Agroforestry the European way?

The SAFE project final Conference

30 March 2005, Brussels
Final Conference of the SAFE project

Programme

Agroforestry Biophysics

Christian Dupraz, project coordinator

Agroforestry Economics

Paul Burgess, WP8 Coordinator

Agroforestry Adoption

Fabien Liagre, WP2 Coordinator

Agroforestry Policy

Gerry Lawson, WP9 Coordinator

Conclusion

Christian Dupraz, project coordinator
Agroforestry biophysics

Are trees and crops compatible?

30 March 2005, Brussels
Trees at the margin?
A radical change of paradigm

Trees and agriculture: exploring a new vision
Quality of Life and Management of Living Resources

Silvoarable Agroforestry For Europe (SAFE)

European Research contract QLK5-CT-2001-00560
Silvoarable Agroforestry For Europe (sAFE)

sAFE goals were

• To reduce the uncertainties concerning the productivity of silvoarable systems

• To extrapolate plot-scale results to individual farms and European regions

• To suggest unified European policy guidelines for implementing agroforestry
SAFE project contractors

Research  Extension
SAFE : Silvoarable Agroforestry For Europe

European Union Contract n° QLK3-CT-2001-00509
August 2001-January 2005

Welcome to the SAFE Homepage
Bienvenue sur le site du projet SAFE
Members only (Password required)

SAFE activity reports on line

Next SAFE Conferences :
BRUSSELS: 30 Mar 2005
WAGENINGEN: 20 Apr 2005

Take a look at the Final SAFE Conferences presentations

Webmaster : Isabelle Lacorte
Last update: 21th March 2005
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What did we learn?
Agroforestry is a concept: it is not something in-between agriculture and forestry.
Traditional practices are valuable

But modern schemes better adapted to present-day agriculture are feasible
Agroforestry is deep-rooted in European agriculture and especially in Mediterranean agriculture.
Agroforestry suggests innovative solutions to modern challenges of rural development

Biodiversity, soil protection, water protection, C sequestration
But the key finding of the SAFE project is:
Agroforestry makes money...

But current grant rules in Europe prevent European farmers to adopt agroforestry
Measured Land Equivalent ratio : 1.29

Dupraz et al, 2005. The Land Equivalent Ratio of a temperate silvoarable agroforestry system. In preparation
Predicted Land Equivalent ratio : 1.60

Dupraz et al, 2005. The Land Equivalent Ratio of a temperate silvoarable agroforestry system. In preparation
Trees outside the forest: a century of decline

The SAFE project described traditional European agroforestry systems (WP2)

Le bocage dans le Perche, près de Nogent-le-Rotrou (Eure-et-Loir). - Cl. L.P.V.A.
A modern approach to agroforestry (WP3)

The SAFE project took advantage of both pioneer farmers’ experience and modern experiments.
Agroforestry and environmental aspects

The SAFE project helped identifying key issues where modern silvoarable systems could benefit the environment (WP4 and 5)
Landscape
Advantages of mixed tree stands
Protection of tree stands against fire hazards
Microclimate mitigation
Biodiversity
Biodiversity : more than what you see
Biodiversity impact of rural trees
(including the companion vegetation under the tree)

• Birds
• Bats
• Earth worms
• Insects (Carabs, hoverflies, entomophthorales, chrysopes, etc, etc...)
• Arachnids
• Mites
• Lichens
• Small mammals
• Soil Microfaune and microflora
• Etc...
Biological control of pests
Biological control of wheat aphids in agroforestry

Sarthou et al, en cours
Biological control of vineyards mites in agroforestry

The pest: *Eotetranychus carpini*

A predator: *Kampimodromus aberrans*

Kreiter et al, en cours
Improving water infiltration

Increase of soil porosity, terracing, increase in soil organic matter pools...
Floods mitigation
For extreme events

- Temporarily storing water
- Reducing the speed of currents
- Inducing deposits of fine and fertile sediments
C sequestration

- The Kyoto protocol recognizes agroforestry plots as qualified for C sequestration accounting

- C sequestration by a pasture is about
  - 1 T/ha/yr for an open pasture
  - 2.7 T/ha/yr for an agroforestry pasture (with 100 poplars/ha)

- Trees deposit C in deep soil layers (root turn-over) where it is undecomposed for long periods.

- The destruction of traditional agroforestry systems = release of C
Protecting ground waters against diffuse pollution by N fertilisers
Biophysical efficiency of silvoarable systems

A SAFE project major achievement (WP3, 4, 5 and 6)
To mix or not to mix, that is the question
Looking for a compromise

• Plant more trees says the forester
• Plant less trees says the farmer

To benefit from the interaction...

Both are necessary
Typical questions by end-users

- What design when setting up new tree-crop systems? (e.g. What tree density or row orientation?)
- How many years can I grow crops in-between trees?
- What tree growth can be expected?
- Should I favour the trees, the crops or compromise and how?
- What crop is best suited for a given tree species?
- What fertilisation scheme for a shaded intercrop?

No model available so far for temperate AF systems on these aspects
The SAFE models family

Hi-SAFE: detailed 3D process-based tree-crop interaction biophysical model (typical run = 1 to 5 years)

Yield-SAFE: simple tree-crop interaction biophysical model (typical run = 20 to 100 years)

Farm-SAFE: economic model at the farm scale (typical run = 20 to 100 years)
Hi-SAFE

Understanding tree and crop interactions at the year time step
Hi-SAFE: a process-based tree-crop interaction model

Modelling different systems

Walnut
Wild Cherry
Poplars
Mediterranean Oaks

Winter and summer annual crops, grass, alfalfa
Hi-SAFE specifications

From tree plantation to tree harvest
Some features of the Hi-sAFe model

Management options included:

• Strategic options (at the inception):
  • tree plantation design including tree row azimuth, initial tree-crop distance, initial crop rotation

• Tactical options (triggered at the year time-step):
  • thinning, branch pruning, canopy thinning, root pruning, cropped area size
Hi-sAFe has some unique features

Below-ground

Opportunistic and reactive tree and crop root systems

Topology of major coarse roots required to simulate root pruning
Hi-sAFe has some unique features

Above-ground

Opportunistic and reactive tree canopies to available space and light

Tree canopy structure required to simulate both branch pruning and canopy thinning

Dynamics of light penetration essential at the day time step (impact on crop physiology)
The Hi-sAFe scene

3D above-ground interaction

3D below-ground interaction

Any number of trees included

The crop is represented by multiple parallel instances of the crop model

The tree-row vegetation is represented by additional instances of the crop model (bare soil, mulch, grass available)
1.29

Poplars - durum wheat
Crop 0.83  Tree 0.46
Hi-SAFE allows to understand the tree-crop interaction processes

- What explains the measured productivity?
- What are the limited factors for productivity?

Light?

Water?

Nitrogen?
Water uptake (by voxel) in the Agroforestry treatment
Water uptake (by voxel) in the Agroforestry treatment
Light is the limiting factor in this Mediterranean mature plot, not water!!
Hi-sAFe predicts the heterogeneity of the crop yields in the plot

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Hi-sAFe predicts the light heterogeneity within any agroforestry stand

North-South tree rows, different tree sizes

NW-SE tree rows

Direct and diffuse radiation (East-West tree rows)
Hi-sAFe predicts the crop productivity and heterogeneity within the agroforestry stand.
Hi-sAFe predicts the tree and crop root patterns that results from the competition
Hi-sAFe predicts the tree and crop root patterns that results from the competition.
Predictions of the model...

- Interception of leached nitrates by deep tree roots
- Injection of carbon in deep horizons of the soil by tree root turnover
What we learned for the technical management of Agroforestry plots
Agroforestry is not afforestation
This is not agroforestry!

Agroforestry is not afforestation of agricultural land.
This is not agroforestry
The agronomical optimum for mature tree densities is low (30 to 100 trees/ha) and allows crop production even with mature trees.
Let's compromise!

- Too many trees is not favourable
- Too few trees will not produce significant advantages

Most of our experimental plots have too high tree densities (>100 stems/ha)
What final tree densities?

- Hedges
- Agroforestry at 80-200 trees/ha
- Agroforestry at 20-60 trees/ha
- Isolated and scattered trees
- No trees
- Taunggya temporary crops in the forest
- Forest
In Agroforestry, all trees should be productive (early thinning, no late thinning, parkland aspect)

LER (Products) > LER (Biomass)
Trees grow faster in agroforestry compared to afforestation (on the same site quality)

Except with some very competitive perennial crops such as perennial fodder grasses
7 simple technical recommendations

1. North-South tree lines should be preferred when possible (homogeneous intercrops)
2. To maintain long term crop productivity, tree lines should be wide spaced (15 to 40 m).

In the case of small plots, trees should be maintained on the plot boundaries.
3. Successful agroforestry requires complementarity in resource acquisition by trees and crops

(Avoid too superficial soils, sub-soiling often required, management of tree root systems)
4. Never hurt the trees by sudden changes in the management scheme
(tree-crop distance, crop quality, soil tillage, root pruning)
5. Align the trees precisely at plantation
6. Protect young trees so that they are easily seen from the tractor seat
7. Focus on formative pruning (few time/ha, but each year during the first 10-15 years)
Some efficient mixtures:

**Walnut, Sorbus**
with winter crops (cereals, rapeseed)

**Prunus, Acer, Fraxinus, Pyrus, Quercus**
with summer crops (maize, sorghum, sunflower)

**Populus**
with legumes, asparagus, winter cereals, on deep alluvial soils

- Always include winter crops in the rotation to control tree roots
- Avoid perennial fodder such as tall fescue...
Directions for further improvements and research

• Precision Agriculture: adapt management to the crop potential as influenced by the trees (e.g. fertilisation)

• Fine tuned tree management is worth exploring (deep fertilisation, root pruning)

• Biological control of pests by habitat management: agroforestry offers great opportunities
Modern agroforestry systems are efficient

Both for tree and crop components
Modern agroforestry systems are compatible with present day agriculture

With some adjustments to practices
Agroforestry is cropping in 3D
Agroforestry mimicks nature. Agroforesters play with species interactions to produce in a sustainable way.
Merci