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Analysis

A Spatially Explicit Choice Model to Assess the Impact of Conservation Policy on High Nature Value Farming Systems

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ABSTRACT

High Nature Value (HNV) farmland is declining in the EU, with negative consequences for biodiversity conservation. Agri-environment schemes implemented under the Common Agricultural Policy have addressed this problem, with recent proposals advocating direct support to HNV farming systems. However, research is lacking on the economics of HNV farming, which makes it difficult to set the level and type of support that ensure its sustainability. In this paper, we focused on a Special Protection Area for steppe bird conservation, analysing how economic incentives, biophysical and structural features govern the choice of farming system. We found that persistence of the traditional farming system important for steppe birds was associated with economic incentives, resistance to change, and good quality soils, whereas a shift to specialised livestock production systems was favoured by higher rainfall and less fragmented farms. A supply curve built using the choice model predicted that the proportion of traditional farming increased from 20% to 80% of the landscape, when economic incentives increased from about 100€/ha to 160€/ha. Overall, our study highlights the dependence of HNV farming systems on economic incentives, and provides a framework to assess the effects of alternative policy and market scenarios to sustain farmland landscapes promoting biodiversity conservation.

1. Introduction

The concept of High Nature Value (HNV) farmland was introduced in the early 1990s to demonstrate the dependence of European biodiversity on traditional and low-input farming systems (Beaufoy et al., 1994). Despite their importance, HNV farmland is declining due to social, economic and policy pressures for either agricultural intensification or land abandonment (Oppermann and Paracchini, 2012). This is compromising the objectives established under the European Union (EU) Biodiversity Strategy to 2020 (European Commission, 2011), and it reveals a failure of the Common Agricultural Policy (CAP) to safeguard farmland biodiversity (Henle et al., 2008; Pe'er et al., 2014).

To improve the support for HNV farmland under the CAP, a recent report for the European Commission suggested an approach based on payments to farms in HNV farmland or operating HNV farming systems (Keenleyside et al., 2014a). There are, however, major operational challenges related to lack of data or indicators to identify HNV farmland or farming systems (Keenleyside et al., 2014a), as well as limited research on economic aspects of HNV farming needed to establish the level and type of funding necessary for its sustainability (Keenleyside et al., 2014a). Indeed, most studies carried out so far aimed at estimating the costs for farmers to participate in agri-environment schemes (AES) (Oñate et al., 2007; Bamière et al., 2011; Wätzold et al., 2016), or to assess farmer's willingness to accept a compensatory payment for management options benefiting the environment (Buckley et al., 2012; Ruto and Garrod, 2009). These studies typically rely on survey data from hypothetical choice experiment designs, or use models to estimate the costs of farm management or land-use changes to comply with policy regulations. In both cases, stated-preference or *ex-ante* assessments are usually applied, confirming a lack of studies using revealed preference approaches relying on observed *ex-post* behavioural data. Other recent works advocate results-based payments, as an alternative to management-based schemes, for farmland biodiversity conservation

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in HNV farmland (Keenleyside et al., 2014b). However, the payment calculations are still based on the same principles set out in the EU Regulations, which provide compensations for additional costs or income foregone resulting from the commitments made, including a possible additional to cover for transaction costs (Article 28(6) of Regulation (EU) No 1305/2013).

The potential of farming systems as a basis for developing agri-environment policy has been suggested (Beaufoy and Marsden, 2011; Poux, 2013; Ribeiro et al., 2016a), supported by studies evidencing links between farming systems and landscape features or farming practices of conservation relevance (Bamière et al., 2011; Ribeiro et al., 2016a, 2016b). This farming system approach represents a significant departure from current agri-environment schemes, which are based on specific management requirements and imply significant transaction costs (Mettepenningen et al., 2011; McCann, 2013; Pannell et al., 2013). This approach could be implemented, for instance, using the concept of greening the Pillar 1 of the CAP by granting a top-up payment to farmers operating farming systems associated with HNV farmland in a specific region (Ribeiro et al., 2016a). This would require identifying these HNV farming systems for different regions across the EU, and calculating the payment level required to ensure sufficient uptake by farmers. Although the underlying idea of an agri-environment policy aimed at supporting HNV farming systems may sound interesting, however, the factors driving the farmer's decision in choosing the farming system are not well understood, nor is the role that economic incentives provided by policies play in that decision.

Here, we developed a case study on a HNV farmland of extensive cereal-steppes in southern Portugal, where previous research has shown that a range of bird species of conservation concern are associated with a traditional farming system involving rotational cereal cultivation and sheep pasturing of fallows (Delgado and Moreira, 2000; Leitão et al., 2010; Moreira, 1999; Moreira et al., 2004, 2007, 2012a, 2012b). In previous studies we have demonstrated a strong dynamics of farming systems in this area in response to the CAP reform of 2003 (Ribeiro et al., 2014), which may have affected landscape patterns (Ribeiro et al., 2016b) and agricultural practices relevant for biodiversity conservation (Ribeiro et al., 2016a). In this new study, we use the same setting to model the economic rational of farming system changes, aiming at: 1) investigating the factors that influence farmer's choice of farming system, subject to biophysical, structural, policy and economic drivers and constraints; and 2) developing a framework to simulate, on a spatially explicit basis, the effects of different policy and market scenarios on HNV farmland. Results were then used to evaluate the potential of our framework to outline empirical supply curves for conservation services (Santos et al., 2008; Lewis and Wu, 2014), relating levels of payment per hectare paid to farmers operating HNV farming systems with the amount of farmland managed under such systems.

2. Methods

2.1. Study Area

The study focused on an extensive HNV farmland area in the south of Portugal, covering ca. 180,000 ha (Fig. 1). The area is characterized by open fields, smooth relief, and typical Mediterranean climate, with hot dry summers and moderately rainy cold winters. It encompasses the Special Protection Area (SPA) of Castro Verde, classified under the EU Directive 79/409/CEE (Birds Directive) to protect several steppe bird species of conservation concern. Studies carried out during the past 20 years suggest that conservation of these steppe birds requires the maintenance of an extensive traditional farming system based on rainfed cereal crops in rotation with long-term fallows grazed by sheep, which dominated the landscape for decades (Moreira, 1999; Delgado and Moreira, 2000; Leitão et al., 2010; Reino et al., 2010; Moreira et al., 2004, 2007, 2012a, 2012b; Santana et al., 2014, 2017). To support this traditional farming system, an AES is operating since 1995, though with limited success for preventing land use changes (Ribeiro et al., 2014) and protect bird diversity (Santana et al., 2014).

Recent studies have shown a shift from the traditional to livestock-grazing specialized farming systems in the area, despite de AES, possibly resulting from the decoupling of direct payments following the 2003 CAP reform, related with the Portuguese authorities' decision to keep a direct payment on suckler cows, goats and sheep (Ribeiro et al., 2014). These changes have affected landscape patterns (Ribeiro et al., 2016b) and agricultural practices (Ribeiro et al., 2016a), but their effects on biodiversity are still poorly understood. In at least some cases, however, changes are likely to be negative, including for instance the anticipation of the cereals harvesting date under the livestock system, which is judged to increase the destruction of bird nests (Ribeiro et al., 2016a). Another problem may be the loss of the rich traditional landscape mosaic represented by cereal fields, ploughed fields, and fallows of different ages and grazing intensity, which likely reduces habitat diversity for birds (Oñate et al., 2007; Delgado and Moreira, 2000; Leitão et al., 2010; Reino et al., 2010; Moreira et al., 2012a; Santana et al., 2017).

2.2. Farming Systems Identification

The dominant farming systems in the study area and their spatial dynamics during 2000 and 2010 were assessed by a cluster analysis performed on farm-level data from the EU Integrated Administration and Control System (IACS), together with spatially explicit farm-parcel data from the EU Land Parcel Identification System (LPIS). Such data has been recommended for HNV farmland research (Beaufoy and Marsden, 2011; Beaufoy et al., 2012; Keenleyside et al., 2014a), and it was successfully tested in previous studies (Ribeiro et al., 2014, 2016b). Five farming systems were identified, including two livestock specialized systems (the Cattle and Sheep systems), two systems specialized in crop production (the Annual crops and the Permanent crops systems), and a mixed farming system (the Traditional system) (details in Annex A in Supplementary Information). Due to its land use pattern, dominated by a low-intensity cereal-fallow rotation, complemented with low-density sheep grazing, this Traditional system was acknowledged as the main farming system underpinning the HNV of the study area. Each farm in each year was assigned to one of these five farming systems, thereby providing information to assess transitions over time.

2.3. Drivers and Constraints of Farming System Choice

Each farm was characterized using biophysical (soil quality, terrain slope and average annual rainfall) and structural features (farm size, farm spatial fragmentation and oak woodlands) (details in Annex B of the Supplementary Information), expected to influence farming system choice (Keenleyside et al., 2014b; Ribeiro et al., 2014). These variables varied spatially but were largely constant over time within the study period.

To capture the effects of policy and market drivers on farmer decisions, we used the gross income ratio to compare the economic profitability of the farming systems. This indicator was used because there was no time-series on detailed farm-level production costs to compute gross margins. We believe this is acceptable, since many of these farms have their own means of production (workers and equipment), which are fixed costs largely independent of the activities in which they are used, and not subject to significant fluctuations during the 10-year time span of our study. Farm management decisions were thus expected to be mostly driven by temporal variation in gross income from sales revenues and direct subsidies. The gross income ratio for each farming system in each study year t (GIR^t) was defined as:

$$GIR^t = GI^t_{RFS}/GI^t_{AFS}$$