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Agroforestry in Europe: A land management policy tool to combat climate change

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ABSTRACT

Agroforestry is an integrated land use management that combines a woody component with a lower story agricultural production recognized as one of the most important tools to mitigate and adapt to climate change. The objective of this paper is to provide a categorization and extent of agroforestry practices linked to agricultural and forest lands at regional level and evaluate how are they promoted by the previous (2007–2013) and current CAP (2014–2020) with a special focus on climate change mitigation potential. Agroforestry occupies almost 20 million hectares in Europe, being silvopasture and homegardens the most extensively spread practices and forest farming not quantified. Agroforestry practices are promoted at European level but in a really complex form as more than 25 measures are implemented to enhance the existing 5 agroforestry practices (silvopasture, silvoarable, riparian buffer strips, forest farming and homegardens). Simplification of the number of measures to promote agroforestry practices is needed to better follow up the implementation and to evaluate and provide future policies more adapted at European levels. Huge potential climate change mitigation options should be focused on the use of silvopasture on forest lands to reduce forest fires and to increase the presence of the woody component on arable lands (silvoarable) but also on the promotion of forest farming and homegardens as forms to increase the use of short supply chains and to increase the connection of urban, periurban and rural areas within a bioeconomy and circular economy framework.

1. Introduction

Agroforestry understood as the deliberateintegration of a woody component with a lower story agricultural production is been highlighted by the FAO (Buttoud, 2013) as one of the most powerful tools to mitigate and adapt to climate change all over the world. However, in spite of being quite extensively used in tropical countries, the extent of agroforestry in temperate areas is rather small as happens in Europe (den Herder et al. 2017) or the USA (USDA, 2011, 2013) due to the previous intensification of farming systems, as well as the lack of integration of forest and agricultural land and the absence of current adequate policies to promote agroforestry practices.

Agroforestry is a land use option associated to different land use covers such as those linked to forestry and agriculture (grasslands, arable lands and permanent crops) on which intensive farming has been promoted by the European Common Agrarian Policy (CAP) during the last century as happened for example in Germany (Niedertscheider et al., 2014). Intensification has caused an improvement of production based on the use of external inputs and losses of soil fertility but also created many environmental concerns and mostly soil degradation (Tsiafouli et al., 2015). On the contrary, agroforestry thanks to the woody component brings to the system an improvement of the use of the existing resources both at aerial and belowground level, linked the so called ecointensification. At aerial level, the increase of the

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photosynthetically active biomass (crop/pasture leaves + tree leaves) per hectare causes a better use of the sun radiation that can originate between the 20 and 80% more biomass production (Dupraz and Liagre, 2011). This increase of the biomass production can be associated with an improvement of the farmer productivity if adequate species are mixed, and at the same time increases the source of organic matter into the soil, the main reservoir (81%) of C in terrestrial ecosystems (Karsenty et al., 2003), therefore contributing to mitigate climate change. The heterogeneity caused by the presence of the woody component in agricultural lands creates patches that improves alpha biodiversity, but also originates modifications at landscape level therefore improving beta and gamma biodiversity. Adequate biodiversity management at landscape level is also a powerful tool to improve biomass productivity (Gross, 2016). At belowground level, the different depths of woody and herbaceous plant roots improve the re-utilization of the nutrients enhancing internal nutrient recycling and avoiding nutrient losses that causes many environmental concerns (Rigueiro et al., 2009).

The European CAP is one of the main drivers of the agricultural and forestry land use in Europe. Nevertheless it does not consider in depth the role that agroforestry has to play. A better approach aiming at agroforestry research feeding future CAP programs is needed (McNie et al., 2016) to provide more agricultural and forest sustainable systems. Former CAP has modified the way of farming in Europe, without supporting the preservation of the woody component in agricultural lands in its origins and brought negative impacts on environment. Moreover, CAP increased the amount of forest lands in Europe but without linking them to agricultural production. On one hand, CAP reduced the sustainability of agricultural lands and, on the other hand, CAP is not keen on fostering the agricultural use of afforested or reforested areas that are usually poorly managed as forest practices such as pruning or thinning are not usually carried out. The underuse of forest lands causes a reduction of the returns from these areas. In both types of land cover, agroforestry can be an extraordinary tool to improve sustainability and land use to deliver forest and agricultural products, which may be linked to the stabilization of rural population in Europe, one of the main social problems in European rural areas. Agroforestry can also be implemented in urban, periurban and rural areas when associated to homegardens. Homegardens are key to provide local and more sustainable healthy food reducing impact of agricultural activities on climate change (i.e. Slowfood movement or Km 0 strategy).

Fostering agroforestry in Europe through the CAP should be linked to the knowledge of the extent of agroforestry practices operating at plot level, the main scale on which CAP acts, but also considering national and regional level, as CAP is currently deployed in 118 different Rural Development programs at European level. In this regard, den Herder et al. (2017) made the first serious attempt to categorize the extent of agroforestry per country in Europe based on the use of LUCAS (Land Use/Cover Area frame Survey) and considering the previous definition of agroforestry in the CAP 2007–2013 framework (land use systems in which trees are grown in combination with agriculture on the same land) but not the new definition coming from the deployment of the Measure 8.2 of the Regulation 1305/2017 which defines agroforestry as a land use systems and practices where woody perennials are deliberately integrated with crops and/or animals on the same parcel of land management unit. The objective of this paper is to provide a categorization and extent of agroforestry practices linked to agricultural and forest lands at RDP-regional level and evaluate how are they promoted by the previous (2007–2013) and current CAP (2014–2020), with a special focus on climate change mitigation potential.

2. Methodology

Agroforestry practices are the form on which the woody component is combined with the lower storey crop at plot level. The agroforestry practices evaluated in this paper are those described in Table 1, which are comparable to those described by some temperate countries such as the United States (USDA, 2011, 2013) or Canada and Mexico as described the Agroforestry Temperate Association (AFTA, 2017). From those practices, silvopasture and silvoarable are the main agroforestry practices. However, practices such as homegardens and forest farming are considered for political reasons as there is a clear division between forest, urban and agricultural lands from a political funding point of view. Riparian buffer strips are also considered as another practice because of the importance of protecting continental waters and provision of environment benefits. For all of them we used “The Land Use/Cover Area frame Survey”, abbreviated as LUCAS. LUCAS is a European field survey program funded and executed by EUROSTAT. Its objective is to set up area frame surveys for the provision of coherent and harmonised statistics on land use and land cover in the European Union (EU). LUCAS includes data relative to landscape features included linear elements and isolates trees (EUROSTAT, 2013). EUROSTAT has the LUCAS survey micro-data collection of cover and land uses which is freely available on the LUCAS website (EUROSTAT, 2013). LUCAS survey has been carried out in 2009, 2012, and 2015. In this paper, we analysed the 2012 data, the year before that Croatia became the 28th EU member state, so the results are only referred to the EU27.

LUCAS is a two-phase sample survey. The first phase is a systematic sample with points spaced 2 km apart in the four cardinal directions covering the whole of the EU’s territory (around 1.1 million different points). Each point of the first phase sample was photo-interpreted and assigned to one of the following seven predefined land cover strata: arable land, permanent crops, grassland, wooded areas and shrubland, bareland, artificial lands, and water bodies.

In a second phase, a representative subset of 270,267 points was selected for the new field survey, based on the stratified information produced by a quasi-regular grid with a LUCAS sampling point on each 4-km block on average. However, points placed above 1500 m and away from the road network were considered inaccessible and therefore were not included. The 270,267 points selected for the second phase were visited in situ by the field inspectors in 2012.

LUCAS uses a double classification system for land covers with multiple layers, used only for specific landscapes, such as agroforestry and complex or heterogeneous area. For example, in agroforestry practices a woody vegetation layer is typically accompanied by a secondary layer composed of crops or grass. In such cases, LUCAS would enter the woody component (trees or shrubs) as the primary land cover (LC1) and crops, grass or bare soil as the secondary land cover (LC2) (see EUROSTAT, 2013 for more information). Another useful variable included in the LUCAS database is land management, which contains information if there are signs of grazing. By identifying certain combinations of primary and secondary land cover and land management it is possible to identify agroforestry points and stratify them into different agroforestry practices. To identify arable agroforestry systems the combinations of LC1 and LC2 must indicate intercropped permanent crops, woodlands or scrubland.

The agroforestry practices identification was based on the combination of two land covers which integrates a woody component (LC1) and an agricultural activity. The agricultural activity can be identified by the presence of crops (LC2) to quantify silvoarable or grassland as secondary cover (LC2) and the column “land management” pointing out signs of grazing to determine the area of silvopasture (Table 2). The presence of homegardens was marked by the land use fields (LU1 and LU2). To estimate the extent of agroforestry of silvoarable, silvopasture and homegardens in hectares with the aim to describe the agroforestry practices at RDP region level, we divided the number of points coded as agroforestry in each territory by the total number of LUCAS points in this territory and multiplied this by the surface of the territory.

A different approach was used to categorize hedgerows and riparian buffer strips. The quantification of hedgerows and riparian buffer strips (avenue trees, conifer strips, managed and unmanaged hedgerows close or not to inner waters) was based on the 270,267 points visited by