Impacts of farmers' management styles on income and labour under alternative extensive land use scenarios

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ABSTRACT

High Nature Value farming systems cover a large proportion of the agricultural land in marginal and mountain areas of Europe. These large areas face environmental, economic and social challenges and formulating policies that support all these aspects is difficult. Although farmers play an important role in maintaining the ecological diversity of these areas, their differing management styles are often not recognised when land use policies are formulated. This paper examines these issues using an optimisation model based on an extensive livestock farm in Western Scotland, where four farmers' management styles are combined with a series of six alternative future land use scenarios, to provide a more realistic and robust insight of policy impacts on land use and habitat, labour and farm income. The management styles derived from a typology that was based on a composite of both available resources and attitudinal components. The six alternative scenarios encompassed competitive land use diversification options (woodland and wild deer shooting), abandonment of native pasture for agriculture, no support, high market prices for livestock products, and increased animal efficiency. Although diversification via forestry was found to be potentially central to increasing farming incomes, farmers' reticence to adopt forestry or any diversification was a major constraint. This case study also reinforced that managing livestock on these HNV farming systems was not economical unless support subsidies were in place. The only scenario which could enhance the HNV biodiversity value on farms was one with high market prices, resulting in the most varied land use (sheep, cattle and forestry). All others scenarios meant an increase in afforestation (which displaced livestock), an increase in livestock grazing or abandonment of the land, none of which would maintain biodiversity in these areas. Very few scenarios were able to increase on-farm labour demand and although greater flexibility in farm labour was found to be essential, labour scarcity in these marginal mountain areas remained a problem. In conclusion, this case study reinforced that farmers' management style and motivation do play a major role on how they respond to policies, and unless this role is acknowledged by policy-makers, these European HNV areas may not be targeted properly for the most desired outcomes and sustainability.

1. Introduction

In Europe, 57% of the agricultural land is classed as Less Favoured Areas (LFA) under European legislation (LFA—Article 2 of EU Council Directive No. 75/268/EEC). This territorial designation reflects the natural handicaps, such as poor climate, short growing seasons, mountainous or hilly topography, tendency towards depopulation, all of which constrain productivity and economic prosperity. As a result, farming in these marginal lands has often been challenging (MacDonald et al., 2000), as the main production systems are often livestock-based in extensive settings, with little opportunity for adaptation or adjustment. Any change in land use policies can have important repercussions and create uncertainty (Acs et al., 2010; Baldock et al., 1996; Cocca et al., 2012).

Moreover, the High Nature Value (HNV) farming system concept recognises that many European habitats and landscapes considered to be of high nature conservation value are intimately associated with the continuation of specific low-intensity farming systems (Bignal and McCracken, 2000). Although some HNV farming systems occur in association with traditional cropping systems in southern Europe, in general the majority of Europe's remaining HNV farming systems are now largely associated with livestock grazing systems on semi-natural habitats in the mountains and other remote areas of Europe (Bignal and McCracken, 2009). Ensuring the maintenance of the farmland biodiversity value associated with such areas therefore depends on ensuring the continuation of appropriate farming systems in those areas. This...
requires an understanding not only of how the different elements of HNV farming systems interact to maintain the high nature conservation habitats and species of interest, but also of how HNV farming systems and practices are influenced by changes in agricultural support policies. Formulating policies for these HNV farming systems and areas becomes challenging and can lead to conflicts (Morgan-Davies et al., 2006, Morgan-Davies and Waterhouse, 2010).

Land use policies are also a key driver of change in such marginal areas, and following the announcement of the latest agricultural reforms, studies have been conducted in Europe to determine how these could affect farming (e.g. Acq et al., 2010; Matthews et al., 2013; Oñate et al., 2007; Vevyset et al., 2014). Most of these studies used simulation models to investigate the likely outcomes under a series of scenarios (e.g. Hanley et al., 2012). Whole-farm computer models can certainly help assess implications of any change to the farming systems studied (Pannell, 1996). Whilst simulation models can be valuable and have been widely used (e.g. Villalba et al., 2006, 2010, on mountain beef systems; Moore et al., 1997, on Australian grazing enterprises; Milne and Sibbald, 1998, for grazing systems; Villalba et al., 2015, for sheep systems), optimisation models can offer an insightful alternative viewpoint. One of the advantages of using an optimisation farm model is that many activities can be considered simultaneously and the effects of changing parameters can be easily assessed (Janssen and van Ittersum, 2007). An optimisation model can also use a combination of existing models outputs to inform and predict likely outcomes.

As well as being fragile in the broadest sense, these European HNV mountain farming systems are also diverse, and the concept of rural diversity is now increasingly recognised (e.g. van Eupen et al., 2012) and accepted. This diversity is apparent not only amongst and within the HNV farming systems, but is also evident within the farmers themselves. For instance, as shown by O’Rourke et al. (2012) in Southwest Ireland and by Morgan-Davies et al. (2012) in Western Scotland, extensive farmers are not a homogenous group, neither in their farming practices nor in their views and their management styles. Janssen and van Ittersum (2007) demonstrated the usefulness of “so-called” farming styles to distinguish groups of farms with different strategies. Farmers’ views, attitudes and goals play a very important role in the day to day management of their business (Brod et al. 2006; Fairweather and Keating, 1994; Girard et al., 2008), and incorporating their motivations into economic models would be useful (Howley et al., 2015). Morgan-Davies et al. (2012) underlined the importance of mountain farmers’ motivations and constraints in their responses to policy reforms, as well as the effectiveness of a typology approach based on farmers’ opinions and motivations, rather than government census farm types. Likewise, Morgan-Davies et al. (2014) suggested that mountain beef farmers appear to not only adapt their production systems according to their current bio-physical and financial circumstances, but also from personal experience.

However, policy-makers do not often take into account these differing farmers’ motivations when introducing new policies, leading potentially to unexpected outcomes (Dumont et al., 2014). There is perhaps in policy-making circles a narrow vision of farmers’ potential behaviour and reactions, which does not necessarily acknowledge farmers’ wider motivations. However, the need to acknowledge the attitude and behaviour differences amongst farmers when devising land use policies has been stressed (Viali et al., 2011; Wilson et al., 2013). Past studies (Battershill and Gilg, 1997; Harrison et al., 1998) showed that farmers’ attitudinal dispositions and personal values are often more important than any financial motivations in their farm decision-making.

Scotland is an example of a country in Europe with a large proportion of marginal land and HNV farming systems. Rural areas occupy 94% of the land mass (Scottish Government, 2012), agriculture dominates land use (72% of the land cover) and 86% of agricultural land is classified as LFA. Despite the preponderance of these marginal lands in Scotland, relatively few recent studies on the impacts of land use policies on farms in these areas are available in the published literature and even fewer studies (e.g. Matthews et al., 2013; Osgathorpe et al., 2011) have used models to investigate their likely futures. No research has been done on how these impacts were influenced by farmers’ management styles. In this context, it would be unique to model at farm level the likely effects of alternative land use policy scenarios on Scotland’s marginal areas, superimposed on the different styles of farmers’ management.

The aim of this paper is therefore to investigate whether modelling alternative future scenarios coupled with different farmers’ management styles and motivations provides a more realistic and robust insight of policy impacts on land use, farm income and labour employment.

2. Methods

2.1. Overview

This paper investigated the effects of different farmers’ management styles on land use, labour employment and farm income in a series of alternative land use scenarios, using an optimisation model. The model (described in further detail by Morgan-Davies, 2014) is based on linear programming that uses information from an existing computer program (Armstrong et al., 1997a, 1997b) to estimate vegetation energy production, nutrition equations (AFRC, 1993) to predict animal energy requirements and then creates an optimisation model based on a Scottish extensive livestock farm case study to link these energy estimates, as well as labour requirements and financial information, in a series of competing productive outputs.

The general structure of the linear programming model was:

Maximize $Z = c_1x_1 + c_2x_2 + \ldots + c_nx_n$

Subject to $b_j \geq a_{1j}x_1 + a_{2j}x_2 + \ldots + a_{nj}x_n$

$\delta_{m} \geq \alpha_{m1}x_1 + \alpha_{m2}x_2 + \ldots + \alpha_{mn}x_n$

and $x_1 \geq 0, \ x_2 \geq 0, \ldots, x_n \geq 0$

where $Z$ was the margin at farm level; $x_i$ was the level of the $i$th activity; $c_i$ was the margin or costs per unit of activities, $a_{ij}$ was the matrix of technical coefficient; $b_j$ was the supply of the $j$th resource or constraint (Pannell, 1996).

A procedure was used to provide input parameters and adjust outcome values associated with the optimisation model. In this instance, energy requirements by livestock at different times of the year were used as the primary connections between animal enterprises and land use. Established computer programs were employed to estimate the energy production of different areas of vegetation (Armstrong et al., 1997a, 1997b) and to calculate animal energy requirements throughout the year (AFRC, 1993). Local values of parameters relating to animal performance, labour requirements, fertiliser application as well as market values of animal sales and input costs were estimated (SAC, 2010). Adjustments needed to be made to the resulting overall objective function to take into account those costs and benefits which do not exhibit linear relationships with the scale of activity. Consequently, to calculate the impact on the farm’s overall estimated trading margins, items such as the farm’s fixed costs, Single Farm Payment (SFP) and Less Favoured Area Support Scheme (LFASS) receipts were included subsequent to running the LP model.

The model had been created around a single parameterised extensive livestock HNV farming system, so that constraints and parameters could be accurately defined, since vegetation data, animal production data, and labour and economic data were easily available. The farm in the model had an area of 2200 ha and was divided into three different simple types of land, as are most extensive mountain farms in Scotland; improved pasture (232 ha), fertilised annually, with potential for silage and hay making; hillpark land (486 ha), non-fertilised fenced-off permanent pasture of lower energetic quality than the improved pasture; hill land (1482 ha), unfenced semi-natural
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