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Different shades of green? Differentiation of hill farming in North Wales, what will be the impact of the future Welsh Agricultural policy?

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Abstract: In the last 20 years Welsh Hill farming has faced many challenges; long-supported specialisation in beef and sheep production systems has been called into question as the policy focus shifted and markets have offered poor returns. Drivers of evolution changed and some near-extinct enterprises have reappeared in the Welsh hills (e.g. dairying, poultry), linked to both market and policy changes. Two in-depth agrarian diagnoses in hill and upland areas of North Wales (Bala and the Vale of Clwyd) show a differentiation of production systems. The apparently homogenous pastoral landscape now sports different levels of management and land use intensity (in fodder output, stocking rates and livestock types). Farms have become increasingly polarised depending on their business opportunities, and these farmed landscapes in Wales are changing rapidly. With the Brexit process and in the context of Covid, changes have intensified as the farming sector seeks to adapt and plan ahead. We assess the likely impact of possible Welsh and UK governments' future policies in the emerging market context, to understand their likely impact, using a typology of production systems in the two landscapes. On this basis, we expect the trend of polarisation in the Welsh hills to continue, raising some challenges for future policy aspirations.

Keywords: Agrarian Diagnosis, Policy Impact, Economic Performance, Case-Study, Farm based Approach, System Based Approach, Brexit

Abbreviations

AR: Agricultural Revenue

AV: Added Value

CAP: Common Agricultural Policy

DC: Dairy Cows

DK: Capital Depreciation

EU: European Union

ha: hectare

KL: 1000 litres

MFF: Medium-sized Family Farm

NVZ: Nitrate Vulnerable Zone

Plas: Large farm - possibly estate home farm

RP: Raw Product

SCD: Spring Calving Dairy system based on grass

SMH: Smallholding

UK: United Kingdom

VoC: Vale of Clwyd

Introduction: How to define hill farming?

- **Welsh hills and uplands form a large share of the country, covering very different types of landscape potential**

Hill farming has varying definitions in the literature but most of them relate to relative disadvantage compared to lowland areas. The threshold for farms in an area to be termed Hill farms was initially determined in UK policy almost a century ago, but today is most commonly linked to the definition of Less Favoured Areas (LFAs): areas where farming faces natural disadvantage that were defined under the 1975 provisions of the Common Agricultural Policy (Cooper et al. 2006). These were later extended, differentiated into categories of Severe (SDA) and (non-severe) Disadvantaged Area (DA) and then re-defined as 'Areas of Natural Constraint' (ANCs), after 2013.

The 'hill farming' definition covers areas that combine geophysical limitations operating together and constraining the range of agronomic options: the profile of the relief and relatively high altitude for Britain (200m), that in turn translates into harsher climatic conditions than in the lowlands. At the latitude of Wales the climate gets wetter, colder and windier with altitude (Met Office, 2022). In Wales more than 80% of agricultural land falls into this category, making it a more important feature than in England (which has only 17% LFA; Welsh Government, 2020). A cartographic analysis shows that the only parts of Wales outside the LFA are lower hills, lowland valleys and coastal areas (Cf Appendix 1). Hill areas are often set in contrast with lowlands (Vigani and Dwyer, 2018): they are sparsely populated (under 30 inhabitants/km²), and isolated.

The nature of the uplands is diverse: as a cartographic analysis of North Wales bedrock, superficial deposits, geomorphology and landscape types reveals (Cf Appendix 1,2,3). From the Palaeozoic bedrock that has been slowly eroded, there is a downslope gradation in the landscape. Water does not penetrate the impermeable bedrock of those uplands but feeds into the talweg that feed into secondary valley that feed in wide alluvial valleys to the coast. Resulting from the bedrock hardness gradient, there is a gradation in interfluvial sizes as we get away from the summits; they increase and the relief is smoother. Glaciation features and deposits can usually be found. Combined with the climate parameters and centuries of human use, these areas feature a gradation of a landscape mosaic with a climb from the valleys up to the mountainous slopes (Cf Appendix 5 or Flatrès, 1953). North-Wales uplands are

characterised by the presence of “high altitude” rough grazing or mountain ground. Analysis of the available data shows a split between high upland areas - with a proportion of rough grazing/ mountain of over 30%, and high relief differences- and intermediate upland areas with closer to 15% of more dispersed rough-grazing, with a smoother relief (Cf Appendix 5, Lloyd and Dyfri Jones, 1980). This split is not representative of the split within the LFA designation, as most hill farms would be located in SDA areas and some DA areas would be in lowlands (Cf Appendix 4).

- **Intermediate hills farming a squeezed middle?**

Historically hill areas have been part of a regionally-stratified and specialised system, they focused on breeding and producing store stock for finishing in the lowlands. The use of the landscape was temporally adjusted to make the most of the differential timing of grass-growth on the different landscape strata. After the second-world war and until 2003, these areas gradually specialised in beef and sheep production, mostly finishing lambs but still rearing mainly store cattle. The policy and market context have gradually changed in the Welsh uplands (Midmore and Moore-Colyer, 2005), conflicting drivers and opportunities have grown in importance challenging existing agrarian structures. Exemplifying it the many farms lost to amalgamation (Welsh Government, 2020). Slee et al. 2014, pictured a “squeezed middle” in Scotland, between Upland and Lowland at the meeting point of conflicting or intersecting drivers. The most recent data available shows that it is also true for to the more populated and productive Welsh hill farmers who are facing an increased range of pressures including some found in Scotland; tree planting for carbon offsetting purposes is a common pressure, using land for tourism and leisure, new residents working outside, public good provision... All those while traditional intermediate hill farming beef and sheep systems return low profits that depend heavily on subsidies (Edward et al. 2020), in the future farms will need to have more self-reliant viability as subsidies are set to transition to an increased environmental focus (Welsh Government, 2020). In the meantime, output and input markets have been heavily disrupted by Brexit, Covid and now the war in Eastern Europe (Hybu Cig Cymru market news 2022, AHDB 2022).

The literature notes that these systems tend to have strong social capital value and are seen as central to the social, environmental and economic fabric of the Welsh uplands (Vigani and Dwyer 2018). Despite this, the vision of multi-functionality in past

policies was mostly focused around agricultural activity (Reed et al., 2009). These systems also provide a wide range of ecosystem services and public goods that are spread-out unevenly and difficult for markets to remunerate (Hodge, 2016).

- **Two areas stand out in Wales in their relative divergence from the traditional model**

Two hill areas stand-out in Wales within this “squeezed middle” vision, North-Wales and Powys intermediate hills. While analysing the 2002-2018 period (Welsh government, 2018) we can see that pastoral farming is still dominant (over 90% of farmed area) but those hill areas boast a bigger than ever range of agricultural and non-agricultural production that is particularly hard to understand at a macro level. This is exemplified by an increased proportion of temporary pasture in the farmed area (+2-3%, 2002-2018) linked to more demanding productions, a sharp drop in the number of active farms (-10%, 2002-2018), but a bigger drop in farms with beef or sheep (closer to 15-20%). Amalgamation of farm holdings is as rapid as in the rest of Wales (+18-20ha per farm) combined with a move to part-time holdings, among family farms. Enterprises once part of the mixed farming systems have reappeared in a more specialised form. While poultry production in Wales is indicated to have decreased overall over the last decade (Welsh Government 2018), a landscape analysis across Wales reveals an increased number of sheds in these upland areas, and the statistics report localised increased numbers of poultry (in Powys, notably). Likewise, the Powys and North Wales hills feature increased numbers of dairy cows, in contrast with downward trends in some more traditional dairying areas. At the same time those two areas boast a reduction in sheep and suckler cows stocking density (-1.5-2 Breeding ewe/ha from 4.5 to 5 and from 0.2-0.3 Suckler cows/ha to 0.12-0.2). We are witnessing a landscape use change in these two areas that is not present in other upland areas across Wales after an analysis of maps on the Welsh small agricultural area statistics.

This paper aims to address these research questions:

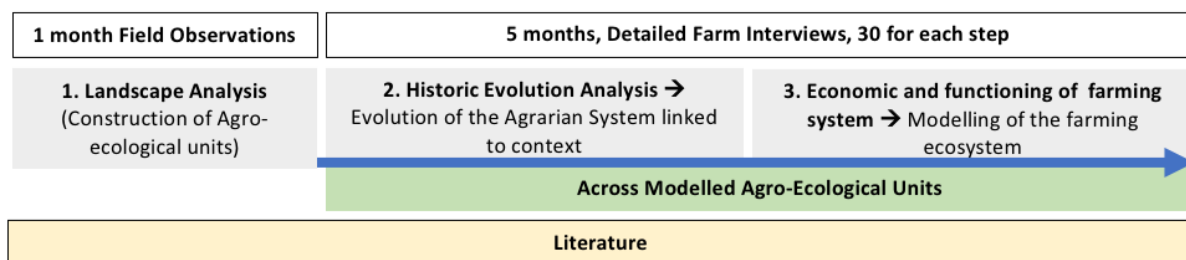
- What are the characteristics of the differentiation of land use and production systems among these intermediate upland-hill farms?
- What has been driving the local evolution of production systems and land uses, and what is likely to happen in the future?
- Are there any differences between the different levels of intermediate hills?

Method, comparing localised case-studies to understand changes

We would like to understand the differentiation that is taking place at a localised scale and its environmental, economic and social aspects. We seek to understand the local dynamics as they are happening now, to be better able to understand likely responses to future support schemes.

The method of agrarian diagnosis (Cochet and Devienne 2007) from French ‘comparative agriculture’ theory enables a holistic systems-based approach to analyse any typical small agricultural area; previously described in Lenormand et al. 2021.

Figure 1: The agrarian diagnosis - detailed study of a small agricultural area (the authors, from Cochet and Devienne 2007)



The typified field study entails three successive and interdependent steps (Cf Fig 1.). The first step is studying and characterising the landscape through desk review and field observations. This is followed by in-depth semi-structured interviews with retired farmers who have witnessed and took part in the agricultural transformations of recent decades. During those, quantified technical, economic, and qualitative environmental and social changes on the farm are discussed as precisely as possible, to understand farmers' motivations in relation to their environment. This enables specific, detailed understanding of farming system differentiation across the agro-ecological units in the landscape.

An analysis of trajectories of farm change takes place using the reconstruction of farm systems through time, generating a typology of farms within that territorial setting. These modelled farm types (‘archetypes’) are linked to their historic differentiation in the landscape. This typology forms the basis for a targeted sampling of farms where a final round of interviews take place: agronomic and economic examinations of existing farm business functioning, based upon characterisation of all the main farming

systems present in the landscape, defined as these distinct 'archetypes' (Cochet, 2015).

Diagnosis at different scales makes it possible to characterise precisely the operating logic of each production system through time and understand its joint evolution with the local environment. Economic performance can be compared across operating structures. We can identify and prioritise between the economic and environmental challenges and constraints faced by each farm type, as well as examine how they combine in the farm decision-making process. This enables us to formulate likely future evolution.

Finally, the generalisation of the findings of an Agrarian Diagnosis relies on the ability to scale its findings up by comparing between areas in different agro-ecological but also socio-economic contexts (Cochet and Devienne, 2007). The trends we are trying to understand are localised but also diversified linked to different development contexts.

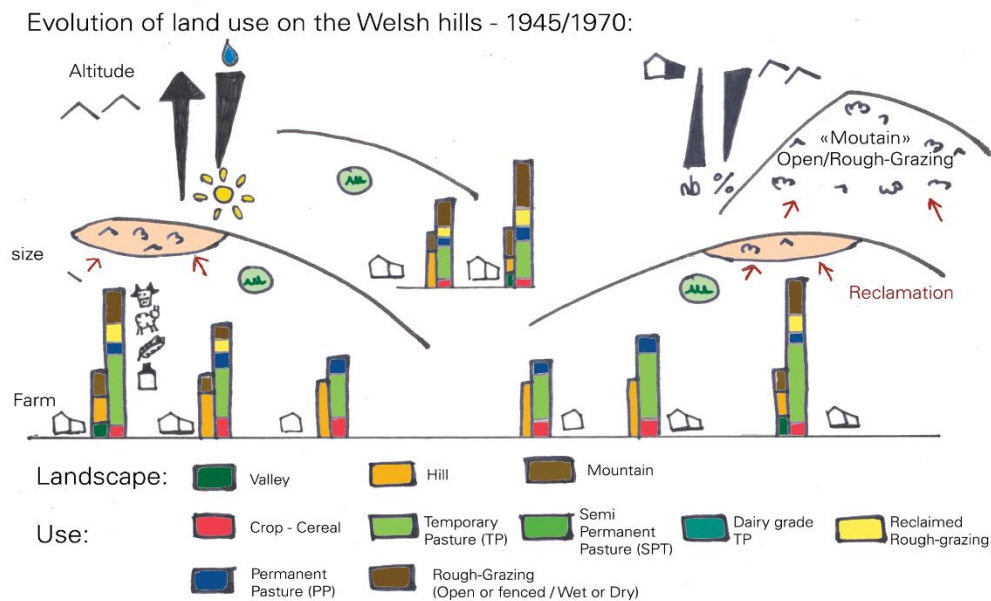
Results: Agrarian Diagnosis case-studies in Wales

As explained in the introduction, intermediate hill landscapes represent a situation in-between mountainous uplands and lowlands. Given the geographical organisation of farming in Wales, intermediate hill farming tends to be linked to other areas, which directly impacts farming and its orientation. We therefore compare and contrast two intermediate-hill landscapes of the Vale of Clwyd (Voc)(Ruthin) and Bala in the Upper Dee Valley, both located in North-Wales (Cf. Appendix 1). The intermediate hills of these two areas are close geographically but nevertheless present different geographical features that match our analysis of the two types of upland organisation in North Wales. The VoC is slightly lower in altitude, has a smoother relief organised around a large depression and has a lower proportion of rough grazing while Bala has a more challenging climate, more deeply entrenched waterways with steeper slopes, a higher proportion of rough grazing and stands closer to Snowdonia.

- **Geomorphology and climatic factors limit farming potential in intermediate uplands (Cf Fig. 2)**

From the hills' bedrock, arise acidic soils that tend to be thin but loamy/clayish, particularly on the steeper slopes and with wet and cold climate conditions giving washed out soils with poor nutrients availability. Combined with the relief it means that the areas that can easily be tillable are limited, even more as we climb up (Chew, H. 1956). They also feature a wealth of semi-natural areas as rough-grazing, often on glacial deposits. In the talweg and valley floor, there are some permanent pastures. Climate conditions restrict growing conditions, with only one large grass growth that cannot be cut and stored as hay (which due to the climate can be difficult to dry) giving a predominantly pastoral landscape with low yields and quality, except in the valley floors (Midmore and Moore-Colyer 2005 and fieldwork).

Figure 2: General evolution of landscape use in intermediate-Hill farming, from after



the second world war to 1970

As a result, the hills focused early on breeding, specific local, roughened local breeds of cattle and sheep would give birth to match the fodder growth with peak lactation, with a gradual movement up and down the slopes to use all the fodder resources through the growing season. The quality and quantity of fodder available would prevent farms from finishing their livestock, which would be sold as stores.

Although hill farms were mixed (ovine, bovine, a few pigs and chickens, some cereals...) as late as the middle of the 20th century, they were predominantly

considered a breeding pool, producing store stock to be sold on and finished in lowland areas.

- **Characterisation of the two study areas:**

The Vale of Clwyd area comprised the Clwyd river catchment area organised around a wide alluvial lowland valley, a syncline with soft bedrock and deep “free-draining” soils, one of the strongest dairy powerhouses in Wales with very high production potential and a favourable micro-climate (Cf Appendix 2 and 3). It is surrounded to the East, West and South by intermediate hills transitioning to mountainous relief with a gradient of hardening but still impermeable mudstone (anticlines). Rainfall erosion and later superficial glaciations, gave a contorted hill landscape relief with some drumlins. Low amount of glacial deposits results in mostly shallow soils except talweg and valleys

- Larger interfluvies. Gentler relief. Better climate.
- Rough-grazing 10%. 10-15% steep slopes. <10% of wet permanent pastures.
- Grass growing stopped by summer drought (max 9-11 T DM/ha/yr), grazing from early April to November. Cereals can be grown on flat bits, lower accessibility challenges.

The Bala area matches the upper Dee valley catchment but also extends onto surrounding mountains used by farms in the area (Cf Appendix 1.). The area is more isolated and scarcely populated and stands on the borders of Snowdonia National Park. This area was impacted more heavily by glaciation giving a steeper relief and a higher proportion of till and peaty glacial deposits, in turn giving heavier soils. The relatively lush, wide alluvial valley transitions up to green hills (brown-topped with semi-natural vegetation) to reach more mountainous parts (higher in altitude – up to 700m - rough grazing with rocky outcrops and screes).

- Smaller interfluvies. Steeper relief. Higher altitude, harsher climate.
- Rough-grazing 15%. 10-15% steep slopes. 15% of wet permanent pastures.
- Grass growing season is shorter but no summer drought (max 9-10 T DM/ha/yr), grazing from early April to November. Cereals cannot be grown easily, accessibility more restricted.

Results of historical differentiation analysis

- **Recent evolution of hill farming to 2003: output growth within farm boundaries for most farms:**

The policy change from 1940-1945 in favour of hill farmers was significant, before this there was little specific support for hills. For the first time hill farms were defined as specific areas and started to receive specific subsidies acknowledging their low production potential (Lloyd and Dyfri Jones 1980) that were maintained once the UK

was in the EEC. The post-war policy focus was on food production (Campbell 1985, Bowers and Cheshire 1983).

As part of this, the hills were transformed, semi-natural areas would be drained, ploughed, reseeded, and turned into perennial grass mixes (maps of Chew, H., 1956, Cf Fig 2. and 3.). Farms were incentivized to focus on the production of grazing livestock due to their geo-climatic conditions. There was a widespread availability of inputs including feedstuff, fertiliser (of different types) that allowed a combined soil and grassland improvement, resulting in improved production of a better-quality grass (protein, sugars...), while more areas were converted to enclosed semi-permanent pasture via reclamation (Welsh Government, June survey statistics). This led to further specialisation of farms in their role as grazing livestock farmers. Increased meat production was the target: a subsidy (the variable premium) was attached to lambs effectively compensating hills for the lower prices they would reach in the market due to their store status and lean conformation combined to specific headage payment and rates for farm improvements (Midmore and Moore-Colyer, 2005).

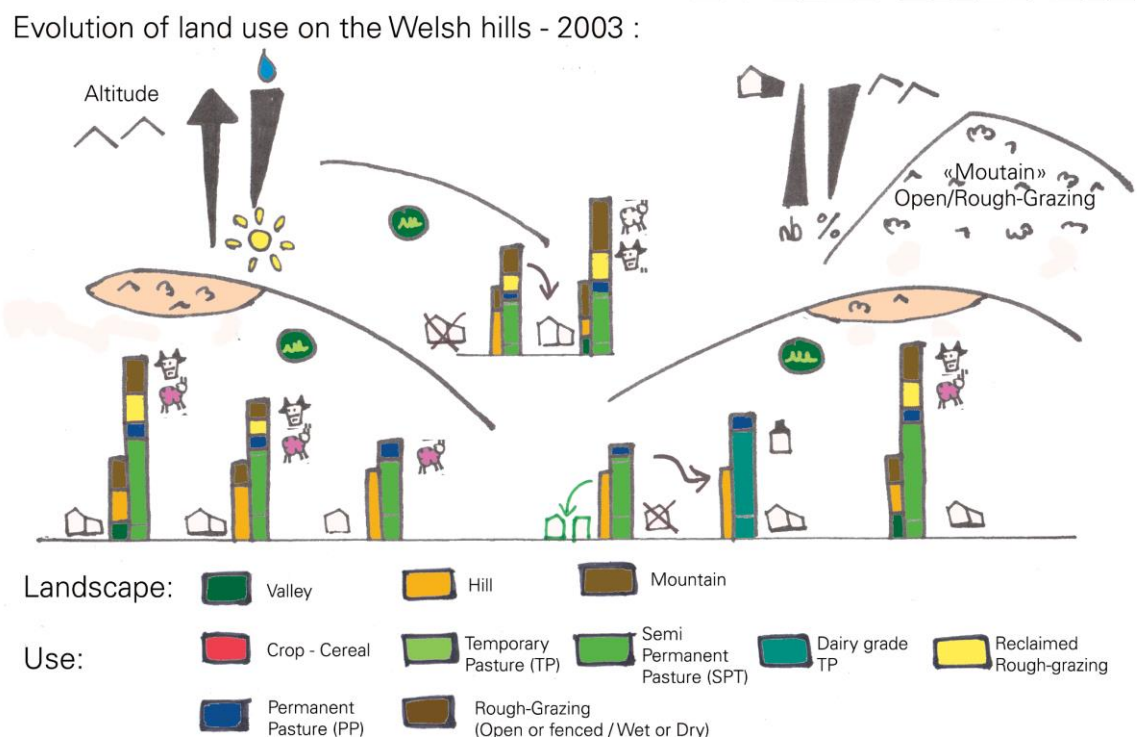
The change in fodder production combined with the feedstuffs now available enabled a switch to larger and more demanding continental and lowland breeds of both sheep and cattle (e.g. Limousin, Suffolk, Texel), depending directly on the proportion of the land that could be worked via tractors, and the rough-grazing land, held by farms. The lower-lying you were, the more you could get out of the different parts of this system. A bigger proportion of farms in the VoC specialised in dairying with its smoother relief, better grass growth curve enabling them to store more fodder.

While the farm and policy environment changed gradually from the early 1980s, becoming economically less favourable for maximising production and with subsidies increasingly paid per head of breeding livestock rather than linked to productivity (Lenormand et al. 2021), a technological package for farming in the hills became available to increase labour productivity, increase output and up-scale farms; with the 4-wheel-drive tractor, quad bikes and big bale silage overcoming geo-climatic constraints around fodder storage for winter. This technology was used by intermediate hill farms to further increase the number of livestock kept, improve the quality of the animals and sometimes shift towards finishing or bringing forward lambing dates (in combination with higher input use). By that time, the few farms that

had made the choice of dairying in the hills gradually transitioned to beef and sheep, in line with those policy and market drivers as were also witnessed in Pembrokeshire (described in Lenormand et al. 2021).

Half a century of agrarian history transformed the hills, and particularly these intermediate hills of North-Wales with their comparatively gentle relief and conditions, compared to Snowdonia. The proportion of rough grazing and rare habitats had reduced significantly (Hodge, 2016), giving way to a relatively homogenous permanent or semi-permanent grassland landscape managed extensively with beef and sheep (Cf Fig. 3)(Midmore and Moore-Colyer, 2005), with stocking densities increasing gradually from 1-1.2 LU/ha (Lloyd and Dyfri, Jones, 1980) to 1.5-2 LU/ha by 2002 (Welsh Government, 2020). The relatively high density of livestock translated into a dense fabric of farms. However, since 2003, the context for Welsh intermediate hill farming has become more complex to negotiate.

Figure 3: By 2003 a relatively homogenous level of landscape use (By the author from fieldwork)



- **Hill farming has faced sharp changes in policy support since 2000**

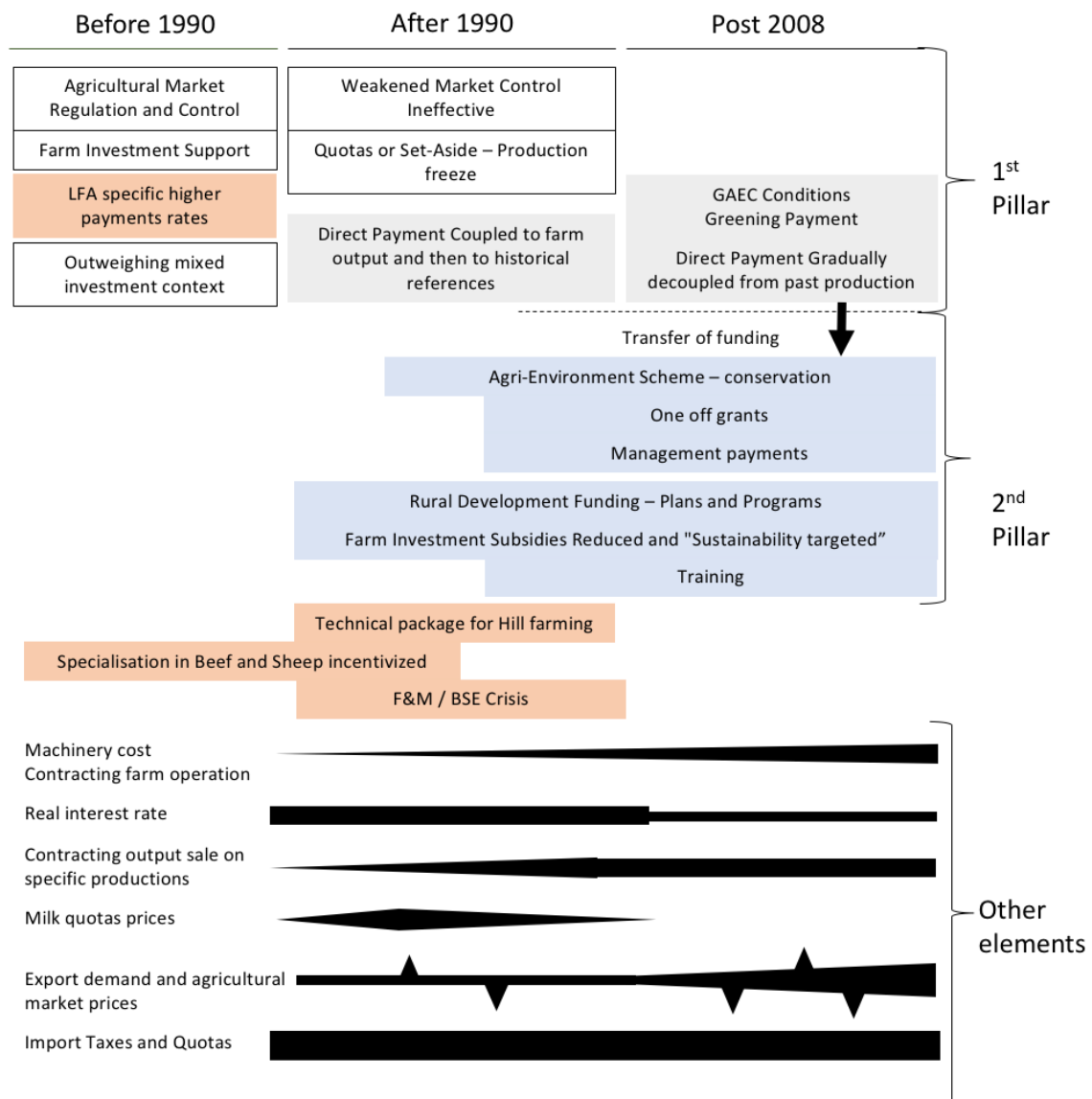
After 1992 the CAP evolved into a twin-track, 'two pillar' model (Cf Fig 4.): one focused on markets, economic outputs, and farm incomes (Barthélémy et al., 1999), the other centred on environmental and rural development measures (Dobbs et al., 2008). The policy was also more developed, enabling national and regional governments to choose the precise implementation of key elements in the package. Market price support measures were gradually weakened and direct payments introduced as a compensation mechanism to maintain farms' income, while agricultural prices were now fluctuating around world market levels (Hobbs et al. 2008).

The second pillar of CAP included agri-environment schemes paying for non-market benefits whose goal was to protect sensitive environmental landscapes. Those payments were linked to long-term agreements to change the management of the land, particularly mountain grazing and protection of some landscape and ecological features (Boatman et al. 2008). The second pillar also featured elements of rural development funding and support.

- **That resulted in a heavy subsidy loss for intermediate hills from 2003 to 2020 leading to rapid differentiation of farms**

In 2003, the Welsh government chose to move CAP implementation wholly away from production-based subsidy payments and implemented a decoupled first Pillar subsidy linked to past output, limiting subsidy redistribution across landscapes and farms (Boinon et al. 2003). Then from 2013, a flat-rate per hectare decoupled Single Payment Scheme was gradually introduced over 6 years (Hart, 2015). Despite having a redistributive payment to smaller farms (defined as those under 54ha), this flat-rate approach favoured large holdings. For hill farms particularly dependent on subsidies (Edward et al. 2020) it represented a major shift. At the same time, the CAP second Pillar subsidies were expanded and the number of farms joining environmental schemes was extended, with part of the funding coming from the budget previously allocated (in Brussels) to CAP first Pillar support.

Figure 4: General drivers of evolution for Welsh hill-farming from before 1990 to today
(By the author from the literature)



After 2003, farms differentiated quickly responding to market and subsidy drivers (Cf fig. 4.), a trend that accelerated further after 2010-2013 following agricultural market fluctuation and the gradual ending of partially-coupled subsidies. This represented a considerable loss to these areas, barely compensated by second pillar schemes, challenging established beef and sheep farms (Lenormand et al. 2021).

The relatively low proportion of land targeted for second-pillar agri-environment aid in these intermediate landscapes (with under 15% of rough grazing/open-grazing, compared to over 30-40% in Snowdonia) and the relatively strong focus on output of those areas (combined to beef and sheep direct subsidy payment rates until 2003) meant that those areas lost between 25-30% of their subsidies over 7 years.

To demonstrate the trend in systems more clearly, in each area we focus on 3 different types of farms with different profiles and access to the landscape in 2003 (Cf Table 1 and Fig 2.); large farms relying at least in part on hired labour that have access to a wide range of milieu; medium-sized family farms that have more limited access and only rely on hired-labour at peak working times; and finally small holdings limited in terms of both reach and labour availability. All these farms were specialised in beef and sheep at the start of our study.

Table 1: Broad typology of farms in our 2 study areas using the agrarian system (By the authors from fieldwork)

Intermediate Hills Farms	Vale of Clwyd	Bala
Plas - Large Farms (Family and hired in)	Access to open grazing and possibly to lowlands, on top of the hills. >250ha	Access to the mountain and possibly to lowlands, on top of the hills. >300ha
Medium-sized Family Farms	Possible access to open grazing. 50-150ha	Access to the mountain - Rented 75-200ha
Smallholdings	No access to open grazing. 20-25ha	No access to open grazing - Rented, 25-30ha

- **2003-2013: Changes in beef and sheep production, maintaining farm income via different strategies**

Table 2: Simple summary of main market trends for a number of economic activities in hill farming areas from 2003-2013 (By the authors from fieldwork and secondary data)

Context for enterprises	Dairy	Beef	Sheep Meat	Poultry	Egg Prices
Prices Demand Quotas/Rights	Remain low Demand on differentiated Cheap quotas	Remain Low Decreasing demand No rights	Remain Low Decreasing demand No rights	Low prices Increase demand No quotas	Low prices Increase demand - differentiated No quotas
Other	Tourism	Land Market	Input prices	Local food	Access to capital
	Strong demand for spectacular areas	Limited demand on hills	Gradual increase	Little demand	Quite difficult easing from 2008

On Appendix 6 a summary of the different differentiation paths of farms can be found

When it comes to Beef and Sheep farms in those hill farming areas it is important to understand the **gradation available in the agrarian system**.

- Those with less favourable agro-ecological conditions (permanent pasture (steep or wet), rough grazing in a gradation) would have specialised on breeding with suckler cows (30 to 40 per worker) and producing stores.
- The gradation would be transitioning from finishing to rearing yearlings (12m stores) or strong stores (18m stores) and in breed types with different demands, from big-framed continental breeds to the smaller Welsh Black Cattle.
- Despite those differences most calving would take place in springtime on the hills, outside.
- There would also be a gradation in sheep numbers and types (rough mountain ewes, welsh mountain, more meaty and prolific beulah sheep, then texels and mules - terminal sires and crosses being part of this picture), using the extra space.
- A gradation also for sheep in terms of breeding stock for the lowlands, in lambing dates (Feb to April) and coincidentally, in growth rates and feed use, with different dates for market access (April to July), resulting in a gradient of prices for lambs (£90 to £70), not affected by subsidy changes. The VoC farms were in a better position market wise due to this gradation.

Large farms (Plas); the larger-acreage holdings could be of two types, either family farms with a large family (over 5 members) or a former estate farm (1-2 family members with staff). The economics of their large beef and sheep production was organised around policies and market incentives (more than 100 Suckler cows and over 1000 ewes).

On the VoC hills, the possible route to compensate for the end of coupled subsidies would be a gradual reduction in stocking density, especially if the farm was overstocked and heavily dependent on bought-in feed (e.g. Table 2). Due to market factors they gradually started to reduce their stocking levels and tried to increase self-sufficiency, stopping barley bull-beef production to produce either strong stores (at 24 months) or finishing on grass (at over 24 months). On the sheep, the focus would shift from maximising ewe numbers to increasing lamb production per ewe, with more attention to finishing weights to achieve better market prices. Better results could be expected on the VoC side, there would be a gradation in terms of breed and sires type leading to a gradation in economics.

For those holding more mountain land, estate-type home farms with less workforce, particularly in the Bala area, they would benefit from agri-environmental payments and would not have been able to increase their stocking levels as much before 2003. They benefited from subsidy rebalancing.

Finally, another route pursued for large farms with a large landholding but not necessarily a large workforce, was transition to organic farming. Without a clear market for organic lamb, the interest was in the subsidy and the proportion of large interfluvies. These estate farms expanded their acreage by taking on more land (either rented or owned - some that would have been rented-out before), while others did so by renting and buying but also increasing their tillage and crops (rootcrops, whole-crop silage), supported by agri-environment payments. Additionally one farm in Bala converted to organic and developed its own processing and retail outlet, based on a tourist market, it represented an outlet for store cattle of local organic farms.

Medium-sized family farms (1-3 family members)(MFF); their smaller acreage and more limited number of family members, most without mountain land (7/10 particularly in the VoC) and with slightly better agro-ecological conditions, may have been dairying in the past.

Those that had retired from dairying in response to market drivers were limited by their set-up to either breeding or finishing store cattle, both with high levels of past subsidies. Despite subsidy reduction their family circumstances would mean less need for income, making some adaptation in terms of reduced input use, with reduced intensity of output per animal but stable output per hectare.

One possible route, particularly for farmers close to retirement, would be to wind down the farm (dropping one enterprise) or maintain it with reduced income. But there was also the possibility to increase labour productivity by increasing size while buying subsidy rights and land and sometimes renting, enterprises remaining the same type but possibly shifting more into sheep if the land was dispersed (Lenormand et al. 2021). Another possible evolution was an association to some lowland's dairy farm growth and hyper-specialisation (Lenormand et al. 2021), they would need someone

to rear heifers for them, but it required smooth relief land for silage, this was restricted to those for those that had been dairying and on large interfluvies to match the fodder production required (quality, quantity).

Finally, in Bala, close to Snowdonia, it was possible to develop camping activities or holiday lets if there was some spare family labour, often resulting in compromise for the agricultural activity. This would be conditional on planning permission. Those with mountain land would be incentivized to remain relatively similar in terms of management by agri-environment agreements, nevertheless they would also try to be more market-focused by adapting their management and trying to rear heavier animals. Some would convert to organic if land was rented (showing the constraint of paying rent), adopting the same changes as for plas farms.

Small holdings (SMH) and smaller medium-sized family farms that might need some income went working part-time, in or out of farming (e.g. pre-retiring, contracting, milking, working in forestry or other jobs). They did not modify their enterprises, merely downsizing. Among these farms, very few would go out of farming and rent out their land as was witnessed in lowland areas (Lenormand et al. 2021).

Overall, the more difficult context meant that despite looking for a greater reliance on farm-produced fodder and a more market based approach, adaptation resulted in increased use of semi-permanent pastures, maintaining the picture of figure 2, but not necessarily with a more extensive management (in fertiliser use or grazing intensity). The agri-environment subsidies were relatively popular on medium-sized and large farms - even farms without mountain land - incentivizing modest increased diversity in the landscape with fodder cropping (e.g. whole-crop barley and peas, turnips). There was a slow reduction in the number of farms and workers.

- **2013-2022: Combined to a more buoyant market context for farming, the new decade opened new opportunities for farming that lead to a reorientation of North-Wales upland**

Table 3: Simple summary of main market trends for a number of economic activities in hill farming areas from 2013-2022 (By the author from fieldwork and secondary data)

Context for enterprises	Dairy	Beef	Sheep Meat	Poultry	Egg Prices
Prices	Gradual increase	Very gradual increase	Very gradual increase	Low prices	Low prices
Demand	Demand increasing No quotas	Demand increasing	Demand increasing	Increase Demand increasing	Increase Demand differentiated
Other	Electricity generation	Tourism and residential	Land market	Input prices	Local food
Easy to access capital	Feed-in-tariffs 2012-2019.	Strong demand for rural areas	Growing demand due to new uses	Volatility but relatively high	Growing demand

For the large farms, the rebalancing of subsidy payments (Cf Fig 4.) benefited those with mountains or was at worst neutral for those with little or no rough grazing. In general, the continuing poor economics of beef and sheep, particularly for stores and light animals, has meant that new income options were sought, including tourism and conversion to organic. New income possibilities appeared, first electricity generation - mostly hydro-electricity or wind generation making the most of the feed-in tariffs (Cf Table 3).

Farms owning their land (over 80% of it) with large families with less mountain land were the most likely to remain fully in beef and sheep, possibly finishing more cattle and growing more of their own fodder, but reducing their suckler herd. The strategy to increase the size of the holding was still retained by some farmers without the larger (particularly owning their land). It was often coupled to a diversification strategy on other economic activity not impacting the farm activities as much as for MFF (camping...).

Others gradually and increasingly moved into spring calving dairy systems (SCDs), following the example of New Zealand, focused on producing milk cheaply from grass with a high labour productivity and a technical package framed around low-cost

operation designed for as much grazing as possible, matching the production of milk to the grass growth cycle (Hugonnet, 2018). Although first implemented in the lowlands this system was also suited to hills. With small and light cows, an intensive and efficient management of grassland combined with tracks to access the fields, early growth and productive rye-grass pasture (sometimes mixed with other perennials), those characteristics fit well the gentler parts of the intermediate hills. The economics are good as they only need very little infrastructure due to the low yield of these cows (6KL/DC maximum, high solids). However, herd numbers have to be relatively high to compensate for the lower yields. They are often coupled to no-till grass renewal techniques.

There was gradual development of SCDs on the hills from 2013 by those large farms with access to large interfluves and can offer a large and “relatively” smooth grazing platform for the large herd. Besides, the infrastructure available would often need less adaptation to be transformed for dairy cows. In many cases the mountain land and rough hill grazing far away from the homestead would be managed using a now separate, sheep-only system, though the dairy land might be used for wintering sheep. This trend has gained pace and started to attract large family farms with few family workers. Covid did not stop the trend of conversion as the appetite for commodities kept growing and borrowing conditions remained supportive until 2021 (but it slowed the speed due to supply-chain issues, Bank of England 2021). The development of those systems rely on share-farm systems that have now developed using profit-sharing models to more easily match land, built capital, working capital and labour (Williams, 2011 or Wynne-Finch, 2012). Like this, they also offer a pathway for new entrants into farming (As shown in Amiss, 2010). The structure of those profit-sharing models vary wildly between farms, the more recent creation usually being less favourable towards farmers.

On these larger farms, forestry or woodlands are already present, so forest expansion would only require a relatively small change in management if markets and/or subsidies are favourable.

For medium sized family farms; these lost a lot from the policy changes given their intermediate position, particularly if they did not have mountain land. On most farms

with 1 to 3 family workers, succession was happening while the economics of beef and sheep remained relatively difficult, particularly for those that struggled to finish or to match peak demand times, adequate weights and conformation. At the same time there are strongly-felt-barriers to farmers leaving their farms (Reed et al. 2002).

Having mountain/open-grazing land was a determining factor in retaining more traditionally-oriented farming systems in beef and sheep, but complementary activities might be needed to support succession: for example, a high added-value system not dependent on land (poultry) or electricity generation. These elements are reliant on the capacity to borrow and planning permission (location dependant). Without heavy investment, further expansion could be sought or a different management of the farm by reducing inputs use and improving the conformation and weight of output using rotational grazing techniques, or more tillage.

With less attractive subsidies, many farms without planned succession have started renting out their land, pre-retiring, sometimes letting it to dairy spring calving units, with a developing market for renting or downsizing while now planting trees. Also, rented farms have been taken back in hand as secured multi-generational tenancies come to an end to be re-let at higher prices (in relation to expected higher possible prospects) or incorporated into dairy units. Some might have been downscaled to small holdings, as part of the farm is removed.

In the lowlands, the change in policy and market context emphasised in Lenormand et al. 2021 has fuelled continuous development of dairying with further hyper-specialisation and fast differentiation. It meant that expanding landlocked lowland farms would gradually look uphill for fodder and potential rearers for their heifers. Operating parts of the farming system of lowland dairy farms under contract has been an interesting prospect. Rearing heifers through contract can be a secure income while limiting capital immobilisation. Different levels of risk are linked to different levels of integration with these dairy farms. Finally, with the rapid development of SCDs, the latter have looked for additional land/farms for rearing animals or producing fodder, further incentivizing this move and also going uphill. These systems might still have some sheep, particularly if they hold mountain land. The decisive factor would be the

infrastructure available and the ability to get access to land where it would be possible to produce good quality dairy grade silage.

More recently, the favourable context for dairying and the gradual increase in share farming, has trained and empowered a growing pool of potential managers ready to take up the challenge of operating their own unit. Recent volatility, history and lateral thinking suggest that these systems will remain profitable. This means that lack of succession or end of tenancies on some MFF has meant the land was converted to dairying, by estates or by their farmer owners. Smaller grazing platforms require some additional land, less adequate infrastructure requires more investment per cow, and increased appetite from landholders given the scarcity of land on offer (Lenormand et al. 2021). This accelerated the sub-contracting route described above. There are different sizes of herd depending on the size of the grazing platform available, but usually smaller than large farm-based SCDs.

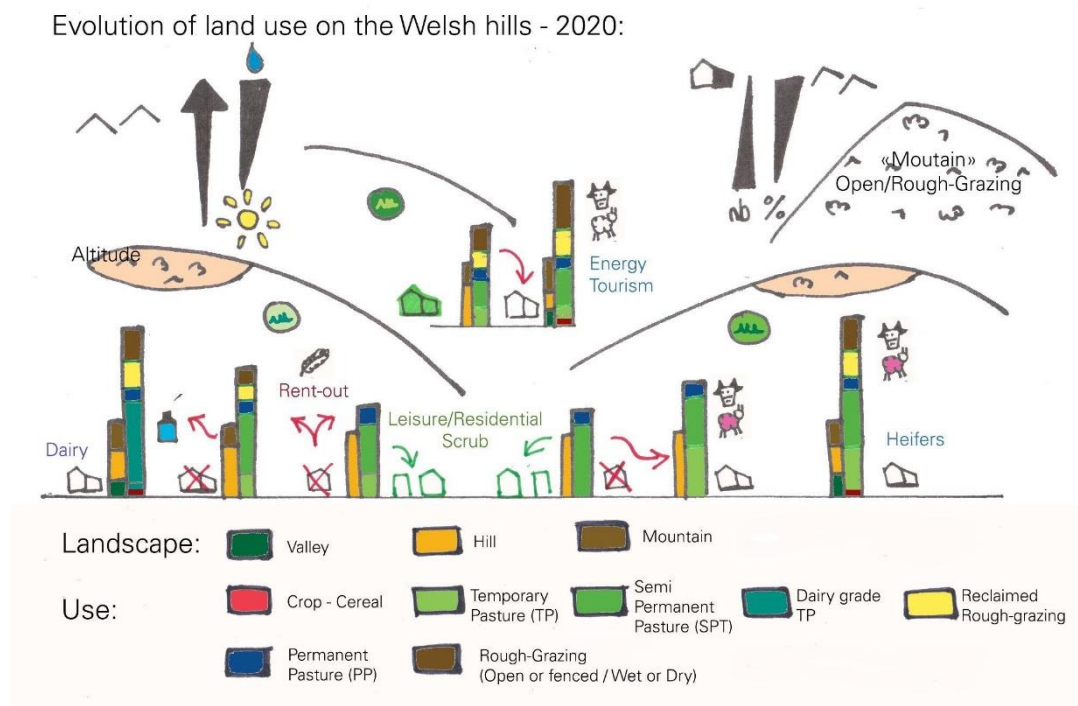
In general, the development of SCDs in the hills has gradually climbed up the geomorphology, climatic and infrastructure scale. In future, more diversity may arise, for example going organic or adopting regenerative systems to deal with this diversity.

Other options that have been available to farmers have been poultry-units. Historically in our study areas very few farms specialised in it. But with the gradual increase in consumer preference for UK eggs and poultry-meat, there has been a need for new units, production being planned by the integrated supply chain. Looking for pools of livestock-knowledgeable farmers was one factor -as in Brittany (Canevet, 1991)- but contract-economics improved after 2008-2010 with relaxing of borrowing conditions which meant that poultry was an option for farms with labour available and an ability to borrow. Planning restrictions including some linked to the neighbouring AONB or National Park limited which farms could move into poultry. Laying hens have been more popular than poultry-meat production due to the higher labour required for meat production and lower cost (the standard hen shed standing at 16 to 32k hens vs 50 to 100k broilers units). These units may need more land or other people to take manure.

On small holdings, with reduced subsidy from the CAP, as farmers grew older some farms were rented-out to other farms and some sold, including for residential and

tourism use where there was no succession. But at the same time there was a greater appetite for local food (local residents and surrounding towns, sometimes linked to tourism). For small holders rather than remaining part-time (or pre-retired) on the farm with a conventional small beef and sheep system (producing stores and late lambs sold at market) there was an opportunity to go towards small hen units (eggs marketed locally), locally selling meat, or even setting-up a micro-dairy: mostly associated with succession.

Figure 5: Landscape of the intermediate hills in 2020, some important changes compared to 2003 with different uses of the landscape (By the authors from fieldwork observations)



The first half of these holdings would now have decreasing or no agricultural output and lesser land management that could lead to scrub or bracken increase. For the other half of them, the changes in process require knowledge, a local side-job to support the nascent activity, or some external financial backing. Such systems could be associated with higher rental value, in cases of the farms being relet. These farms would also be among those trialling alternative management approaches, on grasses and mixes, intensive rotational grazing, no-fence collars or “regenerative approaches” trying different approaches to environmental and lower input management.

As such, the use of the environment went two different ways, one decreasing in terms of land output, sometimes with problems of encroachment and degradation of the vegetation, sometimes to reduce input dependence but with management maintaining an open sward; but the rest of the landscape has seen increased levels of output and sometimes inputs due to the development of dairying and poultry. In the latter case its impact can be spread over several farms and substitute for artificial fertilisers. For dairying in the uplands different approaches are taken to increase the level of output: increased tillage and re-seeding, increased use of imported nutrients (feed, muck, fertilisers) but also particularly in the Vale of Clwyd, crops (roots), while elsewhere, new approaches are trialled (regenerative farming).

Conclusion of the historical analysis

In the less supportive context of recent policy change, we observe how farms that survive (or new entrants), had to increase their added value by either intensifying the use of the best agro-ecological units and/or investing more capital in specialised systems (spring calving dairy, heifer rearing, poultry). For the many farms that are not able to pursue those strategies, options are either retiring or going part-time. This selection process is linked to past agrarian history and socio-economic characteristics of farms (including landholding patterns). This differentiation and the trend of agricultural development in Wales has played a part in developing the rental market in the uplands. While sheep can still be seen in the landscape of these intermediate hill areas, they no longer constitute the dominant output.

Results - economic analysis

Definitions: by Raw Product (RP), we mean the value of the farm's output; by Intermediate Consumption (IC), we mean the value of all intermediate inputs used to produce the output on a regular basis (i.e. bought-in feed or fertiliser, but not buildings). Capital depreciation (DK) represents the annualised cost of farm infrastructure. Added Value (AV) is the difference between the RP and the costs: it represents the economic value created as a result of on-farm production. All the economic analysis is based on an average year for the farming system.

The economic results derive from economic analysis of the identified 'archetype' farming systems, described in the method. We present the economic performance of 13 archetypes that represent the diversity of enterprises resulting from the differentiation described above (Cf Table 4), including both traditional systems and those arising in the intermediate hills as identified by fieldwork in the study areas. 6 of our archetypes have small-scale electricity generation but only 2 export electricity. All monetary values are in pounds sterling 2018 values.

Table 4: Description of farming archetypes studied in the economic analysis (abbreviations referring to the history part)

Spring Calving Dairy 500 DC- 5,5 KL- estate Share farming - Bala area
Spring Calving Dairy 400 DC -5,5KL- Large Family Farm Share Farming - VoC
Spring Calving Dairy 200DC -6KL- MFF - VoC
Rearing Dairy Heifers and Sheep (rough), and electricity - MFF - Bala
Beef Finisher and Sheep (mix) - Strip of land - Large farm family operated and electricity - Bala
Organic beef and Sheep (mix) and electricity - Strip of land - Large farm family operated - Bala
Laying Hens, Sheep finisher and ewes (lowland) and electricity - MFF - Bala
Broilers and Sheep (lowland) and electricity - MFF - VoC
SMH local food Beef and Sheep (lowland) - VoC
Sheep only hill (mix) - Split - Large Farm split in two - VoC
Sheep SMH family (lowland) - Bala
Rent-Out Farm SMH fam - Bala
Hens eggs sold locally and Sheep (lowland) and electricity - SMH family - Bala
MFF: Medium-sized Family Farm SMH: Smallholding Voc: Vale of Clwyd

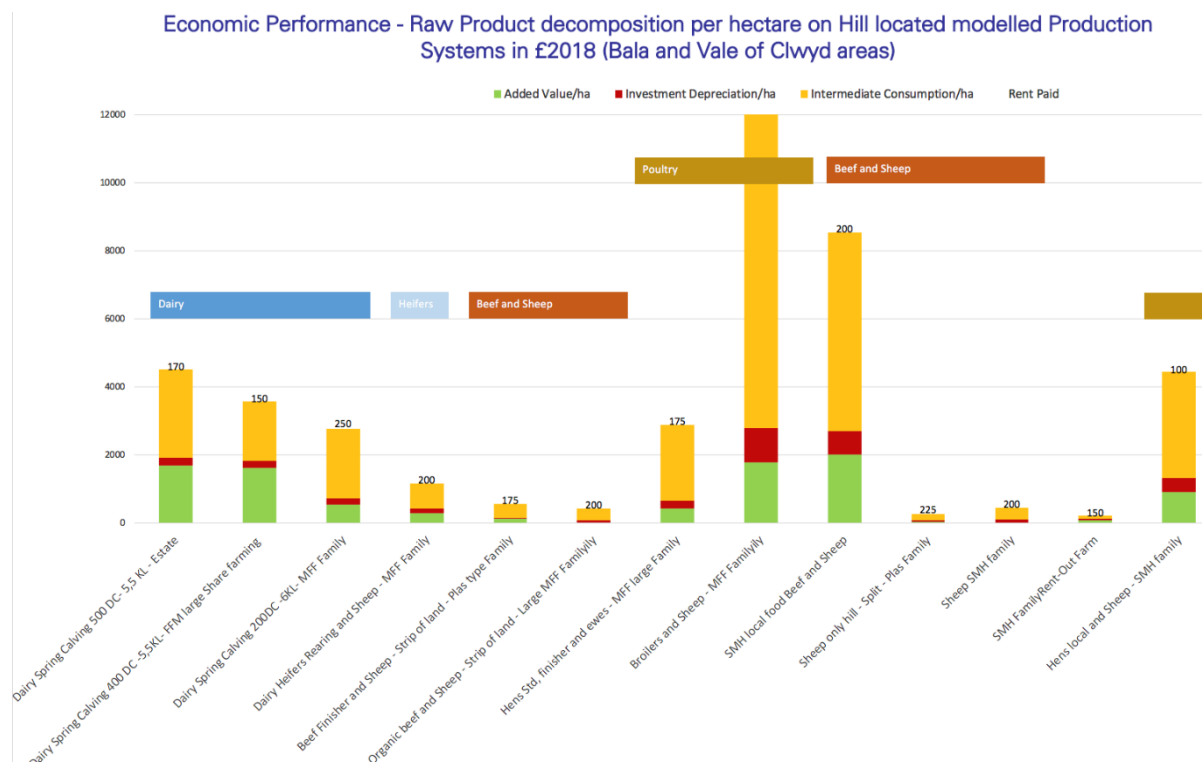
By looking at the agricultural revenue (Added Value - Taxes - Interest - Rent + Subsidies)(before tax), we compare different farms regardless of their business structure, important in this case as SCDs have different arrangements to family farms. Agricultural revenue is therefore examined per full-time equivalent "family worker" (or partner) working on the farm.

- **Raw product decomposition per hectare on hill per hectare (Figure 5) and per worker (Figure 6).**

AV per worker shows the different level of labour productivity of the economic activity of farming. There are enormous differences in terms of land use economic intensity, developing systems are over traditional productions (albeit more decoupled from the land for poultry systems than the others).

SCDs farms, despite their high IC and DK (though lower than lowland high-output systems) show high AV per hectare and per worker. On the flipside, beef and sheep systems' AV are lower and can even be negative, not due to high input use but more to the low value of their production and how extensive it is. Nevertheless, finishing cattle can give a good level of added value per worker, better than organic.

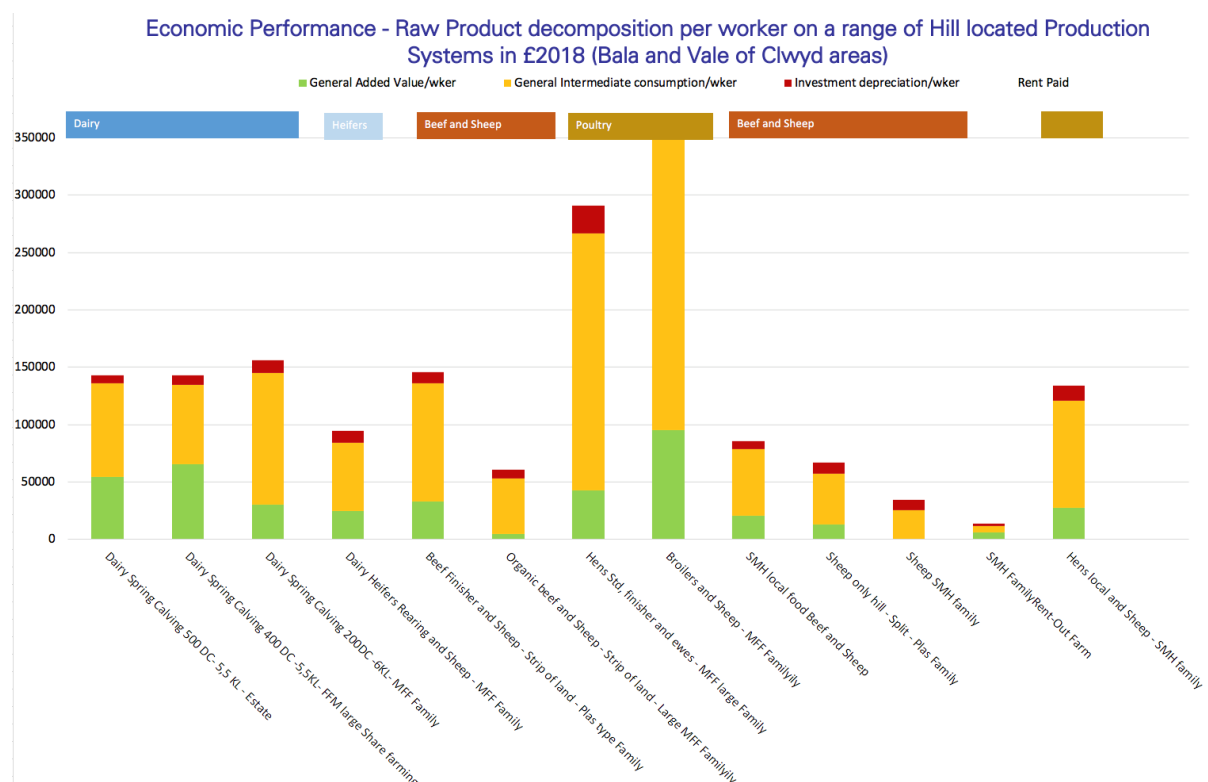
Figure 5: Economic performance per hectare of archetype production systems (By the authors, from fieldwork)



We note that broilers and laying hens all return similar or higher per worker or per hectare AV, while their level of input use dwarfs all other archetypes of the study. The laying hens archetype has much more land and workers and therefore has a lower

labour productivity than the other poultry systems: while retaining good added-value, it also uses fewer inputs overall. We also note that based on economic value creation, none of the traditional beef and sheep systems could pay the land rent per hectare, in contrast to the newly-developing systems.

Figure 6: Economic performance per worker of the archetype production systems (By



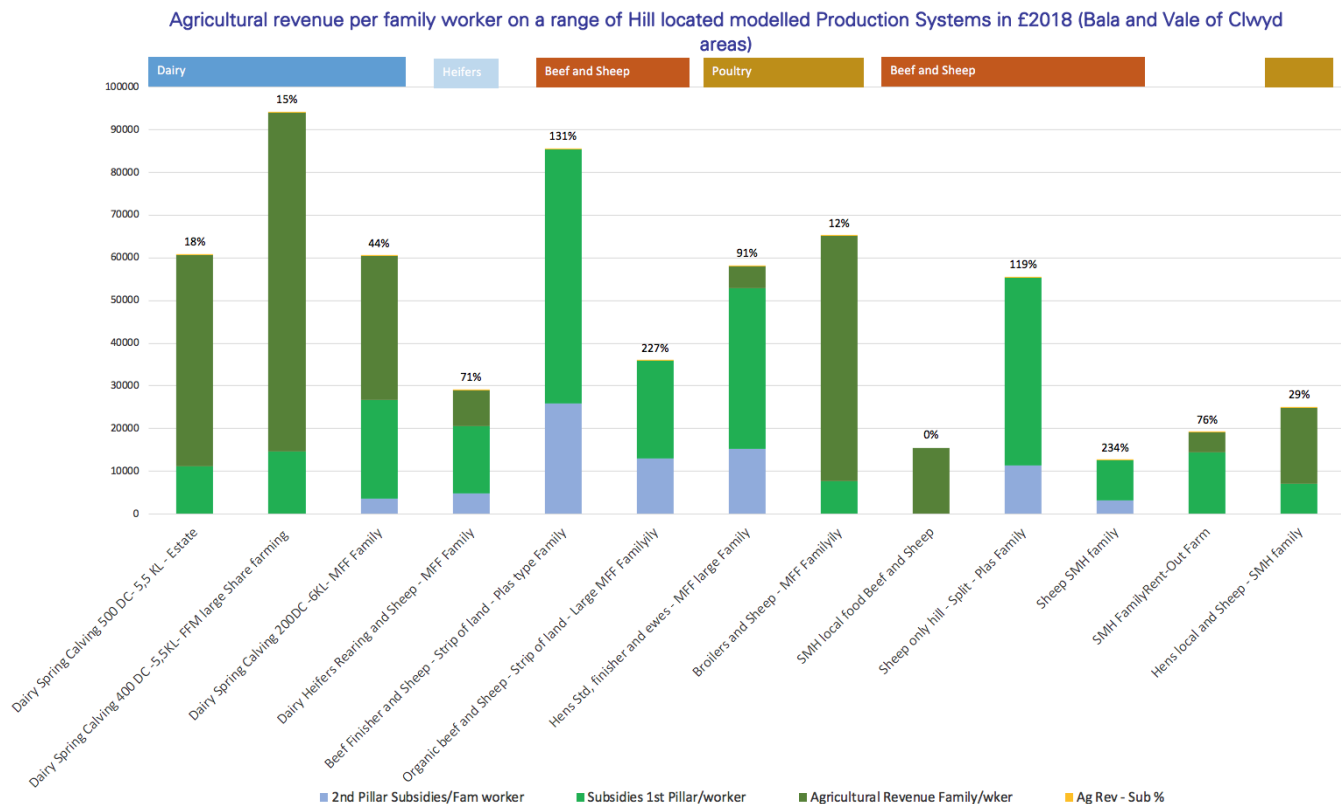
the authors, from fieldwork)

The local food SMH on beef and sheep is impressive in terms of economic value generation, higher than all other beef and sheep systems per hectare, with a different land management, but a lower value generation per FTE worker.

Finally, heifer rearing gives a higher economic generation per hectare than beef and sheep farms at the cost of increased inputs (and land use), while per worker it is on a par with local food producers.

- **Agricultural revenue per family worker and subsidy dependence (Figure 7)**

Figure 7: Pre-tax agricultural revenue per family worker on a range of archetype systems (By the authors from fieldwork)



The spread in agricultural revenue per family worker (pre-tax) is more limited than that for AV per hectare but there are differences in terms of systems' subsidy dependence. Dairy and poultry systems do not depend heavily on subsidies (<45%) but rarely have access to agri-environment subsidy (except the laying hens archetype which also has mountain land).

Without subsidies, these systems would still return an income over £30,000/year. Heifer rearing has a higher dependence on subsidy but much less so than beef and sheep systems. The organic archetype is more subsidy-reliant than the (slightly larger) finishing cattle one.

Renting-out the farm appears a logical choice, economically speaking, compared to working part-time on it, particularly if subsidies are attached. The split of estate/large farms into a sheep holding (very simple with high labour productivity) and a dairy holding returns a higher income than keeping the two farms together, particularly if they have access to agri-environment subsidies. Finally, the local food archetypes show a low reliance on subsidies but not very high levels of income: for the beef and sheep one, the farm is a part-time venture.

This differential in economics combined with the historical analysis explains the drivers of farming evolution in these intermediate hill areas. The archetype economics are based on an average year, showcasing a stable vision of family farms with strong commitment to the farm and a given production pathway (Gasson, 1993). For example, investing in production with a partner partly locks the farm's evolutionary trajectory. Share Farming SCDs or poultry units are planned for 20-30 years ahead. Share Farming renders those systems slightly more fragile in the face of lasting future disruption or crisis, and it also complicates decision-making, but the partners are involved together so the risk is shared.

The relatively level agricultural revenue shows the importance of subsidies for some systems as well as the weight of rent, tax and interest.

Finally, while some systems might not return a high agricultural income, it takes time to build income-generating elements such as a customer base for local products, or to trial innovations, while also continuing with general planning, e.g. land or livestock improvement (boundaries, soil quality...). These developments are enshrined in a long-term sense of culture and belonging, linked to sustained use of the landscape.

Will future agricultural policy, in a more challenging context, impact the current trends?

A new Welsh Agricultural Policy and post-Brexit trade and market environment mean farmers face many changes. Farm support will move towards a predominantly 'public goods for public money' model, although with some support for business development goals and perhaps a modest element of (implicit) income support. To date,

intermediate hill farms without open grazing or rough grazing land have not changed their management significantly when taking part in past agri-environment schemes in Wales. Future uncertainty has triggered more people to look for options to develop their farming system and add income streams (from fieldwork). But in these intermediate hill areas, the analysis demonstrates that this trend has already been evident for a long time: at least since 2003. It is therefore important to try to understand whether the new paths currently developed will be retained under different possible contexts in the longer term, by examining the sensitivity of the archetypes to such changed circumstances.

Dairy markets are likely to benefit from a modest economic upturn arising from the increased transaction costs now faced by imports (Dwyer, 2018; ERAAMP, 2020). The picture is much more complicated for beef and sheep markets: although ex-ante analysis (Dwyer, 2018) seemed negative, the COVID crisis and current buoyant market context present a more nuanced picture, particularly in a context where the Wales breeding herd or flock is contracting (Hybu Cig Cymru, 2022). This signals a tightening of British supply that is unlikely to be impacted by trade deals in the short-term. But those market contexts will be accompanied by the volatility typical of liberalised markets, for both inputs and outputs, as witnessed in the COVID crisis.

To examine future prospects, we focus our analysis on 5 different archetypes: a beef finisher with some mountain land, a dairy spring calving herd with 500 Dairy Cows, a laying hen farm, a small holding selling locally, and a sheep farm resulting from the split of a large farm in two (dairy and sheep). This allows ease of representation while still including a significant range of production systems. Our future time horizon is 10 years therefore levelling some of the localised volatility but also considering the potential duration of future schemes.

Hypotheses

- We take as a hypothesis that the investment context will remain favourable in the short-term with low real interest rates (Bank of England, 2022). The current trends in milk and meat markets will continue, in terms of price and volume.
- The new subsidy scheme will be conservative in terms of subsidy allocation between uplands and lowlands. The scheme will also be conservative in terms

of approach, offering an entry-level payment (L), an advanced one (H) and an organic/afforestation one (O). We consider a 'low budget' option which would result in a cut of 30% of agricultural subsidies, against a 'generous budget' option which retains the current overall amount of support. There are some transaction costs. All of the schemes target active farmers producing agricultural outputs from their land.

- We take as an assumption that supporting advice will be retained as it is now with provision by Farming Connect and Menter a busnes, and that investment and processing subsidies will remain at current levels in the 'generous funding' option (helping NVZ adaptation). We keep the farmed area to a similar level as now, and set inflation at 2% per year.
- On market prices we assume that low input prices will occur when prices are low and that high prices would concur with high input prices (mirroring trends on commodity markets and sellers' pricing strategies - from fieldwork and secondary analysis)

Other Hypotheses to construct the scenarios are developed in Tables 5 and 6.

Table 5: Future simplified scenarios of funding for hill farming. By the authors adapted from Lenormand et al. 2021.

	Generous Funding	Low Funding
Hypotheses	Funding Constant Transaction cost 20% for High and Organic scheme Investment Support - NVZ/ Welfare/ Business	Funding -30% Transaction cost 20% Investment Support - Poor and Competitive
(% of the land)	40% L 30% H 30%O and F	50% L 25% H 25% O and F
Low Tier (L)	+ €119 ₂₀₁₈ ¹ /ha	+ €90 ₂₀₁₈ ¹ /ha
High Tier (H)	+ €210 ₂₀₁₈ ¹ /ha	+ €183 ₂₀₁₈ ¹ /ha
Organic and Forestry Conversion/ Maintenance (O)	+ €164 ₂₀₁₈ ¹ /ha	+ €239 ₂₀₁₈ ¹ /ha

Table 6: Market scenarios retained (By the authors from interviews and farmgate input/output price evolution analysis FAOSTAT/AHDB)

High Prices	Low Prices
Milk: 110% - 30 pence/litre* Sheep: 105% - 90 £/lamb* Beef: 110% - 1100 £/Store* Input costs: 120% <i>Average price given by farmers depending on their product characteristics, in interviews.</i>	Milk: 95% - 26 pence/litre* Sheep: 95% - £80/lamb* Beef: 100% - £1000/Store* Input costs: 100% <i>Market conditions selected as gathered from literature and interviews.</i>
Support Farmers, Renting-Out: Income depending on other farms' economic performance *Prices are purely indicative and do not reflect output pricing in the archetypes **All prices would be converted to £2018 ¹ afterwards	

Those variations gave us 4 different scenarios to test on the farm archetypes mentioned above. The scenarios are as follow:

- Scenario 1: Low prices inputs and outputs, combined with low subsidy payments
- Scenario 2: High prices for inputs and outputs, combined with low subsidy payments
- Scenario 3: High prices for inputs and outputs, combined with high subsidy payments
- Scenario 4: Low prices inputs and outputs, combined with high subsidy payments

The results of the simulation are shown in Figure 8.

The dependence on subsidies remains high for beef and sheep systems particularly if they are based in the harsher parts of the landscape or have mountain land, but their income is high and stable. It is likely that there will be in this case relative stability for those able to access the scheme. Local food systems and dairy spring calving would depend relatively little on subsidies.

The envisaged hen farm has some mountain land and features and remains large which maintains some level of dependence on subsidies, it also has a high number of family workers. But those who would struggle the most to deal with a crisis would be small farms despite a better economic return than for those having only sheep. All the

models that result from new differentiation options fare well whatever the future scenario except perhaps the smallest farms for which we could assume that they would grow gradually in terms of size.

Figure 8: Evolution of farm agricultural income for 5 different farm archetypes over 4 scenarios (By the authors)



We note that maintaining subsidies based on acreage and a relatively conservative scheme would favour incumbents as well as the splitting strategy that some have decided on, trying to separate areas for conservation compared to areas dedicated to economic production; this is obvious for large farms but is also a possible trend for MFF.

Discussion and Conclusion of economic analysis

Brexit is a shock and likely to lead to more challenging conditions for hill farming communities in Wales. Low intensity beef and sheep grazing systems are important in managing existing intermediate hill landscapes (Midmore and Moore-Colyer, 2005; Vigani and Dwyer, 2018), they dominated our study areas for decades with varying levels of intensity of landscape use. A likely impact of post-Brexit scenarios seems to be polarisation of the landscape, with a growing share used by higher added-value production systems of higher land-use intensity. At the same time some land is leaving

the agricultural sector or management is strongly reduced, as a result of reorientation of economic activities.

In the light of further farm structural change and amalgamation of holdings, it seems likely that these areas will absorb some of the anticipated increase in new land uses. The literature and data (e.g. ERAAMP 2020, NRW statistics, Manzoor et al. 2021) show that afforestation could gradually gather pace in Wales. Although we did not witness these trends in North Wales - likely because the strong differentiation witnessed makes afforestation a less competitive option - it might emerge within the polarisation of landscapes as set out before (Lenormand et al. 2021).

The Welsh government may wish to ensure that the Sustainable Farming Scheme, and the wider regulatory and market policy context within which it sits, are sensitive to the pressures upon intermediate upland farms in LFAs which often face trade-offs between production and conservation (Slee et al. 2014). The holistic Welsh policy approach will need to understand the challenges associated with these landscapes and seek to maintain a coherent and multi-functional mix of farm enterprises and related land management, to ensure the sustainability of the upland landscape, retaining jobs and farming communities and the cultural and social values that these embody, without a dualization of the landscape.

For example, the development of upland dairying is of concern for environmental and social reasons as it encourages split farms without the option to retain traditional use of the land. While creating a new simplified framework of management, it is profitable and supports more workers but does not change the capital accumulation process. The development of poultry farming came as a stop-gap to limit people leaving the land when traditional outputs were not remunerative; it has potential negative environmental consequences. Both those evolutions render the farms that choose them locked into a pathway of further specialisation and low bargaining power in the supply chain. Finally, despite good economic performance per hectare, the local scale systems are specific and target a retail share which is less than 3% of the UK food market (probably around 0.1 to 0.5% - Kantar, 2022), meaning their scalability could be problematic despite the fact that their environmental and social advantages.

Small and subsidy-reliant farms could be most at risk of disappearing if not supported in an adequate manner, independent of acreage. For people without farms, SCDs systems with share farming allowed them to overcome several barriers to new entrants (Williams, 2015), they represent the one selective and specific path (Lenormand et al. 2021).

Running our future scenarios in these landscapes suggests that most possible development routes will continue to weaken the viability of “traditional” beef and sheep farms, possibly stimulating further evolution towards higher added-value production with harmful environmental impacts, even in a situation of high input costs and more difficult market conditions, particularly in poultry. The extension of Nitrate Vulnerable Zone restrictions will not greatly affect those farming systems, given their ability to rent additional land from retiring farmers on which to spread manures and/or grow fodder (Lenormand et al. 2021). Competing small size archetypes with low profitability would struggle to pay a high rent except if they have high added-value systems (horticulture, hens...) that come with requirements or high investments. Beef and sheep production systems will lose ground even in relatively supportive policy scenarios, and there could be further retirement and diversification in future. These elements would reduce farmers’ land management time even if they could increase their income streams and possibly reduce subsidy dependency.

Finally, in uncertain conditions managing a farming system is extremely stressful as shown by surveys (RABI, 2020). Farms are looking for certainty and relative security: if those cannot be guaranteed through future schemes, further farming systems change is likely.

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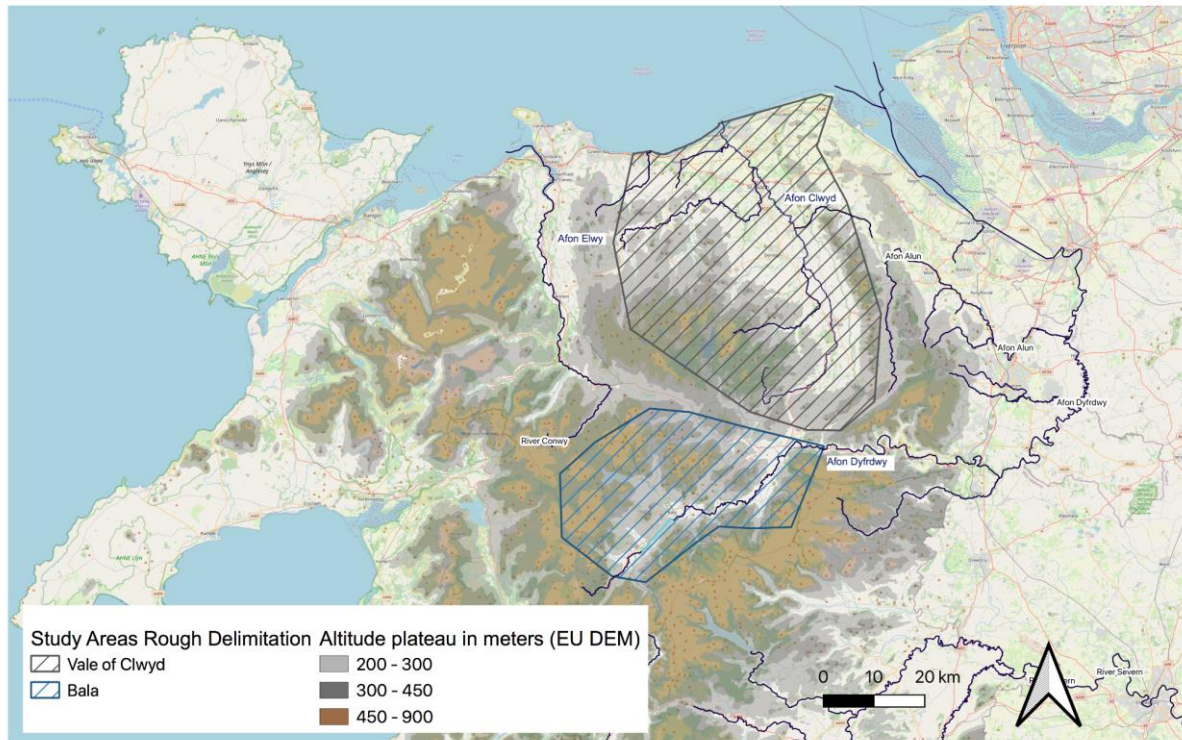
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Appendix Maps:

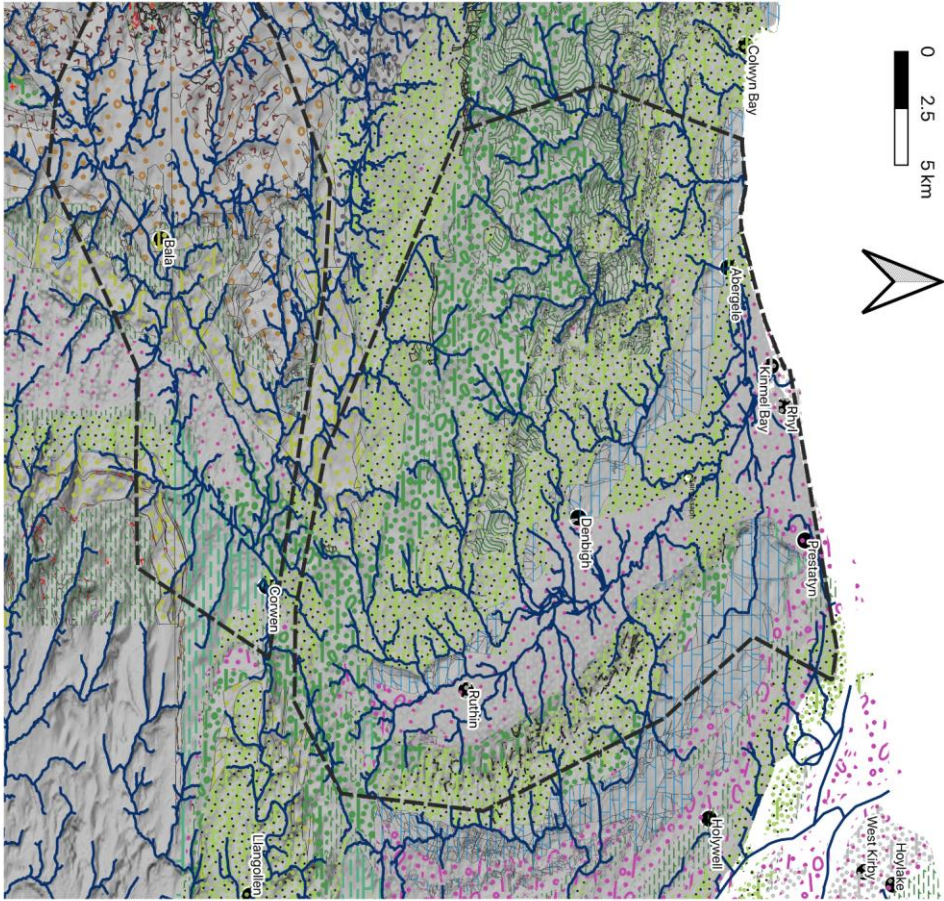
Appendix 1: Situation Map

Situation map of the 2 study areas in North Wales; the Vale of Clwyd and Bala areas both feature extensive hills (By the authors, OpenStreetMap, EU DEM elevation data)

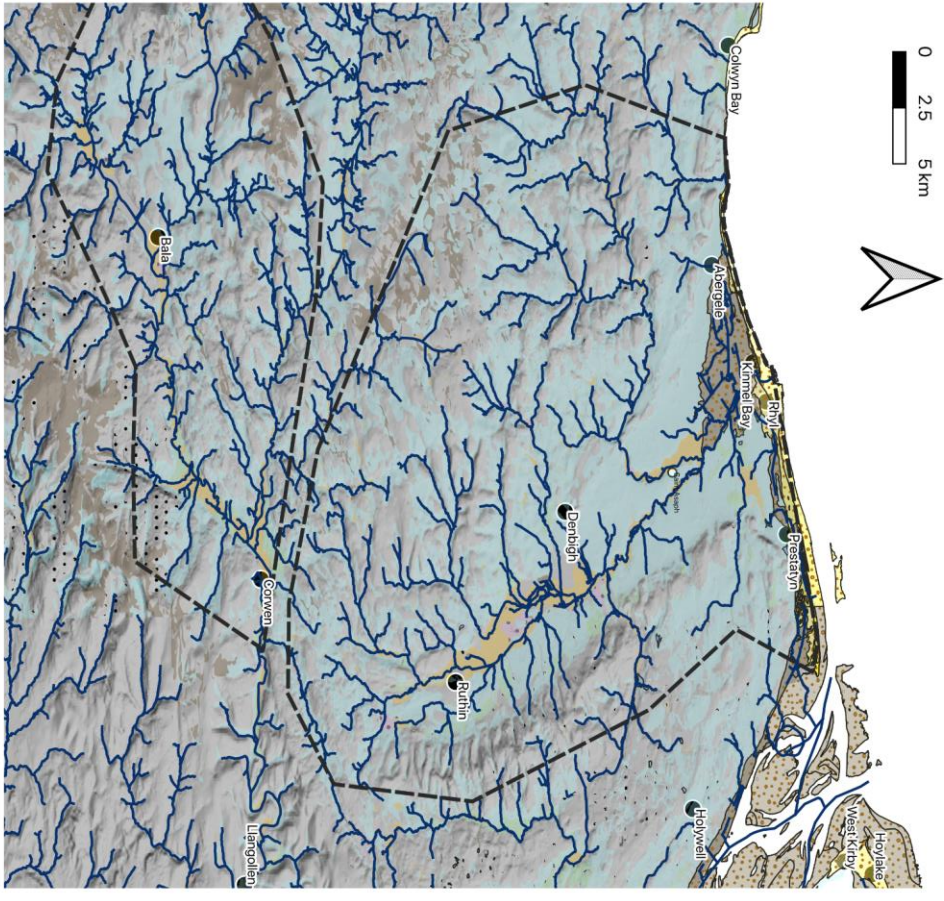


Appendix 2 and 3: Geological maps of the study areas (By the authors from secondary data)

Map of the general geology - bedrock- of two study areas on the relief
(By the authors from BGS data)

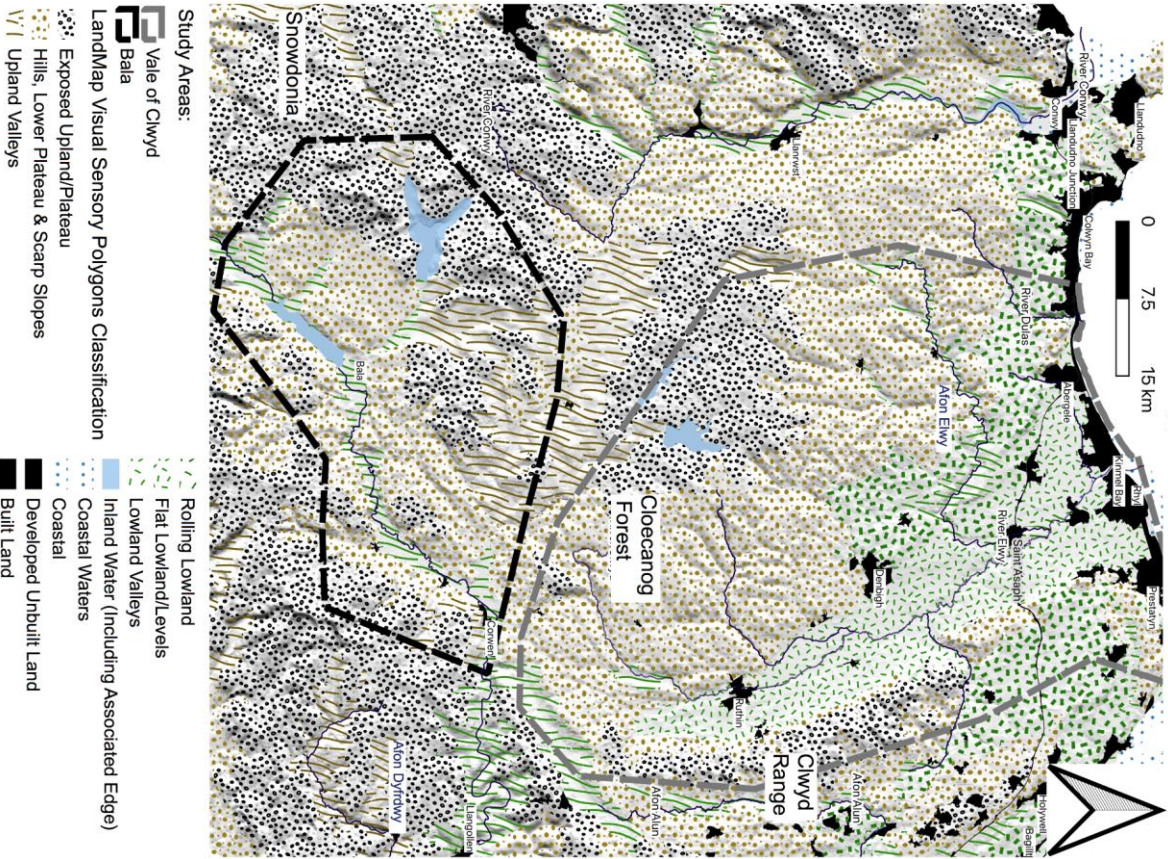


Map of the general geology - superficial deposits- of two study areas on
the relief (By the authors from BGS data)

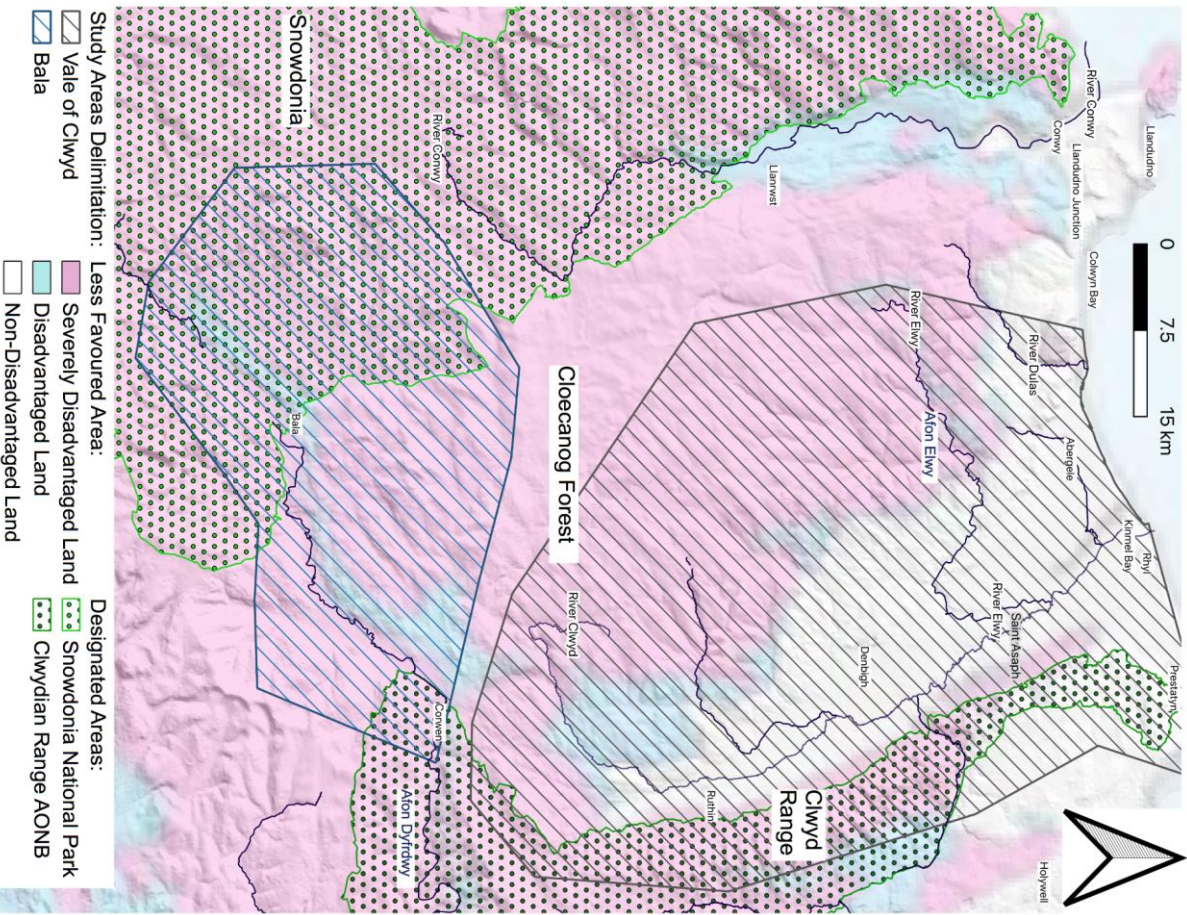


Appendix 4 and 5: Maps of study areas, of their landscape and LFA status (By the authors from secondary data)

Map of the two study areas, (By the authors, data from Welsh Government and Ordnance Survey)



Map of the two study areas, LFA status and designated areas (By the authors, data from Welsh Government and Ordnance Survey)



2020

