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Innovation on agroforestry education, training and practice to develop rural living and environment supported by the AgroFE Leonardo and Agrof-MM Erasmus+ projects

Abstract: *Agroforestry can be applied to all agricultural systems, in all parts of Europe. Europe has a unique heritage of traditional agroforestry systems with a high environmental and cultural value and high potential for innovative modern agroforestry systems developed by research centres across Europe during the last two decades. In recent years, following scientific research, the development of structures and professional experiments in agroforestry has gained national and European recognition. In some European countries, namely Belgium, France and the UK, professional organisations and training organisations have begun to reintroduce agroforestry with training of agricultural students and adults in further education. The main objective of the AgroFE and Agrof-MM projects is to develop an agroforestry training system based on a common framework and core content, and to promote training at European level. The knowledge databank is a component of the project training system. It aims to gather and share a set of documents, resources that partners can use and which will have been accessed by learners and the public users. The core content of different levels of training and the knowledge databank has been developed and the distribution of the results are in progress across Europe by innovative ICT tools.*

Keywords: *agroforestry, education, training, innovation, knowledge databank, environment*

Introduction

Agroforestry systems are traditional land use systems that were and are used in Europe. They can be defined as those land use systems which involve two main components – trees/shrubs and an agricultural crop (which could also be pasture) and are artificially managed. Agroforestry systems can be implemented at a temporal and spatial scale for a land owner, who can use different agroforestry practices.

Agroforestry systems can be exclusively formed by either one or a combination of agroforestry practices (the most common situation) and practised at the same time or at different times during the year on any one farm. Agroforestry practices can also be combined in a temporal (transhumance – Helle, 1995; Bunce et al., 2008) and at a spatial (Mosquera-Losada et al., 2005; Moreno and Pulido, 2008; Moreno et al., 2007) scale.

The agricultural system has experienced a strong abandonment of agroforestry (Nair, 2005) in the 20th century, to count today only a few million hectares in Europe (Price, 1995). Depending on the countries, states or professional organisations and training actors (Jamnadass et al., 2014) try to reintroduce agroforestry in the course of training and qualification in initial training and in adult education (Jongmans, 1996). Based on the results of scientific research, development structures and those of the 'farmer-researchers', experimental courses were conducted in different countries, including Belgium, France and the UK on a small scale as resources, trainers and available skills are scarce.

The AGFORWARD research project (January 2014-December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development. This initial analysis of the AGFOEWARD project suggests that there are at least 52 million hectares of agroforestry, including reindeer herding, across Europe. Excluding the reindeer herding system, the estimate is at least 10.6 million hectares, which is equivalent to about 6.5 per cent of the utilised agricultural area in Europe (den Herder at al., 2015).

The AgroFE (http://www.agrofe.eu) project partners have identified training needs in the short term. These needs are, on the one hand, operators and future operators, adults and pupils/students, teachers and counsellors, tutors. These requirements therefore relate to two levels of qualification, L4 and L5/L6, and two types of learners: students and adults, farmers and future farmers on the one hand (mainly L4/L5), and advisors, level L5/L6. In the short term, the project will address these two publics through a system established by the partners based on innovative teaching practices training, occupational situations providing access to recognised qualifications (NQF, EQF, ECVET and ECTS). Fortunately, the information and communications technology (ICT) tools have been increasingly developed nowadays, so there are tools and methods for e-learning and e-collaboration (Bustos et al., 2007; Herdon and Lengyel, 2013; Herdon and Rózsa, 2012). One of the important parts of the project

is to apply innovative solutions for building and using the websites, social media and knowledge repositories for teaching and learning agroforestry. The Agrof-MM (http://agrofmm.eu) project extends the education and training to Mediterranean and mountain areas in Europe.

The term e-learning is widely understood to refer to the use of ICT in learning and teaching. E-learning systems can be observed at both the institutional and the local level in higher education. Institutional systems include learning management systems (LMS), used primarily to manage delivery of course material to enrolled students, and the platforms that support massive online open courses (MOOCs) (Porter, 2015). Local e-learning systems are observed at the level of a single course, class, lesson or learning activity. While investments at both levels can contribute to improvements in learning and teaching (Gunn, 2010), each has its own goals, methods and challenges.

Economics in agroforestry

The importance of agroforestry systems at a global scale are highlighted in Agenda 21 of the Rio Convention, where agroforestry systems, and therefore agroforestry practices (Nair, 1993; Mosquera-Losada et al., 2008), are mentioned as a sustainable land management option (Figure 1). If we compare the income generated from a forest, agricultural or agroforestry land managed system during a whole cycle of tree development, it can be seen that these profits not only vary because of the type of product obtained (tree and crop), but also because of the period of time when economic benefits are obtained within the different systems. Agroforestry productivity depends on the type of tree and tree management in the long term. Tree profitability is usually higher with fast growing species because the time required to obtain a return is shorter compared with slow growing tree species. It is important to highlight that nowadays, it is more widespread silvicultural practice to promote high stock densities at planting as the aim is to increase tree volume per hectare (Evans, 1984).

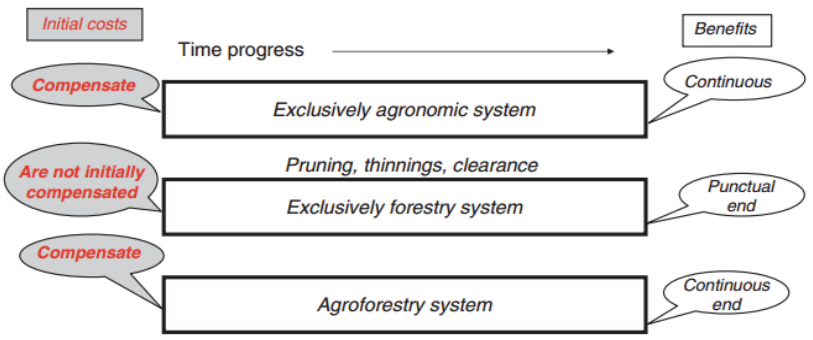

Figure 1. Initial costs and benefits obtained with an exclusively agronomic system, exclusively forestry system and with an agroforestry system for a stand life (time progress goes from plantation to harvesting) and varies with the type of tree

Source: EEA, 2005.

European policy

European policy has traditionally been based on production. For example, land use in Europe is classified as being either agriculture or forestry, and the Common Agricultural Policy (CAP) has therefore tended to encourage the removal of scattered trees, particularly from arable land (Lawson et al., 2005). The ecosystems approach suggests that there is need for a more integrated approach to land management. At present, agricultural land within the European Union (EU) must be kept in 'good agricultural and environmental condition'. In the future the focus may be on the provision of a broad range of ecosystem services. Such a change would encourage the creation of more mixed cropping systems. In Spain and Portugal, the cultural and environmental importance of agroforestry systems has been recognised. In both these countries, oak trees in dehesas and montados are protected by national policy and, at a European level, various directives and initiatives have sought to enhance such areas through social and environmental programmes (Shakesby et al., 2002; Pereira and Pires da Fonseca, 2003; Gaspar et al., 2007; Pleininger, 2007). In the new European Rural Development Regulation agroforestry is specifically mentioned as receiving special support. However, in some countries there is uncertainty over whether areas of agroforestry remain eligible for Single Farm Payments. For example, some guidelines focus on agroforestry in terms of the continuing use of agriculture within the tree canopy, whilst others focus on specific definitions related to the number of trees per hectare. These issues are currently being debated, particularly by those wishing to promote agroforestry systems in Europe at a broader scale and in as wide a range of scenarios as possible.

Existing research indicates that appropriate application of agroforestry principles and practices are a key avenue to help the EU to achieve more sustainable methods of food and fibre production that produce both profits for farmers and environmental benefits. Agroforestry practices have been overlooked by previous CAP schemes, resulting in billions of trees being destroyed across Europe. Recently incentives for establishing agroforestry plots have been introduced and in the new CAP agroforestry will receive support through Pillar II. Article 23 of Rural Development Regulation 1305/2013 is devoted to the establishment of agroforestry systems and it now depends on Member States and regions to use this article to adopt agroforestry measures in their Rural Development Programmes.

Rural development, environment, social benefits and agroforestry

McAdam et al. (1999) and Sibbald (1999) reviewed the rationale behind agroforestry (largely as practiced in the British Isles) being viewed as a sustainable land use option, and concluded that, because of the employment created by multi-functional systems, it can have a positive impact on sustainable rural development, in comparison with conventional farm woodlands.

The main environmental benefits which agroforestry systems deliver are the improvement of use of nutrients through the reduction of losses at a farm level (including erosion) but also by the enhancement of carbon sequestration, the reduction of fire risk and biodiversity enhancement. There is an acknowledgment of the importance of woodland grazing to improve biodiversity (Finck et al., 2002; Redecker et al., 2002) and regeneration (Mayer, 2005; Smit et al., 2005; McEvoy et al., 2006) in forestry areas if an adequate animal stocking rate is used (Zingg and Kull, 2005). Social benefits of agroforestry systems for owners and people in general are based on their productive and environmental advantages (Figure 2).

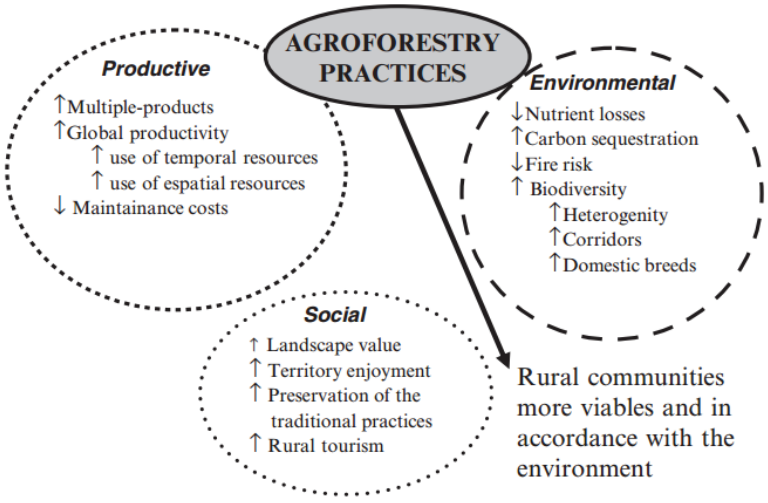

Figure 2. Productive, environmental and social benefits of agroforestry system practices

Source: not stated.

Methodology

Building a Core Content

The method is the backbone of an organised, planned process, from training design to transfer after development, experimentation and assessment. The partners have established a common professional referential whose training declination is a solid and enforceable core, also called 'Core Content', which aims to prepare for the exercise of the profession of agroforester. The training will therefore be declined to operational aims, taking into account the diversity of possible context for the necessary adaptations, each project being a particular case. The process of developing such a 'European Professional referential of Agroforester' is composed of three stages and is based on the French professional methodology of referential development. A professional referential is called professional reference book as well.

1) Collecting of information from actors and stakeholders, based on:
   - Investigation(s) of literature, of business documents, from testimonies of experimenters, experts, researchers, technicians, developers etc.;
   - Questionnaires and interviews including questions such as (examples): What major agro-ecological principles the agroforester must master to design a viable project? What reasoning on the place and role of agroforestry on the scale of the farm, the scale of the territory (interest, complementarity, implementation, conduct etc.), reasoning the farmer should be able to hold and its impact on the management and daily practice? What an agroforester should know concerning the CAP applied to one particular country?

2) Organising of the information collected in a structured document:
   - Either structured under the form of 'significant professional situations, SPS';
   - Or structure under the form of 'core competencies' (or Main Competencies) by country or by actors.

3) Validating the professional referential (professional reference book) in a process involving all the domain actors, all the stakeholders.

The list of actors and stakeholders involved in the production process-validation of the AgroFE is available.

Building the knowledge databank

In computing, a database is gathering highly structured data, a well-defined organisation, based on different types of structures: relational, hierarchical. This is absolutely not the case in a databank in which we store structured tables of numbers as well as illustrated text or video or emails, external knowledge or those from the project in their various forms. But it should be noted that the KDB in the prototype of the AgroFE project is based on a software, RUBEDO developed in PHP and RUBEDO is built on different components (a database management software (DBMS), type 'NoSQL', MongoDB and the user interface uses the ElasticSearch search engine). The development phases were the following:

- Building the prototype, winter 2014–2015: Spring 2015 (interactive online training via Vidyo system with screen sharing, the partners had to provide five documents in their national language, provide metadata in a file according to the process involving intermediate files.
- Started the test with students, trainees and stakeholder in the AgroSup, Dijon. These presentations tests resulted maintenance for the assessment of the list of documents.

- Presentation test librarians. The responsible resource centres have raised several comments and judicious remarks. This type of resource matches to a need for teachers, trainers and pupils, apprentices, students, soon in that the information (documents) are of quality and content validated, somehow certified. Some of the materials/content did not respect the rules of quotations and intellectual property. The access of KDB was released in late October 2015.
- During the development work of the KDB, an evaluation of the interface and the organisation of the access will be organised with the participation of master students, Hungarian and French consultation conducted by students in Master AgroSup Dijon. A first phase resulted in proposals for interface and aspects. The thesaurus and taxonomy are very important part of KDB, it can be the basis of the search strategy.

Results

The AgroFE Leonardo project

In the AgroFE project, in partner countries there is a need for conversion and development of about 15,000 to 20,000 farms, in the next 5–7 years, which means training of the same number of operation managers. To achieve these goals more advisors and trainers in agroforestry are needed.

The main project objective is the development of an agroforestry training system, based on a common framework and core content, and to promote training at European level. The training should involve professionals, agroforesters, and should be as innovative as possible: field based training, usages of ICTs, development of training materials. The specific objectives were:

- Producing of one proposal of European professional referential of farmer agroforester, as support of the training common framework – core content, which one could be adapted to local environment;
- Designing, implementing a knowledge data bank (KDB - BdC), knowledge which will be used as materials, resources for training, including the existing and the transfers from partners;
- Developing new training pathways, then carrying out experimentations targeting student future farmers or advisors and adults, farmers, in the countries of the partnership;
- As much as possible, inserting, developing the training in the framework of the qualification, certification systems for the targeted levels, training based on to the needs and specifications of the country education systems.

Related to the objectives of the AgroFE project the following results can be highlighted:

- A collection of different resources was made based on the synthesis of needs and expectations of partners. This collection was used in developing new and existing training sessions;

- A professional book of references has been developed to support for transfers in training;
- The knowledge database has been developed which will be used for tools and training resources and which will also integrate existing resources in the future;
- Collaborative and dissemination platforms were created such as official web site, videoconference system, facebook, mailing list and Moodle for project document and as LMS.

The Agrof-MM Erasmus+ project

Based on the AgroFE Leonardo project the Agrof-MM project extends the activity to the Mediterranean and mountain areas between 2015 and 2018. Education is essential, not only in order to make this innovation method of production known, but also in order to allow the acquisition of new competencies and knowledge by those working in the agroforestry agricultural profession. This is why Agrof-MM sets up different types of training:

- Courses, group work, conferences;
- Training in the field and online;
- Self-training;
- Thematic workshops;
- Case studies;
- Visits to agroforestry plots;
- Tutored placements on farms.

The Agrof-MM training programmes are directed to pupils, students, farmers and future farmers, foresters, workers, teachers, trainers and agricultural advisors. Agrof-MM analyses existing educational systems and develops new innovative tools:

- A description of existing training procedures and an identification of needs;
- A census and evaluation of existing educational tools;
- The enrichment of the European book of professional reference for agroforestry farmers. Created in the framework of the preceding AgroFE project, the book of professional reference describes the tasks that the farmers and foresters who practice agroforestry must be able to achieve. It also serves to support the transferral of training;
- The design of the book of professional reference as well as the training systems;
- The production of educational material including multimedia tools;
- The practical validation of educational systems;
- The analysis and dissemination of the results obtained.

The knowledge database has been developed which will be used for tools and training resources and will also integrate with existing and future training resources. Collaborative and dissemination platforms were created such as an official web site, video-conference system, Facebook, mailing list and Moodle training portal for project document and as a LMS.

The knowledge databank is a component of the project training system. It aims to gather and share a set of documents, resources that partners can use and which will have been accessed by learners and the public users. The project focuses to the newest innovative ICT solutions and trends. The knowledge databank is to enable the sharing, access and consultation in the use of certain resources for training. These resources are under different forms: Mono document objects (such as a photo, a text, a diagram) and composite materials (for example a html web page with images, a pdf file with pictures and diagrams, a video clip with images and sounds etc.). The prototype of the AgroFE project is based on a software, RUBEDO[1], developed in PHP and RUBEDO is built on different components: a data base management software (DBMS-SGBD), type 'NoSQL', MongoDB, and the user interface uses the ElasticSearch search engine. The paper describes the knowledge databank system prototype and the used ICT tools in the project, such as LMS and the collaborative working environment. These tools have been used in both the AgroFe and the Agrof-MM project.

Practical training – field work (in Hungary at University of Debrecen)

Education in Agro-FE project is contained a field trip, which topic was NATURA2000 habitat mapping of agroforestry and salty grassland to using mobile GIS technology in practice in near Püspökladány, Hajdú-Bihar County, Hungary. During in the field trip, the participants visited three locations:

- In the first location, estimation of tree mass was determined by tree diameter and height. The tree height was measured by Leica DISTOTM D8 laser distance measurement. Finally, the estimation was made by DigiTerra Explorer (the tree volume estimation module), which is used tree volume estimation based on the Sopp-board; and it can be used field as well with GPS. In the first location *Quercus robu*r L., *Ulmus turkestanica* and *Fraxinus excelsior* were measured and the estimation module is required for valuation ten tree/species.
- In the second location were presented groundwater monitoring wells and ecological habitat assessments. The depth of ground water was measured and the precise positioning of monitoring wells were detected with mobile GIS tools. Furthermore the main soil type of the area were shown using soil profiles.

[1] http://www.rubedo-project.org/en/homepage/rubedo-dream-team

- In the third location was Ágota-pusza, which is part of Hortobágy National Park, and it is one of the four sample areas of ChangeHabitats2 project. This area is mainly characterised by salt affected soils, alkali grasslands, micro heterogeneous relief with isolated micro watershed. In this location was shown how can we combine the field measurement with mobile GIS tools. We used EMRC tools to detect the electrical conductivity values of this soils, and we combined it with mobile GIS tools (tablets) to detect the precise positioning of measurement points.

The University of Debrecen (DE) held professional day for AgroF-MM on 19 October 2016 in Tokaj-Tarcal. At the first location the participating farmers and future farmers heard presentations from the colleagues of the Vine and Wine Research Institute about the region, the erosion protection solutions and agroforestry/afforestation role in preventing erosion. Furthermore DE presented the AgroF-MM project. Briefly described its purpose, presented the operating principle and theoretical background of those instruments to students what they tested on terrain in the remainder parts of the practical day. On the second and third locations, colleagues presented their knowledge of terrain erosion protection. They demonstrated the current experiments and described the used erosion protection devices in practicing together with colleagues of DE. The following instruments were presented: Green Seeker, TETRACAM multispectral camera, Hexium type thermocamera. The farmers and future farmers can select the optimal areas of tree planting with the help of these instruments.

Discussion

Related to the objectives of the AgroFE project the following results can be highlighted:

- A collection of different resources was made based on the synthesis of needs and expectations of partners. This collection was used in developing new and existing training sessions;
- A professional book of references has been developed to support for transfers in training;
- The knowledge database has been developed which will be used for tools and training resources and which will also integrate existing resources in the future;
- Collaborative and dissemination platforms were created such as official website, videoconference system, Facebook, mailing list and Moodle for project document and as LMS.

In relation to the AgroFe-MM project objectives, the following results are highlighted:

- A collection of different resources was made based on the synthesis of needs and expectations by the partners. This collection was used in developing new and existing training sessions. A professional book of references was also developed to support the transfer of training curricula across different countries;

- The knowledge database has been developed which will be used for tools and training resources and will also integrate with existing and future training resources. Collaborative and dissemination platforms were created such as an official website, video-conference system, facebook, mailing list and Moodle training portal for project document and as a LMS.

The different ICT tools were integrated into a toolset, but they were used to separately too. The Moodle server was used as virtual collaboration space and e-learning system. The system was implemented on 09/01/2014. We created the initial structure for collaborative work and starting the e-learning courses. Within the AgroFE project (2014–2015) 217 users were registered (enrolled) in the system. From these, there are 155 enrolled students from different countries. The Vidyo videoconference systems was used for project virtual meeting, video conferencing, distance teaching and conference broadcasting. The Videotorium serves as repository for project videos. For supporting the quality assessment more questionnaires have been developed and the LimeSurvey was used for online survey and evaluation.

The proposal of professional referential (book of professional specifications) of the agroforester job in Europe has been developed. A professional referential describes what an agroforester must be able to do in the context of his/her professional activity. This document was produced by iterative and interactive contribution of partners AgroFE project and agroforestry stakeholders. The partners have established this common professional referential whose training declination is a solid and enforceable core, also called 'core content', which aims to prepare for the exercise of the profession of agroforester. The training will therefore be declined to operational aims, taking into account the diversity of possible contexts for the necessary adaptations, each project being aparticular case. The result of the work done by AgroFE partners and covers the professional practices of the partner countries, namely, from east to west, Romania, Hungary, Czech Republic, France, Belgium, and the UK. These proposals can be found in the public KDB.

Within the project, more training programmes were implemented assed on the knowledge transfer from the project. Summarising the results, it seems the subject was exciting for the students. Nowadays, in Hungary, agroforestry systems are not so popular, maybe one of the results of this project can be extending this system. The opinion of students on this system would be important. The term of content of this course was good and useful for the students and they evaluated to good and excellent the IT tools used in the course. Under the AgroFe-MM project, we are planning to extend the education to MSc level and transfer this agroforestry knowledge to mountain areas in Hungary, as one of the goals of this new project.

The developed collaborative environment which consisted of more subsystems served the project partners very well. The videoconference systems (desktop and the multimedia central unit) served the virtual meeting of project

partners and videoconferences efficiently in high quality. The live broadcasts on the Internet used for delivery the lecture to a wide audience (students, experts, farmers). The virtual meetings had been recorded on video. Because of the efficiency and quality of service, more project partners asked for permission to use these services in other projects. The LMS had been used as virtual collaborative space for project members and organising learning and training courses in different countries. Based on the quality assessment, the content and service also was of high quality. It gave possibilities for very efficient work for more than 200 participants in agroforestry. The knowledge database (knowledge data bank) is very new innovative solution for harvesting, storing and delivering contents in agroforestry. It was used in different training programmes with good feedback. The knowledge database will serve the AgrofMM partners in the coming years.

This education development project is unique in Europe. The Center for Agroforestry at the University of Missouri is one the centres contributing to the science underlying agroforestry, the science and practice of intensive land-use management combining trees and/or shrubs with crops and/or livestock. They give webinars and organise training, workshops but their training materials relate to their environments. In Europe we need to develop educational tools for European specialities.

Conclusion

Agroforestry will be important for rural areas and farms according to several aspects. Environmental, economic, agricultural production, rural living are very important issues. The project participants are involved in developing training curricula for different levels (L4/L5/L6). The latest version of the Moodle system has been implemented for collaborative space and we carried out more virtual meetings by the new videoconference systems, which have been tested and used many times. All the virtual meetings have been recorded in the Videotorium system. We are convinced that by using innovative technologies and solutions the system will help to achieve the project goals. Analysing the open source tools, we have created the architecture of the knowledge base and service system for harvesting materials, building knowledge base and information service, implement e-learning service in agroforestry. The KDB and service system will be finished this year. Finally, the Hungarian specialties in the projects, such as education, subject about agroforestry, conference and workshops and field trip in Püspökladány and Tokaj-Tarcal region are introduced.

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