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AGRICULTURAL AND RURAL DEVELOPMENT AND INTERNATIONAL VIEW

AGRÁR- ÉS VIDÉKFEJLESZTÉS, NEMZETKÖZI KITEKINTÉS

IMPACTS OF POLICY REFORM ON HILL FARM INCOMES IN UK

ÁCS, SZVETLÁNA – DALLIMER, MARTIN – HANLEY, NICK – ARMSWORTH, PAUL

Abstract

Hill farming in UK is experiencing very difficult economic circumstances and many farmers rely on subsidies provided by the government for a large fraction of their income. The Peak District National Park is used as a case study to examine how farmers might respond to current policy changes – in particular, the move from area- and headage-based payments to the Single Farm Payment. The objective of this paper is thus to develop production models that predict how farmers will respond to changing policy framework conditions. For this purpose socio-economic surveys were carried out on 44 sample farms. Based on these surveys six representative farm linear programming models was developed, which represent typical farm types in the uplands in the Peak District. These models are used to calculate the effect of different policies, carried out under CAP reform, on incomes, land use and the intensity of production. In this study the focus is on typical sheep and beef farm type, the most common in this region.

Keywords: changes in subsidies, risk, survey, farmers' reaction

Introduction

The uplands are nationally and internationally important for biodiversity as well as being of significant landscape, archaeological, recreational, heritage, and natural resource value. In much of Europe, agricultural activity has largely shaped the upland landscape, and without some form of management these areas could lose much of their valuable biodiversity. Governments in many countries in the EU are increasingly recognising these values, and incorporating them into rural development policies.

The Common Agricultural Policy (CAP) is the most visible and expensive land use policy within the EU. In the early 1990s, it was recognised by the Commission that, production-based (headage) payments under the CAP had provided an incentive for farmers to keep high numbers of animals and that some farmers in receipt of these payments were damaging natural and semi-natural vegetation through overgrazing. Problems of surplus accumulation and trade interventions were also important factors for reform of the CAP (HM Treasury & Defra 2005). The CAP has undergone a series of significant reforms, most recently those of Agenda 2000 (1999) and the Mid Term Review (June 2003 and April 2004). These reforms are bringing about a phasing out of production-linked support and protection, and a re-targeting of measures on non-market and environmental outcomes. In 2005 eleven direct payments were replaced by the Single Farm Payment (SFP), which is not linked to the production of the farm. SFP is planed to be progressively reduced and phased out (HM Treasury & Defra 2005).

In the UK uplands play a key role in supporting habitats and species of conservation concern (Ratcliffe & Thompson 1988, Rodwell 1991, UK BAP 2004). Despite their ecological value, large areas of upland habitat deteriorated throughout the last century (Anderson & Yalden 1981, Tudor & Mackey 1995), due in part to the steady intensification of hill farming (Anderson & Yalden 1981). English Nature recently found that two thirds of the most

valuable moorland areas in England are now in an unfavourable condition with historical and current overgrazing by sheep presenting the most common threat (English Nature 2005).

In this study the aim is to investigate how decoupling (2003 CAP reform) affects farmer's income and land use in the uplands. Different policy scenarios are analysed and compared by using a linear programming model for typical farm types in the uplands in UK.

LP models have frequently been used for policy analyses. Several studies were found using previous CAP reforms at farm level in different European countries (Donaldson et al. 1995; Pacini et al. 2004; Veysset et al. 2005). A few scientific studies were found that analysing 2003 CAP reform at farm level in Europe (Offermann et al 2005, Breen et al. 2005) and none of them were focusing on the upland area. With this study we try to fill this gap by developing and applying the model to average farm types in the upland of the Peak District National Park, in UK.

Methods

Socio-economic farm survey

The purpose of this survey was to investigate how land is managed on hill farms in the Peak District, and to provide inputs to the linear programming (LP) models. The survey was designed and carried out with the help of experienced agricultural surveyors from the University of Nottingham through the winter months of 2006/2007. It included 44 farm visits. Farms were chosen on the basis of their location and their access to moorland grazing (livestock farms in two km from the moorland line). The survey included questions on land area and land types (moorland and in-bye), land use (grazing, fodder and crop), production activities on the farm and subsidy payments received during the reference period of 2006.

From the survey, four types of farms can be distinguished in the case study area based on their dominant production activities: sheep & beef, sheep & dairy, sheep only and beef only.

Concerning land types, 70 % of the total surveyed area (24 000 ha) is covered by moorland, 30% by in-bye land type, which includes permanent pasture, rough grazing, rough pasture, temporary grassland and traditional hay meadow. 85% of the in-bye land types are occupied by permanent pasture.

The survey showed that most of the farmers get Single Farm Payment and Hill Farm Allowance (HFA) and many of them participating in different Agri-Environmental Schemes (AESs), such as Environmental Sensitive Area (ESA) and Countryside Stewardship Schemes (CSS), which are currently getting replaced by the new Environmental Stewardship Schemes such as Entry Level Stewardship (ELS) and Higher Level Stewardship (HLS) schemes (Figure 1.).

The technical and economic data from the survey was used to parameterise the linear programming farm models. Based on the survey results, the most typical sheep & beef farm is taken as an example to show the effect of subsidy changes based on CAP reform. The effect of the payment on farm management, land use, livestock density and income is analysed in more detail.

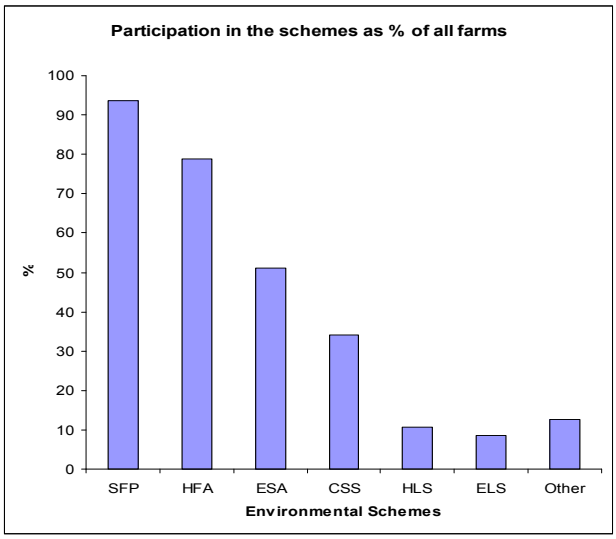

Figure 1. Participation in different schemes as a % of all farms in the survey

Farm models

General structure

The general structure of the models is shown in Table 1 and has the mathematical form of the standard linear programming model (Hazell & Norton, 1986):

Maximise {Z $c'x$}
Subject to A$x \leq b$
and $x \geq 0$
where:
Z = gross margin at farm level
x = vector of activities
c = vector of gross margins or costs per unit of activity
A = matrix of technical coefficients
b = vector of right hand side values

The group of activities are shown at the top of the Table 1 under twelve headings: activities for different land types, production activities representing several fodder crops and animal production systems, seasonal labour, purchase of fertilizer and feed and activities for sold animal products and subsidy payments. The rows of the matrix indicate the type and form of the constraints included: land availability, supply and demand of fixed and seasonal labour, feeding and housing requirements for sheep and cattle, fertilizing requirements per land type, constraints on organic manure use in Nitrate Vulnerable Zone and constraints on subsidies for headage and Single Farm Payment based on production and land type, respectively. The objective function of the LP model is to maximise the gross margin, i.e. total returns from animal production and subsidy payments minus variable costs, including variable operations, fertilizer and seasonal labour. The output of the model includes the corresponding optimal production plan with optimal land use, labour use and fertilizer application. To get the optimal solution for the LP models, the CONOPT solver was used in GAMS (General Algebraic Modelling System) programming language.

Data used

Farm and land types
According to the survey results of the 44 farms in the Peak District 6 types of typical farms can be distinguished depending whether a part of the farm has moorland coverage or not (Figure 2.)

The surveyed farms are characterized by farms 75 % of which on average range from 50 to 500 ha and 25% from 500 to 3000 ha. The average farm size also differs according to the farm types (Figure 2).

For our analysis the average sheep & beef type of farm, representing more than 25% of total farm types in the area, is used for illustrative modelling purposes, assuming a total area of 1070 ha, 86% of which is moorland and 14% is in-bye land. In-bye land is represented by permanent pasture, which is the most common in-bye land type for this farm type.

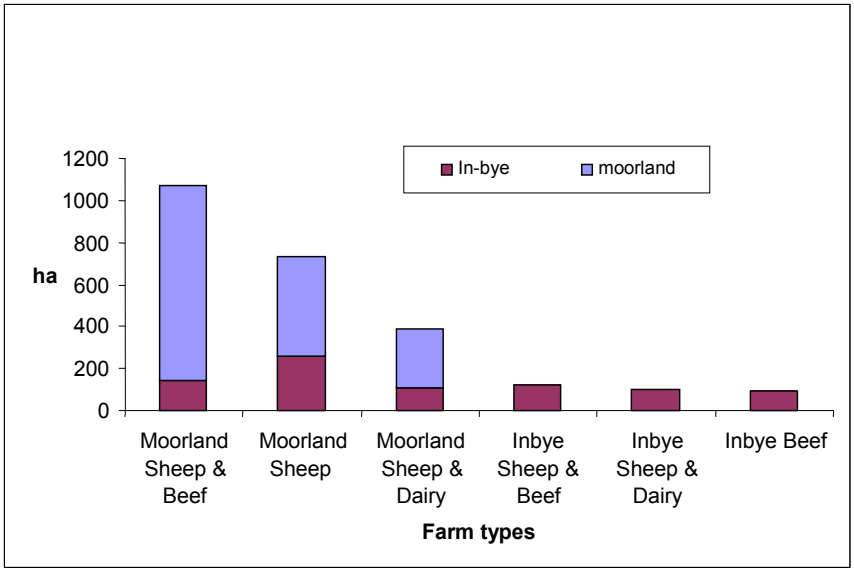

Figure 2. Average farm sizes for different farm types

Animal production
The central element in the LP model is animal production with two types of livestock: sheep and beef. The production and the feeding requirements for each of these types are described below.

As a central element for the sheep production is an average upland crossbreed ewe with finished and stored lamb production based on grazing and lambing in March-April. The feeding requirements per ewe with lambs included for the whole year are taken from The Farm Management Handbook 2006/07 (Beaton 2007). The feeding requirement consists of grass grazing, silage, hay and ewe concentrate. In the model it is assumed that 1.5 lambs are borne per average ewe with a 4% mortality rate. Due to voluntary and involuntary disposal of ewes it is assumed that per year 25% of the ewes are replaced by gimmers raised on the farm. The ram requirement is also included, 2.5 per 100 ewe. The returns from ewe production come from finished and stored lambs, cull ewes and wool sales. The costs per ewe include costs of health care, feed additives, straw bedding, shearing, and other costs (commission, levies, haulage and tags).

As a central element for the beef cattle production an average hill suckler cow is used with calving in February-April, and sale in October with 220 days (235 kg). This includes 10% calf mortality and 1% cow mortality. Bull ratio is 1 to 35 cows. In winter the suckler cows are kept inside. The feeding requirement of cows and calves in winter days consists of silage, straw, creep feed, cow concentrates, cow cobs and some grazing on hill pasture. In summer the cows with calves are kept outside and fed by silage and grazing. The returns from beef production come from calf sales of steers and heifers, minus the replacements after 7 years. The cost per suckler cow include concentrate costs, cow cobs and creep feed costs, health care, straw bedding and other costs (commission, haulage and tags).

Feed production and purchase
The land on the farm can be used for growing grass, which can be used for grazing and for producing silage and hay. Silage can be fed in winter and summer. In addition to the home-grown feed, concentrates can be purchased. Dry matter production of grass, silage and hay makes the link between the feeding requirements of sheep and cattle and supply of it by each land type. On in-bye (permanent pasture) land, grass can be grown and fed to sheep and to cattle. On heather moorland only sheep can graze, and this fulfils part of their feeding requirement.

The dry matter production of grassland per year depends mainly on the amounts of water and nutrients and on growing conditions. The water level based on weather conditions are kept constant. For the inclusion of the effect of nutrients in the model, different levels of N use were distinguished. The most commonly used combination of N use and cutting frequencies (1-3 cuts for silage and 1 cut for hay) were represented with separate activities ranging from 0 – 375kg N/ha (Beaton 2007). The following main types of land use were distinguished: grass used only for grazing (N: 75, 125, 175, 250 or 375 kg/ha), used for silage with aftermath grazing (1, 2 or 3 cuts; N: 0, 125, 220, 250, 275, 300 or 375 kg/ha) and used for hay with aftermath grazing (1 cut; N: 0, 70, 125, 200). On moorland no activity is assumed in the model, such as cutting or fertiliser use, only it is used for grazing sheep. The costs of grassland include cost of renewing grassland, sprays, costs of mowing and ensiling.

Labour
Sheep and beef cattle require labour. Throughout the year a particular amount is necessary for each period. Therefore the year is divided on a monthly basis. The amount of available family labour is assumed to be 2 full-time labour units or 5500 hours/year, which is an average labour supply in this region for a 1070 ha farm. Apart from family labour there is the option of hiring seasonal labour. Labour can be hired any time of the year at a cost of 6 £/h assuming a standard worker (Beaton 2007). Information about the labour requirement per head (ewe or cattle) and per ha is derived from Farm Management Pocketbook (Nix 2007).

Fixed costs
Fixed costs are calculated separately from the LP-model, given input factors such as the size of the farm, basic machinery and buildings (i.e. housing capacity of the barn), the land rent and other miscellaneous costs.

Land management schemes and regulations for uplands
Farmers in the uplands can take part in many different schemes. Payments under CAP (headage payment, SFP) are explained, along with other important schemes for the uplands such as the Hill Farm Allowance and different Agri-Environmental Schemes.

Headage payment

Headage payments (HP) have long been used to support farming in the uplands. These payments supported farmers in sheep, and cattle sector. The support was connected to the production of livestock on the farm, for each type of livestock separately. These direct subsidy schemes for sheep, beef and dairy production can be seen in Table 2. Most have now been phased out as part of the de-coupling process, but underlie the calculation of the SFP in terms of historic payment rates. These payments were included in the model for calculation of the headage payment for the "HP" scenario.

Table 2. Headage payments for sheep, beef and dairy cattle production in 2004 (Nix 2007)

Headage payment	**£/head**
Suckler Cow Premium	161.5
Beef Sepcial Premium (steer)	102
Beef Special Premium (bulls)	142.8
Sheep Annual Premium	14.82
Sheep Annual Premium Suplement (LFA)	4.76
Dairy (2006) £/liter	0.0248

Single Payment Scheme

The Single Farm Payment Scheme (SFPS) was introduced by EC Council Regulation 1782/2003. It replaced most existing crop and livestock payments from 1 January 2005, including the above mentioned ones in Table 2. This new scheme breaks the link between production and support. To comply with this scheme, farmers need to keep their land in good agricultural and environmental condition and comply with specified legal requirements relating to the environment, public and plant health and animal health and welfare ("cross-compliance"). In England, the payment is consists of two elements: historical and flat-rate regional average payment elements. The historical payment is additional to the flat-rate payment, the amount of which is based on producers' historical claims during the 2000-2002 reference period.

During the period of 2005-2012 the scheme will move from low percentage flat-rate and high percentage based on historical payments to a simple flat rate across all eligible land in England. The proportion of these payments can be seen in Table 3.

Table 3. Percentage of historical and flat-rate payment over the years (Nix 2007)

Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Historical (%)	90	85	70	55	40	25	10	0
Flat-rate (%)	10	15	30	45	60	75	90	100

The flat rate payments for 2005 and the estimated flat rate payment in 2012, when it will account for 100% of payments can be seen in Table 4. For the model calculations these estimated payments, excluding deductions from modulation, were included to calculate the effect of the SFP.

Table 4. Flat rate payments for 2005 and estimated for 2012 for the upland areas

Year	2005	2012	
		before deduction	after deduction*
Non-Moorland SDA	16	175	131
Moorland SDA	2.29	24	18

* estimated 25% dedustion after EU and National modulation

Hill Farm Allowance
The Hill Farm Allowance is a compensatory allowance for beef and sheep farmers in the English Less Favoured Areas (LFAs) in recognition of the difficulties they face and the vital role they play in maintaining the landscape and rural communities of the uplands. HFA is based on area payment, which paid at different rates for different types of land and size of holding. The first payments of HFA were made in 2001 and will currently continue until 2009. However the Government is revising these payments and proposed moving away from the compensatory nature of the HFA towards a more targeted scheme which rewards farmers for maintaining the upland landscape and environment. From 2010 uplands support is going to be integrated into Environmental Stewardship as a specific uplands standard (Uplands Stewardship Scheme) (DEFRA 2006).

Agri-Environmental Scheme
Agri-environment payments are intended to compensate or provide an incentive for farmers to undertake measures which go beyond Good Farming Practice. Current Environmentally Sensitive Area and Countryside Stewardship Schemes are going to be completely replaced by 2014 by new AES so called Environmental Stewardship Schemes. These new schemes were introduced in 2006 and they aim to provide funding to farmers and other land managers in England who deliver effective environmental management on their land.

Nitrate Vulnerable Zone
Most of the farms in uplands in this region are situated within a Nitrate Vulnerable Zone. It means there is a limit on organic manure applications. The maximum is at 250kg/ha of total nitrogen each year averaged over the area of grass on the farm. This limit is also included in the model as a constraint.

In the model the focus is on HP and SFP and the other environmental payments (HFA and AES) are added, as average payments per farm for sheep & beef farm type, to the gross margin of the farm to calculate the labour income. It should be noted that these payments are based on additional activities done by the farmer to preserve the nature and environment, and might have an effect on farmers' gross margin, however, currently these activities are not included in the model.

Policy scenarios

Three policy scenarios were chosen to analyse the 2003 CAP reform and see the economic and land use affect of it in the long run: Headage payments, Single Farm Payment and No payments. This choice was based on focusing on three different points in time the situation before the reform (HP scenario), after the reform (SFP scenario) and the situation of probable abolishment of SFP in the future (NP scenario).

In the Headage Payment scenario we assumed a situation before the introduction of the SFP. The year 2004 was chosen, as the last "active year", to represent the effect of direct payments, which include all the payments listed in Table 2. These were added to the model calculations.

In the Single Farm Payment scenario we have chosen the year 2012, when the flat rate payment will account for 100% of payments (Table 4). The historical payments differ considerably between the farms and farm types and this is the year when all farm payments will be completely detached from historical production and based only on their current eligible land

types. These estimated payments, after deductions from modulation, were used for this scenario analysis.
In the No Payment scenario we assumed no payment from the CAP. So, all the direct payments and SFP were set to zero.

The model is set to 2006 output price and input cost levels for farming activities.

For all three scenarios the model provides an optimal income and production plan at farm level, including the number of hectares used for fodder crops and grazing livestock, number and type of livestock on the farm and the optimal input use.

Results

Optimal production plan

The optimal land use of the farm for the three policy scenarios can be seen in Figure 3. In the *Headage payment* scenario it is optimal to use the land for beef at a maximum capacity of the grassland. On moorland only sheep can be grazed and the need for hay and silage is provided by the grassland. In this scenario the beef production is more profitable than sheep farming, which explains the maximum number of beef production under land and animal housing capacity constraints. In *Single Farm Payment scenario* to keep large number of sheep and small number of beef cattle would be the optimal strategy. Without headage payments sheep are more profitable that beef production. Since the payment is not connected directly to the type of production the optimal production plan is identical with the *No payment* scenario.

These optimal strategies have influence on the production intensity of the farm. Since, livestock density and fertiliser use have important effect on the natural habitat and biodiversity we will focus on these. With HP more beef is kept on the farm, with SFP more sheep, however, the total livestock unit on the farm is lower in the case of SFP than that in the case of headage payments. The higher livestock unit on the farm requires more fodder which leads to more intensive grass production for grazing, silage and hay. This higher production on the farm is supplied by higher amount of fertiliser use per ha on grassland. This high fertiliser use is covered by the higher headage payment compared to the SFP. With no payment it is more optimal for the farmer to produce more extensively. The feed requirement of sheep is lower than that of the beef cattle, which makes lower fertiliser use more attractive for the farmer.

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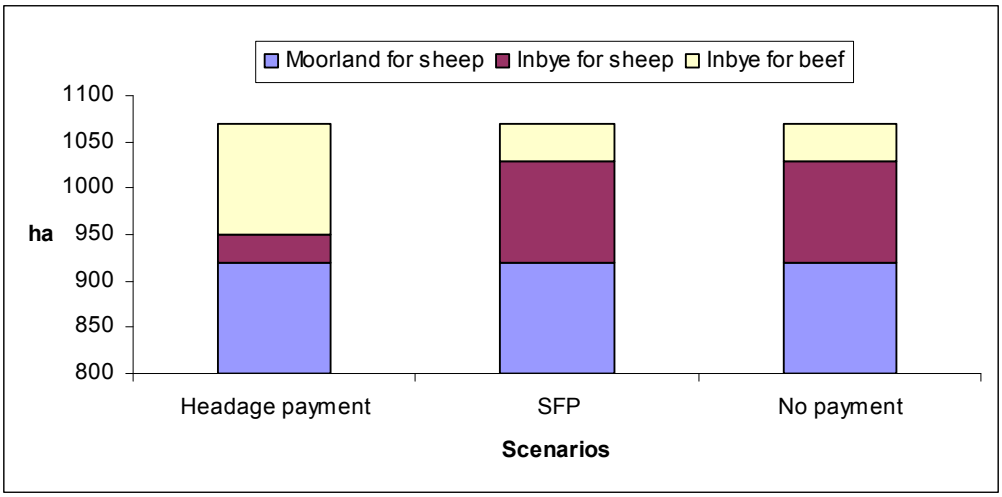

Figure 3. Optimal land use for different policy scenarios

Economic results

The economic results show that HP scenario brings the highest income compared to the SFP or NP scenarios. Farm revenue comes from sales from sheep and beef production. The revenues in HP scenario are higher, since the production is more intensive. The variable costs show the same trend. Farm variable costs include direct cost for grass, silage and hay production, costs of hired labour, and fertiliser purchase.

In addition to the revenue farmer gets subsidy which is higher in the case of headage payment than SFP. Since the intensity of production is rewarded the farmer tries to get the best out of his land. In the case of SFP the payment is connected to the land type which is fixed for the farmer. In this case his/her actions do not influence the amount of payment he/she gets.

Since the farmers in the uplands also involved in different Agri-Environmental Schemes and receive payments for environmental friendly farming, this forms part of their income. The HFA is calculated on a hectare base per land type, which is a fixed amount for the farmer. This HFA and AES payments were taken from the survey results as an average for this farm type and added to the farmer's income calculations. Labour income is the income the farmer gets from all his revenues and subsidies (HP and SFP) and HFA and AES payments, after variable and fixed costs are deducted. As a result the scenario of HP shows the highest labour income which is due to higher headage payment compare to the other two scenarios. The SFP scenario shows lower labour income but still shows a positive sign. Without any subsidy with NP scenario the income of the farmer would become negative.

The fertiliser use is much lower in the survey results then in the HP scenario but higher than in SFP scenario, which is identical with No payment scenario. Sheep numbers are quite similar between the survey and HP scenario results, but the HP shows higher beef production which means more intensive production compared to the real situation. In the case of SFP more sheep is produced on the farm and a bit less beef. However, it also can be seen that the model maximises the gross margin of the farm which means more production than in reality. This shows that there are some other constraints on the real farms that lead farmers to more extensive production. On the one hand, it could be i.e. the labour availability or housing capacity for the cattle on the farm. On the other hand, the reason could be explained by that the farmers are still in the period of policy changes, which give farmers different incentives

and require additional constraints. The farmers still have not adjusted completely to the new policies, especially that some of which are currently under development.

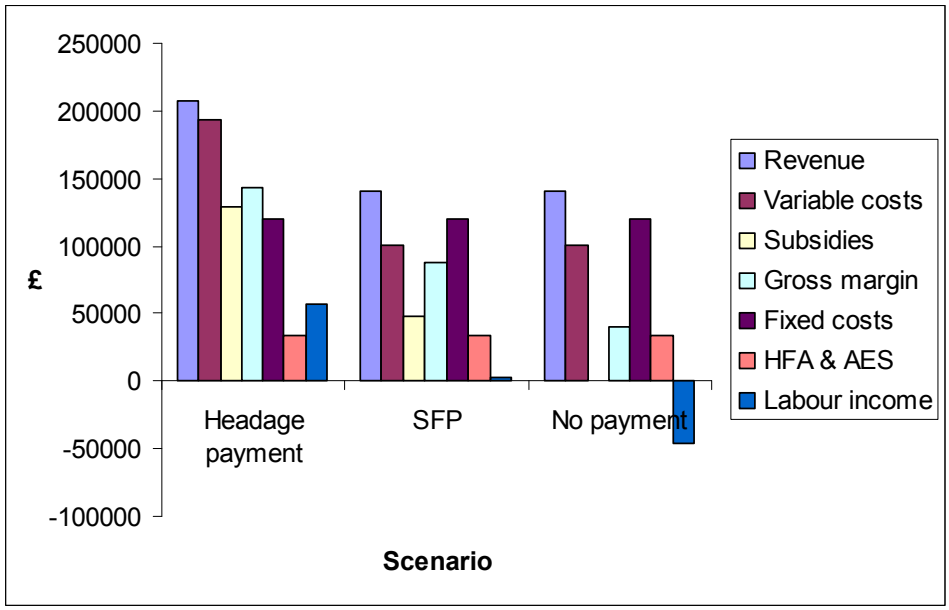

Figure 4. Economic results from the LP model with Hill Farm Allowance and Agri-Environmental Schemes payments

The comparison of the fertiliser use and livestock density of the model and survey results can be seen on Figure 5.

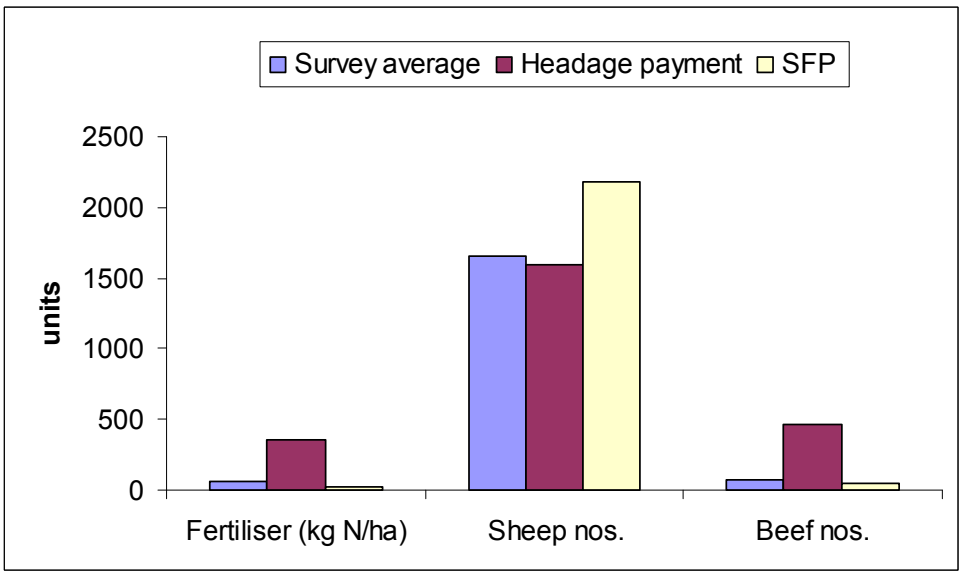

Figure 5. Comparison of survey and LP model results with HP and SFP scenarios.

Conclusion

In this study the aim was to investigate how policy changes under CAP reform affect farmer's income and land use in the uplands. Different policy scenarios were analysed and compared by using a developed linear programming model for a typical sheep and beef farm type in the uplands. The results show that headage payment strongly increases production intensity, by

high fertiliser use to support high stocking density, where the beef production is preferred to sheep production, from economic point of view. The Single Farm Payment motivates the farmers to farm more extensively, since the high fertiliser costs for more intensive production are not "compensated" by the payments or revenues from sold livestock products. In this scenario sheep production is preferred to beef production, as also the case for the No payment scenario. The extensification, lower fertiliser use and the shift from beef to sheep production in the uplands due to CAP reform was found also in other studies (Oglethorpe 2005).

The analysis of the subsidy payments by farm type show that LFA grazing livestock farmers received £125 per hectare on average in 2004 during pre-SFPS time (Defra 2007). In the LP model this figure was £120 per hectare for the HP scenario.

Grazing livestock farms are heavily dependent on support payments, and tend to lose under the new scheme (Holland 2007). This study shows that the switch of the subsidy payment from HP to SFP will decrease the labour income for the farmer. This is due to lower revenues due to more extensive farming and lower subsidy payment, which is hectare base in the case of SFP. Statistical analysis of the LFA grazing livestock farms showed that 40% (60% after modulation) of the farms will loose some subsidy from this change, and the beef farms are more affected by this change than the sheep farms in the uplands (Holland 2007). This is also due to the higher revenue farmers got from beef production compared that of the sheep production during the period of headage payment.

Other analysis showed that without any payment the farmers' income will become negative (Oglethorpe 2005). This result is also supported by the findings of this study. It should be also noted that in most of the cases SFP by itself is not enough to cover the costs of the farmer and get a positive labour income. Other payments such as from the Agri-Environmental Schemes play an important role in the hill farmers life.

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Appendix

Table 1. The general structure of the sheep, beef and dairy farm models

``	Moorland	Inbye land	Fodder production for own use	Sheep production	Beef production	Dairy production	Seasonal labour	Purchase of fertilizer	Purchase of feed	Animal production for sale	Headage payment	SFP	Right-hand side
Constraints													
Land requirements	1	1											≤ available hectares
Land types for fodder production	-1	-1	1										≤ 0
Labour requirements			+aij	+aij	+aij	+aij	-1						≤ available fixed labour in hours
Housing requirements					+aij	+aij							≤ avaible cattle places
Feeding requirements			-aij	+aij	+aij	+aij			-aij				≤ 0
Fertilizing requirements			+aij		-aij	-aij		-aij					≤ 0
Nitrate Vulnerable Zone		+aij		-aij	-aij	-aij							≤ max. manure application
Subsidy Headage Payment				+aij	+aij	+aij					-aij		≤ 0
Subsidy SFP	+aij	+aij										-aij	≤ 0
Objective function			Costs (£/ha)	Gross margin (£/head)	Gross margin (£/head)	Gross margin (£/head)	Costs (£/hour)	Costs (£/kg)	Costs (£/unit)	Revenue (£/head)	Revenue (£/head)	Revenue (£/head)	

aij - the technical coefficient that relates activity i to the constraint j