agriculture



Catchment scale



Converting woodlands to woodland grazing ?



Opportunities for improved land and economic output ?

Upland systems



Agroforestry plots
at Glensaugh



Poultry



Fruit & Nuts



Timber products

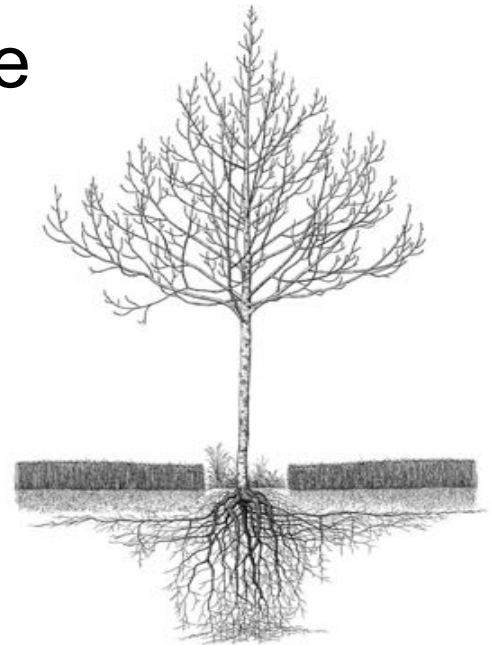


Biomass



- EURAF www.agroforestry.eu/
- AGFORWARD www.agforward.eu/
- AGROFE www.agrofe.eu

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Bluebell Farms Ltd



Agroforestry into practise

- 250ha organic farm
- Owned, tenanted, contract
- 52ha agroforestry



SPEEDWELL FARMING
organic : sustainable : profitable



Rain Alarm





Whitehall Farm cropping

Clover	10ha
W Wheat	20ha
W & S Oats	60ha
Leeks	10ha
Apple trees	4ha
Environment	6.0ha
Total	110ha

- **2009-2011 yields**
- WW av.5.2t/ha
 - Best 6.25t/ha
 - Worst 4.4t/ha
- W & S Oats av.6.75t/ha
 - Best 8.0t/ha
 - Worst 3.2t/ha
- Conventional yields (historic)
 - WW 8.6t/ha (3.5t/ac)
 - OSR 3.7t/ac (1.5t/ac)
 - S Beet 60.5t/ha (24.3t/ac)
- Organic is c.73% - 80% of conventional yield

Drivers



- Multifunctional land use
- Cropping & enterprise diversity
- Soil protection
- Conservation & Habitat creation
- Market opportunities

Soil erosion - a serious issue!



Soil erosion - a serious issue!



Limitations

- 15yr tenancy
- Retain CAP eligibility
- Capital
- Profitability
- No livestock facilities



Agroforestry system - 85 trees per ha



Intensive orchard – 850 trees per ha





An aerial photograph of a rural landscape featuring a patchwork of agricultural fields. A large, irregularly shaped area in the upper portion of the image is outlined with a yellow dashed line. This area contains a mix of green and brown fields, with a small cluster of trees in the center. The surrounding landscape consists of various colored fields, some dark brown (plowed) and some green (cultivated or grassy). In the bottom left corner, there is a farmstead with several buildings, a parking lot with yellow tractors, and a large white cylindrical tank. A road runs horizontally across the middle of the image, separating the agroforestry area from the farmstead.

Agroforestry 52ha



3m

24m

3m

Layout

- 85 Vs 850 trees per ha
- 3m between each tree in the row
- 27m between each row
- 3m pollen rich strip under trees
- 24m working width between rows





Tree & Variety

Pinova	388
Fiesta	313
Red Devil	195
Limelight	184
Red Windsor	540
Rajka	300
Red Falstaff	1102
Herefordshire Russet	350
Saturn	278
Bramley	482
Adams Pearmain	90
Ashmeads Karnell	89
Chivers Delight	89

- Rootstock & Vigour
 - MM106
- Pest & Disease tolerance
- Soil suitability
- Drought & scab tolerance
- Low input 'easy care' system
- Eating vs Juicing
- Heritage vars. to aid pollination
- Picking – mid Sept (Red Windsor) to late October (Pinova)





24m

27m







2009

Winter 2009

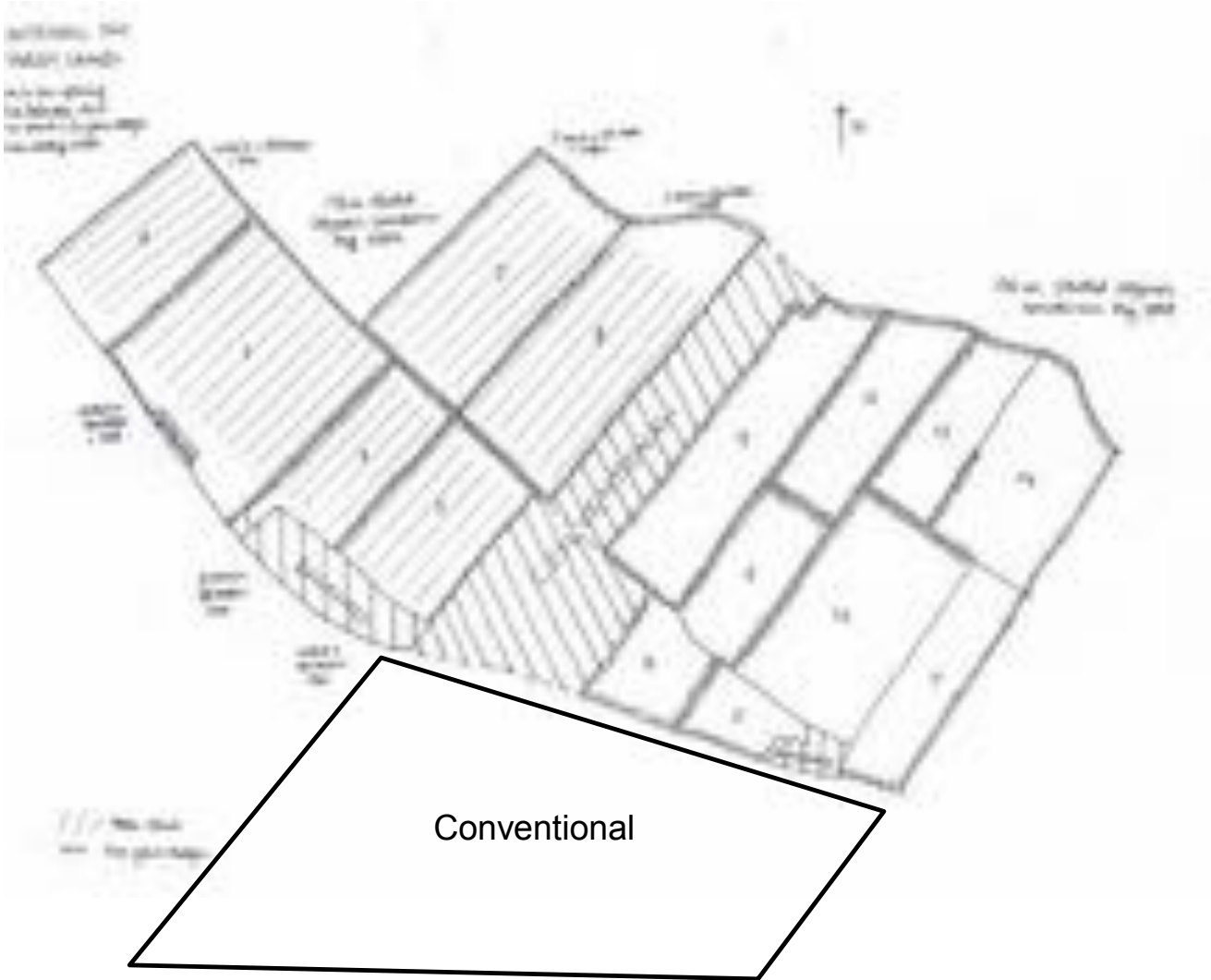


Research

- RSPB
- Barn Owl breeding & monitoring
- Wheat Link
- Legume Link
- ORC Eco-system services – baseline fauna survey and on –going with PhD
- ORC Agroforestry
- Reading Uni – MSc Soil Structure differences organic vs conventional farms
- Reading Uni – PhD insect and work populations under legumes
- Own work on Min-Till and Agroforestry



Summary of biodiversity baseline data from Whitehall Farm, Butterflies, bumblebees and flora



	Organic Arable	Agroforestry	Conventional
<i>Pieris brassicae/rapae</i>	47	23	18
<i>Pieris napi</i>	4	2	3
<i>Maniola jurtina</i>	13	39	7
<i>Inachis io</i>	8	20	11
<i>Pyronia tithonus</i>	2	3	8
<i>Vanessa cardui</i>	0	1	1
<i>Aglais urticae</i>	1	2	0
<i>Ochlodes sylvanus/Thymelicus sylvestris</i>	5	7	1
Total abundance	80	97	49
Total no. Spp.	7	8	7



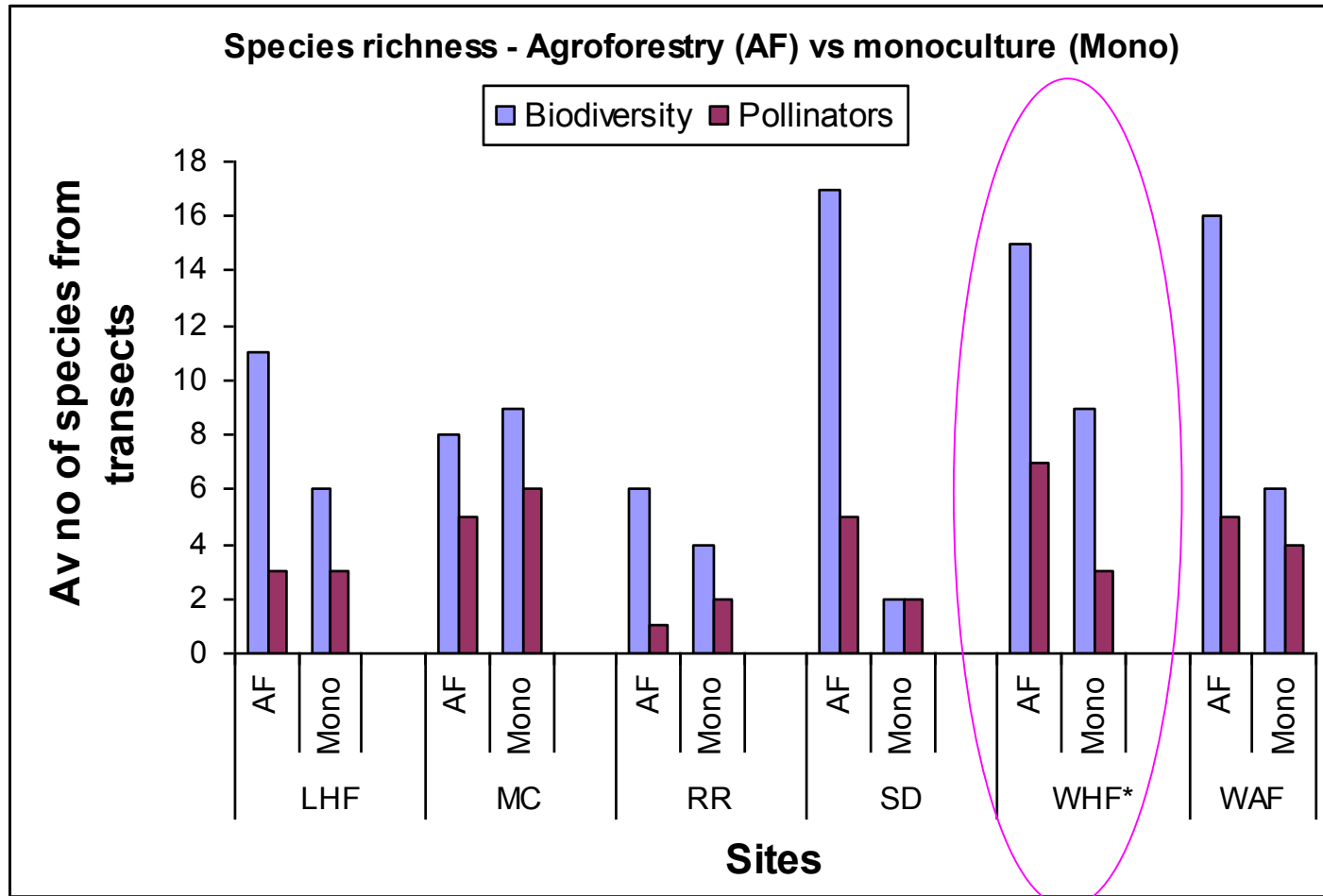
Table 1.1 Butterfly abundance in three management systems, Farcet, Cambs.



	Organic Arable	Agroforestry	Conventional
<i>Bombus lapidarius</i>	37	43	6
<i>B.terr/luc</i>	13	25	10
<i>B.pascuorum</i>	3	0	0
<i>B.hortorum</i>	1	0	0
Total abundance	54	68	16
Total no. spp	4	2	2

Table 1.2. Bumblebee abundance in three management systems, Farcet, Cambs.

Biodiversity & Ecosystems services research



Comparison of species richness between agroforestry (AF) and monoculture (mono) at 6 farms in England 2009-2012.

Source : A Varah Reading University

Yields and economics

UK farmer experiences

Whitehall Farm

- **Capital costs**
 - 4.00ha tree lines - £150/ha pollen/wildflowers - £0.13/tree - £600
 - 4500 trees (apple) - £12/tree (tree, post, guard, mulch mat, plant) - £54,000
 - TOTAL £54,600
- Organic conversion (Top fruit) conversion grant - £28,000
- **£26,000 to recover** investment from output
 - Yr1 – 4 zero yield
 - Year 4 – 1.1t/ha x 4ha x £850/t = £3750
 - Year 5 - 1.8t/ha x 4ha x £850/t = £6120
 - Year 6 – 3.2t/ha x 4ha x £850/t = £10,880 << (**break even at yr 6.5**)
 - Year 7 -6.25t/ha x 4 x £850 = £21,250
- **Management & Maintenance**
 - Replanting 2%/yr - £1000/yr
 - Pruning – 14 days / yr – £1,120/yr - £0.25/tree
 - Harvesting – 10 days / yr – 4 people £3,500/yr - £077/tree

Wheat / Apple orchard monocultures VS Wheat – Apple Agroforestry – at yr 5

	land area %	yield ha/yr	Value £/t	Component Output £/ha/yr	Total Output £/ha/yr
Monoculture					
Apple orchard @ 1000 trees / ha	100	10.4 t	850	8840	8840
Organic wheat	100	5.0 t	270	1350	1350
Agroforestry					
Apple @ 90 trees / ha	13	1.1 t	850	765	765
Organic wheat	87	5.0 t	270	1350	1350
					2115
LER = 1.1	1.1	$\frac{\text{Tree agroforestry yield}}{\text{Tree monoculture yield}}$	$\frac{\text{Crop or livestock agroforestry yield}}{\text{Crop or livestock monoculture yield}}$	5	
	10.4	$\frac{\text{Tree agroforestry yield}}{\text{Tree monoculture yield}}$	$\frac{\text{Crop or livestock agroforestry yield}}{\text{Crop or livestock monoculture yield}}$	5	

i.e. 10% more land needed under monocultures to produce same yields

Willow alley cropping at Wakelyns

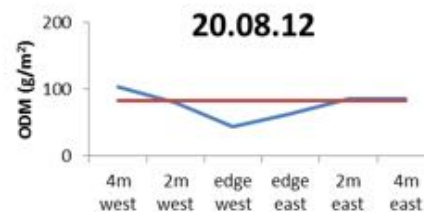
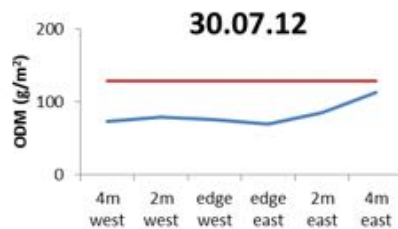
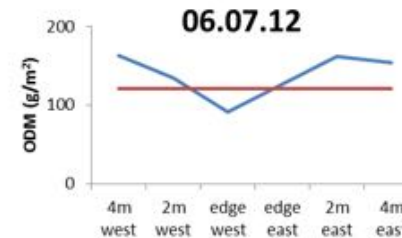
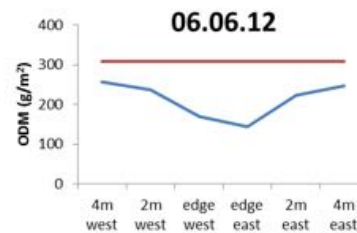
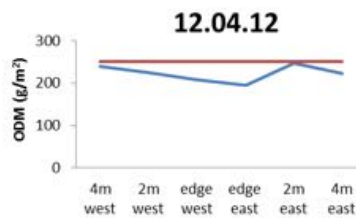


Productivity – an example

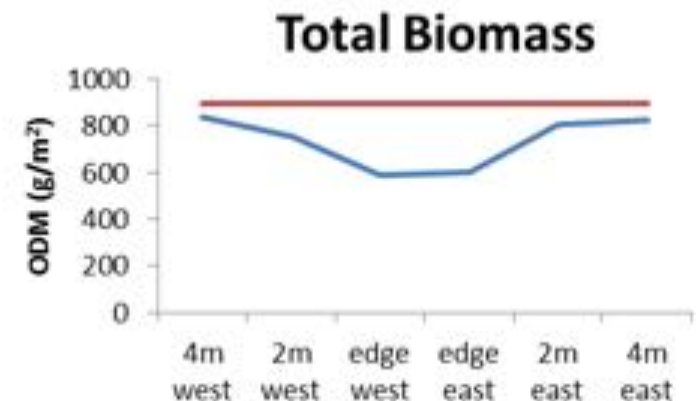
AGROFORESTRY



CONTROL



But remember this is productivity of only one component of the AF system – productivity of the trees need to be included in total productivity!



Land Equivalent Ratio

Willow

SRC Plantation: 25 odt/ha **every 3 years** = 8.33 odt/ha/year

Agroforestry: 6.7 odt/ha **every 2 years** = 3.35 odt /ha/year

Winter wheat (organic)

Monoculture: 5 t/ha

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

Shaded area @ 50% yield = 0.13 ha (0.45 t/ha)

+

Non shaded area @ 100% yield = 0.67 ha (4.68 t/ha)

Wheat output = 5.13 t/ha

SRT coppice willow / wheat monocultures

vs

Willow – Wheat Agroforestry

	land area %	yield ha/yr	Value €/t	Component Output €/ha/yr	Total Output €/ha/yr
Monoculture					
SRT Plantation Willow	100	8.33 odt	60	499.8	499.8
Organic wheat	100	5.1	270	1350	1350
Agroforestry					
Willow	20	3.35 odt	60	201	201
Wheat 100%	67	4.68 t	270	1263.6	
Shaded wheat 50%	13	0.45 t	270	121.5	
		5.13 t	270		1385.1
					1586.1
LER = 1.43	3.35	The agroforestry yield	Drop or livestock agroforestry yield		5.13
	8.33	The monoculture yield	Drop or livestock monoculture yield		5

Land Equivalent Ratio

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

$$\text{LER} = \frac{3.35}{8.33} + \frac{5.13}{5}$$

$$\text{LER} = 0.40 + 1.03$$

$$\text{LER} = 1.43$$

i.e. 43% more land needed under monocultures to produce same yields.

Pictures of Whitehall Farm











3m wide Nectar & Wild flower
strip Under tree rows



Drilling 2017





52ha of Agroforestry at my own farm in Cambridgeshire













Robocrop





Controlled traffic farming





































Soil Health monitoring

Contact : NICK MORRIS
 BRITISH SUGAR PLC
 WISSINGTON SUGAR FACTORY
 COLLEGE ROAD
 WISSINGTON
 PE33 9QG
 Tel : 01366 377364

Client : BLUEBELL FARMS LTD
 WHITEHALL FARM
 RAMSEY ROAD
 FARCET
 PETERBOROUGH
 PE7 5DH

B 28

Please quote the above code for all enquiries

Local Rep : DANIEL GODSMARK
 Telephone :
 Sample Matrix : Agricultural Soil

Laboratory Reference
 Card Number 29110/12

Date Received 05-Nov-12
 Date Reported 06-Nov-12

SOIL ANALYSIS REPORT

Laboratory Sample Reference	Field Details		Soil pH	Index			mg/l (Available)		
	No.	Name or O.S. Reference with Cropping Details		P	K	Mg	P	K	Mg
128473/12	1	3.3 hectares Other Crop into Other Crop	6.3	3	2+	3	26.4	155	106
128478/12	2	12.2 hectares Other Crop into Other Crop	6.4	3	2+	3	28.6	182	107
128479/12	3	4.5 hectares Winter Wheat into Spring Wheat	6.8	3	3	2	31.2	272	90
128480/12	4	6.0 hectares Winter Wheat into Spring Wheat	6.5	3	3	2	29.0	282	98
128481/12	5	2.9 hectares Winter Wheat into Spring Wheat	7.3	3	2+	2	41.4	217	87
128482/12	6	6.4 hectares Other Crop into Other Crop	5.9	3	3	3	26.8	256	118

If general fertilizer and lime recommendations have been requested, these are given on the following sheets.
 The analysis methods used are as described in DEFRA Reference Book 427
 The index values are determined from the DEFRA Fertiliser Recommendations 2009 8th Edition (Appendix 4)



SOIL ANALYSIS RESULTS



Abbey Analytical Ltd 01223 802100 ext 201

Client: Soil Association
 CT trial

Date: 29.11.2014
 Sample ID: SBLO66 - Whitehall Farm
 Crop: Arable

Contact: Simon Parley

Soil Microbiology Report

Organism Biomass

Analysis	Units	Result	Guideline	Low	Optimal	High
Moisture content	%	42.00	15-55	[Progress bar: ~75%]		
Active Bacteria	µg/g	22.4	20 - 25	[Progress bar: ~80%]		
Total Bacteria	µg/g	362.0	150 - 300	[Progress bar: ~90%]		
Active Fungi	µg/g	53.7	20 - 25	[Progress bar: ~95%]		
Total Fungi	µg/g	208.0	150 - 300	[Progress bar: ~70%]		
Hypheal Diameter	µm	2.75	>2.5	[Progress bar: ~85%]		

Organism Ratios

Analysis	Units	Result	Guideline	Low	Optimal	High
Active/Total Bacteria		0.06	0.15 - 0.20	[Progress bar: ~30%]		
Active/Total Fungi		0.26	0.25 - 0.20	[Progress bar: ~95%]		
Active Fungi/Active Bacteria		2.4	1.0 - 2.0	[Progress bar: ~85%]		
Total Fungi/Total Bacteria		0.56	1.0 - 2.0	[Progress bar: ~25%]		

Protocols

Analysis	Units	Result	Guideline	Low	Optimal	High
Flagellates	No/g	7351	>5000	[Progress bar: ~85%]		
Amoebae	No/g	962	>5000	[Progress bar: ~15%]		
Ciliates	No/g	112	50-100	[Progress bar: ~90%]		

Nematodes

Analysis	Units	Result	Guideline	Low	Optimal	High
Total Nematodes	No/g	10	20 - 20	[Progress bar: ~50%]		
Nematode types	Fungal feeders: 37%, Bacteria feeders: 14%, Predators: 5%, Plant parasitic: 28%, Juveniles: 16%					

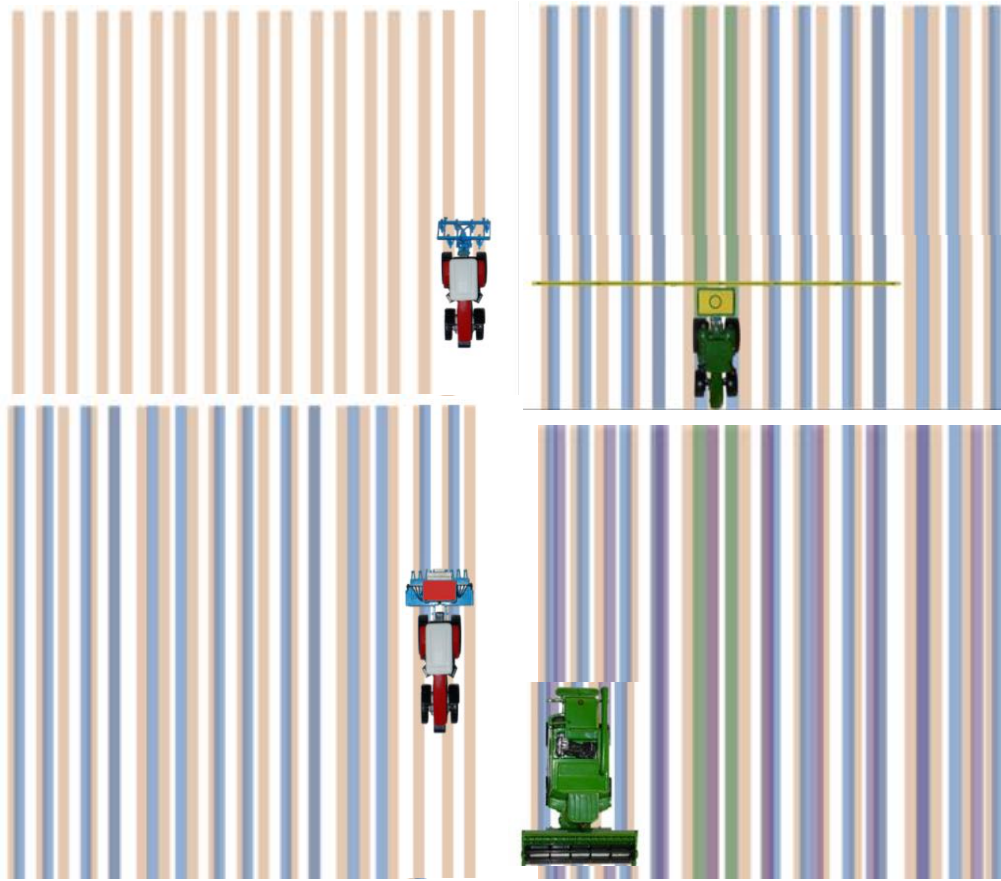
Mycorrhizal Colonisation

Analysis	Units	Result	Guideline	Low	Optimal	High
Ectomycorrhizae	%	NA	10-50	[Progress bar: 0%]		
Endomycorrhizae	%	14	10-50	[Progress bar: ~28%]		

Potential Nitrogen in Soil

Nitrogen (N)	kg/ha	84-112*	Potentially cycled for a period of 3-6 months			
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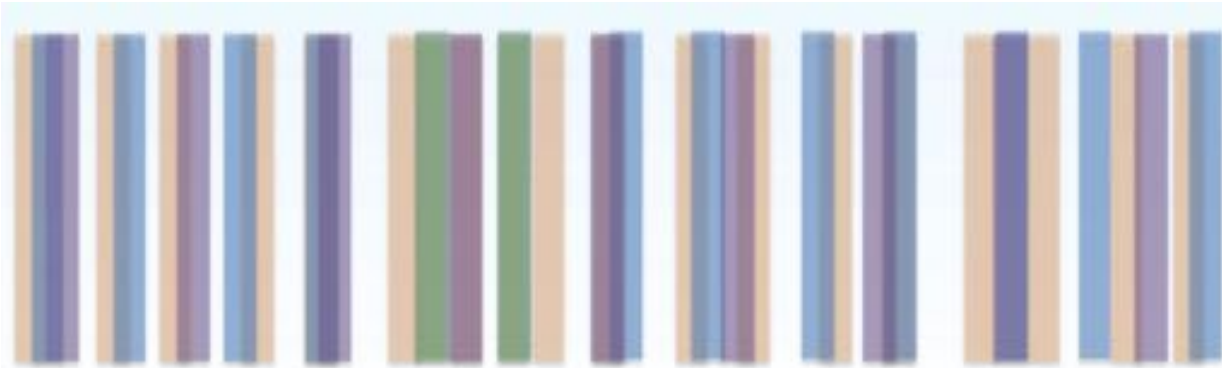
* Please note that this value is related to the microbiological activity and is not a chemical measure of nitrogen.



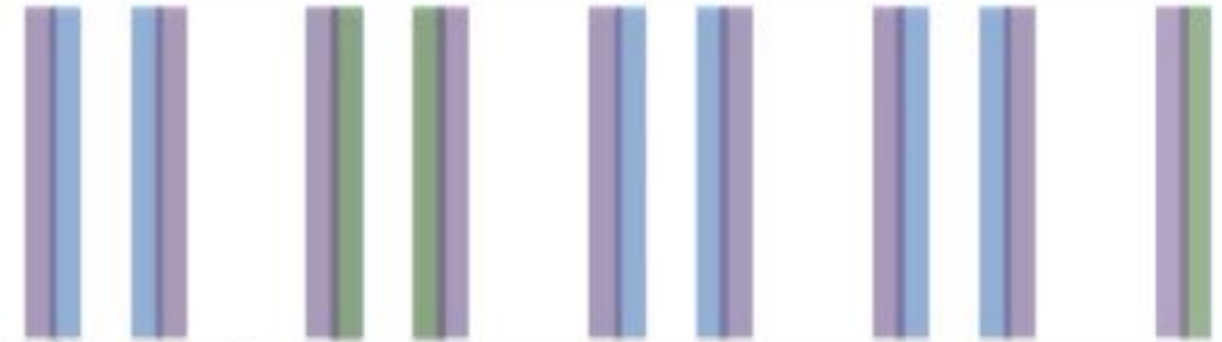
Controlled Traffic Farming

Conventional traffic v. CTF

Conventional traffic



CTF



Companion planting, Relay cropping & precision Ag





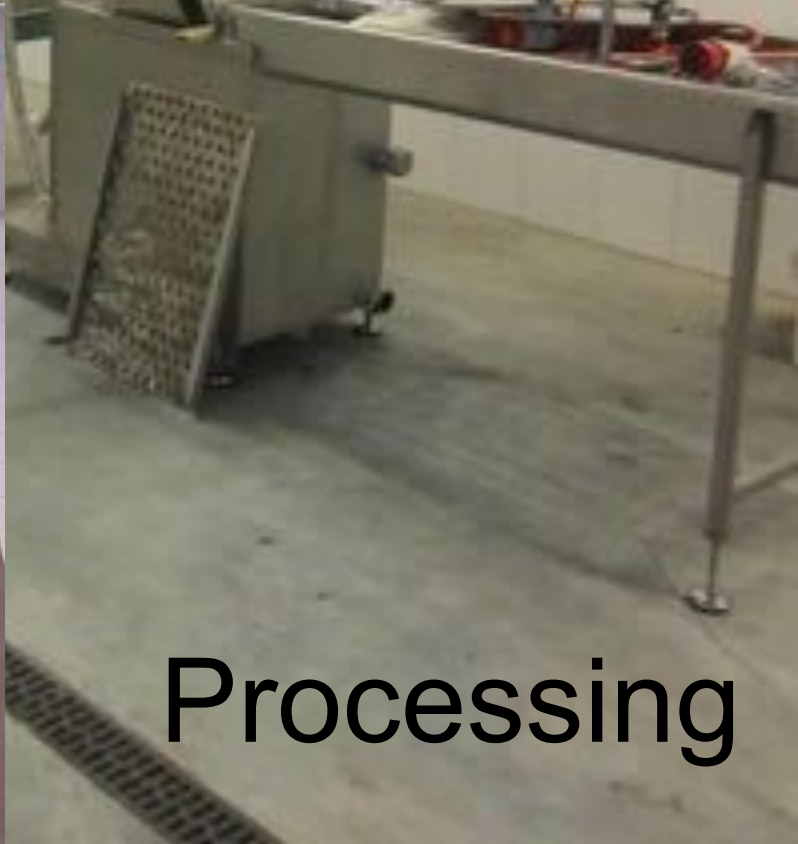
**Specialist
markets**



Storage



Market



Processing





HARVEST BARN

FARM SHOP






HARVEST BARN
FARMSHOP



Concluding
thoughts



Unexpected Issues

- Security
- Dry autumn/spring
– establishment
- Hares-re-guarding
- Pigeons & Rooks
- Road safety
- Planes!



Food and Agriculture Organization
of the United Nations

HEALTHY SOIL IS THE KEY TO FOOD
SECURITY AND NUTRITION FOR ALL



COMES FROM OUR SOIL



2015
International
Year of Soils

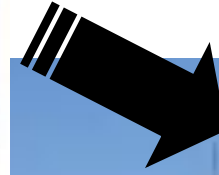
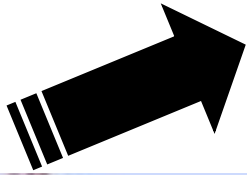
www.fao.org/soils-2015



Agroforestry = 'Ecological' intensification

Summary ;

- Improved resource capture and use
- Profitability equal to or greater than monoculture
- Soil and environment protection
- Enhanced biodiversity
- Upland systems improve productivity of land & livestock
- Silvoarable - 80-120 trees/ha density ideal on 24, 36m alleys
- Alley crops maintain annual income -Trees provide long term income & capital asset Improved resource use
- Policy developments required



For construction....

There was a '*breakthrough*' moment

I believe that agroforestry is a
'*climate smart*' *breakthrough* for agriculture





**Farmers should
adopt
agroforestry on
at least 20% of
their land**

Agroforestry is one of the few options with the potential to help reduce greenhouse gas emissions, help protect natural resources whilst at the same time producing more food and biomass

Trees will grow in most places !



Go home

Walk outside.....

Look up.... Look down ...

**Consider the extra dimensions
that can be cropped
to produce more !**

3 Dimensional Land Use



YOUR BEAUTIFUL LIFE

LOOK DEEP INTO
NATURE, AND
THEN YOU WILL
UNDERSTAND
EVERYTHING
BETTER.

-ALBERT EINSTEIN