ORGANIC FARMING AT ADAS PWLLPEIRAN

1993 - 2001

by

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WDA

ADAS WALES

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ACKNOWLEDGEMENTS

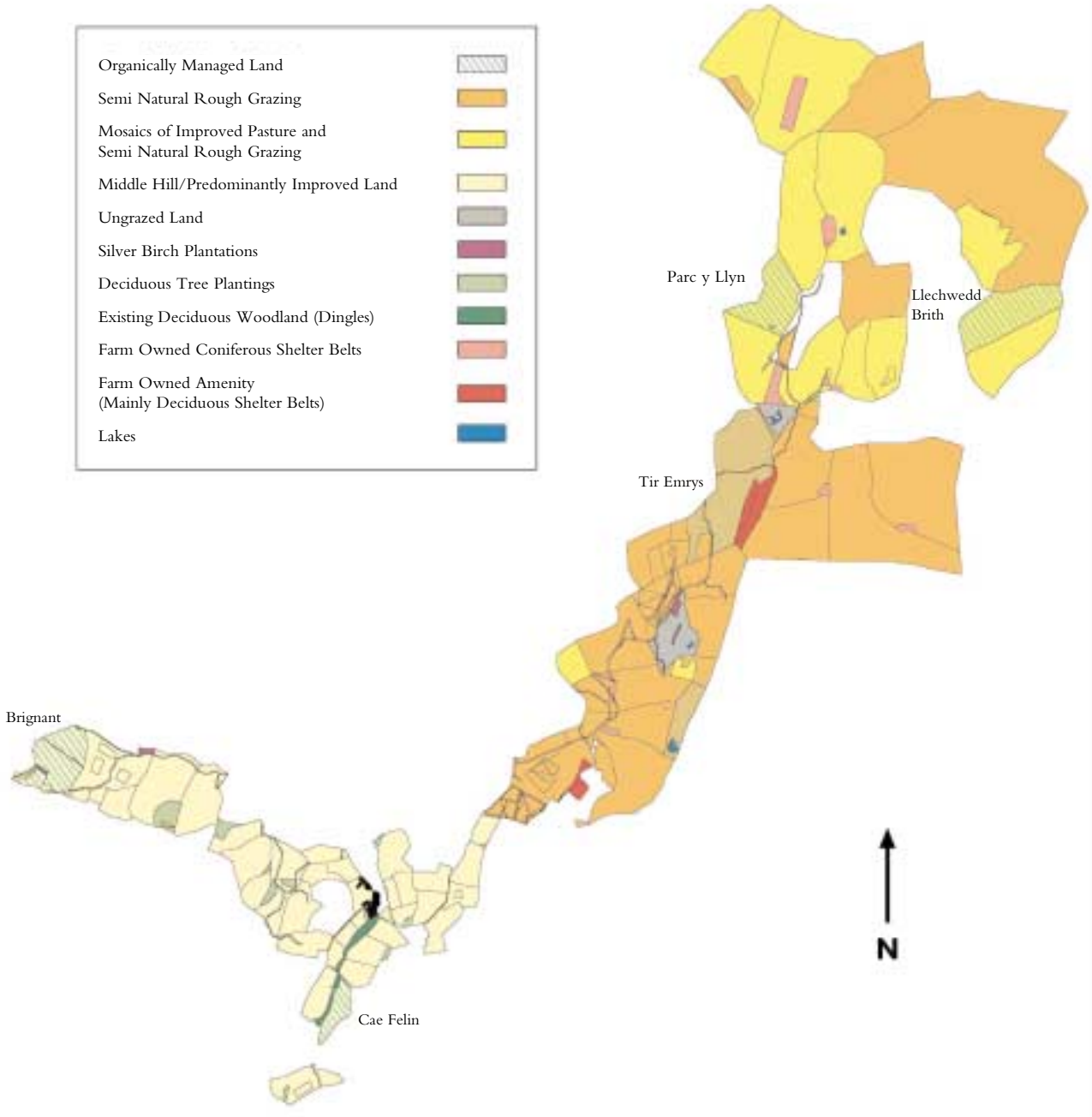
D. E. Evans has been responsible for data collection since the start of the project and A. E. Lathwood assisted with data analysis for this report. Thanks are also due to the staff of the farm at Pwllpeiran with responsibility for the organic unit especially G. E. Rowlands, H. W. Hughes and J. P. Jones.

The preparation of the report was funded by the Welsh Development Agency under the EAGGF Rural Wales Objective 5b Programme. This support is gratefully acknowledged.

ADAS is a partner organisation in Organic Centre Wales which is based at the University of Wales, Aberystwyth. The centre is funded by the National Assembly for Wales and the Welsh Development Agency / EAGGF. A version of this report can be found on the Centre's website www.organic.aber.ac.uk. Further hard copies or CD-ROM versions can be obtained from ADAS Pwllpeiran, Cwmystwyth, Ceredigion SY23 4AB, tel. 01974 282229 or from Organic Centre Wales, Institute of Rural Studies, University of Wales, Aberystwyth, Ceredigion SY23 3AL, tel. 01970 622248.

David Frost, Pwllpeiran Research Centre, December 2001

ADAS Pwllpeiran



Map Not to Scale

Produced by ADAS Spatial Data Team
March 2002

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1. INTRODUCTION

Agriculture at Pwllpeiran has a long history. At Bwlch yr Oerfa, a scheduled monument and one of the principal features along the Pwllpeiran Trail, there is evidence of a medieval agricultural settlement that was once part of the former Cwmystwyth Grange of the Cistercian Abbey at Strata Florida.

In the eighteenth century Pwllpeiran was host to the radical agricultural experiments undertaken by Thomas Johnes of Hafod. Johnes was a friend of Thomas Cooke of Hookham and Charles 'Turnip' Townsend and attempted to introduce their system of rotational cropping on the estate. Eventually he developed a variant of the Norfolk four-course rotation based mainly on turnips, oats and temporary pastures and introduced lowland breeds of sheep and cattle.

The dramatic decline of Thomas Johnes' Hafod estate was followed in the late 19th and early 20th century by a period when a more pastoral system of farming developed, with increasing emphasis on hill sheep farming. By the 1930s, however, Pwllpeiran was again associated with ground breaking agricultural development with the work of Sir George Stapledon. As first Director of the Welsh Plant Breeding Station, Stapledon received a donation from Sir Julien Cahn, a Midland Manufacturer, to establish a research unit for the improvement of hill pastures. The resulting Cahn Hill Improvement Scheme at Pwllpeiran encouraged a massive programme of ploughing, fertilizing and re-seeding among Welsh hill farmers.

Pwllpeiran was eventually established as an Experimental Husbandry Farm in 1955. During the following forty years, work at the farm achieved substantial improvements in the quality and quantity of lamb and beef produced, but by the turn of the millennium the emphasis of agricultural policy was turning away from increased livestock production *per se* and towards the development of environmentally sensitive farming systems.

The 1,118 ha Pwllpeiran Research Farm is now managed by ADAS Wales. The land is rented from the National Assembly for Wales and the Forestry Commission. All of the land is under a 'whole farm' Environmentally Sensitive Area agreement. The farm is approximately 22 km inland from Cardigan Bay at an altitude rising from 265 m to 625 m above sea level. The prevailing wind is Westerly or South Westerly and the farm receives on average 1,700 mm rainfall at 300 m and 2,250 mm at 600 m.

1.2 Organic Farming at Pwllpeiran

The 111.5 organic unit was established in 1993, supported by the Countryside Council for Wales, Development Board for Rural Wales and the National Trust. The aim of the project was to evaluate the applicability of organic systems to hill livestock farms with limited or no arable potential. The sponsors were aware that many livestock farms in upland Wales had low fertiliser and agri-chemical inputs already and conversion to full organic status might not involve major changes in farming practice, but could bring benefits in environmental terms and through the opportunity to market a premium product.

Most hill farms in Wales are restricted, through soil type, topography and climatic conditions, to sheep and beef production. The Pwllpeiran project presented an opportunity to test the practicalities of organic livestock production on an upland farm with limited improved grassland. The unit achieved full organic status in 1995.

The unit attracted European EAGGF Objective 5b funding in 1994 for a project to assess the technical, economic and environmental implications of adopting an organic system for the production of hill sheep and cattle. In 1996 and 1998 this work was extended with further Objective 5b funding for projects to set up the Cambrian Organic Group and to develop the infrastructure for organic farming in Wales.

The organic unit is also involved in research and development projects. The organic unit at Pwllpeiran is one of ten linked farms in a DEFRA funded Organic Beef and Sheep Production project. The unit also undertakes research for commercial clients and provides an organic consultancy service.

1.2.1 Organic Farming Projects at ADAS Pwllpeiran

1. Developing Organic Farming in the Uplands Project
2. Developing the Infrastructure for Organic Farming in Wales
3. Improving the Infrastructure for Organic Farming in the Uplands of Wales
4. Upland Beef and Sheep Production
5. Organic Demonstration Farm Network for Wales / Farming Connect Development Farm
6. Commercially Funded Research
7. Organic Conversion Information Service Wales (OCIS)
8. Organic consultancy

2. THE PWLLPEIRAN ORGANIC UNIT

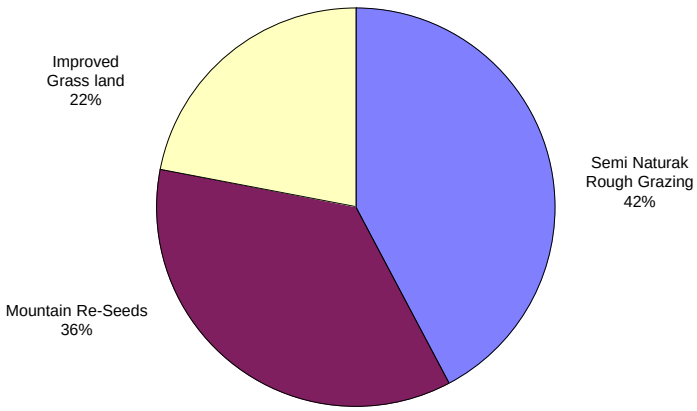
2.1 Land area

The 111.5 ha organic unit lies within the 1,118 ha ADAS Pwllpeiran hill farm in the Cambrian Mountains ESA. The unit comprises 47.1 ha semi natural rough grazing (SNRG), 39.9 ha mountain re-seeds (mosaics) and 24.5 ha improved grassland which is in similar proportions to the farm as a whole. The unit thus comprises a series of separate enclosures spread out over the 10 mile length of the farm, rather than one block

Table 1 Land area in the Pwllpeiran Organic Unit (ha)

Semi natural rough grazing	47.1
Mountain re-seeds	39.9
Improved grassland	24.5
(Suitable for forage conservation)	(9.1)
Total	111.5

Figure 1. Land Area in the Pwllpeiran Unit (%)



2.2 Stocking

Stocking comprises suckler cows and breeding ewes. Mixed stocking is advantageous in an organic system. When sheep and cattle graze the same pastures there are benefits for both species. This is partly due to a dilution of the parasitic burden, but a further advantage lies in the complementary grazing habits of both species and the better use of herbage. Furthermore when cattle are winter-housed on straw, the resulting FYM can be targeted on fields used for forage production, thus ensuring the efficient recycling of nutrients around the farm.

2.2.1 *Stocking Rate*

The stocking rate was chosen in 1993 following comparison with average data for Welsh hill farms collected in the UCW Farm Business Survey. The stocking rate was set at 60% of the conventionally farmed area, with a higher cattle to sheep ratio (16 ewes/1 cow) than on conventional farms locally. This was thought likely to help reduce nematode worm problems. Lower stocking rates were also thought likely to benefit dwarf shrub vegetation, especially heather, which is declining in extent and quality in Wales. Increasing the proportion of cattle would also reduce the rate of bracken spread in vulnerable areas.

2.2.2 *The Suckler Herd*

Cattle were generally regarded as a subsidiary enterprise on the higher hill farm and their main function was to act as pasture controllers for the benefit of the sheep enterprise. At Pwllpeiran, by the 1990s, the herd was primarily Welsh Black since these cows fulfil the role of pasture improvers most successfully. In 1993 the decision was made to establish a pure-bred herd of 10 Welsh Black cows on the organic unit.

Organic livestock standards emphasise the need to select breeds best adapted to the environmental conditions of the farm and the Welsh Black is well suited to upland organic systems. The breed is hardy and easy calving, it is genetically suited to a grass-based system and can maintain itself on the coarse and less palatable vegetation typically found in mountain pastures.

Cattle on the organic unit are housed in November and fed big bale silage plus approved concentrates. The herd is spring calving which has many advantages for organic beef production: It minimises conserved forage requirements and avoids potential health problems from housing young calves in winter.

2.2.3 *The Sheep Flock*

Although many breeds of sheep have been evaluated at Pwllpeiran, it was decided in 1993 to select the Hardy Speckle Face for the organic unit. This ewe is well adapted to wet upland conditions and has the potential to produce a larger lamb for the market than the Welsh Mountain. Since establishment the ewe flock has been closed. Lambing starts in the second week of April, three weeks later than the conventional flock. Late lambing means that there is more grass available to the ewe enabling lambs to suckle more and graze less at the time when *Nematodirus* hatch occurs. There is still some exposure to infestation however, but this stimulates development of the lamb's natural immunity.

2.3 Grassland management

The basis of any successful organic system in the uplands is good grassland management. At Pwllpeiran management follows both organic standards and ESA prescriptions. This means that there are a number of factors limiting production.

The first limiting factor is that when the SNRG in the mountain mosaic pastures is included, *semi natural vegetation constitutes 60% of the organic unit land area*. Management of the semi natural rough grazing according to ESA prescriptions involves restricting grazing and limiting the number of stock. The 47 ha of heather moorland has more than 25% heather (*Calluna vulgaris and Erica tetralix*) and under the ESA agreement must not be grazed at more than an average daily stocking rate of 1.24 sheep/ha/day from 15 April to 15 October. The total grazing allowance can be used by concentrating stock into several short periods within the whole; but at no time must sheep numbers cause over-grazing. In practice, Tir Emrys is grazed by replacement ewe lambs from April to September, and by dry ewes between weaning and tupping.

The second limiting factor on production is that *the area of improved grassland suitable for forage conservation comprises less than 10% of the total*. The aim is for the unit to be largely self-sufficient in feed, with 95% of the annual feed supply coming from grassland within the unit. As the area for forage conservation is small compared to the overall size of the unit, there is a limit to the numbers of stock that can be carried.

A third limiting factor on production is the weather. *Weather patterns are changing and rainfall is increasing*. Meteorological records taken at Pwllpeiran confirm a trend of increasing precipitation in recent years.

Under the ESA agreement the forage conservation fields are managed as hay meadows in order to achieve environmental objectives and to encourage botanical diversity. Hay cutting must be delayed until at least 15 July. In practice, in the increasingly wet situation, the conserved forage is baled and wrapped in August. This successfully provides winter feed for the cattle, but is less successful for sheep. Late cuts of silage have less energy, lower digestibility, and in wet years the silage is low in dry matter and thus less suitable as sheep feed.

The fourth factor limiting organic production is that *the ESA 'hay meadow' agreements exclude pasture renovation*. The improved fields on the lower land lie between 300 and 400 m and are on mineral soils. Two of the three were re-seeded at approximately six-year intervals prior to conversion, and these are now the forage conservation fields. The 1994 conversion plan suggested that re-seeding of these pastures might be necessary every 6 – 8 years. Entering them into the ESA hay meadow agreement maximised the level of grant payments, but precluded such a programme of re-seeding or over-seeding.

3. PERFORMANCE OF THE PWLLPEIRAN ORGANIC UNIT, 1993 – 2001

3.1 Soil Fertility

The mountain mosaics and the semi-natural rough grazing are characterised by organic soils whereas the improved fields on the middle hill all have mineral soils. On the mountain mosaics no nitrogen fertiliser has been applied since 1988, and on the middle hill fields there has been no application of nitrogen fertiliser since 1992. Since conversion started in 1994, only lime and permitted sources of phosphate and potash have been applied to the mountain mosaics but the middle hill fields have also received farmyard manure (FYM). Soils have been regularly analysed to assess soil pH, available phosphorous (P), available potassium (K) and available magnesium (Mg).

Soil pH is a measure of acidity or alkalinity and generally ranges in agricultural soils from 4.0 (very acid) to 8.0 for soils which are naturally rich in lime or have been over-limed. The status of the nutrients P, K and Mg can be expressed in terms of available milligrams of nutrient per litre of soil (mg/l) or as indices which indicate the relative amounts in the soil available to crops. The indices range from 0 (deficient) to 9 (very high).

Grass-clover swards are less tolerant of acid soil conditions than all grass swards and clover is likely to be less persistent at soil pH levels below the optimum. This is particularly important in organic systems where clover is the main source of nitrogen. A pH of 5.8 – 6.0 and P & K indices of 2 are generally regarded as necessary to maintain good clover levels on mineral soils, with a pH of 5.3 – 5.4 recommended for organic soils.

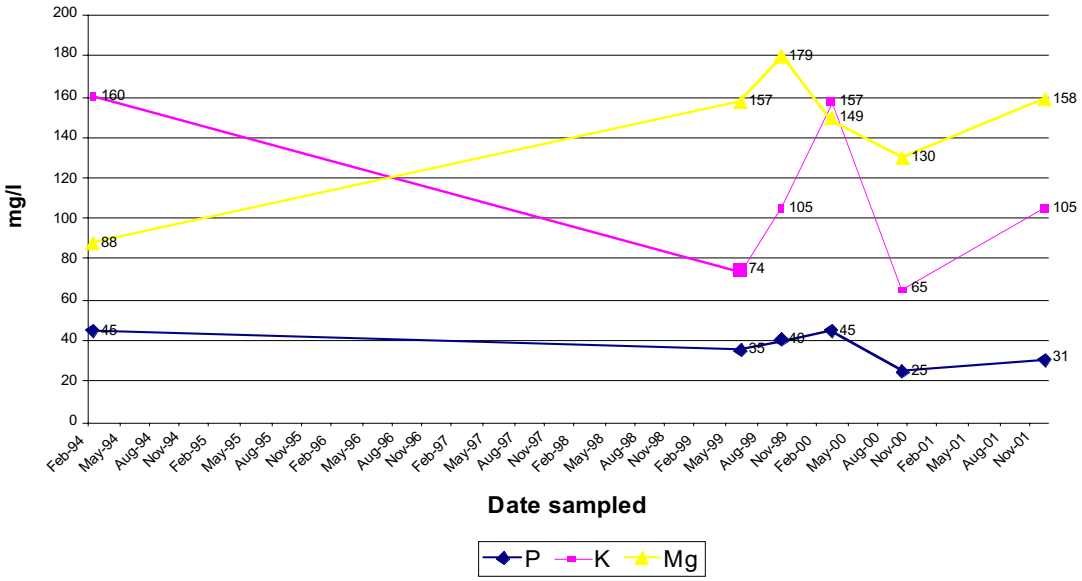
The soil analyses carried out between 1994 and 2001 indicate that without regular applications of lime, or other neutralising agents, the pH of the mineral soils falls to around 5.8, while the pH of the organic soils falls to around 4.5. As the main neutralising agent used is magnesium limestone, Mg levels have tended to rise when magnesium limestone is applied.

In the improved fields used for forage conservation soil pH has remained close to the optimum level of pH 6.0 for continuous grass clover swards on mineral soils. On the mountain mosaic pastures however soil pH levels have ranged from 5.3 to 6.5. On such organic soils as these the optimum level is around 5.4. The application of magnesium limestone in 1999 raised pH levels to 6.0 and 6.5. This over-liming of acidic peaty soils can contribute to trace element deficiencies in manganese, copper and cobalt.

K levels for the improved fields used for forage conservation are depleted by the regular off-take of silage, and soil analyses confirm the importance of returning all FYM to these fields and the value of applying additional sources of K permitted under the organic standards. P is much less mobile in the soil than K and the trend on the conservation fields since conversion has been a gradual decline in P levels.

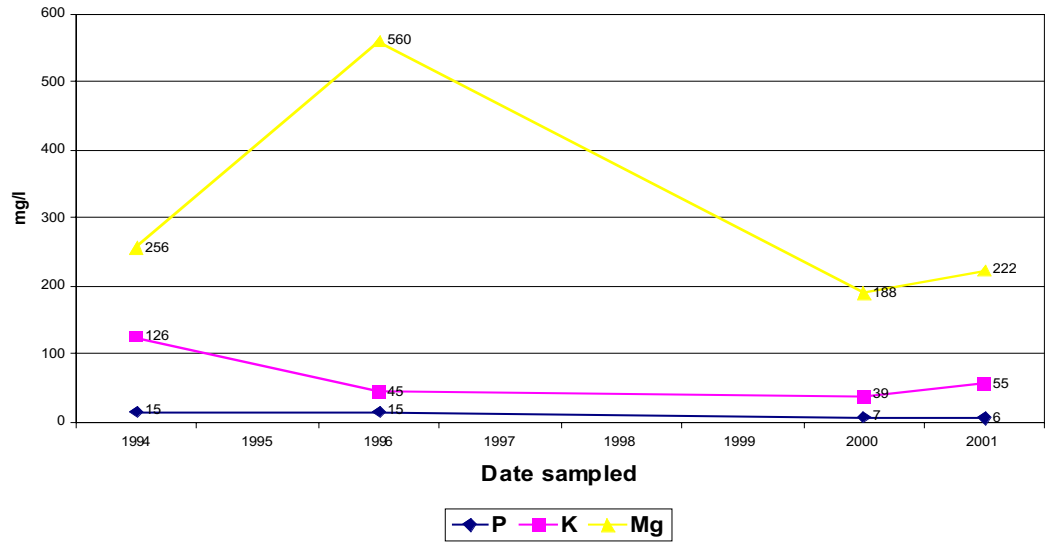
Inputs of FYM from the organic unit alone have been insufficient to maintain K at the recommended level for optimum grass /clover production in the fields used for forage conservation. Application of a permitted fertiliser (Cumulus K) in September 1999 raised the K level from index 1 to index 2 in Cae Felin, the main forage conservation field. Cae Felin has also been the main target for applications of FYM, and although there has been a gradual decrease in P levels here, they have remained in the range satisfactory for optimum grass/clover production. In the other conservation field, Brignant Pella, where there has been no additional permitted K inputs, and where FYM input has been lower, P and K levels have remained consistently below the recommended levels.

Figure 2. Cae Felin P. K. and Mg Levels



Soil analyses of the mountain mosaic pastures suggest that maintaining optimum soil levels of P, K and Mg is extremely difficult. Mg levels in Parc y Llyn were raised by the application of magnesium limestone in September 1999 but this had the negative effect of raising pH levels above the optimum for these acidic peaty soils. Overall, levels of the major nutrients have fallen between 1994 and 2001. This is despite the enclosures only being used for grazing, with no depletion of nutrient attributable to forage conservation. The overall shortage of FYM, coupled with the distance of these fields from the home farm has made the application of organic matter impractical.

Figure 3. Parc y Llyn P. K. and Mg Levels

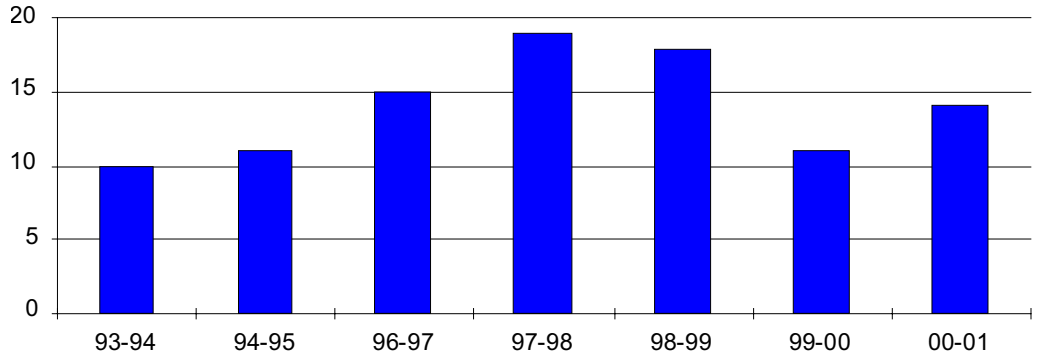


3.2 Grassland

3.2.1 *Clover content of swards*

Without inorganic N inputs a white clover percentage of 20% – 25% in swards is necessary to fix nitrogen at rates equivalent to 150 Kg N/ha in upland swards. Generally, clover content showed an initial increase within the improved grassland in the organic unit following conversion. There was a marked decrease in clover content in 1999, but in 2000 clover content started to recover and by 2001 was restored to 16% – 20% in the silage fields surveyed.

Figure 4. Clover: % content of improved swards 1993 - 2001



At Pwllpeiran it has been particularly difficult to maintain clover levels on the mountain pastures, especially with the low P and K levels described above. Furthermore, grazing too long in autumn to reduce demand for winter fodder prevents aerial tillering and means clover plants are smaller in spring and less able to compete with grasses in the sward. Planning autumn grazing is therefore very important. Even on the improved fields clover can crash every five to seven years as tap rooted parent plants die, leaving the small clover plants previously connected to them by stolons. These satellite plants have little root structure and are less able to cope with stressful conditions so grazing needs careful management. Clover content does recover, but until it does forage can be in short supply. Where there are no agri-environment scheme restrictions, a programme of re-seeding or over-seeding with a grass clover mix can ensure adequate clover content.

3.2.2 *Botanical diversity*

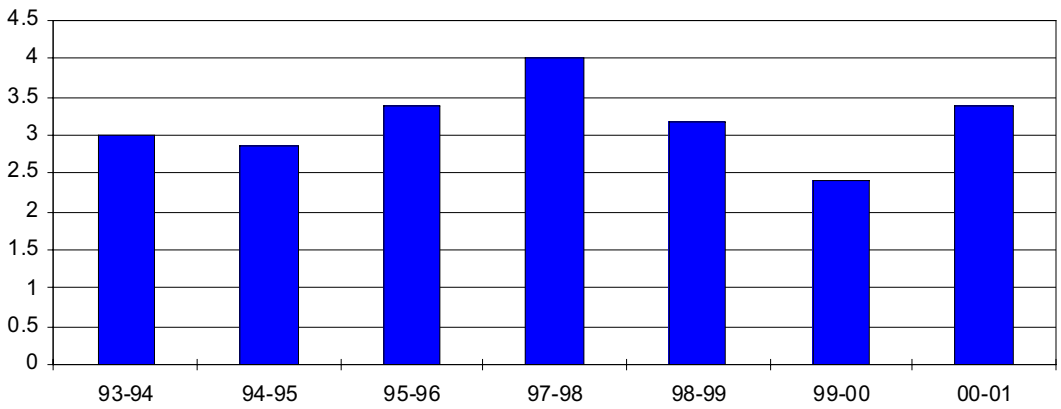
Following conversion, an overall increase in plant species was recorded in the improved grassland and mountain re-seeds (mosaics). There were only minor fluctuations in the extent of heather cover on the semi natural rough grazing, the height of the heather also changed very little, ranging between 14 cm and 19 cm depending on the varying growing conditions.

Surveys of the Brignant organic fields showed that on the organic land in 1993 there were 14 plant species recorded in the re-seeded fields and 19 species in the permanent pasture, by 1995 the numbers of plant species recorded had risen to 23 and 35 respectively.

3.2.3 *Silage production and forage self-sufficiency*

At the original stocking rate it was calculated that the organic unit would be self sufficient for silage at 3.0 t DM /ha. The variation in silage yield over the whole period 1993 – 2001 reflects the cyclical changes in clover content in the swards.

Figure 5. Silage yields 1993 - 2001 tonnes/ha (Dry Matter)



3.2.4 *Weed control*

In the mountain mosaics rushes have become invasive in the improved areas. These areas were created during the 1970s after a light surface disturbance followed by seeding with perennial rye grasses and white clover. It was recognised then that more drastic cultivation would favour rush infestation on the wet, organic soil.

Intensive sheep grazing, low fertiliser input and infrequent topping leads to increased rush infestation on wet improved grassland. Sheep avoid grazing mature rushes and are generally less effective at controlling them than cattle. Cutting repeatedly during the grazing season using a flail is effective but expensive. Combinations of cutting and grazing are more effective than either cutting or grazing alone.

Docks are invasive in some areas of the silage fields. Control methods include topping and manure management to prevent spread of seeds. Minimal winter grazing, with a sacrifice area used for feeding, helps to avoid compaction. Tight sheep grazing in early spring also helps, but late spring grazing reduces the ability of the grass to compete with docks. Cutting early for silage rather than later for hay can prevent docks seeding.

3.3 Animal performance

3.1 *Stock numbers*

The number of suckler cows kept on the organic unit has remained unchanged, but in October 1999, 13% more ewes – a total of 196 – were mated because of earlier indications that the unit could support more. The unit had fully met herbage and forage requirements in the years 95-96 and 96-97, and so ewe numbers were increased. This increase proved unsustainable with heavy pressure on autumn grazing and winter forage. Ewe numbers were cut back to 166 in 2000 and reduced again to 161 in 2001.

Figure 6. Livestock Numbers 93 - 01

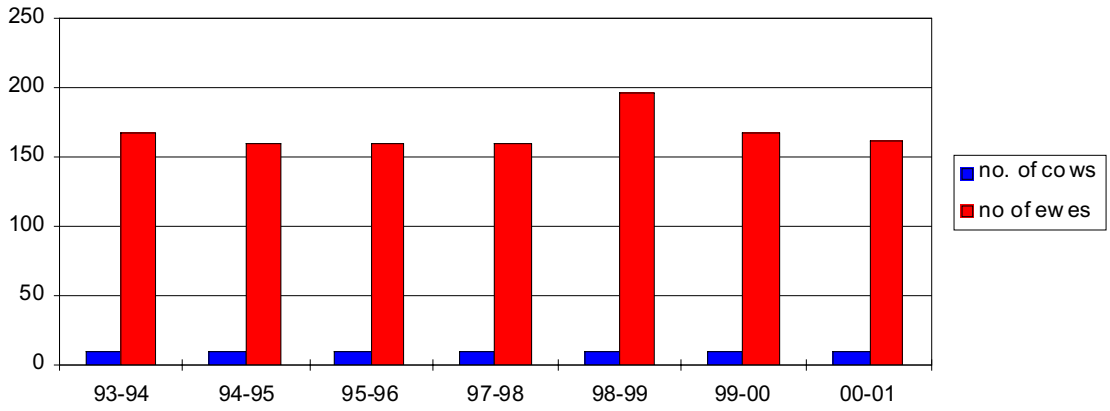
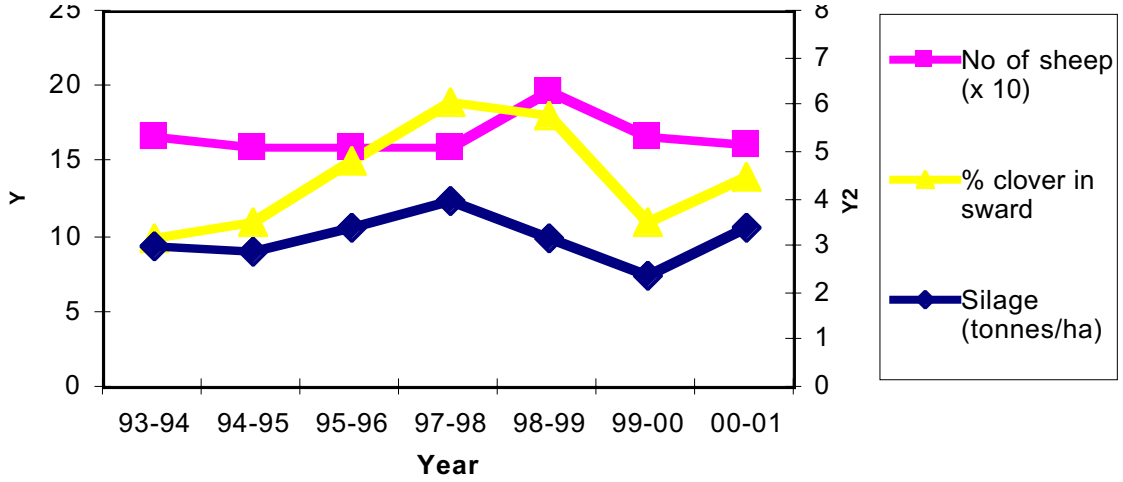


Figure 7 shows the close relationship between clover content, silage yield and ewe numbers. Ewe numbers were increased when silage yields were high, but had to be reduced when clover content and silage yield fell.

Figure 7. Clover content of swards, silage production and sheep numbers 1993 - 2001



3.3.2 *Lamb and Beef Production*

The percentage of lambs reared to ewes mated has averaged 115% since conversion, with the total number of lambs produced fluctuating with the numbers of ewes in the flock. An average of 50 replacement lambs are retained each year for breeding and these are away wintered off the farm. The suckler herd size has remained stable, with two heifers retained each year for herd replacements. The number of beef and lamb animals produced has remained largely in proportion throughout the period since conversion. In 2000 – 2001, however, the lambing percentage dropped but beef sales rose. There had been an increase in the numbers of calves born in 1999 – 2000 due to an exceptional number of twins.

Figure 8. Lamb Production 1994 - 2001

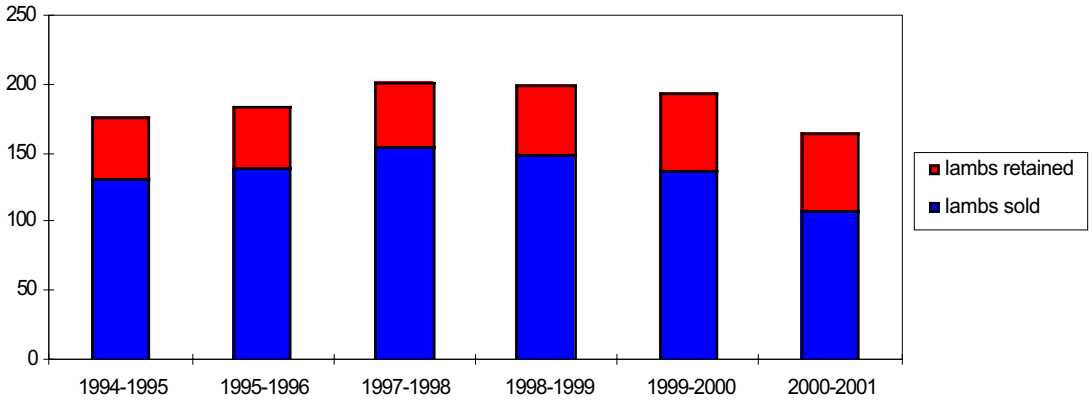
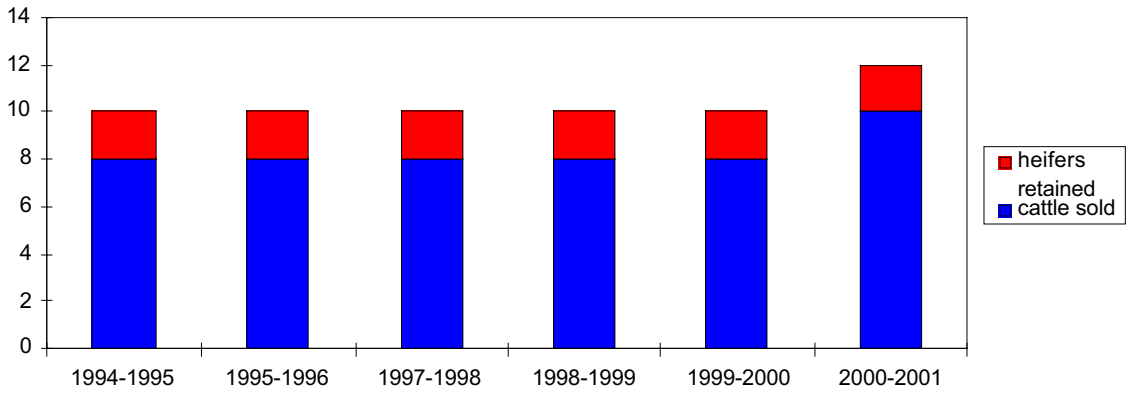
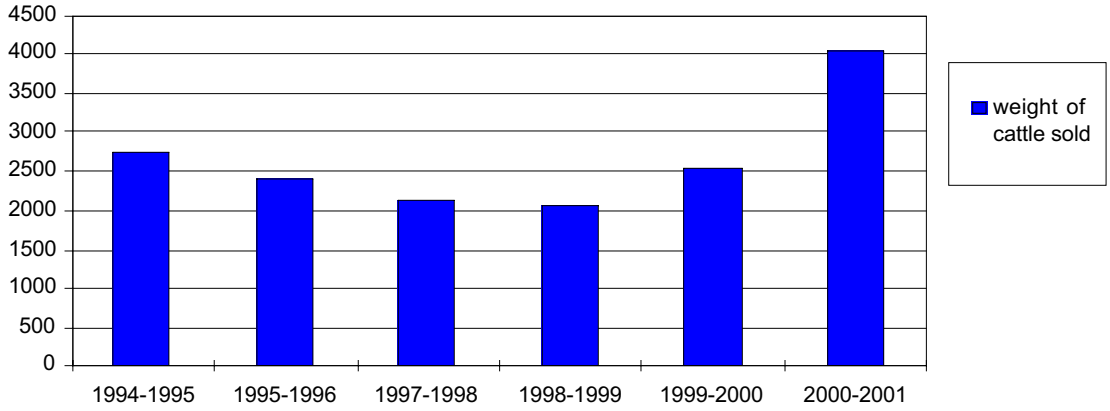


Figure 9. Beef Production 1994 - 2001



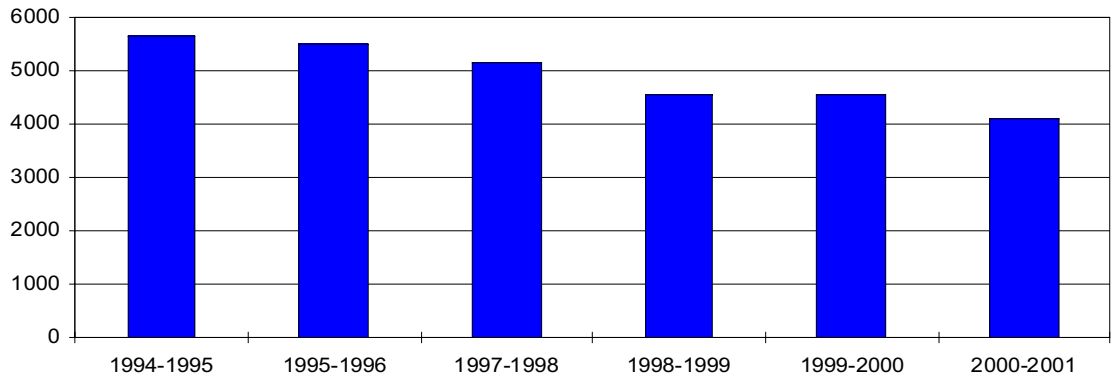
The total weight of beef cattle sold dropped between 1994 and 1999, but increased in 2000. The large increase in weight of beef cattle sold in 2001 is a result of both an increase in number of calves sold, and the fact that they were sold at three months older than in previous years.

Figure 10. Liveweight of cattle sold (kg) 1994 - 2001



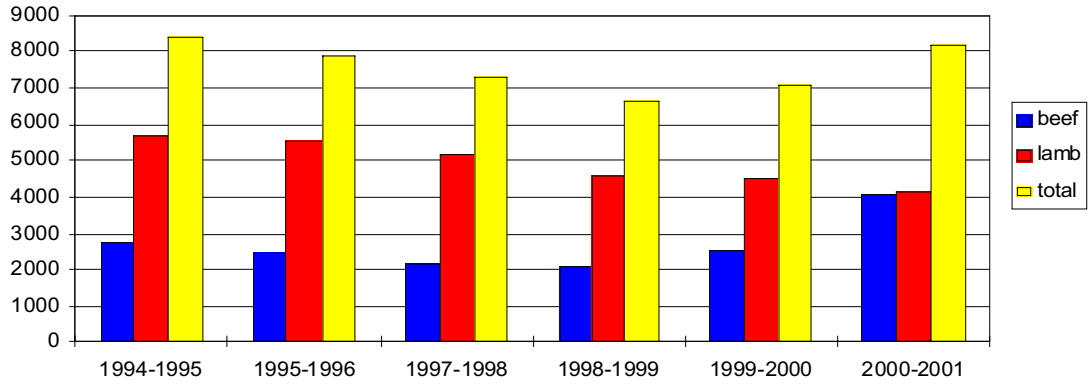
Lamb production measured by weight of lamb produced at weaning has fallen during the period with only a slight fluctuation in the trend due to the increase in ewe numbers in 1999.

Figure 11. Weight of lamb produced at weaning (kg) 1994 - 2001



When the weight of lamb produced at weaning is added to the weight of beef sold as stores, the data show a downward trend following the end of the conversion period but an upturn in the last two years as a result of increased beef production.

Figure 12. Total lamb and beef produced (Liveweight, kg) 1994 - 2001



3.3.3 *Livestock condition and health*

Throughout the period average ewe weight and condition score at tupping have reflected herbage and forage availability. Cow weight and condition, which are recorded at housing and at weaning, also tend to follow this pattern.

Table 2. Ewe liveweight and condition score at tupping: averages 1994 – 2001

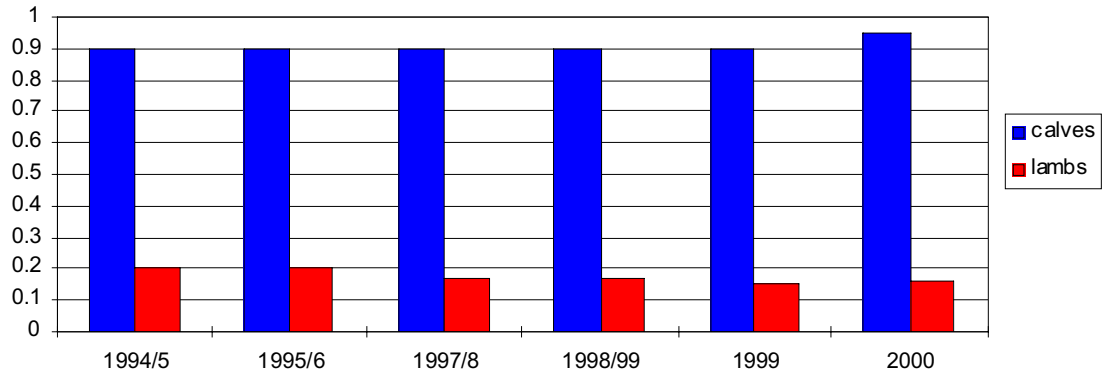
	1994	1995	1996	1997	1998	1999	2000	2001
Liveweight	47.8	47.1	40.3	50.7	42.5	42.4	38.8	40.9
Condition score	2.9	2.7	2.9	3.0	2.7	2.3	2.2	2.5

Table 3. Cow liveweight and condition score at housing: averages 1994 – 2000

	1994	1995	1996	1997	1998	1999	2000
Liveweight	573	562	595	625	634	592	658
Condition score	3.5	2.5	3.1	3.4	3.5	3.7	3.5

Calf and lamb performance has been similar to conventional management. Daily weight gain from birth to weaning has averaged 0.18 kg for lambs, and 0.9 kg for calves.

Figure 13. Average calf and lamb daily weight gains, birth to weaning (kg) 1994 - 2000



The flock and herd are rotated around the farm but it has not been possible to devise a clean grazing system given the restrictions arising from the physical nature of the unit and the ESA prescriptions. Nonetheless the worm challenge is diluted by mixed stocking. A combination of late lambing and rotation of the available land results in a safe grazing system to protect susceptible lambs. The use of anthelmintics to control intestinal parasites has fallen for the flock and is not required at all for the herd.

Mineral deficiencies are potential problems on the unit. In the early years of conversion cobalt deficiency was associated with cases of Pine amongst lambs, and copper deficiency is a potential problem for fertility in the suckler herd. Mineral deficiencies have been treated with permitted supplementation. Dressing the pastures with a nutrient enhancer containing a range of minerals is now undertaken to obviate the need for animal treatment by injection or bolus. Over-liming of the peaty organic soils on the mountain mosaics has to be avoided as this can induce further deficiencies of trace elements which can adversely affect livestock growth.

3.4 Marketing and financial performance

3.4.1 *Marketing*

Between 1993 and 1999, finished lambs were slaughtered at a local organically certified abattoir and sold to an independent butcher. In order to minimise late autumn and winter grazing on the organic unit and to avoid the cost of supplementary feeding to finish lambs, it was decided to sell the 2000 and 2001 lamb crop as stores. Store lambs sold in September 2000 for £1.40 kg liveweight averaged 26.1 kg, returning an average price per lamb of £35.21. The comparable figure for 1999 when most, but not all, of the lambs had been sold finished was £32.00 per lamb.

Cattle have been sold locally as stores throughout the lifetime of the project. Demand for organic cattle has been strong. In 2000, 11 month old stores sold for £1.40 kg liveweight at an average price per animal of £444. In 2001, 14 month old stores sold for £1.21 kg at an average price of £545 per animal

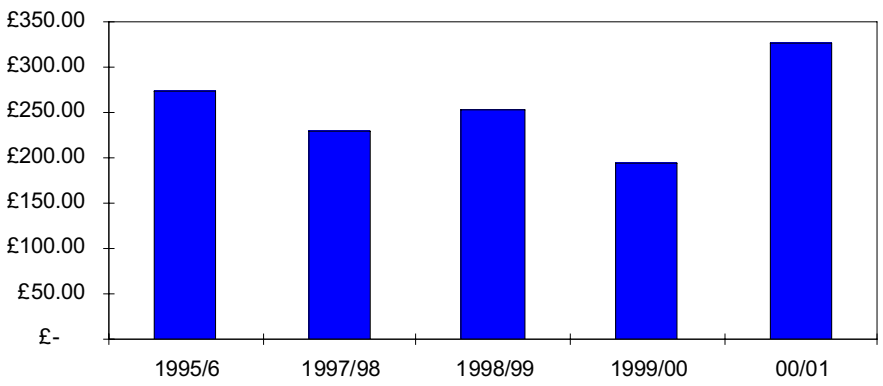
3.4.2 *Gross margin analysis*

There was an improvement in the gross margin per hectare following conversion. By 1998/99 the unit outperformed the conventional results without taking into account ESA payments. The difference reflected the premium prices commanded by organic lamb and beef and the collapse of the conventional market.

Premia prices for organic lamb and beef continued in 1999/2000, but as a result of higher input costs and lower subsidy payments the gross margin per hectare fell to the lowest recorded.

Financial performance improved in 2000/2001. This reflected additional Beef Special Premium payments and the effect of the area-based Tir Mynydd scheme which replaced the headage-based Hill Livestock Compensatory Allowance.

Figure 14. Gross Margin/Effective Ha (£)



4. ORGANIC FARMING AT PWLLPEIRAN – A SUMMARY

The results from the Pwllpeiran unit underline the difficulties of organic farming in a severely disadvantaged upland area. The unit's performance demonstrates the potential for production of organic lamb and beef but it also indicates some of the limitations on organic production.

Organic farming theory and practice developed primarily in the lowlands and on mixed farms and these origins remain clearly evident in current standards for organic agriculture. Farming in the hills and uplands is, however, in many ways distinct. The lack of opportunity to grow arable crops, the difficulties of growing legumes such as clover and the shortages of farmyard manure, organic fertilisers and farm produced feed all represent particular challenges to the organic hill farm. At Pwllpeiran, production has been constrained by declining soil fertility which in turn has had an adverse effect on grass / clover production and thus on herbage availability and forage conservation. The system operated to date has not produced enough FYM to maintain soil nutrient levels in all of the organic pastures, a major constraint on the level of production. This leads to two important conclusions regarding organic farming in the uplands. The first is the importance of regular and systematic soil sampling to identify possible nutrient deficiencies. The second is the need for sector bodies to recognise that organic farming in severely disadvantaged high rainfall hill areas may require more regular input of permitted P and K fertilisers than lowland and mixed farms. Without such inputs production levels are likely to fall in the medium to long-term and more work needs to done on the best method of supplying these nutrients to the organic hill farm.

At Pwllpeiran the decision was taken to accept a lower stocking rate on the organic unit, and to maintain financial performance by generating extra income from ESA agri-environment payments and organic premiums. The unit's experience demonstrates that combining organic farming with environmental conservation schemes on the mountain farm may add to the unit's income, but environmental prescriptions will also place further limits on production. The balance of advantages to the organic hill farm offered by entry into an environmental management scheme needs to be weighed carefully.

The future viability of the Pwllpeiran organic unit depends on maintaining farm income levels by optimising herbage and forage production and utilisation, and by controlling input costs, and producing quality beef and lamb. The impact of other factors like market prices, global trade and government policy will prove equally important. Control of these lies beyond the farm gate.