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The farming system component of European agricultural landscapes

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ABSTRACT

Agricultural landscapes are the outcome of combined natural and human factors over time. This paper explores the scope of perceiving the agricultural landscapes of the European Union (EU) as distinct patterns of farming systems and landscape elements in homogeneous biophysical and administrative endowments. The focus is on the farming systems component of the agricultural landscapes by applying a typology to the sample farms of the Farm Accountancy Data Network and scaling up the results to the landscape level for the territory of the EU. The farming system approach emphasises that agricultural landscapes evolve from the praxis of the farmers and takes into account the scale, intensity and specialisation of the agricultural production. From farming system design point of view, the approach can be used to integrate the landscape in the design process. From a policy point of view, the approach offers handles to implement policies that design agricultural landscapes by targeting the farming system pattern.

1. Introduction

Landscape is one of the public goods delivered by agriculture and thereby an important part of agricultural policies (European Commission, 2013). However, the changing farming context related to for example climate change, volatile prices, increasing food demand, means that farmers continuously have to adapt their farming systems and management practices (Martin et al., 2013). These changes again affect the delivery of public goods, including landscapes. How can landscapes be integrated in this process of adaptation and more specifically in farming system design?

Recently a new approach integrating agronomy and landscape ecology has been emerging. Landscape agronomy aims to integrate the two disciplines from the idea that research on agricultural landscapes should include both the influence of landscape on farming practices and the role of the farmer as actor shaping the landscape (Benoît et al., 2012). For more applied ends Rizzo et al., 2013 suggested improving the farming system design process by adding a landscape approach. However, the concept of landscape is frequently used with very vague definitions if any.

Over the last decades, agricultural landscapes were defined in different contexts. Meeus (1995)p. 58 suggested a fundamental definition of cultural landscapes as: "...recognisable parts of the surface of the earth, which have a characteristic composition, structure and scenery.". Meeus further added that the degree of anthropogenic influence determines the landscape types. Wascher (2000)p. 17 elaborated further on this, again stressing the duality of natural and cultural features: "Landscapes are the concrete and characteristic products of the interaction between human societies and culture with the natural environment.". The European Landscape Convention confirms this duality defining the landscape as: "...an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors." (Council of Europe, 2000). More specifically the Organisation for Economic Co-operation and Development OECD has defined agricultural landscapes as "...the visible outcomes resulting from the interaction between agricultural commodity production, natural resources and the environment..." (OECD, 2001, p. 368). Finally, many studies refer to the agricultural landscape as a spatial scale above the field, farm or local level rather than an area unit that can be mapped and quantified (Prager et al., 2012).

Within the discipline of Agronomy, it has been argued that the agronomic domain is under a rapid enlargement into the landscape to integrate non-productive landscape elements such as buffer strips in the process of designing cropping systems and in identifying trade-offs between various services in landscape simulations (Wery and Langeveld, 2010). However, looking at the 59 contributions in European Journal of Agronomy using the term landscape since the publication of the paper by Wery and Langeveld, this has not led to a more precise definition of agricultural landscapes (Table 1). The term landscape is in more than half of the cases used solely to refer to a spatial scale above the farm level or a particular area or space in which something is located. A few refer to landscape as a visual phenomenon or to the non-farmed landscape features such as hedgerows, buffer strips or semi-natural areas, and

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Table 1
Results of search for the term 'landscape' in European Journal of Agronomy vol. 32, no. 2, 2010 to vol. 78, 2016 (1).

Use of the term 'Landscape'	No. of papers
Spatial level/unit	31
Specific landscape	4
Visual feature	1
Ecosystem service/function	4
Non-farmed features	3
Heterogeneous structure	12
Farming/cropping systems	4
Total	59

The search was performed on http://www.sciencedirect.com July 7th 2016. 22 of 81 initial search hits only use the term landscape in references or in author credentials. These are not included in the table.

a few refer to landscape as a function or an ecosystem service. 12 papers refer to landscapes as heterogeneous spaces using terms like fragmentation, position etc. Only four papers link the concepts of cropping and farming system and landscape. This is, for example, the case for Doré et al. (2011) reviewing issues related to ecological intensification of agro-ecosystems; Spiertz, (2012) linking cropping systems and landscapes conceptually; Sausse et al. (2012) analysing gene flows at landscape level; Deytieux et al. (2012) examining the environmental impact of weed management arguing that the spatial distribution of cropping systems at the landscape level has to be taken into account.

Within the discipline of landscape ecology, the majority of studies of biodiversity in agricultural landscapes have a focus entirely on the natural and semi-natural habitats and features and not on the farmed areas. The habitat focus stems from a binary perception within the discipline dividing agricultural landscapes in a habitat/matrix structure, where the natural and semi-natural habitats support biodiversity and the farmland matrix is seen as a hostile environment (Fahrig et al., 2011). Examples of studies focusing on or including the farmed area are studies on organic farming (for example Holzschuh et al., 2010), on field size (for example Fahrig et al., 2015) or crop cover types (for example Benton et al., 2003). Recent studies explicitly address the lack of focus on the farmed area when dealing with biodiversity at the landscape level. However, most of these studies restrict themselves to look at the diversity of crops. This is, for example, the case in Bertrand et al. (2016) which conclude that both spatial and temporal heterogeneity of the crop mosaic may have an impact on carabid beetles using simple and general metrics to describe the crop mosaic. Vasseur et al. (2013) elaborate on this by advocating for looking at the cropping system pattern rather than solely on the crop mosaic. The concept of cropping systems is not concisely defined in the paper, but can loosely be understood as the spatio-temporal organisation of farming practices. By including the farming practices, Vasseur et al. change the perspective from solely land cover (i.e. crops) to land use (i.e. tillage, fertilization, etc.), but still maintain the focus on cropping and not on the entire farming system. Other studies have included the farmed area by focussing on the intensity of farming based on data from agricultural statistics (Reidsma et al., 2006; Teillard et al., 2016). The first study provides insight in the relation between farm types, intensity of farming and biodiversity by calculating ecosystem quality based on farm level data, but does not specifically address the landscape level.

The term farming system is also often used without stringent definitions. Some authors argue that the term should be used to indicate a way or thinking (Darnhofer et al., 2012) or is highly depending on scale of application (Giller, 2013). Giller (2013); acknowledging that it is not good solution, suggests that farming systems are defined as ".a population of individual farm systems that may have widely different resource bases, enterprise patterns, household livelihoods and constrains" (Giller, 2013 p. 151). In this paper the term farming system is used to highlight that ultimately a 'soft' understanding of systems, including economic, technological, environmental and social aspects, is needed to fully understand the agricultural landscapes. However, working at the European level data availability limits the inclusion of especially social aspects. The 'hard' quantitative representation of farming systems and agricultural landscapes applied in the analyses must not be seen as an attempt to reach one generic method, but as a necessary trade of given current options to include information (see Discussion in Darnhofer et al., 2012).

The objective of this paper is to ensure that the landscape is integrated in the process of agricultural change and into farming system design by: (1) suggesting a new concept of agricultural landscapes for application in farming systems design at the landscape level; (2) defining a state equation of agricultural landscapes; (3) operationalising the farming system component in a method for mapping and quantification of European agricultural landscapes based on the spatial pattern of farming systems; (4) suggesting spatial indicators for the farming system component of agricultural landscapes and (5) discussing the scope of applying the concept and the quantitative method in farming system design.

The aspiration of the work presented in the paper is primarily to advocate for a new understanding of the agricultural landscapes taking into account the farming systems component. The paper also demonstrates how the understanding can be operationalized, but this must not be seen as an attempt to reach a generic method. For applications in farming systems design the landscape concept should be generic, but the method in terms of typologies, data use, scale etc. can be different for the specific applications.

2. Materials and methods

The starting point of the analyses is to detail the information on the agricultural factor of the landscape based on data using recent advances in science linking statistical data on agriculture to the bio-physical endowment. The quantitative approach uses statistics on farms and farm characteristics from the Farm Accountancy Data Network–FADN (European Commission, 2015) to identify and describe the agricultural landscapes of the EU.

In this paper, an agricultural landscape is conceptually understood as a distinct pattern of farming systems and landscape elements in a homogeneous biophysical and administrative endowment. To facilitate the understanding of the concept and to lay the foundation for the quantitative analyses the concept can be expressed in a state equation: An agricultural landscape = f(C(t), R(t), S(t), FS(t), STR(t)). Where C is climate, R is the administrative region, S the soils, FS the farming systems, STR the landscape elements and (t) the time. The order of the factors does not necessarily reflect the importance in relation to agricultural landscapes. However, it reflects the scale at which the different factors play the major role in forming the landscapes. Climate sets the overall conditions for farming at the highest scale; administrative regions depict equal legal and marked conditions for farming at the second highest level; soil conditions provide the most detailed local conditions for farming; within and across soil conditions the pattern of farming systems varies and, within farming systems the landscape structure (hedges, ponds and other landscape elements like nature areas, buildings, urban areas etc.) is unequally distributed spatially. The results presented in this paper uses a spatial framework from previous work taking into consideration climate, soil and administrative regions. In addition, the farming system component is developed, mapped and analysed. Data on the landscape elements are not readily available across the territory of the European Union and are not included in the analysis. Though the time dimension provides important information to understand not only

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