AGROFORESTRY SYSTEMS OF HIGH NATURAL AND CULTURAL VALUE IN EUROPE: CONSTRAINTS, CHALLENGES AND PROPOSAL FOR THE FUTURE

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Introduction

European agroforestry systems of High Nature and Cultural Value (HNCV) are used for multiple purposes which generate woody products, non-woody plant products, high-quality foods, livestock and game products, recreational or cultural services. In addition, HNCV agroforestry supplies us with important ecosystems services such as biodiversity maintenance, carbon sequestration, soil fertilization, microclimate amelioration, and control of atmospheric contamination and control of soil erosion (Wallace, 2007). The capacity of these systems to sustain multiple functions and products has been emphasized in recent decades as new needs and challenges have emerged in modern society. These systems allow the exploitation of conventional forest functions and products together with a diverse array of new uses (e.g. bioenergy) that increase economic profitability or reduce uncertainty in land use.

However, most of these HNCV agroforestry systems are currently facing both environmental and economic threats that might compromise their long-term persistence. Changes in the technological and socio-economic conditions and common agricultural trends and policies are imposing a loss of traditional empirical knowledge, a continuous decrease of profitability of these systems and their products, what is leading them to two divergent trends, intensification and extensification or abandonment, that compromise their long-term persistence (Asner et al., 2004). Intensification has resulted in a shift from the traditional farming systems with very low external inputs to a much more simplified system involving intensive management techniques, with partial substitution of extensive, low-intensity grazing for semi-intensive management regimes, and decreasing diversity of land uses (Plieninger and Wilbrand 2001). The increment of livestock rate or grazing pressure, progressive soil degradation, tree populations at the end of their life expectancy due to a prolonged lack of tree regeneration, and loss of habitat and biological diversity has been denounced (Moreno and Pulido 2009). Extensification results in woody encroachment of agroforestry systems in many parts of the world (Eldridge et al., 2011; Archer 2010), and notably in Mediterranean countries (Pereira et al., 2004; Mazzoleni et al., 2004) with important changes on their functioning and productivity.

This work aims to identify the bottle-necks for the conservation and promotion of HNCV agroforestry systems in Europe, and to search in collaboration with stakeholders potential innovations that guarantee the long-term ecological and economical persistence of these systems.

Methods

This work is done in the frame of the European project AGFORWARD (www.agforward.eu),that works with ten agroforestry systems of high nature and cultural value located in the main European biogeographical regions (Table 1). In each of the ten case studies, a stakeholder group is involved, including , for example, farmers, breeders, foresters, landowners, representatives of regional and national associations, agricultural services companies, extension services, nature-related NGOs, local action groups, policy makers and scientists. The objectives for the stakeholder groups were:

i. to identify main constraints and challenges for the promotion/conservation of agroforestry systems of high nature and cultural value,
ii. to propose management innovations to improve the productivity, sustainability, marketing of the products, governance of HNCV agroforestry systems,
iii. to identify ongoing innovation practices initiated by participants and organisations,
iv. to establish a network of sites to test the proposed innovations. Ideally the network should include both experimental and demonstration sites to test scientific hypothesis at the former and to evaluate the feasibility and profitability of proposed innovations at the latter, and
v. to organize and participate in dissemination activities including field visits.

Each stakeholder group held at least one meeting with an open discussion on the main concerns and challenges for the respective agroforestry system. At each meeting, stakeholders also completed a standard questionnaire which sought to rank their assessment of the positive and negative issues associated with the agroforestry system being considered.

Results

The main challenges identified by the stakeholder groups can be grouped under nine topics: farm profitability, system design and management, tree protection and regeneration, pasture quality and fodder autonomy, grazing schemes and cost-efficient herding, animal production, nature conservation, extension, and policy and governance. **Table 1** gives details of the main concerns expressed for each of the ten case studies.

Table 1: List of the high nature and cultural value agroforestry systems (mostly wood pastures), with indication of the respective partner.

The most popular innovations claimed by stakeholders are provided in **Table 2**. They include:

Bio-region	Country	System	Main concerns
Mediterranean	**Portugal**	Montado: grazed open oak woodlands	Possible negative consequences of shrub encroachment of woodlands on cork yield and quality
	Spain	Dehesa: grazed and intercropped oak woodlands	Low profitability, marked seasonality of fodder resources and deficient tree regeneration
	Italy	Grazed oak woodlands in Sardinia	The lack of forage availability and quality
	Greece	Grazed valonia oak woodlands	Oak regeneration and poor pasture understory yield/quality
Atlantic	**France**	Bocage agroforestry in Brittany (hedgerows integrated with grassland and arable land)	Decrease of hedgerow density and their reduced importance in farming management and ecological services
	UK	Wood pasture and parkland	Re-instituting tree management, balancing the prevention of infilling with natural regeneration
Continental	**Romania**	Grazed wood pastures and grasslands with ancient non-productive trees in Transylvania	Conservation of veteran non-productive trees and of tree species diversity. Need of economically and socially viable strategies to increase tree regeneration
	Germany	Flood plain meadows with tree hedgerows	Hedgerows abandonment Lack of interest of farmers for trees
Pan-onian	**Hungary**	Grazed wood pastures and grasslands with ancient non-productive trees	Infilling of abandoned wood-pastures, and lack of public awareness of their nature and cultural values
Boreal	**Sweden**	Wood pastures and grazed forests devoted to reindeer husbandry	Adaptation of forest operations to reindeer husbandry

Valuing traditional and new marketable products: branding strategies to communicate to consumers the high quality and low (or positive) ecological footprint of wood-pasture products.
Integrating grazing livestock with tree layer conservation and regeneration: cost-efficient protectors for tree regeneration, included virtual fencing and GPS-based devices, and management practices compatible with tree regeneration.
More efficient use of local forage resources to increase the fodder autonomy of the farms.
Adaptation of policy measures for extensive and multipurpose wood-pasture systems.
Public acknowledgment of the cultural value and the ecosystem services provided by wood-pastures.

Table 2. List of identified innovations which can be tested

Innovation to be tested	Specific experimental work
System design/management: refers to conservation of specific elements, as native species, veteran trees, reintroduction of formely used species, hedges and windbreaks conservation and/or rejuvenation	Shift from single model of novel hedgerow to modular models and progressive management techniques. Rebuilding connections between hedgerows and scattered farms across the landscape. Combining crop rotation management, pasture management and 3 dimensional design and management of hedgerows to avoid soil erosion. Renewing encroach-abandoned wood pastures Effect of different understory management options on cork growth/calibre and cork quality
Tree regeneration: cost-efficient protection of regenerate	Seeding combined with dead branch/wood, mulches (e.g., Ramial Chipped Wood), thorny and/or nursery shrubs Artificial thorny protectors Mix of specied for "auto-protection
Livestock management: cost-efficient herding, optimisation of fodder resources use, and halting system degradation	Viability and cost-effectiveness of "invisible fencing" GPS collar, equipped or not with negative-stimuli devices Holistic or grazing (intensive fast-rotational grazing) to improve soil and pasture quality and protect tree regeneration Effects of grazing exclusion on the vegetation structure, biodiversity and wildfire
Fodder resources	Selection of species/varieties of legume pastures adapted to shade and tree competition Selection of double-cropped winter-forages (e.g. Triticale) adapted to shade and tree competition
New products	Questionnaire to assess the willingness to pay a premium price for different AF products (e.g. acorn-derived products) and services (e.g., biodiversity, historical/aesthetic landscapes). Questionnaire to identify mechanisms to promote efficient marketing of AF products (e.g. human consumption of acorns in different products)
Conservation	Ramial wood chips and other organic mulch Adoption of optimal livestock species in wood-pastures to halt soil degradation and to reinforce biodiversity Testing the openness of local communities to value/protect ancient trees on WP
Governance	Favouring the design (and diffusion) of a model of cooperative (e.g. skills and machines pool) for re-developing HNCV agroforestry

Conclusions

Explicit long-term strategies should be designed and specific policies implemented to promote management practices that ensure the conservation of agroforestry systems of high nature and cultural vale and reinforce their economic, social and ecological roles. However, better knowledge is still required to convince landowners, administration and policy-makers. For instance, studies focusing on the conditions under which net balance of trees is positive (facilitation) or negative (competition) for pasture understory are still needed. Similarly, guidance on the optimal tree density for such agroforestry systems under different uses and ecological constraints (i.e., water shortage) is still required. The analysis of consequences and opportunities of woody encroachment of extensive semi-natural pastoral systems and landscapes also deserve more attention. Woody encroachment could be favorable for tree regeneration, but it is doubtful whether shrub encroachment would keep stand functioning (e.g., hydric and nutritional tree status, biodiversity) and profitability (e.g. livestock carrying capacity). Pasture production, tree growth and/or fruit production and tree regeneration need be analyzed taking into account the complexity of the canopy-understory interactions. Moreover, there is a complete lack of systematic and detailed knowledge on the extent and constraints of most of these systems. No official data or maps are available on these multilayered systems, resulting in an information failure that precludes the elaboration of specific proposals for management and policy to face current threats.

Summarizing, through the integration of traditional and scientific knowledge we still need (i) the elaboration of innovative techniques for the long term production of timber and non-timber agroforestry products; (ii) An integrated analysis of economic and environmental values to incorporate recreational and ecosystem values in public policy; (iii) modeling and predictive tools to create integrated systems of support for decision making; (iv) the elaboration of policy proposals to reinforce the public environmental goods and services provided by agroforestry of high nature and cultural value; and (v) the development of effective institutions and governance structures to help value and manage silvopastoral systems.

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