Agroforestry design 16 July 2018

THE ORGANIC RESEARCH CENTRE

ELM FARM

ABACUS AGRICULTURE

advice that counts

PLANNING AGROFORESTRY

Learning from existing systems

Planning Agroforestry

A. IDENTIFY GOALS & PRODUCTION LIMITATIONS

The Design influenced by agricultural policy & the objectives of the farm.

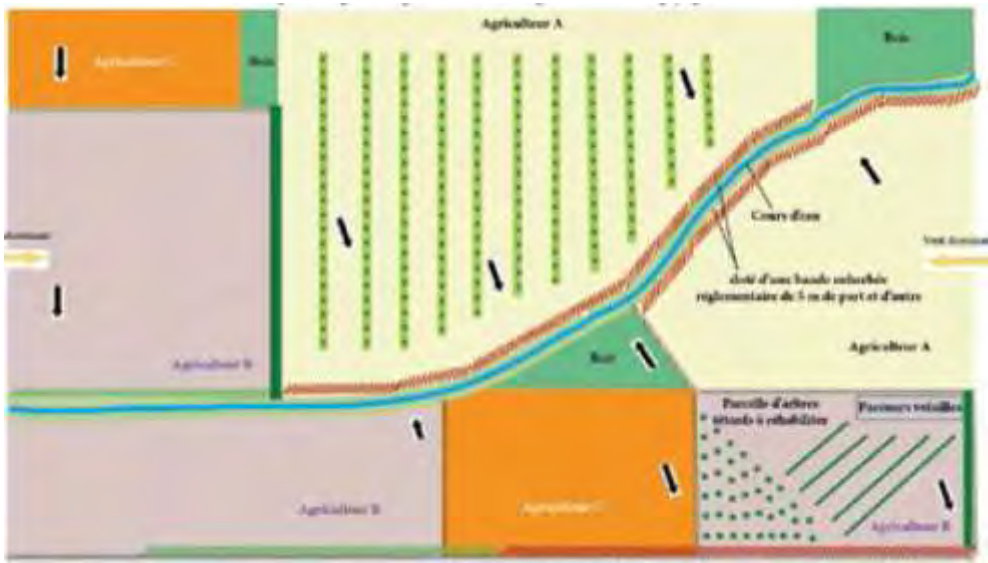
The Design depends on Enterprise mix – livestock, cereal, fruit, nut, viticulture etc

Several objectives Should be considered for agroforestry.

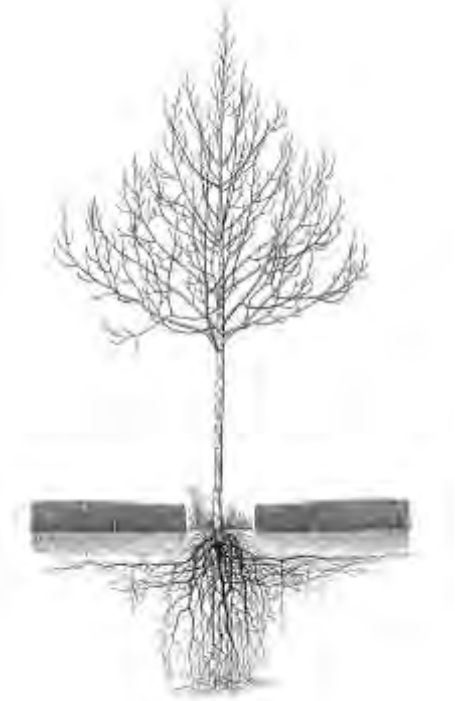
- Produce timber and / or woodfuel medium and long term.
- Diversifying production: Fruit Production Short term, honey, medicinal plants ...
- Improve the agronomic potential of fields (soil improvement, fertility ...)
- Protection of natural resources: biodiversity, protection of groundwater, erosion control...
- Improve animal welfare.
- Economic productivity.
- Create an income for following generations

B. IDENTIFY OPPORTUNITIES

- Consider fragmentation, connectivity & rivers, catchments, areas of habitat etc
- review of maps / aerial photos
- Consider how Agroforestry fits into field Parcels & into the local landscape



Landscape considerations



Land constraints and opportunities

- Conformation and location of fields: topography, size, remoteness ...
- Tenure: land owned, location ...

Agronomic constraints and opportunities

- Agronomic potential
- Soil characteristics (texture, organic matter, biodiversity, depth ...)
- Sensitivity to erosion, wind exposure

Environmental constraints and opportunities

- Pest pressure ...
- Disease pressure ...

Technical constraints and opportunities

- conventional and organic farming
- Labour, simplified cultivation techniques, till, no-till ...

Regulatory constraints and opportunities

- CAP and cross-compliance
- catchment feeding areas ...

Economic constraints and opportunities

PLANTING ARRANGEMENTS

To design the arrangement of trees within fields, consider heterogeneity, the system, management, harvesting and mechanisation.

General principles

Tree lines:

• Use a long field edge as a datum to position the first lines of trees.

•Smooth out any curves along the border.

• If the shape and orientation of the plot allow : Position the tree lines in a north-south axis to reduce shading and distribution of light in the fields.

For hedges and windbreaks:

• A spacing of 100 to 200 m between two lines is a good compromise.

• Connect the rows of trees to existing trees (woods, hedgerows, riparian forest, meadow trees etc...)

Agroforestry and crops

• The width of the cultivated aisles between the rows of trees = Multiples of the width of the largest equipment

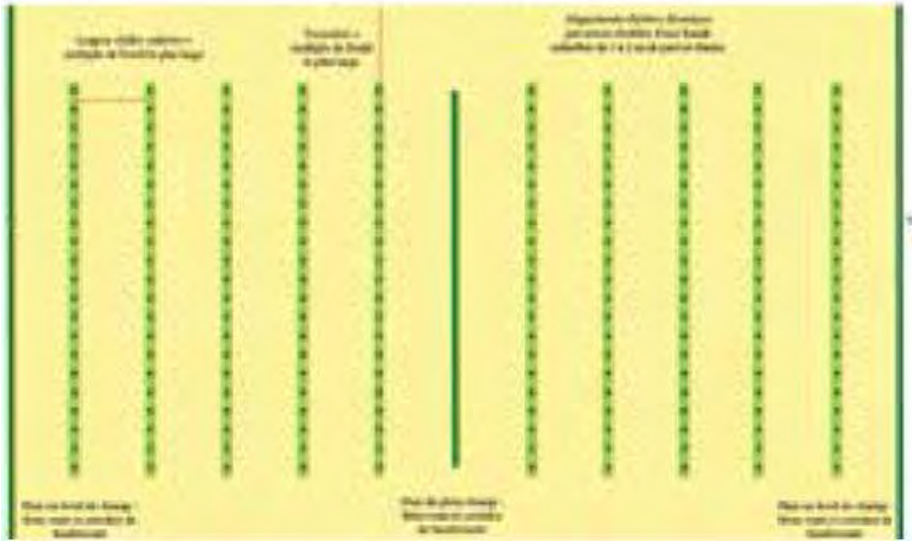
• **Recommendation**: cultivated aisles should be a minimum of 2X the height of a mature tree & at least 20 m wide to reduce possible shading effects.

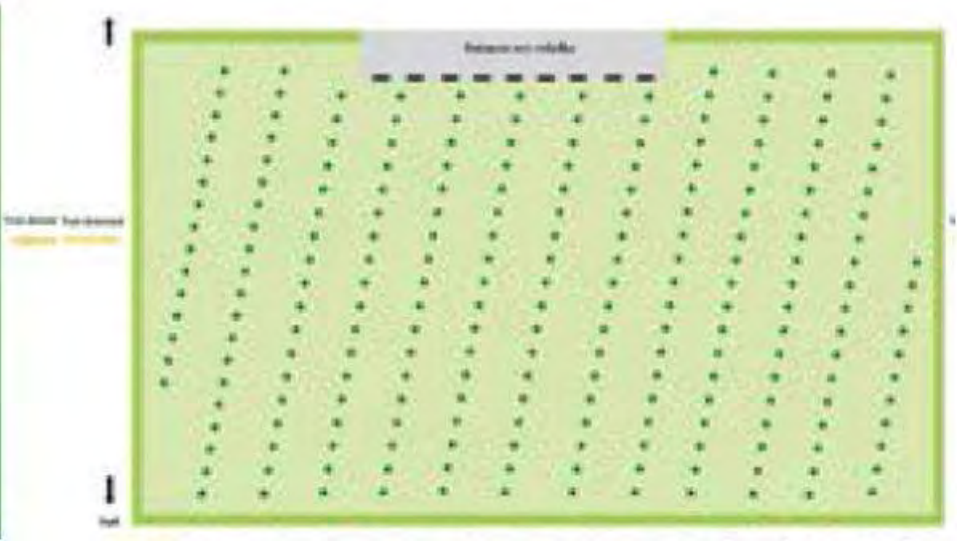
• A grass strip at the base of the tree lines: 1.5 to 2 m in overall width to avoid damage and promote biodiversity.

• **Tree in-row spacing**: enough space to reduce shadowing effect: 6-9 m on average (avoid having less 4 m between trees).

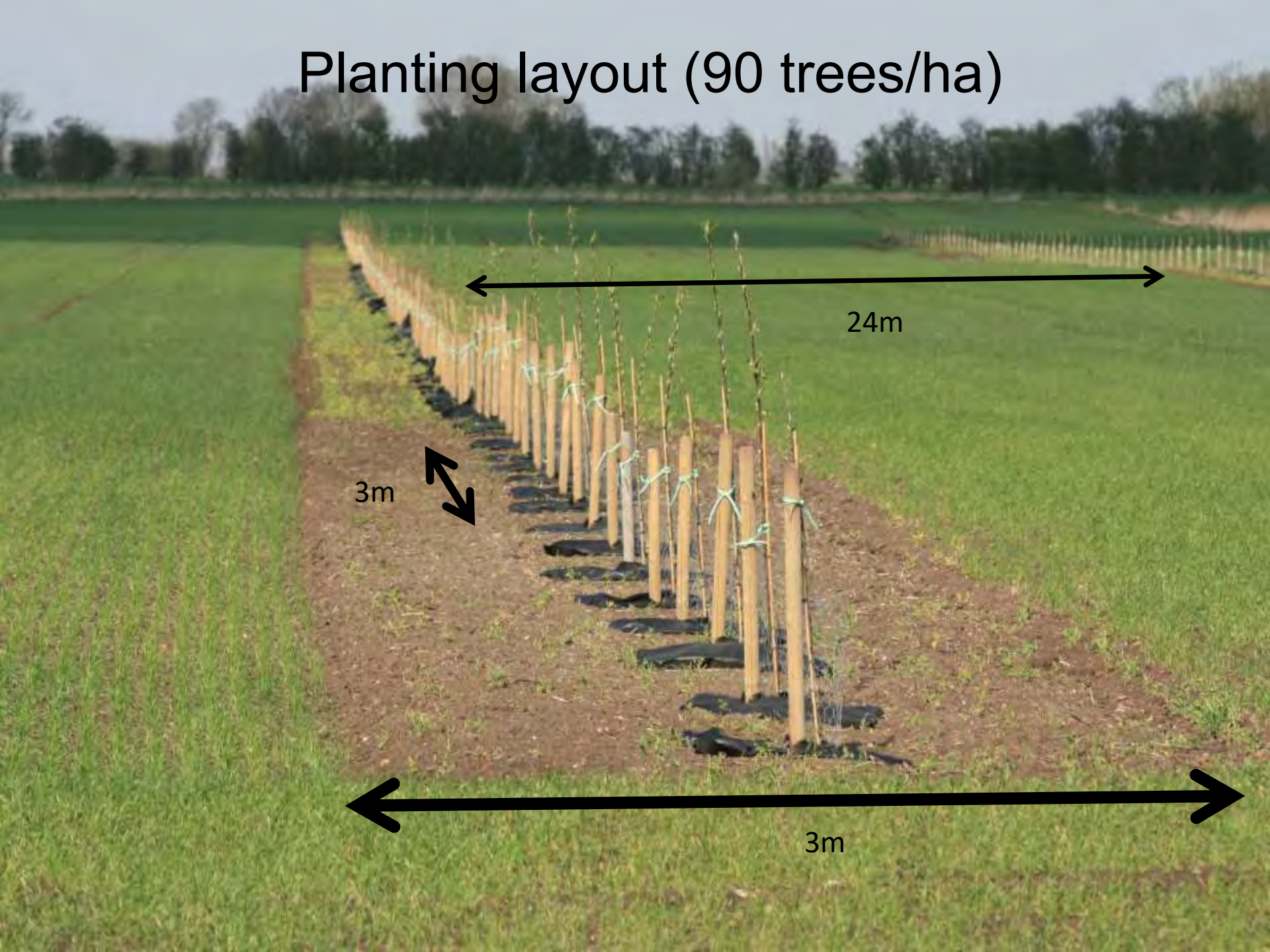
• Keep the end **headlands** unplanted for machinery access - In general the same width as the cultivated aisles.

• desirable average **density**: 50 – 100 stems / ha.





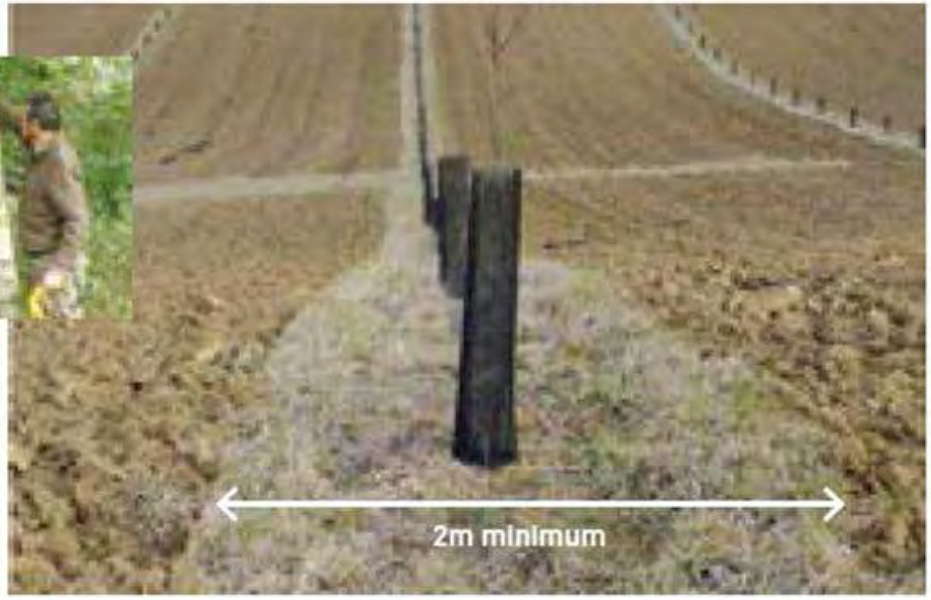
Planting layout (90 trees/ha)



Allows access for large machinery for inputs

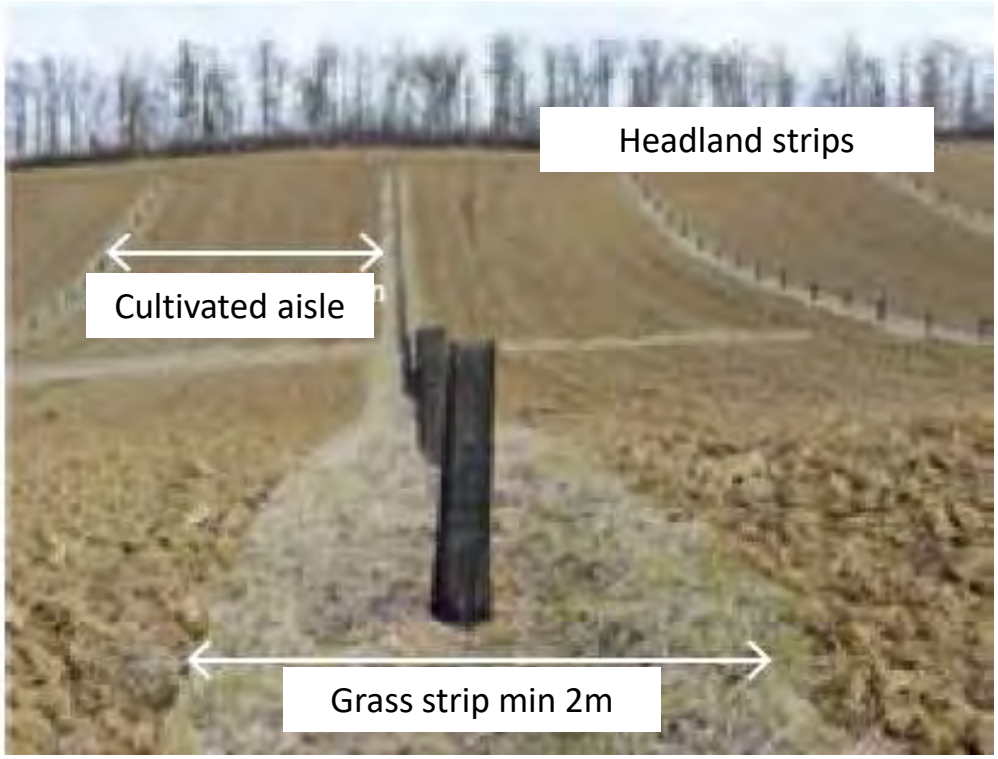
Grass, or sprayed strip left to protect trees

Turning area required at row ends



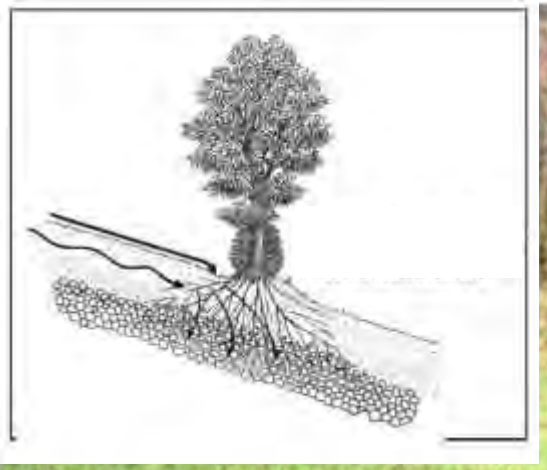
Agroforestry & Livestock

• If there are no constraints on mechanization, space trees evenly in the field to promote air and livestock and therefore reduced ‘clustering’ of livestock (reducing grass damage, erosion and localised dunging)
• For poultry, align trees to meet buildings and ranging area or space to allow access for mobile housing..
• In addition to the tree lines, it is a good idea to also plant other structures like hedges and tree shelter belts or plant near buildings for shade or water/noise/pollution abatement.



Crop rotation & timescales longer

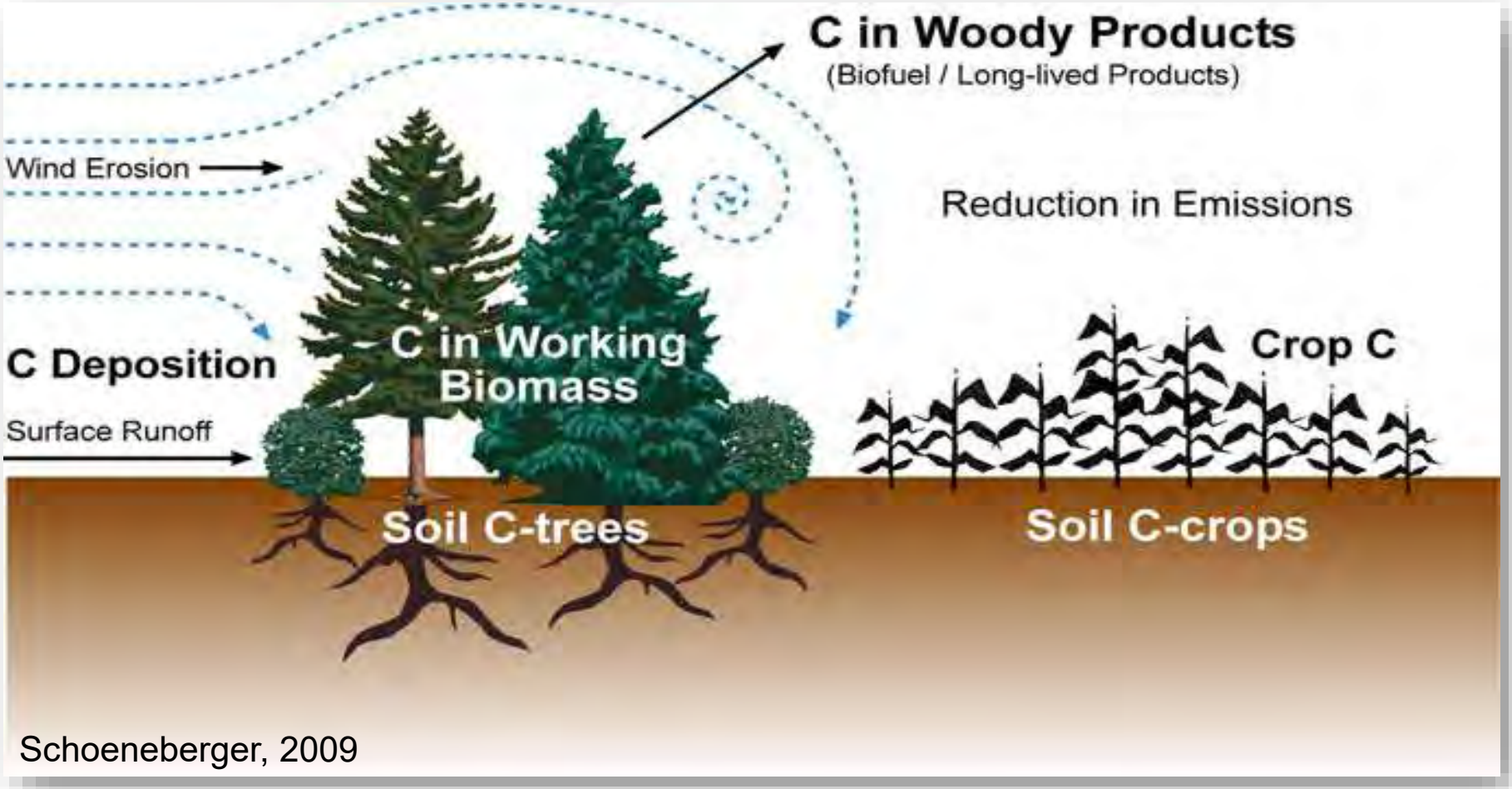
field scale machinery use



Design for soil protection ?

Climate regulation – Global Climate

Wind reduction & erosion prevention



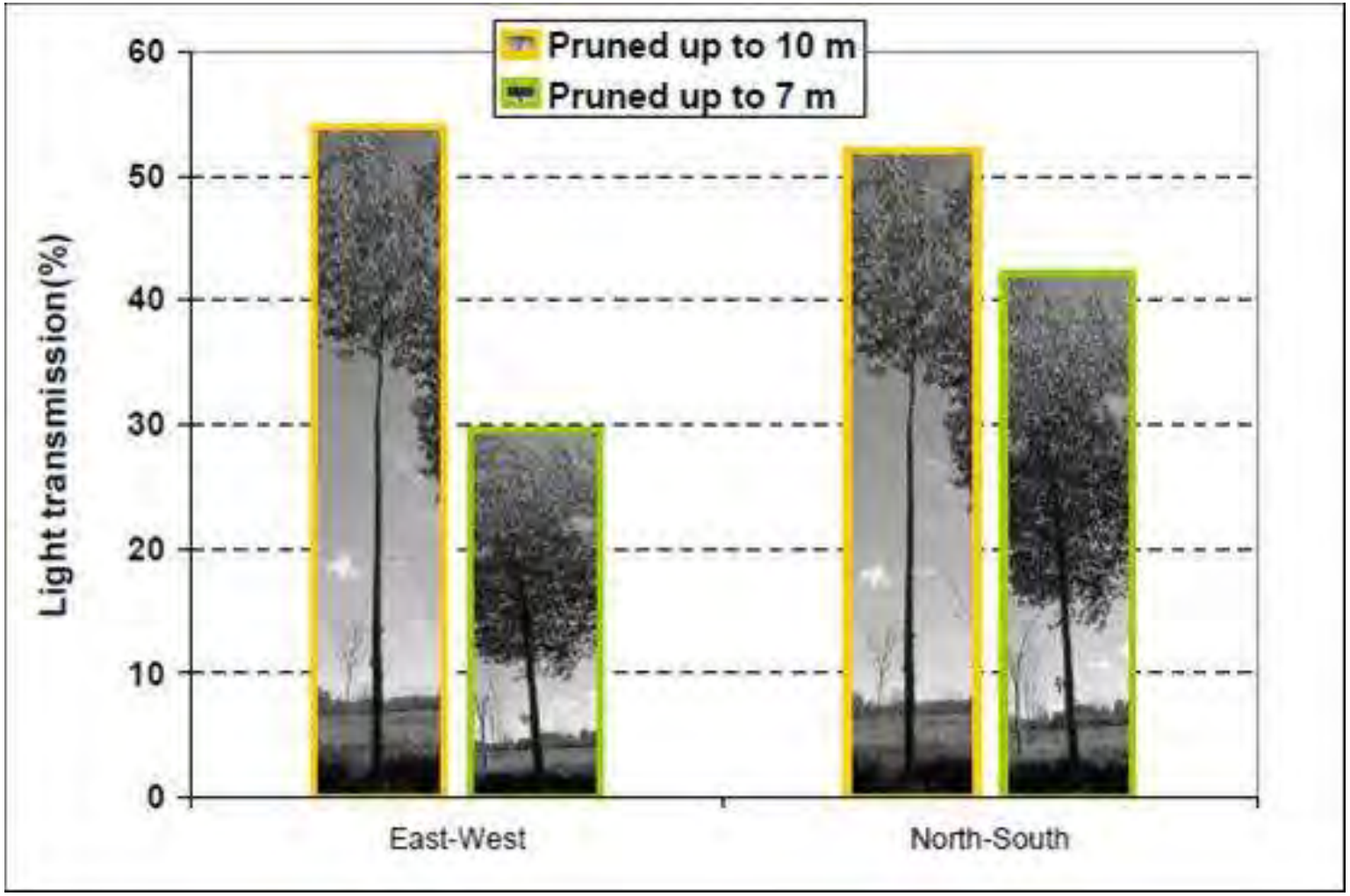
Schoeneberger, 2009

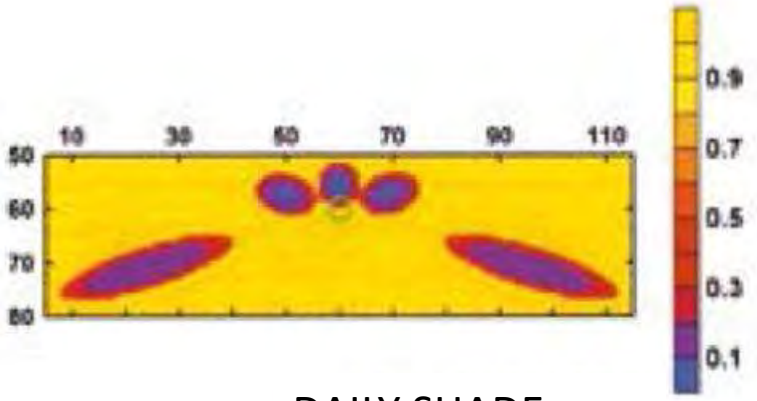
SHADE MANAGEMENT

Vézénobres agroforestry site researching : E:W & N:S orientations.

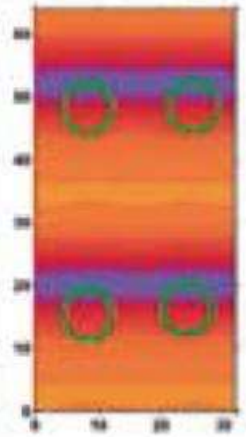
- N:S tree row orientation reduces crop shading
- Tree canopy management reduces shading
- Some crops more tolerant of shading

Impact of the pruning height on the average light transmission on the cropping zone at the Vézénobres experimental site for two tree row orientations in June 2004

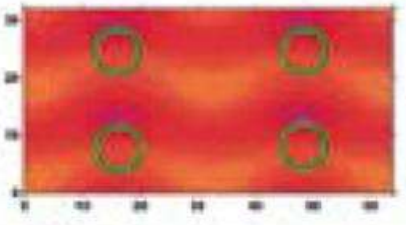


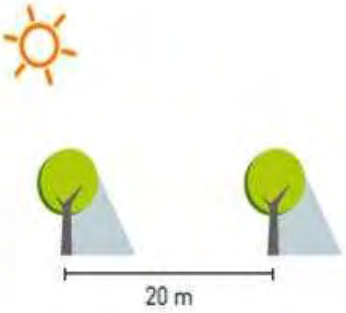


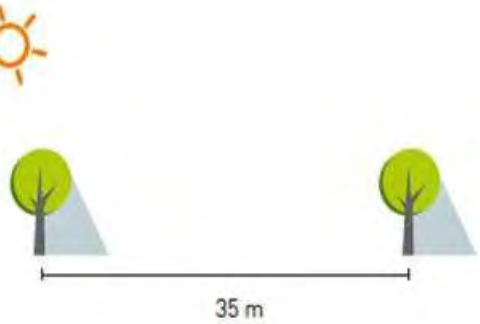
DAILY SHADE



SEASONAL SHADE

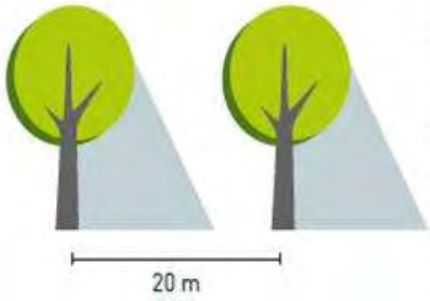


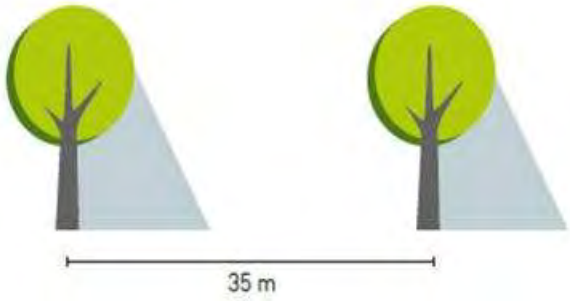




30 yrs

30 yrs



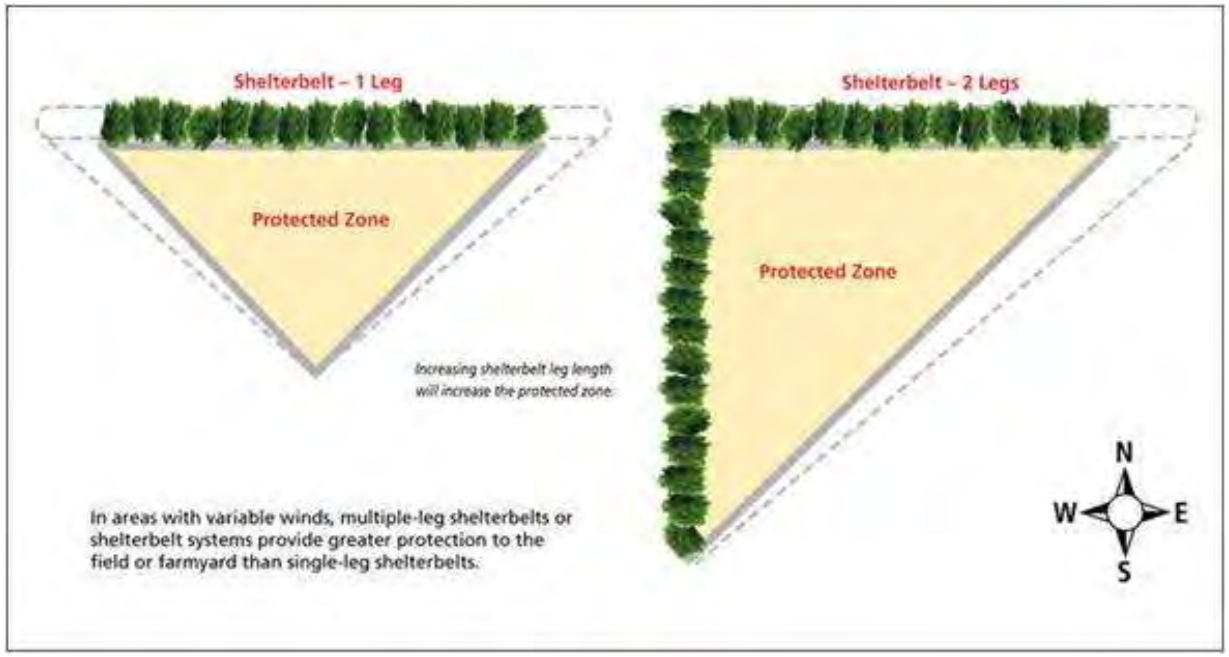


Shelterbelt design

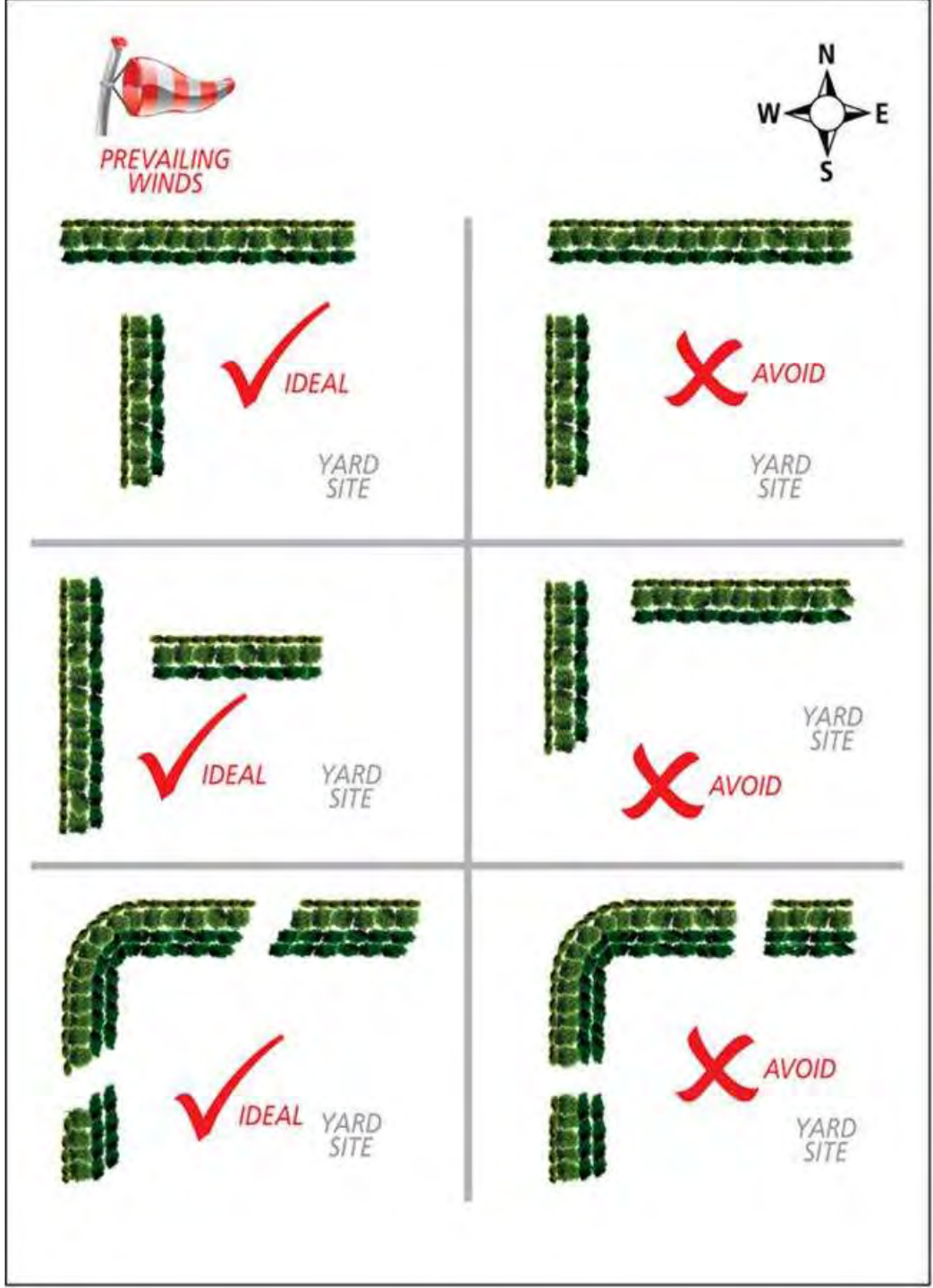
•Orienting shelterbelts perpendicular to the prevailing wind direction provides the most protection

•As the wind changes direction and no longer blows directly against the shelterbelt, the protected area decreases. (Although the wind may blow predominantly from one direction, it rarely blows exclusively from that direction)

•Shelterbelts should ‘ideally’ protect from more than one direction



- Avoid field access openings in shelterbelts to from prevailing wind side
- If you must have an opening to these directions, stagger the shelterbelt planting to reduce the wind tunnel effect.

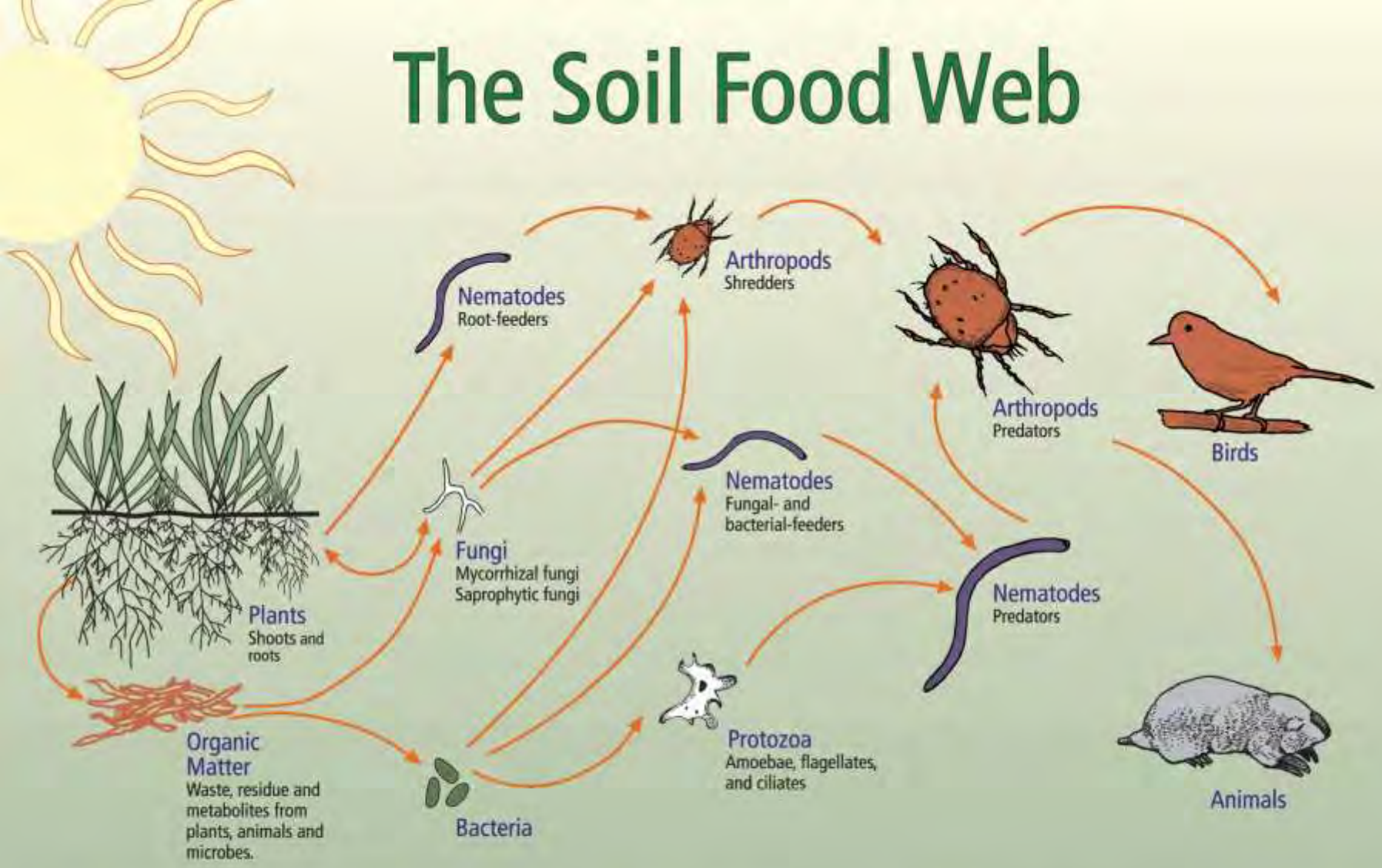


Trees bring up nutrients from deep

Leaf fall provides fertiliser

Nutrients available to crops

The Soil Food Web



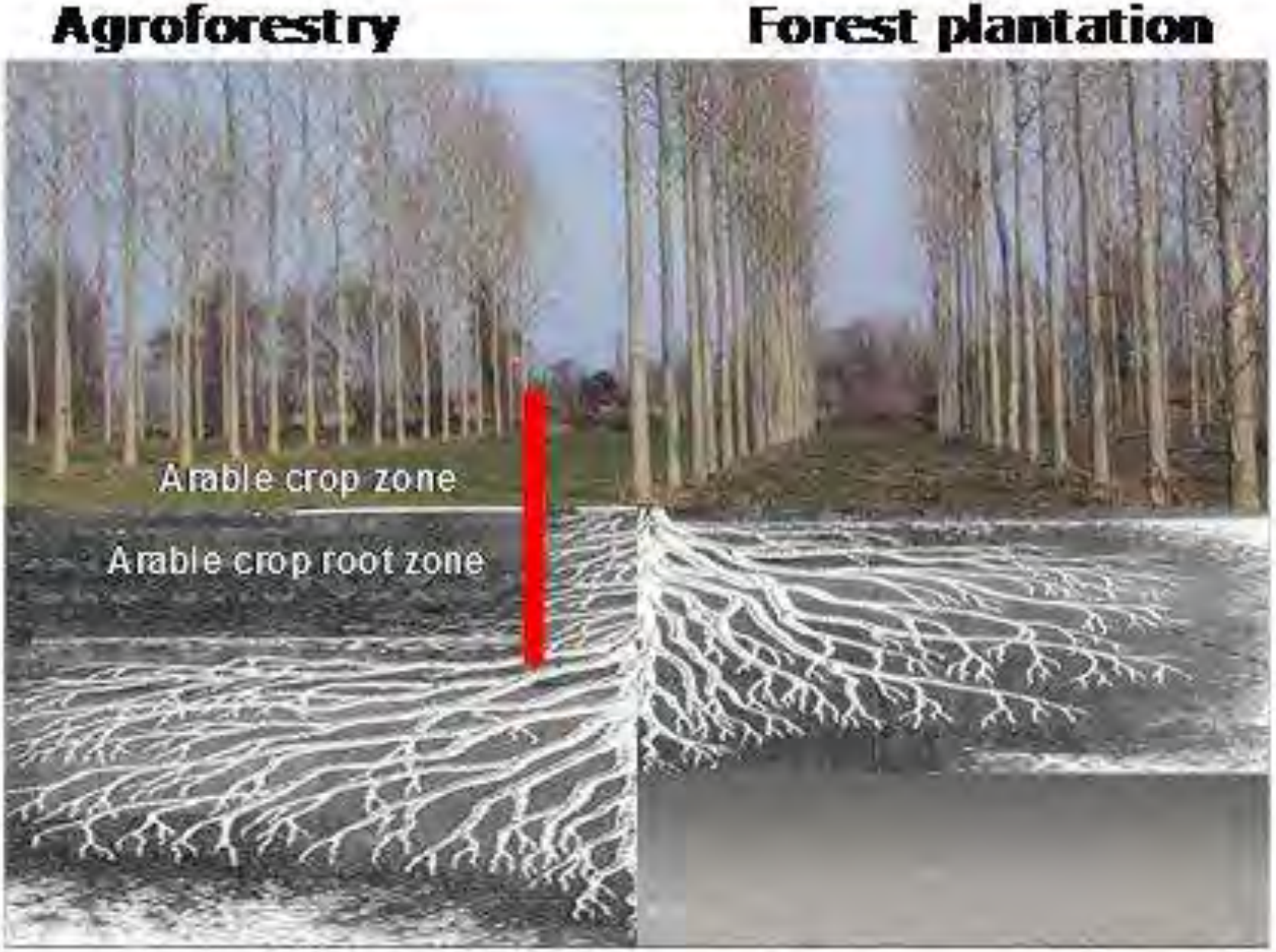
First trophic level:
Photosynthesizers

Second trophic level:
Decomposers
Mutualists
Pathogens, Parasites
Root-feeders

Third trophic level:
Shredders
Predators
Grazers

Fourth trophic level:
Higher level predators

Fifth and higher trophic levels:
Higher level predators


Agroforestry
Forest plantation
Arable crop zone
Arable crop root zone

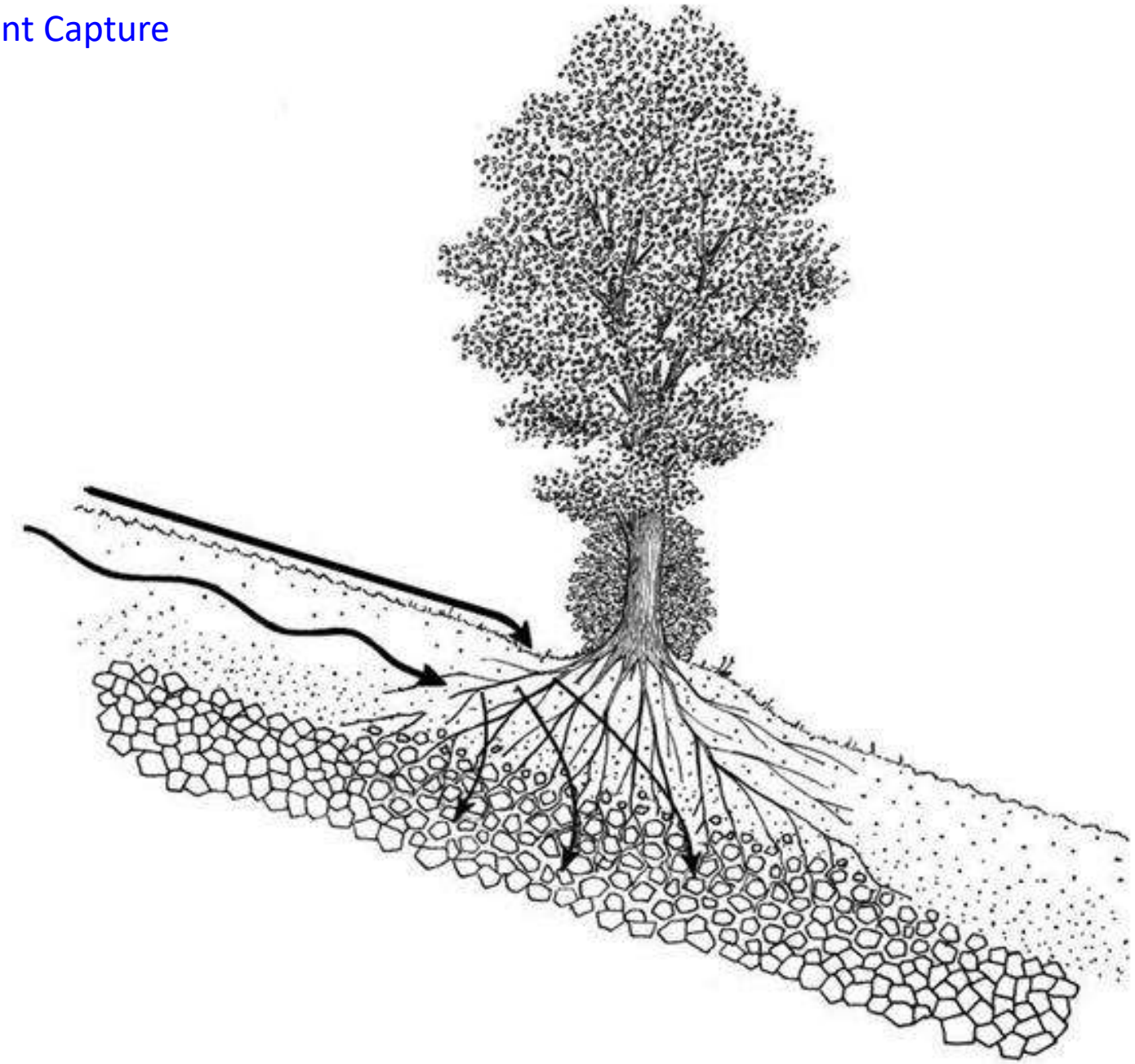
Agroforestry Poplar tree roots

Deeper rooting

Forestry plantation poplar tree roots

Shallower rooting

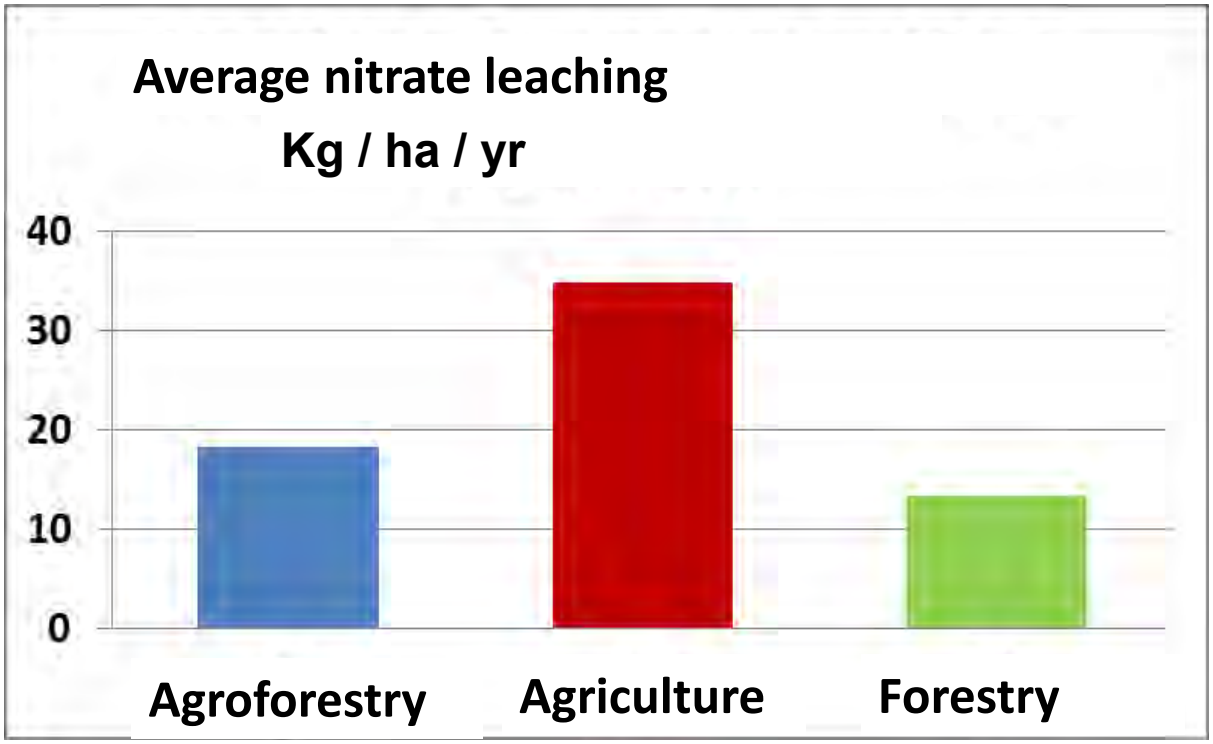
Nutrient Capture



Reduced Nitrogen leaching

Up to 50% less N lost under Agroforestry than arable

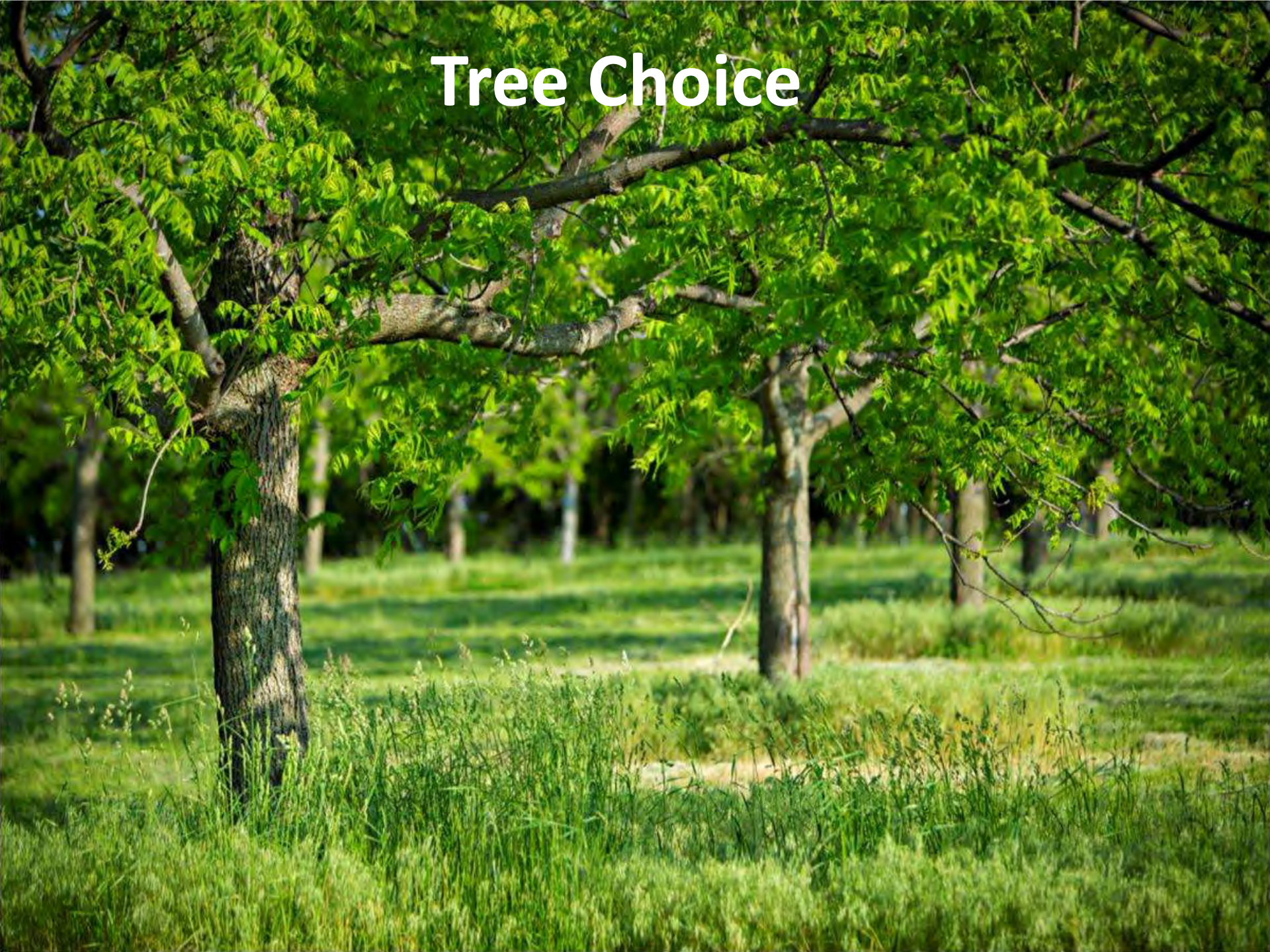
Trees capture N not used by crops



Source : Research by INRA Restinclières, France

AGRONOMY

Tree Choice



Tree Choice

Blackcurrant

Elderflower & Soya

Elderflower

Coconut and Mexican marigold (*Tagetes erecta*)

Maize, Beans & Pineapple (Uganda)

Tree Choice

- Farming System (crop vs livestock)
- Tree / land use interactions
- Land tenure
- Location (Lowland / Upland),(Wet/Dry), (Windy/Sheltered)
- Timescales
- End use of tree products (Timber, fruit, biomass etc)
- Economics & investment
- Tree management.....

Tree Choice

- Tree management.....
  - Pruning, thinning
- Harvesting methods
  - Clear fell, thinning, pollard,
- Legislation and CAP etc

TREE SPECIES OPTIONS

- Nut (Walnut, Hazel, Chestnut etc)
- Fruit (Apple, Pear, Cherry, Quince etc)
- Hardwood (Walnut, Oak etc)
- Softwood (sycamore, Ash, Poplar, willow, alder, hornbeam, spruce, larch, Fir etc)
- Biomass (Willow, Hazel, Birch)
- Hedge & Shrub


Crop Choice

LIVESTOCK

FORAGE

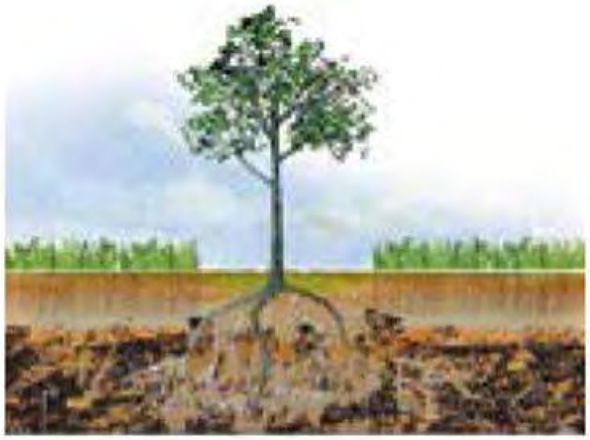
Arable crops

Row & veg crops

Farming Gliricidia and Maize. Photo: World Agroforestry Centre

PLANTING

- Soil Preparation
- Cultivate or loosen soil before planting
- Prepare seedbed if grass/ legumes to be sown – sow first then plant trees



Use testing plants and avoid defects damaged plants

Plant into holes with good soil structure & carefully align tree rows

Tree Guarding & Understory management

Guarding

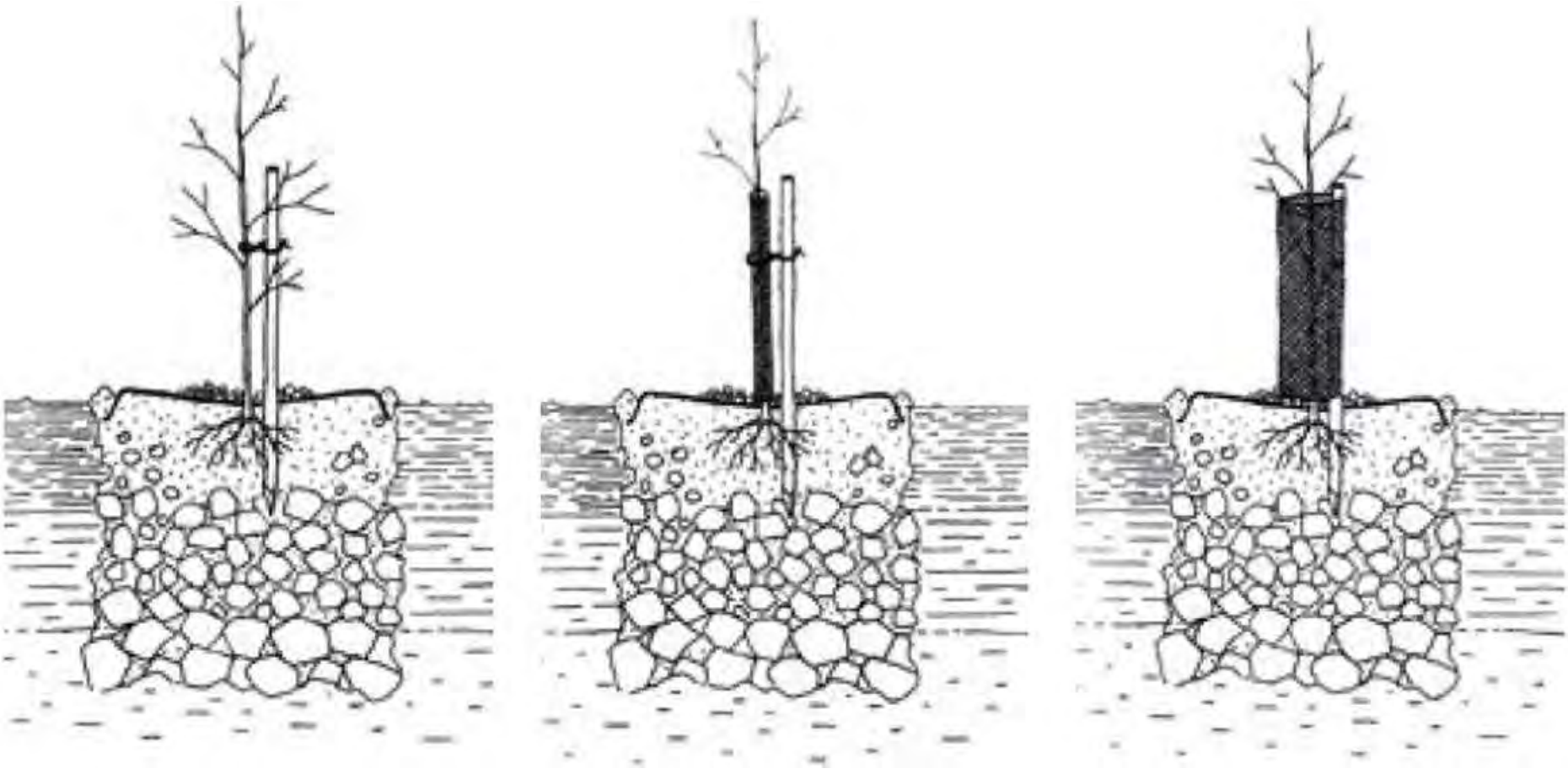
Sheep Guards

Anti-Rodent Cages (fruit)

Cattle Guards

Guarding

Mulch Mat



Tree strip

Natural Re-growth

Sown cover

Mowing ± 30 min / 100m

Herbicide control

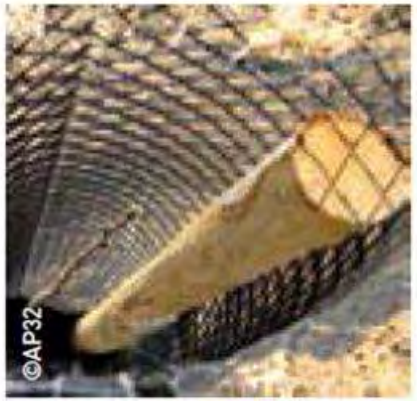
Damage from missing protection

Pest damage on young unprotected tree

Guarding young trees

Cherry tree with guarding

Agroforestry sapling guarded



Mulch with wheat straw

Straw buffers around trees

Woodchip mulch

Clover & Grass understorey

Mulching Tree bases

•Objectives: to obtain a favourable environment for the establishment and growth of young trees.

•Mulching maintains a constant humidity and warms the ground, keeps a stable structure, and reduces the competition with grasses.

•Each tree can have a mulch 1m2 around the trunk of wood chip, straw or a biodegradable film/sheet (corn starch).

Weed management

Chemical control

Pre-planting herbicide

Hooded / band spraying

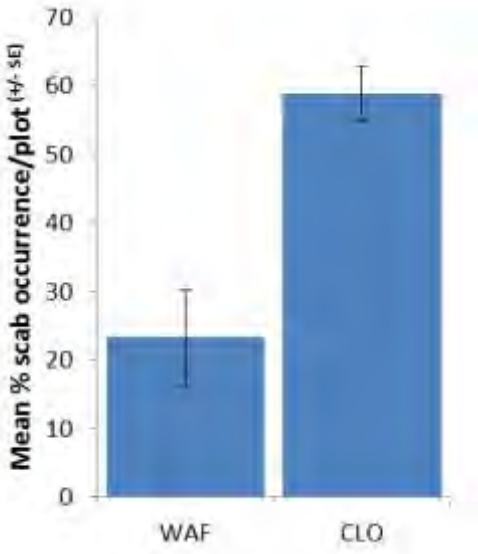

Mulching

Root pruning

P&D considerations

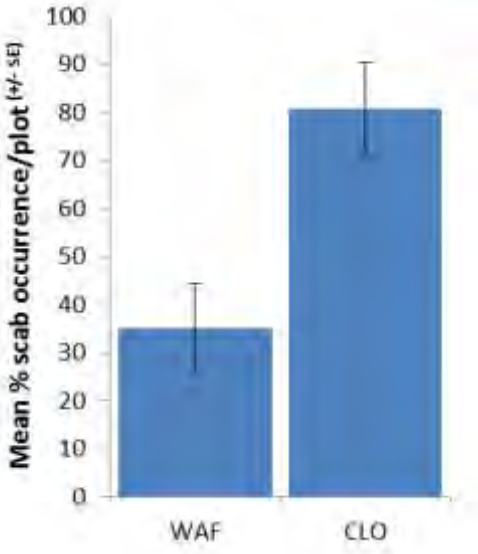
Apple - Scab occurrence 2012

Small fruits (early July)

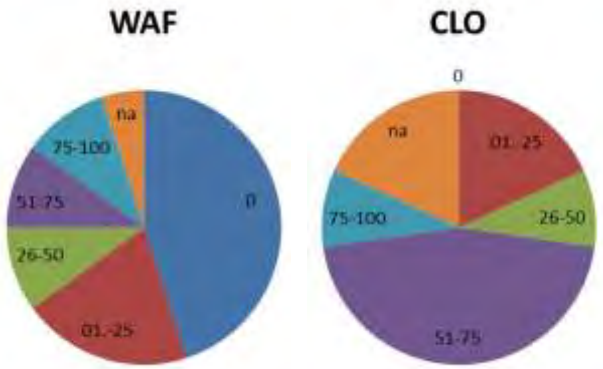


% occurrence per variety

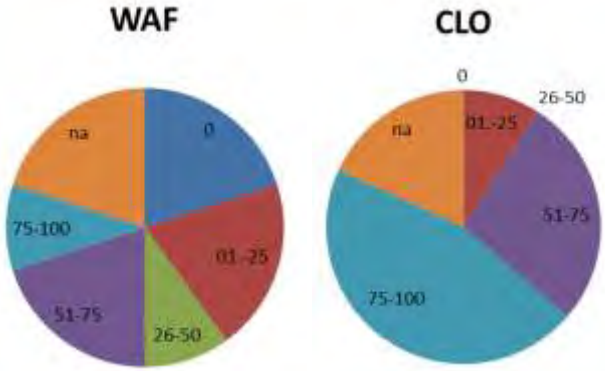
Large fruits (end August)



% occurrence per variety



Clarkes Lane Orchard



Wakelyns Agroforestry

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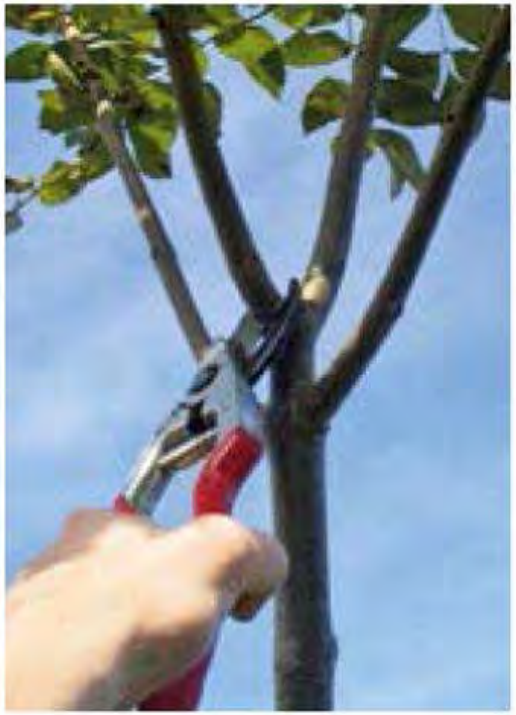
ELM FARM

Pest damage

Tree Canopy Management



- Hand pruning year 1 – 5
- Pruning shears year 6 -15
- Mechanical pruning year 15 onwards

Tree maintenance

Characteristic of a Quality tree :

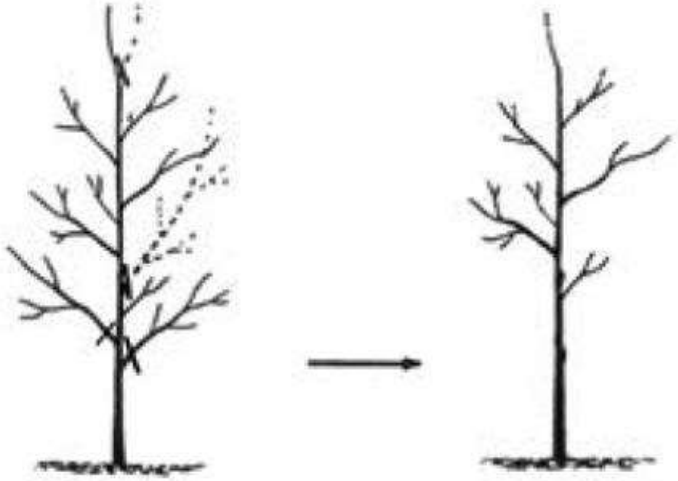
- dominant
- healthy and vigorous
- No damage
- Full branching

Main defects of trees:

- co-dominance
- forking
- nodes
- injuries
- winding / twisting

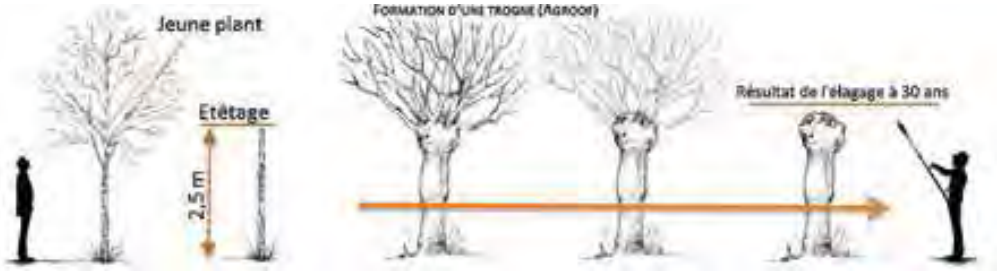
Tree maintenance

Objective: To form the axis of the trunk.
When: 1 or 2 years after planting preferably in summer for about 5 years.
Principles: Remove any forking & remove competing branches on the main stem
Time: 25 to 50 trees / hour



Objective: avoid knots in timber to achieve quality trunk to a predetermined height.
When: annually from year 3-5 up to 10 - 15 years.
Principles: cut branches larger than 2 to 3 cm (optionally 3-5 cm for vigorous trees).
Time: 30 to 40 trees/h for pruning to 2 and 5 m
12 to 16 trees / h for thinning of 5 to 8 m

Pollarding & Coppice



Pollarding

1. **Pollard**: winter when the stems are 5 cm in diameter, 1-3 meter above the ground. Then repeat every 2 or 3 years or more when the tree is older.
2. Remove shoots from the trunk each year.
3. **Harvesting** :

• during periods of dormancy (mid-November to mid-March), at 3 to 5 years for rapid growing species , 6-8 years for slower growing species,
• cleanly cut all the stems of the pollard,
• Equipment: platform, harnesses and lifelines, chainsaw

Coppicing

1. **coppicing size**: start the winter following planting, manually using secateurs to 5 cm.
Then mechanically using small saws or chainsaws.
2. **Harvesting**: for small sites, harvesting and processing with chainsaws and chippers For large sites, possibly choose a shredder grabs.
Harvest in winter during the dormant period taking into account the intercropping / alley crop present.

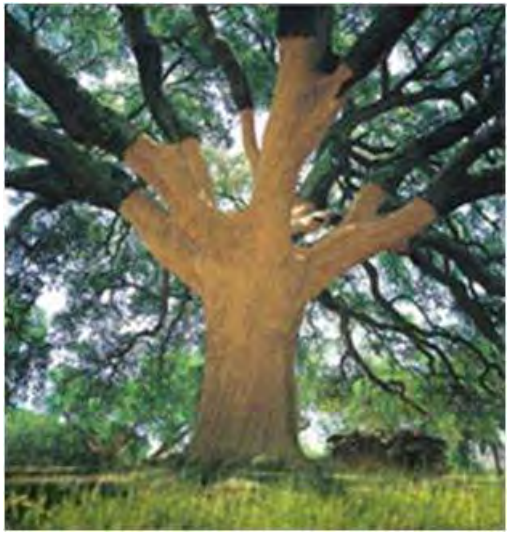
HARVESTING

Harvesting


CLAAS


STIHL


MONTAGNY
2003



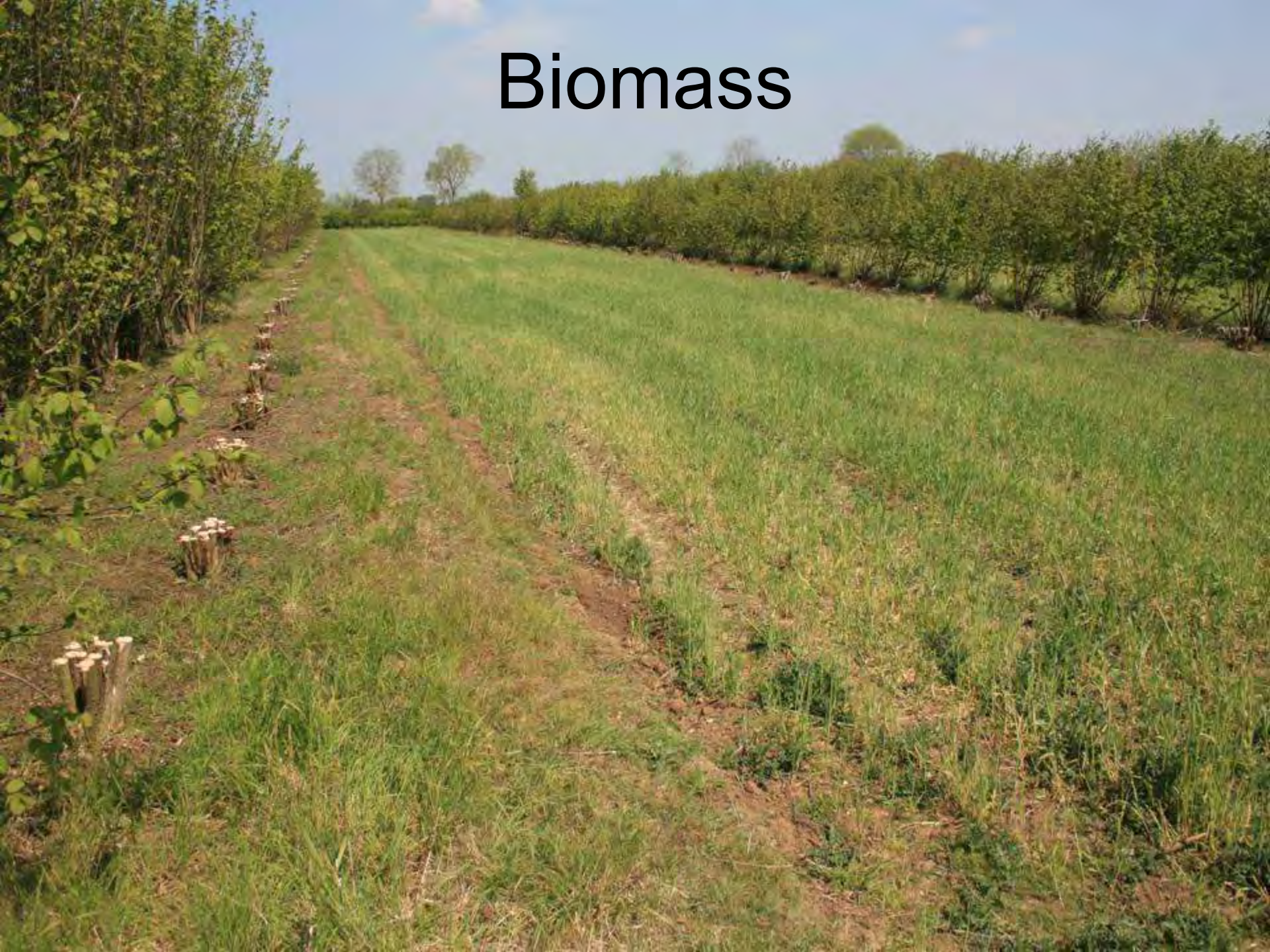
Markets

Timber products

Woodland products

Wood chip from prunings

Biomass

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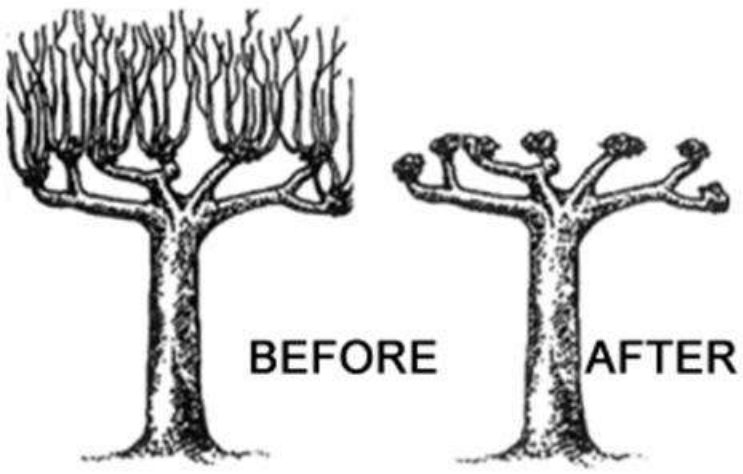
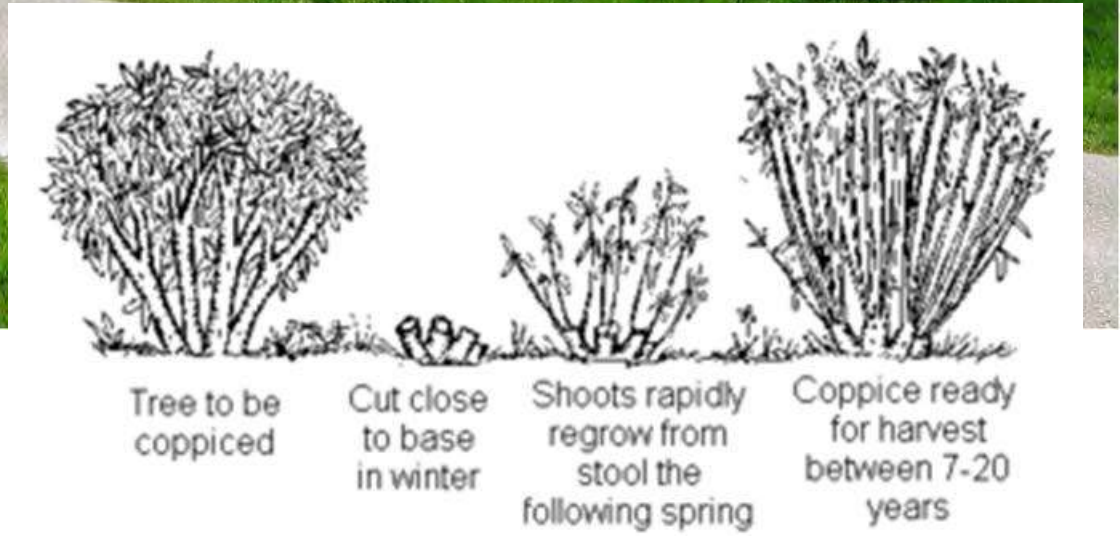
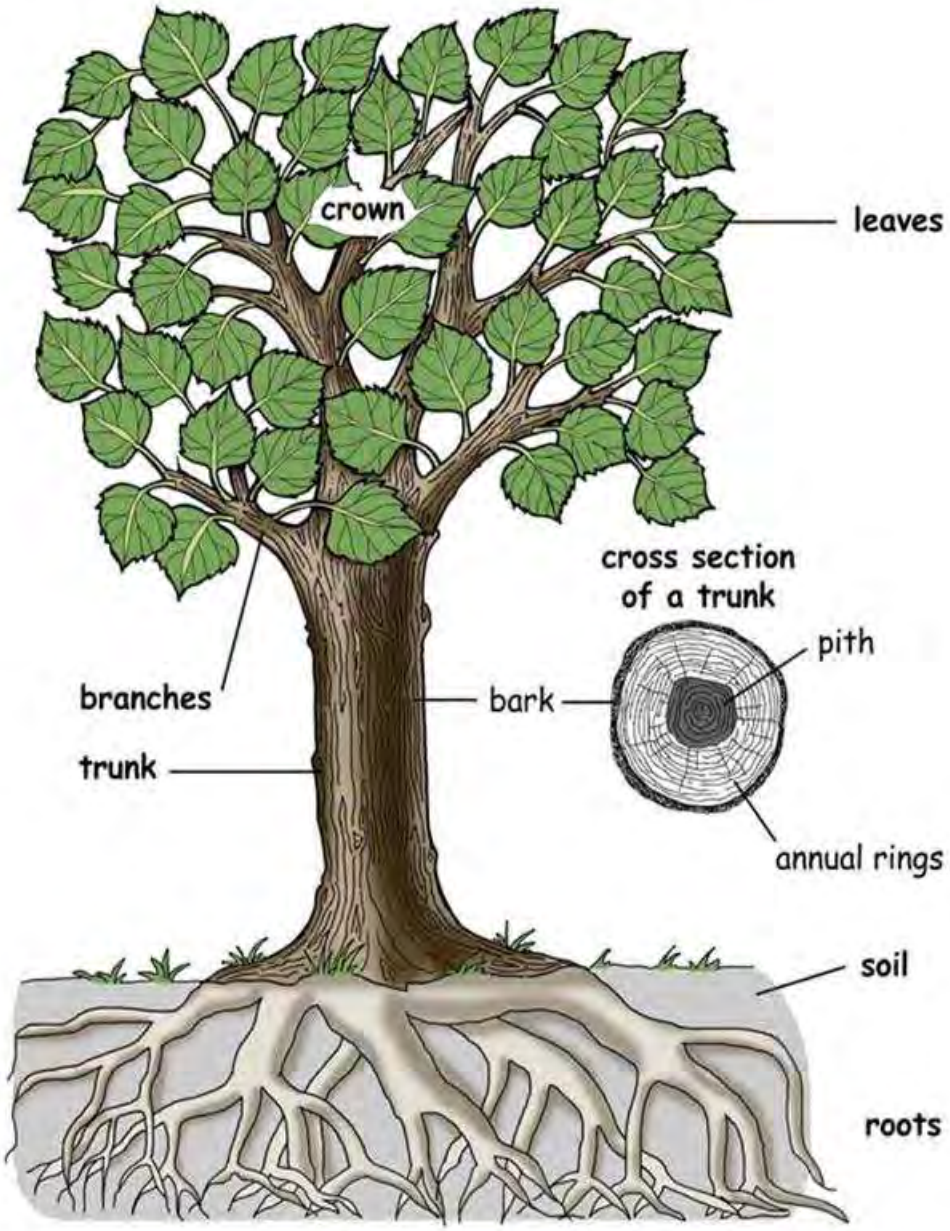
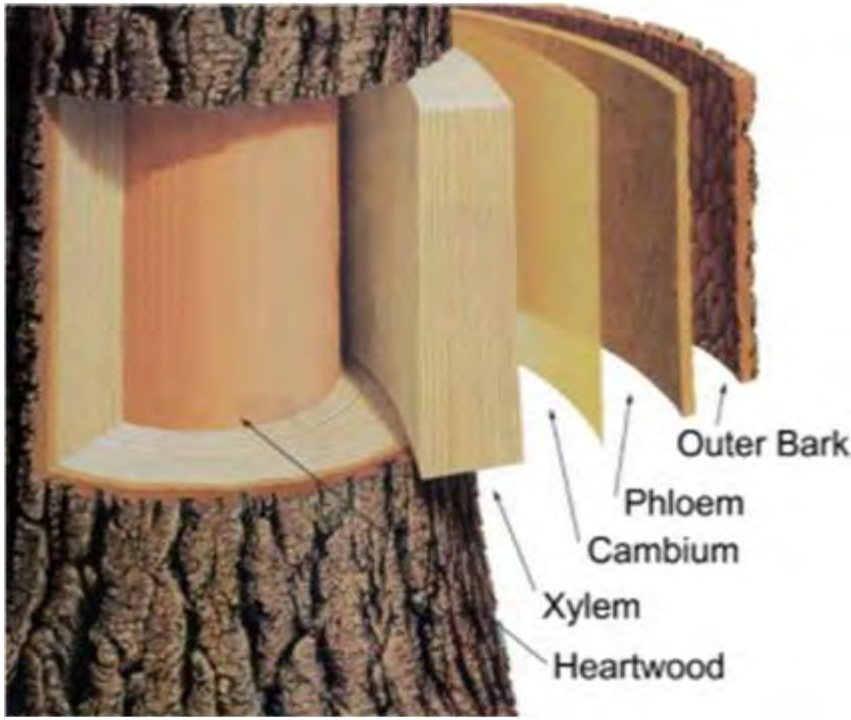

BEFORE
AFTER


Tree to be coppiced
Cut close to base in winter
Shoots rapidly regrow from stool the following spring
Coppice ready for harvest between 7-20 years

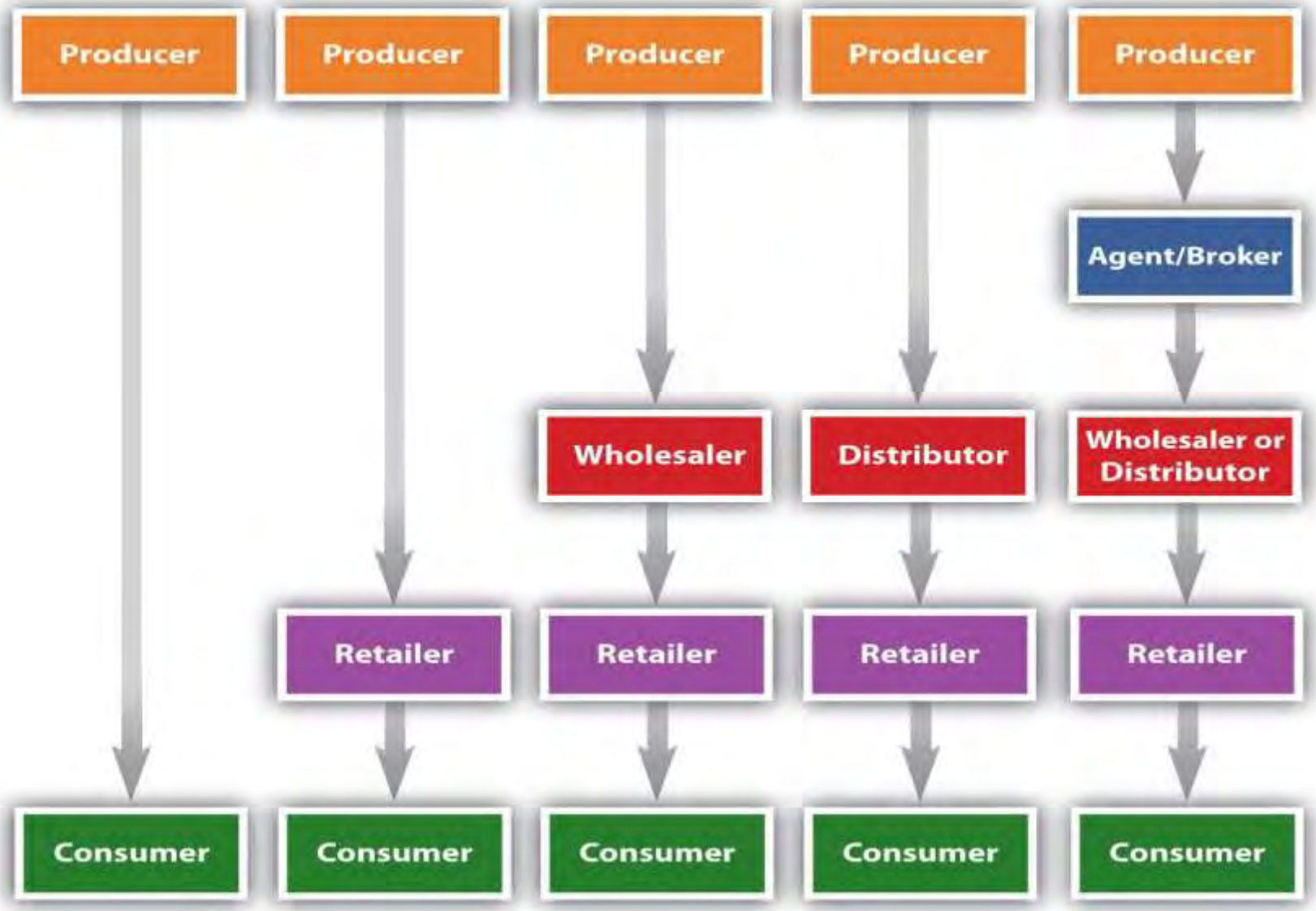
Parts of the Tree



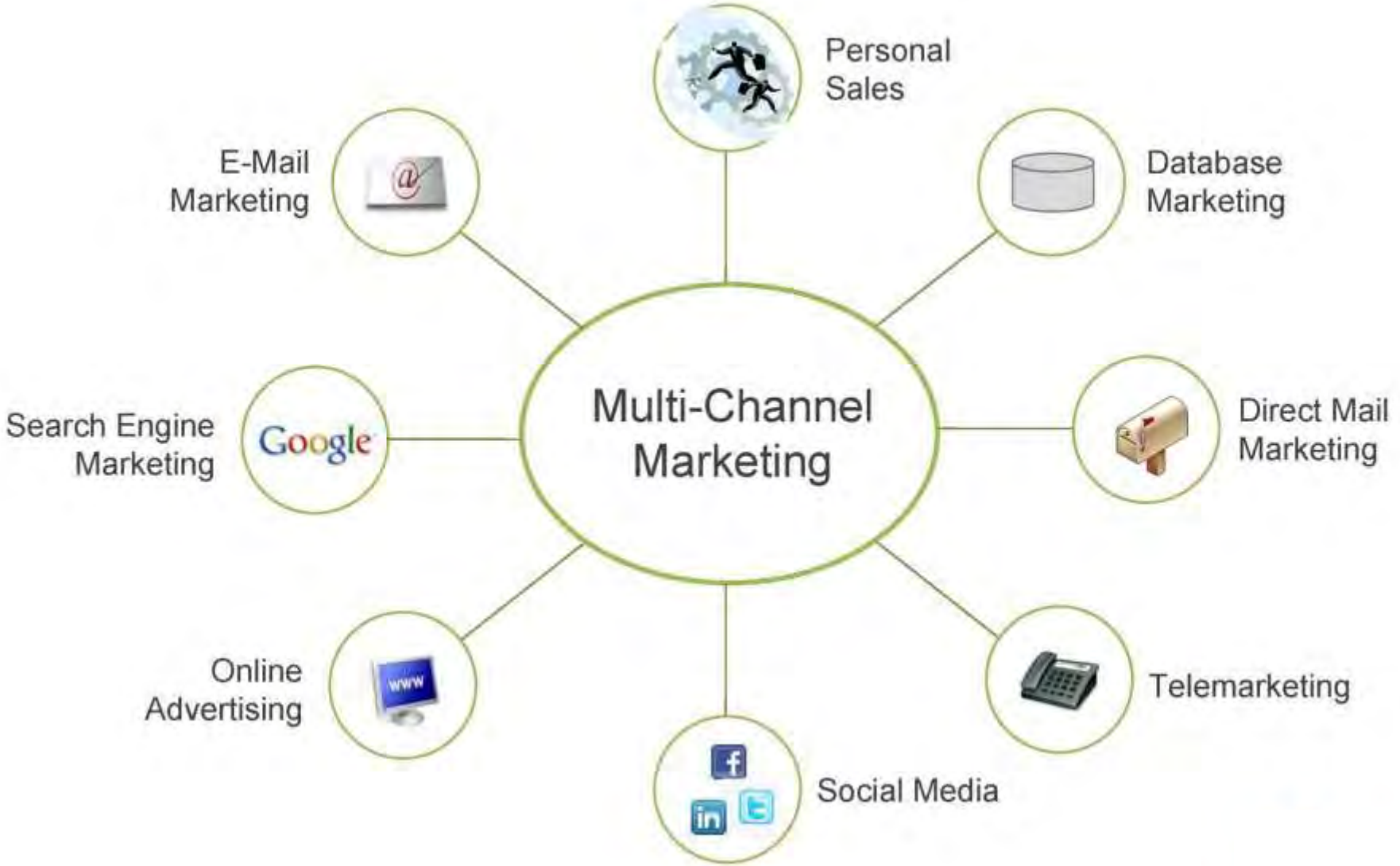


Fruit & Nut products

Market channels



Market channels

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