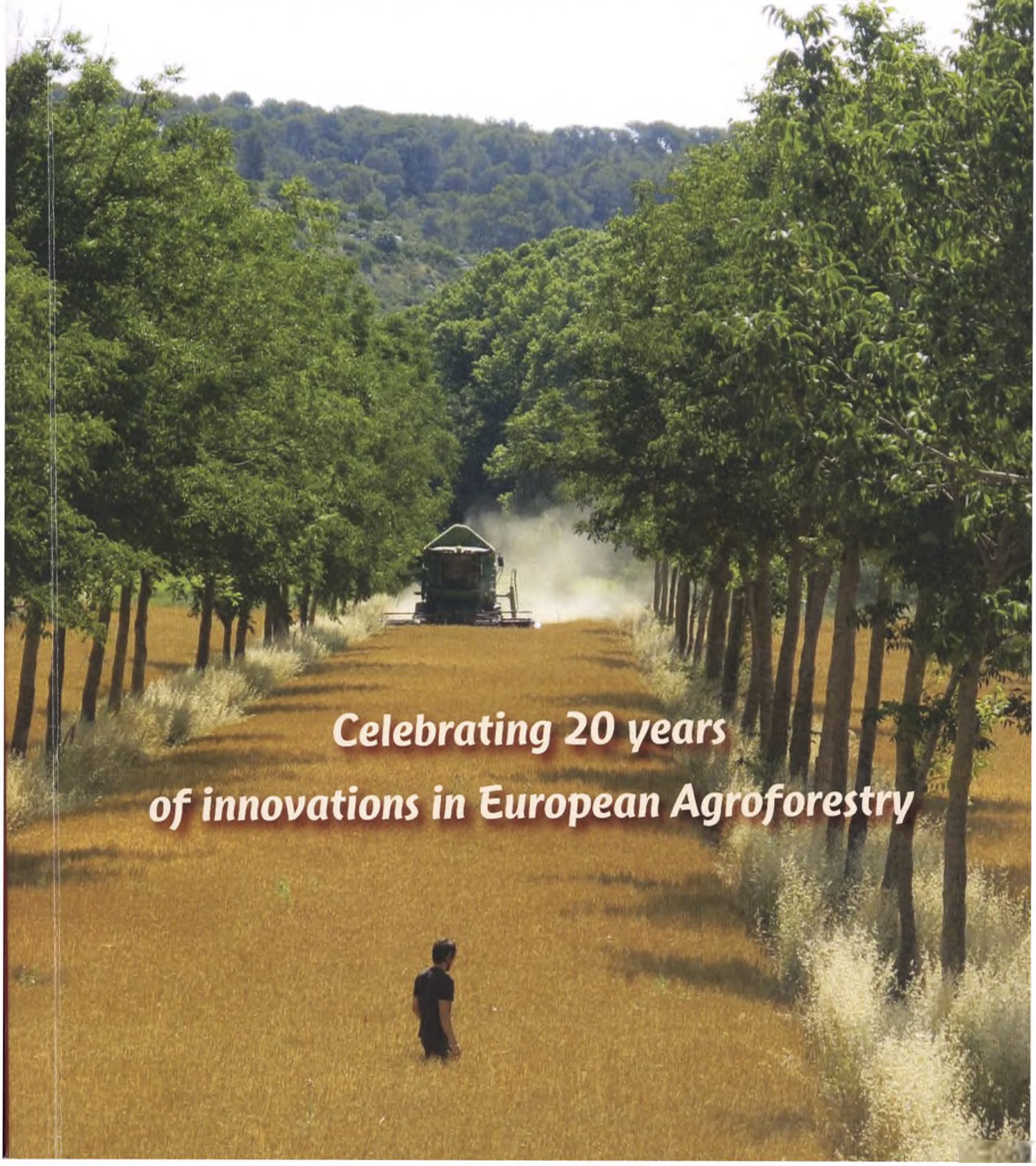
Book of Abstracts

3rd European AGROFORESTRY Conference 2016

23-25 May 2016 – Montpellier SupAgro, France



Celebrating 20 years

of innovations in European Agroforestry

EURAF

EUROPEAN AGROFORESTRY FEDERATION

3rd European Agroforestry Conference

Celebrating 20 years of Agroforestry research in Europe

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ADDRESSING CLIMATE CHANGE CONCERNS IN TROPICAL AGROFORESTRY

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Introduction

Agroforestry is regularly cited as an appropriate land use to simultaneously achieve both mitigation of and adaption to climate change (Mbow et al. 2014; Torquebiau, 2016). The potential of trees to increase biomass stocks and soil carbon content comes as a first argument but the potential of tree-based systems to increase resilience to climate-related stress or favor ecosystems services is also regularly cited (e.g. Cardinael et al. 2015). We provide a few examples coming from coffee and cocoa agroforestry showing that agroforestry can indeed be considered as a relevant approach for dealing with climate change concerns but indicating also that mainstreaming agroforestry in the agricultural sector has still a long way to go, justifying to better include agroforestry in the policy agenda.

Climate change adaptation

Coffee cultivation under shade trees in Nicaragua showed a clear niche differentiation in the exploration of soil by the roots of coffee and the roots of trees **(Figure 1)**. This supports the hypothesis of complementarity between roots of trees and crops for water use. Although not shown, shade trees were also found to reduce air temperature and had positive effects on coffee fruit abortion and drop as well as coffee quality (Padovan et al. 2015).In the case of cocoa agroforestry, positive effects were found on household income and diversification in Central America (**Figure 2**) and in Cameroon (**Figure 3**). In the savanna zone of Cameroon, cocoa agroforestry has been practiced for a long time by farmers. The association of the cocoa crop with trees allows farmers to grow cocoa in areas supposed to be beyond its climatic tolerance, an important asset under a possibly future drier climate in Africa. Shade trees create favorable microclimatic conditions reducing cocoa transpiration and an increase in top soil C (**Table 1**) through recycling of organic matter. The combined effects of reducing water demand and increased topsoil fertility may explain the adaptation of cocoa in those suboptimal conditions. The efficient management of different tree stands on the very long term allows farmers to improve soil fertility without any input of chemical fertilizer. These agroforestry practices are a good example showing that it is possible to significantly reduce greenhouse gas emissions by reducing nitrogen use and / or losses as N_2O (better management of nitrogen inputs, substitution of these inputs by cocoa cultivation with other fruit and forest species).

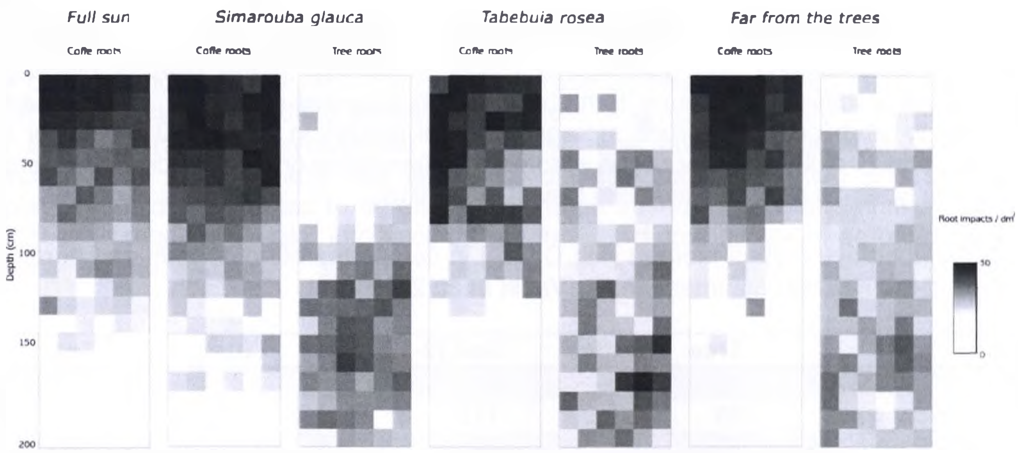

Figure 1. Fine root density of coffee and shade trees. Full sun coffee plantation (left column); Coffee agroforestry (other columns) with two different timber tree species. Nicaragua (Padovan et al. 2015).

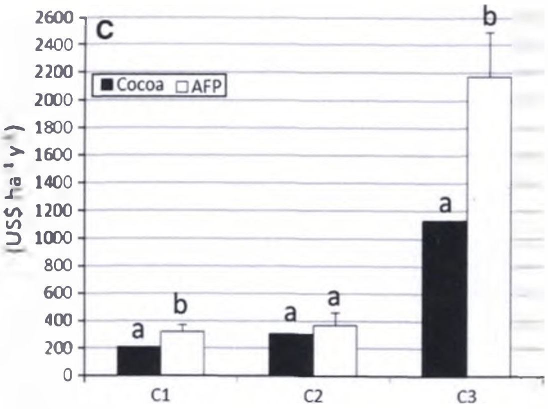

Figure 2. Contribution of cocoa and other agroforestry products (AFP: banana + fruits + timber) to family benefits in 3 agroforestry systems in Central America. C1: large size, moderate tree density and low cocoa yield; C2: small size, high tree density and low cocoa yield; C3: moderate size, high tree density and high cocoa yield. Different letters between bars indicate significant differences between cocoa and AFP (LSD Fisher, $p<0.05$) (Cerda et al. 2014).

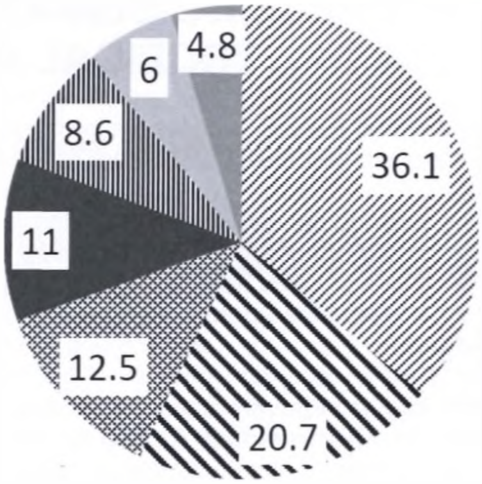

Figure 3. Use values (%) attributed to species in cocoa agroforests. Clockwise, from noon: Wood and non-wood market products (including cocoa seeds); Non-wood products for farm use; Wood products for farm use; Soil fertility enhancement;Medicinal products for farm use; Non-wood products for social exchange; Shading (Jagoret et al. 2014; Central Cameroun).

Table 1. Clay and organic matter content (± SD of the mean) in topsoil (0-20 cm horizon) in 10 grassland plots and in 47 grassland cocoa agroforestry plantations according to their age. Values followed by the same letter are not significantly different ($p < 0.01$, Newman-Keuls test) (Jagoret et al. 2012; Central Cameroon).

Age of plantation	Clay content (%)	Organic matter content (%)
Grassland (control)	18.8 (± 0.81) a	1.70 (± 0.09) c
< 10 years	17.5 (± 0.55) a	2.25 (± 0.18) b
10-40 years	17.8 (± 1.58) a	2.82 (± 0.16) ab
> 40 years	19.3 (± 1.61) a	3.13 (± 0.37) a

Climate change mitigation

Arabica coffee grown under native trees in the Western Ghats region of India maintained carbon stocks at levels equivalent to those in surrounding forests (**Table 2**). In Latin America, a meta-analysis of carbon stocks in coffee agroforestry plantations showed that 10 years after planting, the carbon stock in different agroforestry associations ranged from 15 to 30 t C/ha while it was only 8.5 t C/ha in monocrop coffee (**Figure 4**). Although coffee or cocoa cultivation does contribute to deforestation and greenhouse gases emissions at the time of planting, this negative effect is offset in the long term by the high potential of coffee- and cocoa-based agroforestry to store carbon. Carbon storage potential ranges in the10-150 t C/ha for coffee agroforestry and 10-100 t C/ha for cocoa agroforestry depending on tree species used, previous land-use, soil type and climate conditions (Vaast etal. 2015).

Table 2. Comparative carbon storage (Mg C ha^{-1}) in compartments of forests and agroforestry plantations in the Kavery catchment, India (Vaast et al. 2015).

System	Tree	Coffee	Soil (0-1.5 m)	Litter	Total
Forest	97		97	2.4	196
Arabica + local trees	88	4.8	112	1.6	206
Arabica + exotic trees	73	3.3	105	2.2	183
Robusta + local trees	78	13.0	90	1.8	182
Robusta + exotic trees	47	10.1	78	1.9	138

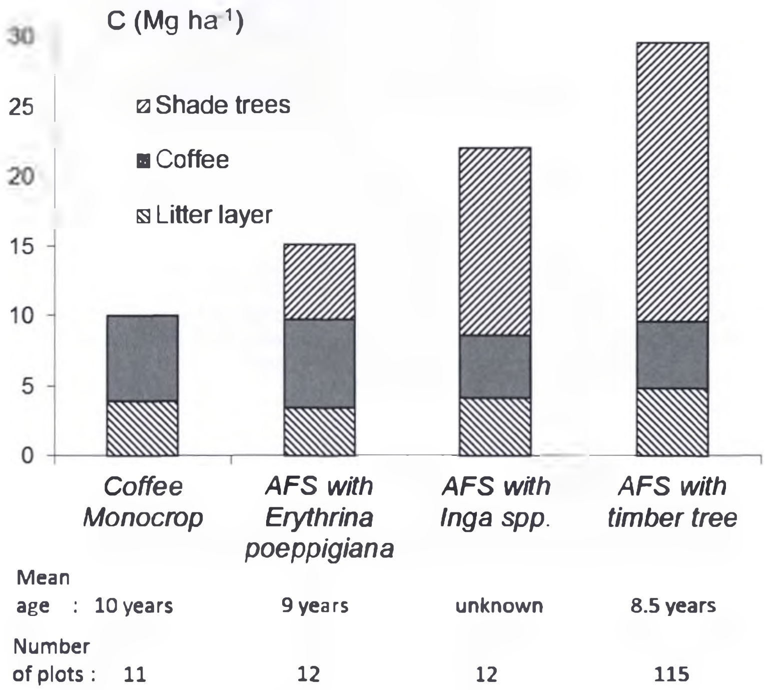

Figure 4. Mean carbon accumulation (Mg C ha^{-1}) in aboveground biomass and litter in different coffee monocrops and different coffee agroforestry associations of about 10 years old (AFS: agroforestry system) (Harmand et al, 2007; Hergoualc'h et al, 2012).

Mainstreaming agroforestry in the agricultural sector has nevertheless a long way to go
Despite a high potential, many barriers to agroforestry still hinder its development (FAO, 2013). A delayed return on investment is often mentioned by farmers since trees take several years before showing a positive interaction with crops or being productive. In many countries, markets for tree products are under-developed and do not allow easy marketing of tree products except for some well-known commodities such as fruits. Most research and extension services in both developed and developing countries put emphasis on commercial agriculture, ignoring farm use of tree products or ecosystem services provided by trees. Broadly speaking, there still is a massive ignorance of the advantages of agroforestry among farmers,agricultural experts and the broad public. For instance, although it is possible to have both coffee production and carbon sequestered, very few farmers achieve that (**Figure 5**). The status of land and tree resources is not always conducive to tree planting on farms: in many tropical countries where the land is state property or land right not secure, farmers do not plant trees because of insecure tree tenure. Few regulations take into account multifunctional land management as required by agroforestry associations, e.g. taxations or subsidies which apply to monocrops only. Finally, there is a lack of coordination between sectors such as agriculture, forestry and livestock, leading to policy conflicts or omissions, if not adverse incentives.

A few critical conditions are necessary to encourage agroforestry (FAO, 2013), namely: (1) there should be clear immediate benefits for farmers (and not only delayed environmental or social benefits); (2) skill development is required at all levels, for farmers, extensionists, researchers, etc. (3) land and tree tenure conditions must be clarified and secured; (4) germplasm should be adapted to agroforestry through adequate breeding and (5) innovative governance is required to take into account the multifunctional nature of agroforestry and its inter-sectoral requirements.

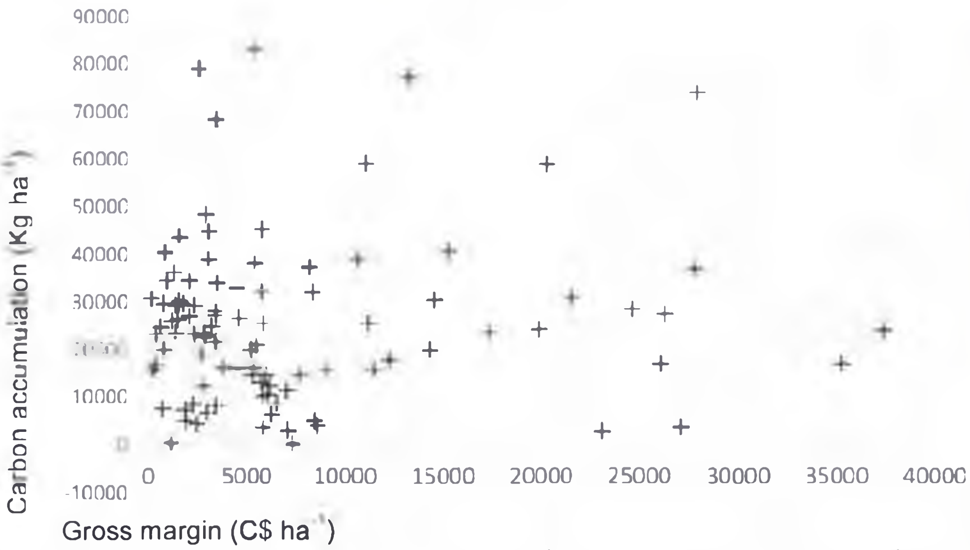

Figure 5. Carbon accumulation in the aerial part of shade trees of coffee agroforestry as a function of gross margin, Northern Nicaragua (Notaro et al. 2015).

To promote agroforestry and realize its potential to address climate change challenges, innovative policies targeting agroforestry are required at national and local levels (FAO 2013). Such policies may be based on: (1) better information about agroforestry in the global society, (2) improved regulations towards a better inclusion of land multifunctionality and ecosystem services, (3) acceptance that trees are production factors in agroforestry, (4) development of agroforestry-targeted incentives and (5) promotion of agroforestry markets. Research efforts are also required to improve the overall diversified production of tree-crop mixed systems, to address shade management, and to foster breeding (both trees and crops) for agroforestry. Climate change-targeted environmental services (e.g. diversified tree composition with multifunctional objectives) also need to be further developed. in order to support the increased recognition of agroforestry benefits, facilitate the development of policies promoting agroforestry and taking into account the climatic vulnerability of many developing countries.

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