Impact of agricultural policy (1992-2020) on a welsh lowland landscape (UK): A widening gap between farms under the future Welsh Policies?

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Topics: Agricultural and Rural Policy, Farm Production and Supply Analysis, Theoretical Advances in Agricultural Economics, Land Ownership and Tenure - Land Reform

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Summary:

Since 1990 South-Pembrokeshire has seen rapid changes to its once homogenous landscape dominated by dairy farms. An analysis of this differentiation was made using a system-based French method: an 'agrarian diagnosis' in which the current situation is perceived as being the result of both the constraints and qualities of the geographic context in which agriculture is situated, and of a history that has shaped its production methods and social structure. 92 semi-structured farm interviews were carried out in a discrete South Pembrokeshire area, formed of 3 different landscape units with a wide diversity of farm types, and combined with literature, documentary and secondary data analysis. From 1990, the relatively similar dairy farms across Pembrokeshire differentiated under sustained income pressure, linked to an output/input price squeeze and a challenging environment for business expansion. Those farms who stayed in dairying used different strategies to expand, at different times. A ruthless selection process took place, as many farms were pushed out of milk into beef and sheep. This was the first step in a trend towards renting out the land and retiring from farming altogether. The reduced pressure on land use in some farms allowed Potato farming to re-emerge in the landscape, among specialized farms and in just one landscape type. Gradually, a complex, interdependent ecosystem of farms has developed, with businesses exchanging outputs and inputs. The detailed modelling of current farming systems using functional 'archetypes', examining economic performance and agricultural income, allows us to understand the economic structure of land use. From this we can forecast a likely second turning point in farm evolution arising from the new support policy and emerging post-Brexit and post-Covid economic environment.

L'impact des politiques agricoles (1992-2020) sur une petite région agricole des Lowlands gallois (UK): Des divergences croissantes entre les exploitations agricoles sous les futures politiques galloises?

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Mots Clés: Diagnostic Agraire, Études d'Impact, Performances Économiques, Exploitations Agricoles, Étude Systémique, Étude de Cas

Résumé:

Depuis 1990 l'agriculture du sud du Pembrokeshire a connu des changements fondamentaux et rapides. Un paysage dominé par des fermes laitières aux méthodes de production extrêmement homogènes a fait face à la différenciation des modes de production. L'analyse de ces changements s'est faite à travers l'application de la méthode du diagnostic agraire issu de l'école de l'agriculture comparée (Cochet, 2011) sur une petite région agricole. Le paysage et son utilisation par l'agriculture étant perçu comme le résultat combiné des caractéristiques pédo-climatiques du milieu cultivé et de l'évolution dans le temps des structures sociales de productions face au contexte socio-économique. 92 interviews semi-directives cherchant à reconstituer le fonctionnement des systèmes de production dans le milieu furent menées en 2019 sur les 3 grands types de paysages observés dans le sud Pembrokeshire. Ces interviews ont fait l'objet d'une analyse qualitative tout en la croisant avec la bibliographie (base de données statistiques et de prix…). Ceci permet la reconstitution de leur différenciation et d'expliciter leur modes de fonctionnement actuels. Depuis 1990, les fermes laitières du Pembrokeshire ont fait évoluer leurs systèmes de production dans un contexte de pression extrême sur les revenus agricoles. Ceci étant lié à un ciseau défavorable des prix des intrants par rapport aux prix agricoles qui perdure aujourd'hui ainsi qu'à un contexte d'investissement et d'expansion défavorable. Une sélection extrêmement dure prit place parmi les fermes, différentes stratégies pour gérer cette crise furent suivies en fonction des besoins et capacités des fermes. De nombreuses fermes sortirent de la production laitière pour s'orienter vers l'allaitant ou les ovins (finis et maigres). Cette évolution représenta un premier pas vers la retraite. Cette évolution résulta en une réduction des besoins en fourrages permettant la mise en location de terres. Pour les fermes laitières s'étendant et intensifiant leur production par vache et par ha. Mais aussi pour la reprise de la production de pommes de terre avec des fermes spécialisées organisées autour d'une coopérative. Un écosystème de fermes extrêmement hétérogène (productions, productivités fourragères, stratégies commerciales…) échangeant des sous-produits s'est constitué. La modélisation de ces fermes à travers des archétypes qualitatifs permet d'étudier leur fonctionnement agronomique dans leur milieu et leurs performances économiques. Cette étude révèle leur fragilité avec un risque d'un second point d'inflexion pour l'évolution des fermes dans le Sud Pembrokeshire vers toujours plus d'hétérogénéité.

Abbreviations:

AR: Agricultural Revenue RP: Raw Product DK: Capital Depreciation AV: Added Value
BSE: Bovine Spongiform Encephalopathy
CAP: Common Agricultural Policy
DC: Dairy Cows
DM: Dry Matter
EU: European Union
ha: hectare
IT: Information Technologies
ITW: Context elements collected during interviews
KL: 1000 litres
MMB: Milk Marketing Board
Pbs: Pembrokeshire
UK: United Kingdom
WTO: World Trade Organisation

Lexicon:

Real Term: Economic value after the effect of rising prices is considered
Direct Payment: Payment directly given to the farmer
Coupled payment: Payment linked to farm's output
Decoupled payment: Payment not lined to farm's output
Historical reference: Payment computed from a given time period farm output
Milk Marketing Board: Monopoly Cooperative on Milk from 1932 to 1992.

1. Introduction - a brief history of farm and policy change in Wales

Agricultural Policy in the UK from 1945 to 1990 was focused on production at all cost

Over the 20th century farm support and its goals have evolved tremendously in the United Kingdom (UK) (Campbell R. 1985)(Stead D. 2007). Farms were largely semi-subsistent mixed farm holdings which gradually got integrated into national and global markets while implementing a fossil-fuel-based agricultural revolution. Increased output was made possible thanks to increased capital and input use (and cost), as greater mechanisation and increased labour productivity were offered to farmers (Devienne, 2003). Agricultural markets were regulated and partially protected from foreign competition, starting in the 1920s and strengthening particularly after 1940. Two goals were successfully pursued; increasing food production to meet UK domestic needs and increasing farm incomes to match those of the wider society (in the rest of Europe, agricultural policy also triggered a significant labour decline, whereas in the UK the proportion of those employed in farming was already quite low, as a result of industrial expansion and rural exodus in previous centuries)(Bowers, 1975). Following EEC accession, by the late 1970s domestic surpluses began to stack up and market regulation costs skyrocketed (via storage, export refunds, etc.), putting the Agricultural Policy under increased scrutiny and giving rise to a well-documented analysis of its failings (Campbell R. 1985, Bowers and Cheshire, 1983; Body, 1984).

From 1984 a very gradual move away from a production focused CAP in Wales

From 1984 the Common Agricultural Policy (CAP) introduced production regulation through quotas (and later, set-aside) for main agricultural products (Barthélémy et al. 1999). The UK government at the time reduced its EU spending through the Fontainebleau agreement (EU Parliament 2016). The MacSharry reform of the CAP in 1992 supported the idea of a multi-functional approach to farming. In the subsequent decade the policy developed its 'second pillar', with subsidies supporting environmental measures (management, restoration or investment) and rural development (Dobbs et al, 2008), while the market measures of the 'first pillar' were transformed through successive price cuts and the introduction of direct payments as compensation. In Wales, the earliest agri-environment schemes were the Environmentally Sensitive Areas, introduced from 1987 (Buller 1999). By 1998, farm output prices were aligned on fluctuating world market levels. Across the UK, agricultural marketing monopolies were broken up during this period. Finally, agricultural regulations were tightened most notably in the form of an expanded implementation of the EU Nitrates Directive, from 2002 (Burt et al. 2010).

Under devolution, Wales gained new powers to determine its own agricultural policy as more options were offered to EU member states in respect of how CAP was implemented. At first, Wales kept the implementation of 1st Pillar subsidy partially linked to output, using historical reference levels (Boinon et al. 2003) to calculate a decoupled Basic Payment Scheme (IDELE, 2015). From 2013, a Wales-wide, flat-rate decoupled single payment scheme was gradually introduced, with a redistributive element which favoured smaller holdings.

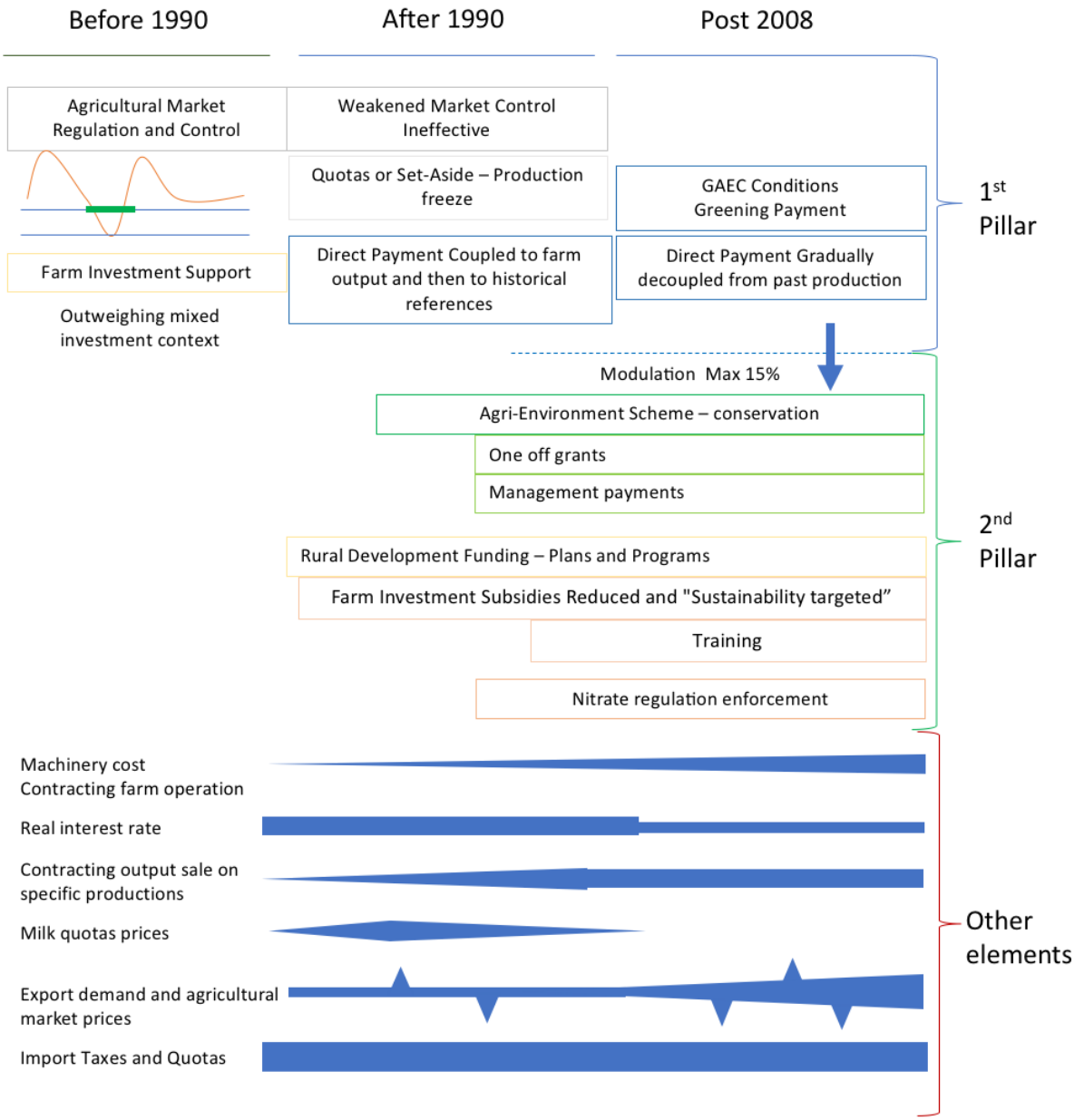

Figure 1: Simplified evolution of farming environment in Wales from before 1990 to 2019. By the author, derived from table 1.

Full decoupling was finally attained in 2019, with payments subject to cross-compliance conditions (Hart, 2015). This process was less radical than that followed in England, where full decoupling and the move to a flat-rate payment was complete by 2012.

For the 2nd Pillar, from 2005 two Agri-Environment schemes followed one another, Tir Gofal and then Glas-Tir focused mostly on the management or creation of environmental and historical features through 5-year contracts including annual payments (management) and environmental grants (investment support) (Wynne-Jones 2013)(itw). The welsh government also developed business support for farming with investment grants and public-funded advisory bodies Farming Connect and Menter y busnes.

Table 1: Drivers of change in Pembrokeshire Farming from interviews and complemented by literature analysis (By the author)	
Global economic and investment context	The global economic environment changed enormously over the course of the 20th century and beginning of the 21st century. Looking at the real interest rate (comparison between the interest rate of the Bank of England and the inflation rate) gives us an idea of the cost to borrow capital (Savills Research UK, 2018). For the time period of interest we can distinguish 2 contexts: from 1990 to 2008 real interest rates were high; then from 2008 to 2020 real interest rates have been very low, offering a much more favourable investment context. Banks would lend to farmers with enough collateral (i.e. owning assets) or on high added-value and relatively low risk business plans.
Agricultural input prices	Most inputs used in farming are imported with costs based on world markets. They have increased steadily (in real terms) over the last 3 decades (i.e. doubled for petrol-derived products 1990-2019) with high volatility (most notably in the financial crisis of 2008). Feed costs and fuel (and derived - N-fertiliser) prices stepped up from 2008. (FAOSTAT 2020)
Agricultural output farmgate prices	On the flipside, although most of Wales' products were destined for the EU, agricultural farmgate prices also gradually mirrored world markets. Reduced prices and increased volatility have been witnessed. Export bans, as well as a downward consumption trend in meat, increased nervousness due to the BSE and 2001 Foot and Mouth outbreaks. A high sterling exchange rate further pressured prices downward even more, until 2008. From 2008 onwards, output prices started to gently increase again in real terms on most livestock products, as developing countries' demand began to pick up. (FAOSTAT 2020)(World Bank Open Data 2018).
Quotas on Agricultural Products	Quota prices on agricultural products were never a big limit for meat production but they were extremely costly to buy for milk, until 2005 (Townsend Chartered Surveyor 2016)(Barthelemy et al.). By then, UK milk production had reduced substantially and was below the total UK quota, which made it gradually worthless. In 1992 the MMB monopoly was liberalised, ending a 'one price for all' policy and giving way to direct processing contracts with variable bonuses/cuts and stringent milk specifications (*itw)*. Small dairy farms tended to be those receiving the lowest prices. *(itw)*
Liberalisation of the land market	The land market previously in favour of the tenant farmer was liberalised through a new set of flexible tenancies, from 1995 (Hill et al. 1985). This reversed the balance of power with landlords able to adopt a best-price approach to renting land, with the possibility to retain control of land. (Savills Research UK, 2018).
Apparition and promotion of new farming systems tools	The industry around farming made technical evolutions available gradually going towards greater work productivity and increased outputs. Infrastructure and machinery would go towards capital substitution to work (Milking robots, GPS guided tractors…).

1. Method - agrarian diagnosis: analysis of a case-study area using a system-based approach

Welsh farming evolved swiftly from the 1990s, and a wide diversity of tools and scales has been used for its analysis (Hodge and Midmore, 2008). The French method of agrarian diagnosis (Cochet et Devienne, 2007) from the 'comparative agriculture' theory enables a systems-based approach in any typical small agricultural area (40-50 km2); providing a fine-grained **qualitative construction of quantitatively-defined models,** connected to the wider context. This systematic approach is distinctive: analyses of farming change tend to adopt macro and quantitative approaches for modelling mostly using secondary data, and there are few qualitative local approaches or case studies: these tend to be less amenable to generalising, but can offer a deeper understanding of drivers (Bitsch, 2000). The system approach is flexible and can be applied at local scales or broader scales (Norman, 1995). The case study fits the criteria enunciated in Westgren and Zering 1998 for economic research.

Field study entails three successive and interdependent steps. The first step is studying the **landscape** through desk review (geology from the BGS, geomorphology, soil science, secondary data...) and observations (long-term). The landscape results from centuries of agrarian management (Deffontaines, 1997). This step also helps delimit the boundaries of the study area and define its particular landscape types.

The definition of typical agro-ecological units in the landscape 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 both **quantified technical, economic, and qualitative environmental, social changes on the farm are discussed as precisely as possible.** It aims at understanding farmers' motivation and choices, going further than a simplistic approach for a better analysis of policy impact (Brown et al. 2021). Those were linked in parallel to the literature and secondary data sources (agricultural prices, policy…). This enables understanding of farming system differentiation across the agro-ecological units in the landscape. It analyses trajectories of farm change responding to multiple drivers, in an approach not unlike a decision tree approach (Darnhofer et al. 2005) but using the reconstruction of the farm system through time to produce the pathway. This generates a typology of farms, linked to their historic differentiation in the landscape.

This typology will be gradually fine-tuned and forms the basis for targeted sampling of farms where the second round of interviews will take place. The final element in the 3-step analysis is a in-depth **agronomic and economic examination of current farming businesses**, based upon a characterisation of all the main farming systems present in the landscape, identified as distinct 'archetypes'. Archetype constitution is the result of a qualitative analysis of farm systems, considering landscape, products, historic differentiation and farming system characteristics and resources. The goal is to quantitatively describe a qualitatively modelled farm (Cochet, 2011).

The approach makes it possible to characterize the operating logic of each production systems and measure their economic performance. This facilitates a presentation and an understanding of economic drivers and responses without needing to present data from individual farms and farming households (thus preserving the anonymity of interviewees). The identification and prioritization of problems and the projection of trends observed in the medium and long term, highlighting the conditions and mechanisms leading to these developments, make it possible to establish a diagnosis of the situation and formulate appropriate proposals.

The next section presents the results of applying this diagnostic analysis to the landscape of South Pembrokeshire. 92 hours long farm interviews of the two types were conducted between March and August 2019.

2. Results - landscape analysis *Cf figure 2 and 3*

South Pembrokeshire (Pbs) is a hilly lowland area under 200m of altitude with a bocage landscape (a landscape of hedged fields). Pastures either permanent or temporary are dotted with a few cropped areas. South Pbs has a landscape which offers a variety of agricultural potential that depends most of all on the breadth of valleys and steepness of slopes. The geology of Pbs helps us to understand and divide it into 2 large valley/hill types with contrasting agricultural potential, combined with a climate gradient. On cold mudstone with coal seams, valleys are smaller with cold and wet soils. The other substrates give bigger, warmer and drier valleys with potential for greater and earlier grass production. Fields can be cropped to the south, on the red soils. (Geology of Britain)(Ordnance Survey). This diversity allows for a range of typical welsh lowland farming enterprises including milk, beef, sheep and potatoes. Pbs farming was always focused on livestock and grassland (Welsh Agricultural Statistics 2018, Small Agricultural Areas)(Davies et al, 1994).

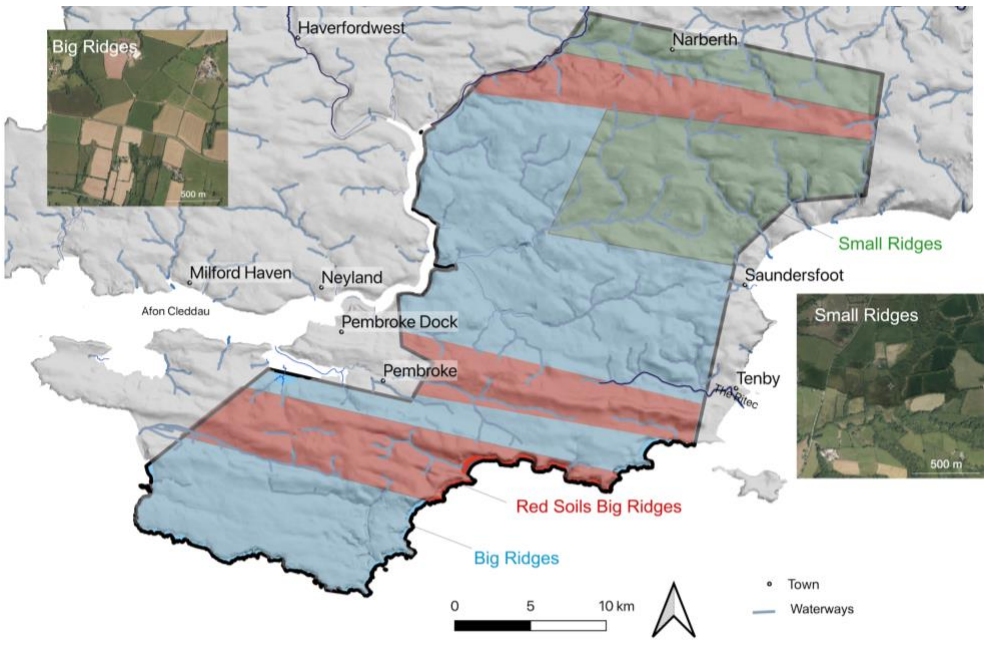

Figure 2: Study Area of South Pembrokeshire and different landscape identified. Aerial photography samples for big and small ridges. By the author, from Ordnance Survey data.

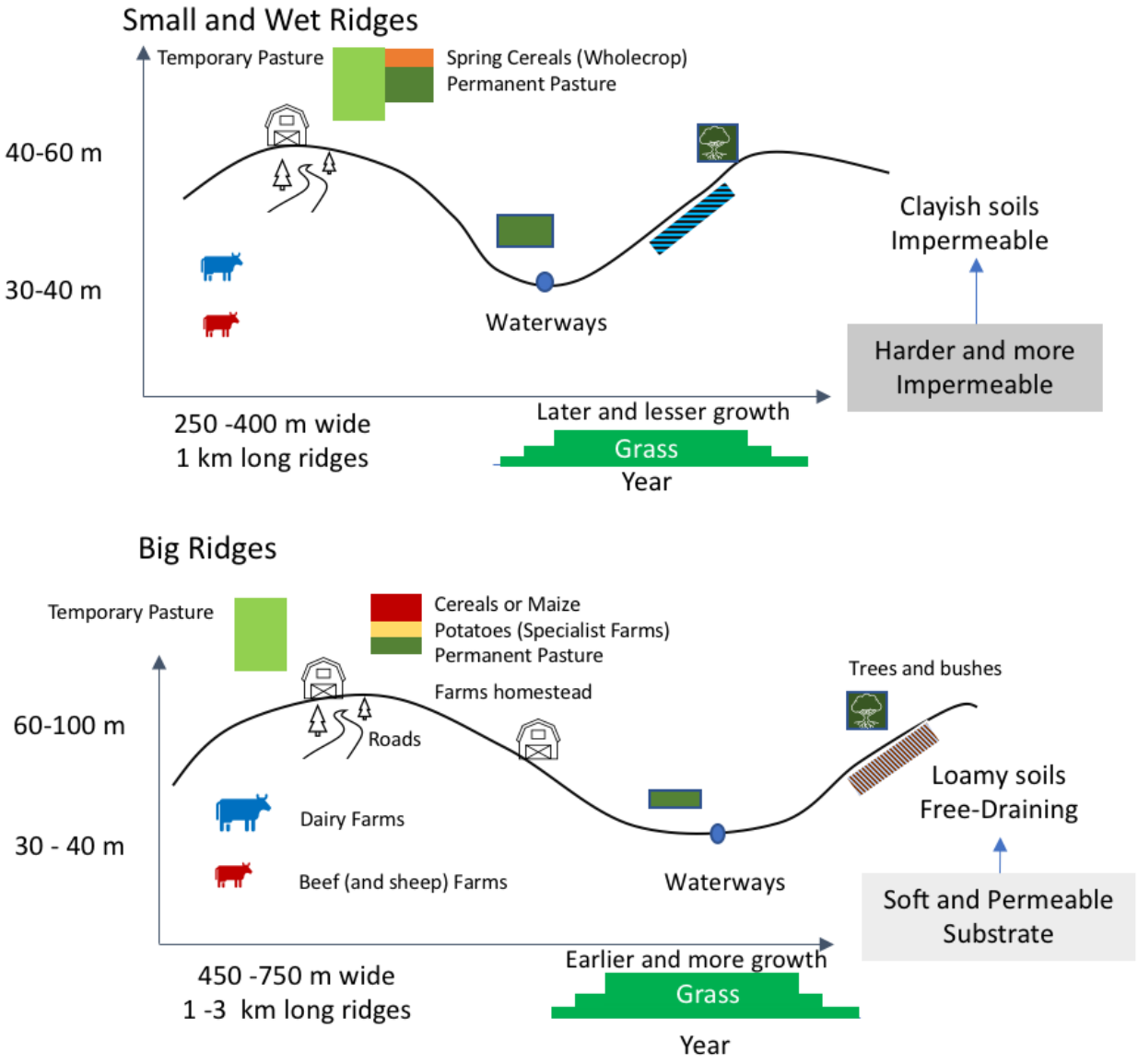

Figure 3: Farmed landscape in Pembrokeshire 3 landscapes but only 2 different relief profiles and organisations. Big ridges can be on free-draining red soils or more impermeable loam. By the author.

3. **Results - Historical analysis** :

Post-war changes

Interviews in Pbs showed that after 1945, the 20th century agricultural revolution was facilitated by sustained policy support. This levelled up all the farms in the landscape to a standard described in figure 3: specialised in grass-based dairying. All farms' resources were focused on milk production with labour productivity gains driven by mechanization. Farms gradually ceased their other enterprises. A high yield dairy farming package was adopted gradually: combining high-yielding ryegrass and bought-in feed for demanding British Friesian dairy cows (DC). Fertilizer supported grass growth with a simplified cropping system and silage, allowing greater winter fodder production. New parlours/tanks catered for more milk, and all farms could manage most farm operations themselves.

The only farms not specializing in dairying were those with ample supplies of red soil on big ridges. They could grow early potatoes as well as feed wheat in order to fatten beef cattle rapidly with the use of more demanding (but rewarding) continental breeds. Potato farming had previously fallen into decline due to price pressure (volatile prices and an expensive crop to manage). There was a slow adoption of silage by these farms because haymaking was easier on drier soils. **Most farms had not expanded in acreage, but fodder productivity gains allowed growth in production and incomes. In 1986 most farmers in Pbs owned their own farm (over 90%, often bought from the estate).**

From 1984- An exogenous expansion and differentiation of farms (Cf figure 4)

The context as stated in figure 1 and table 1 was particularly challenging from 1990 to 2000. New equipment (herringbone parlour, self-propelled harvester…) and increased fodder productivity options (winter cereals, maize silage, italian rye-grass, only on the big ridges) came, although at a cost. Small labour and fodder productivity gains were made possible for every farm via contracting (e.g. self-propelled harvester, third cut of baled silage…), and adoption of high-yielding holsteins (*from itw*). As a result of these opportunities and constraints a ruthless selection and differentiation took place among existing farms.

- **Farmers close to retirement** and with no immediate succession went out of dairying (sometimes helped by schemes and quota sale or leasing). Depending on their holding and age, some farms went into beef: either finishing cattle on the big ridges, or producing stores on the small ridges. All was associated with a sharp decrease in production (simplification of husbandry and land management). Those going out of farming altogether were able to rent-out their land to **expanding farmers** with more profitable and flexible rental agreements (FBT, Grazing agreements…).
- **Dairies preferred to collect milk from fewer, big farms and offered them higher prices through newly introduced direct contracts, matching the milk bought to their desired product mix.** It was challenging to expand in this context, and investment-heavy, high-input strategies were favoured. Increasing the number of cows and rearing barley bull beef was the main strategy, made possible by increasing input use and costly fodder and productivity gains.

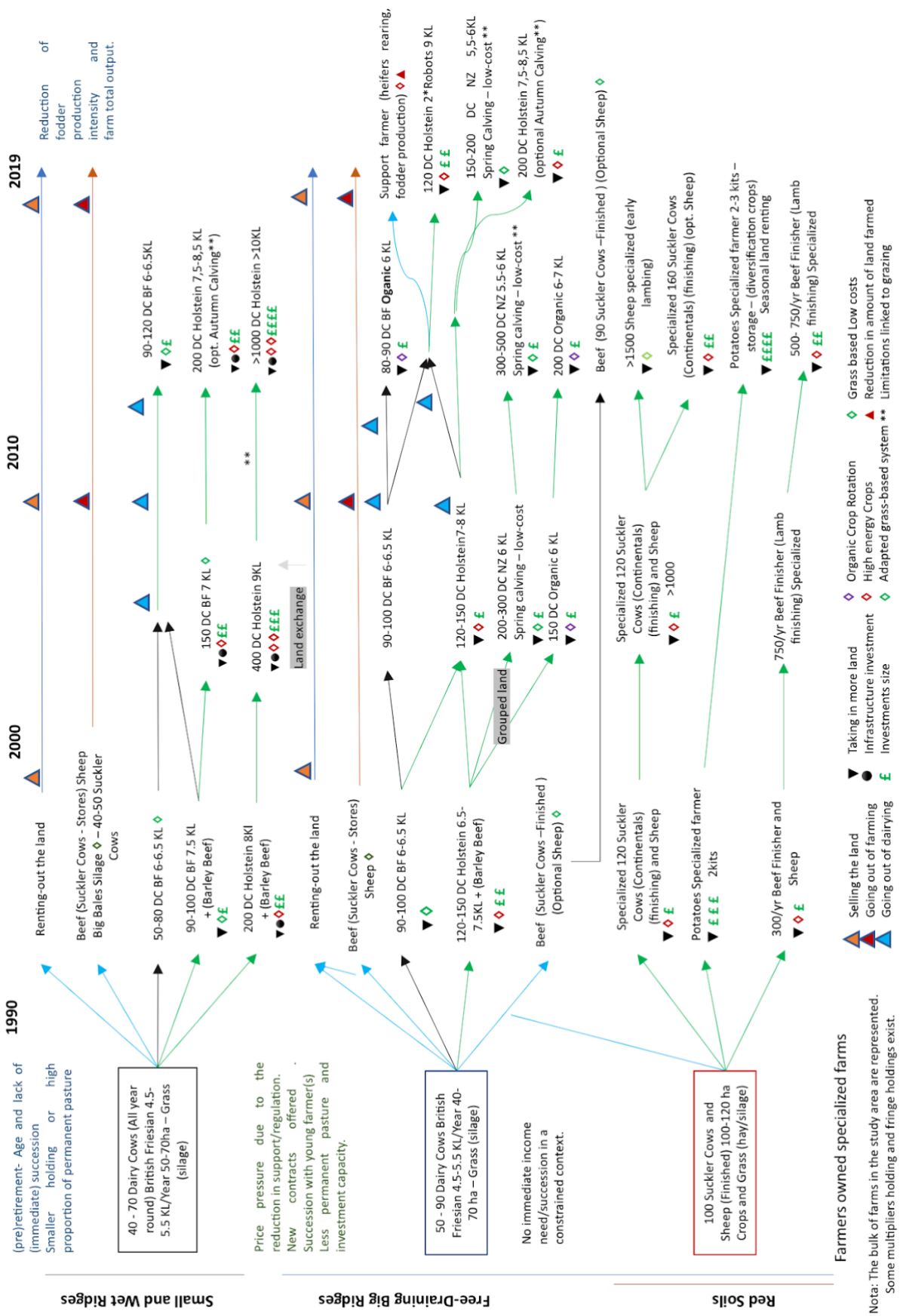

Figure 4: Farm differentiation pathways from 1990 to 2019 on the 3 different Pembrokeshire landscape types, obtained through the analysis of farm interviews. By the author.

- Dairy farms without investment capacity (e.g. those already with a mortgage), without young farmers went **for a less investment-heavy approach** trying to maximize income with limited investment. Small extensions, opportunistically renting small acreages, making a third cut of silage, gradually contracting out the cropping, all enabled increased labour productivity with limited means.
- **On smaller ridges**, expansion was more challenging due to bio-climatic conditions, and the acreage required to cope with the cost of increasing herd sizes was higher, so size increases were more limited.
- **On all landscape types, management was greatly simplified**: stock was not rotated but mob grazing was used depending on the size of the field. Importantly, expansion in this period was mainly enabled by increased purchase of inputs. **There was still very little land available on the market.**
- **On Beef and Sheep farms, the BSE/Foot and Mouth** crises also changed how farms worked. Cattle had to be fattened faster (under 36 months) and at the same time the beef market was depressed (as exports were banned). Under pressure to increase labour productivity and liveweight gains by using increased inputs, farms specialized. The under 36 months rule favoured the development of specialised finisher farms. Sheep farms shifted to earlier lambing and increased bought-in feed to secure more rewarding market prices (Easter market). Also, due to the subsidy regime, farms tried to maximize the number of animals on the farm.

This period of change also enabled a return of potato cropping. In the mid-1990s Puffin Produce cooperative was created by local potato farmers, reducing the market oligopoly and targeting rewarding (contracted) markets (chippers, supermarkets..). Among farmers on red soil, those able to irrigate and spend/loan the upfront finance necessary to pay for the expensive kit were relatively few. The potato rotation over 5 years led these farmers to rent-in significant amounts of land (seasonally). This produced an input-heavy but high output operation (facing some market uncertainty and volatility).

At the turn of the 21st century (*Cf figure 1.*) the general context started to ease, contracting was being developed and quota prices were down. The move away from subsidies linked to stocking in 2005 marked a need to find another way to sustain farm incomes, with milk prices remaining at low levels. This led to the end of all beef barley units before 2008. Combined with the tightening of nitrate rules in the UK in 2002-2003, and renewed specialization in dairy herds, investments were needed on most farms. Farms that hadn't increased size or yield before this were in a tight spot because post-2005, direct subsidy payment was calculated according to historical references.

- **Small dairy farms around 90-100 dairy cows that had increased slowly** (yield and cow numbers) now tried to ramp up their number of animals in parallel to the adoption of the 1990s package. Specialization and simplification took place with an expansion enabled by many neighbouring farms exiting the sector.
- Other farms deprived of investment capacity would either expand lightly taking on close-by land combined with input use (and a third cut of silage), or go out of dairying.

Farms that had already expanded substantially continued to scale up to 2005, to 150 – 250 dairy cows, or to the limit of the herringbone parlour used.

M**ost dairy farms had good historical reference levels through the 1st Pillar** as they had high milk yield per animal and had tried to keep as many animals as possible on the farm. Due to the high land fodder production and overall high output of farms, **subsidies per acre went down by approximately 30%-40% on most farms** after 2013, except on small early extensive early beef and sheep holdings.

The 2nd pillar of the CAP was not taken up by most Pbs farms as they were not in target areas and managed few outstanding features. The 2nd Pillar support in Pbs focused on investment grants (hedges, tracks…), while very few farmers were offered agri-environment management contracts.

The amount of subsidy per Pbs farm declined in this period, despite continuing farm amalgamations.

4. Today's farm ecosystem

Change in farm structures leading to today's farm ecosystem: a hyper-specialization

From 2008 farms (*Cf figure 1.)* shifted further towards specialization due to increased volatility in agricultural output markets. Milk prices remained depressed and the cost-price squeeze was not favourable to producers (oil prices increased, bought-in feed prices increased...), with repeated market shocks. An easing of constraints around farm expansions and investment offered opportunities in turn for farms to expand with limited interest rates. Since 2010, agricultural markets for livestock-based outputs have regained some demand but prices remain low. Dairy firms offered differentiated prices not only for farm size but for milk production pattern and milk quality, to better match their processing apparatus and product mix. To make an income out of ever thinner margins and reduced subsidies, dairy farms had to try to differentiate in return.

New farming techniques to reduce inputs surfaced alongside an IT revolution in dairying, with massive labour productivity gains (robots, rotary, GPS based…), at a cost. Some farms increased their use of external resources to specialize all their own labour, land and infrastructure on dairy cows, either contracting out the management of cropping systems, buying in silage (grass-maize), or removing the heifers from the home farm. Whole crop – wet harvest silage for wheat/barley (quite suited to Pembrokeshire's pedo-climatic conditions) offered a new high energy crop to farms on every part of the landscape.

Farm pathways described below can be observed on figure 4.

High Volume, High Input Strategies:

- Farms that expanded during the 1990s-early 2000s were stretched by past capital interest costs and had little choice but to keep pushing up numbers and milk production, taking up IT to increase their labour productivity and focusing on stockmanship. As herds and yield per cow grew it became more and more difficult to include grazing in the cows' routines; these were typically herds that exceed 500 cows, with milk yields over 9KL/year/cow.
- For smaller farms in a similar position, implementing the IT revolution was possible for a 1-1.5 fte farming system with under 200 dairy cows.

High milk price, High Input: Most remaining dairy farms would be a notch down from this in terms of labour and cow productivity. Their more limited investment capacity precluded major expansion, growing only to 200-250 DC with yields around 7.5-8.5 KL/year/cow, by combining use of whole crop silage and grass, and using increased external resources. The maximisation of milk prices was attained via contracts based on autumn calving or all year round tight milk specifications. These farms are limited by their available grazing that determines their maximum carrying capacity. Some farms might have shifted to autumn calving thus reducing summer grazing pressure, or reduced the grazing regime. On bigger ridges, farms' accessible grazing areas tend to be larger.

A development of low input strategies: Most farms had moved away from short rotational grazing as herds grew and the grazing pattern wasn't linked to an efficient use of the grass growing cycle. A way to use less input to reduce cost and grow more of the farm's fodder was to return towards more grass-based and home-fed farming systems.

- Some spring calving herds located on big ridges have emerged, to make the most of the bigger grazing areas available: their main features are low yields combined with very high labour productivity and simplified herd management. Cow numbers could range from 90 to 250 DC for "legacy" family farms and up to 500 DC for spring calvers. The latter entrepreneurial holdings come from former home farms (owned or rented- share-farmed or in FBT) or amalgamations.
- Since 2005 organic farming increased, linked to a new incentive scheme. For farms on the big ridges, a diverse rotation allowed the maintenance of soil fertility and catered for fewer, lower yielding DC. Some farms that had a large amount of land could transition to organic with a higher number of cows. This also offered an opportunity for smaller farms to access higher added value production with low costs, offering a good income. The transition to organic could be difficult to manage with limited land to enable renewal of fertility under longer rotations - so requiring more land to be included in the farm.

Outside of dairying:

- *Beef and sheep enterprises;* For the farms that dropped out of dairying, there are a range of store cattle producers and fatteners. Among renewed trends in beef enterprises is calf-rearing (bought-in from dairy farms) for fattening or sale as stores. As the beef market slowly recovered from the impacts of diseases in the 2010s more farmers on the small ridges moved into fattening using maize or whole-crop silage. There is a wide range of input and output profiles among beef and sheep units, depending mainly on the age of the farmer(s) and their land tenure.
- After retiring, a growing number of farmers are renting-out their land while still maintaining their farmer status. Some farmers growing crops and rearing heifers for bigger dairy farms have also appeared out of former dairy farms, since 2010. A couple of sheep farmers are also present in the landscape.

Over the course of 30 years the numbers of active farms has been more than halved as farms have roughly doubled their dairy herd sizes. The number of farm workers has reduced under the replacement of work by increased use of capital (machinery and equipment).

In Pembrokeshire most farms are still grass-focused in an overwhelmingly green landscape (over 90-95% and closer to 97% pasture cover in winter) that still provides the bulk of DC diet. But there is much more diversity among farms and between farming systems than before. This is represented in the landscape use with different level of production for pastures. While some fields are increasingly included into input-heavy rotations others have gone the opposite way. This can also be said of many other farming system components dairy cows or grass seeds. Pbs farms are working as an interlinked ecosystem trading goods to make a profit out of this good quality land. The number of farms has fallen sharply as farms have been forced to specialize and expand to survive in a competitive environment.

Economic analysis of farms in Pbs: few enterprises are profitable

Note: Common Agricultural Policy payments were until 2020 based in euros (before conversion), thus the choice of €2018 for the model, constructed in 2019.

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 fertilizer, but not buildings). Capital depreciation (DK) represents the annualized 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.

We present the economic performance of only 13 archetypes that represent the diversity of enterprises from the 29 archetype variations identified in the original thesis.

Dairy farms despite their high IC and DK show high AV per animal ***(figure 4.)***, per hectare and per worker. On the flipside, beef systems' AV are lower and can even be negative. The only exception would be the beef and sheep farming systems most specialised in fattening. Beef producers that fatten animals get twice as much AV/ha than the ones producing stores.

Potato farms have a high AV but the market for this product is extremely volatile. AV/ha is over 200€/ha on all dairy systems and 100€/ha on beef, and can reach over 1500€/ha for potatoes and dairy combined.

In more detail:

- Systems that have very high AV per worker have a high worker productivity linked to past investments that they need to support through high production (e.g. wagon mixer, rotary parlour, robot milking or new potato equipment).
- By contrast, simplifying farm management, reducing input use, increasing the autonomy of the farm and relying more on grass are strategies to limit cost and attain higher added value.
- Sometimes it is just not enough to cut cost - some beef and sheep and even smaller dairy farms have a negative AV, these tend to produce low value outputs like store cattle, or have a low number of animals. They would be typical of pre-retirement or part-time systems.
- Some farmers choose to produce highly valuable goods to get a higher AV, such as 30-month slow-reared beef, autumn milk, potatoes or organic produce.

These differences in enterprise strategies lead to very different agricultural incomes.

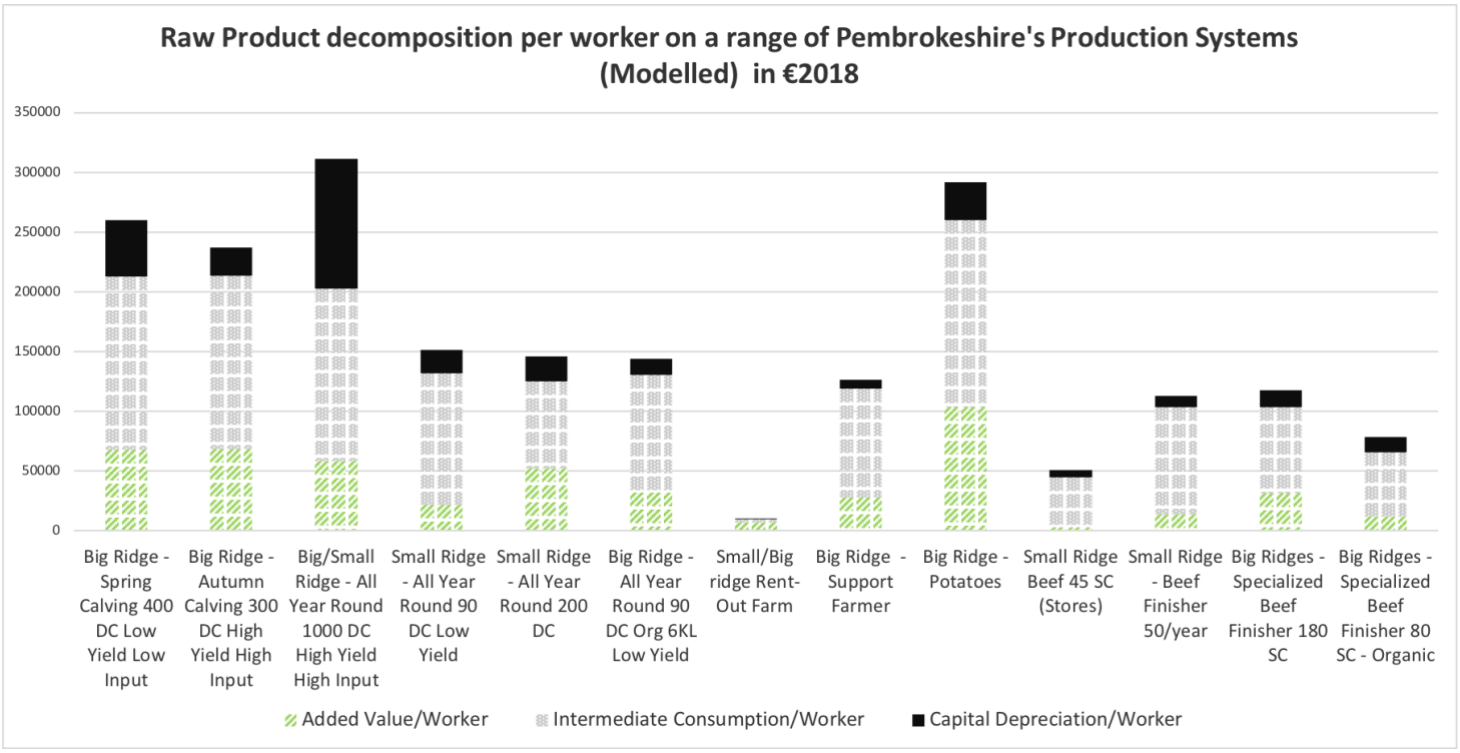

Figure 5: Raw Product decomposition per worker on a range of Pembrokeshire Production System, in €2018. Differences between enterprises and landscapes. By the author.

A spread of Agricultural Revenue , small farms depend heavily on subsidies (figure 6)

By looking at the agricultural revenue (Added Value - Taxes - Interest - Rent + Subsidies)(before tax), we compare different farms regardless of their business structure. Agricultural revenue is therefore examined per full time equivalent working on the farm.

Note: we take 20K€/year/family worker as the UK living wage and 30K€/year/family worker as the viability threshold for the farm

We can see that Agricultural Revenue (AR) differentials between farms seem relatively modest compared to the AV spread (*Cf figure 6.)*. They relate to the relative weight of loan interest payments, rents and salaries, as key resources that have enabled the expansion of specialized farms. There is a gradation in terms of income per family worker across the farm archetypes in Pbs, primarily linked to the type of production: dairy and potato farms return higher agricultural income than beef and sheep or support farms. The only beef and sheep farms that are able to match some of the dairy farms' income are those specialized in finishing.

Beef and sheep farms depend overwhelmingly on farm subsidies to survive, even including specialized farms (subsidies represent between 75% and 100% of the AR). In the dairy sector, the smaller the farm the more it is dependent on subsidies but the larger farms and those with potatoes have a very low dependence. Organic farms also tend to depend more on subsidies for their income.

Due to the structure of agricultural markets (oligopoly among processors) and the subsidy system, bigger farms tend to have bigger AR per family worker. There are some exceptions due either to the high added-value niche, the amount of land rented by the farm, and/or its history of change (with higher interest rates for any investments made before 2008).

Farmers renting out their land and some with beef and sheep enterprises get an AR below the living wage. Those renting rely heavily on their tenants and how they are doing financially. The income mostly complements a retirement pension or another job. Farms playing a support role (e.g. rearing calves) tend to have a higher income.

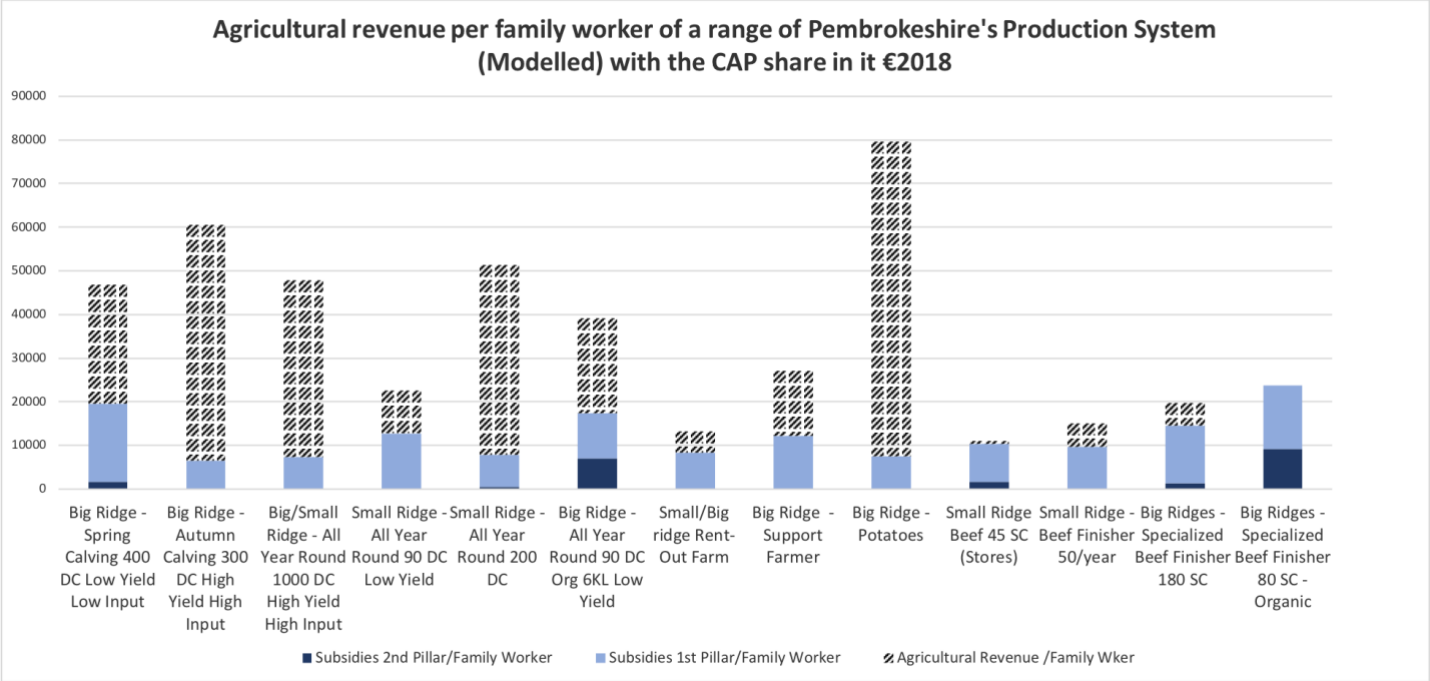

Figure 6: Agricultural revenue per family worker on a range of Pembrokeshire's production systems (Modelled) with the CAP share in the revenue in €2018. The orange line would represent a subsistence income (20K€) and the green one a reproduction threshold (30K€). By the author.

Conclusion and discussion

The Pbs case study is a typical Welsh lowland landscape. From a previously homogenous farm structure in the 1980s we can see the emergence of very different, yet complementary farms that now work together in the landscape. This is particularly notable in terms of land use intensity. The case study shows that there is no uniform 'Welsh model of agriculture', as stated in Morgan et al. 2010, even in the lowlands. We note the linkages in the farming ecosystem between specialized farms on different landscape types. South Pbs presents a green, grass focused area but also features some of the best land in Wales. From this comes a diversity of complementary enterprises and farming systems. Although dairy and potato farming are the real economic performers in this farming community, many other systems retain important agricultural capital, but their annual economic performance is not enough on its own to enable continued farming (the exception being the most specialized farms fattening beef or rearing calves).

The diagnosis showed how the contemporary farm structures come directly from past patterns interacting with agricultural market trends and other opportunities. Farms are a very complex socio-economic activity, a livelihood enshrined in a landscape, a market economy and continuously evolving. Very similar economic results or income levels can hide very different functioning, strategies and pathways of change. Examining a specific agricultural landscape offers an interesting scale to study the process and drivers of farm evolution and its economic and environmental consequences.

Because this analysis is built around archetypes and specific enterprise mixes, rather than the details of each individual business, it is possible to scale-up from such case studies to attain broader understanding of the prospects of farming across the territory.

Future Policy impact on farming in Wales, a second pinch-point?

A new Welsh Agricultural Policy and the post Brexit environment mean farmers face many changes. Farm support will move to a 'public goods for public money' management scheme, accompanied by business investment grants. To date, lowland farms have been little included in agri-environment schemes in Wales. Dairy and potato sectors and horticulture are likely to benefit from a modest economic upturn arising from the increased transaction costs now faced by imports (Dwyer et al. 2018).

To conclude this paper we chose to run a quick simulation on modelled archetypes with an assessment of how solid this Welsh Lowland Farming would be.

Hypothesis:

- We take as an hypothesis that the investment context will remain favourable in the short-term. The current trends on milk and meat market will continue in terms of price and volume.
- The subsidy scheme to come will be conservative in terms of subsidy allocation between Upland and Lowlands. The scheme will also be conservative in terms of approach, offering an entry level payment, an advanced one and an organic/afforestation one. We consider a 'low funding' option which would result in a cut of 30% of agricultural subsidies on lowlands, against a 'generous funding' option which keeps the current overall amount of support, into the future. Transaction costs supported by the scheme are set at 20%.
- We take as an assumption that supporting advice will be retained as it now is, and that investment and transformation subsidy will remain at current levels in the 'generous funding' option (helping NVZ adoption…) rather than a disappearance of agricultural investment support. We suppose that there will be a requirement for farmers to have agricultural products to get into the schemes. We kept the farmed area to a similar level as now, and set inflation at a 2%/year level
- **Other Hypotheses to construct scenarios are developed in Table 2 and 3**

Table 2: Future possible simplified scenarios of possible Subsidy Funding for Pbs farming. By the author from the Study Area CAP payments 2019 for farms.

Type of Funding	Generous Funding	Low Funding
Hypothesis (% of the land)	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
	50% L 20% H 30%O and F	60% L 20% H 20% O and F
Low Tier	+ 119€ 2018/ha	+ 90€ 2018/ha
High Tier	+ 210€ 2018/ha	+ 183€ 2018/ha
Organic and Forestry Conversion/Maintenance	+ 64€ 2018/ha	+ 239€ 2018/ha

Table 3: Market scenarios retained (interviews and farmgate prices evolution analysis FaoStat)

High Prices	Low Prices
Milk: 100% - 27 pence/litre* Sheep: 100% - 90 £/lamb* Beef: 100% - 900 £/Store* Average price given by farmers depending on their product characteristics, in interviews.	Milk: 95% - 25.6 pence/litre* Sheep: 90% - 81 £/lamb* Beef: 89% - 801£/Store* Market conditions selected as gathered from literature and interviews.
Support Farmers, Renting-Out: Income depending on other farms' economic performance Potato: Market already characterized by high volatility. Farms in the area operate on contracted terms with supermarkets, through a co-op. Mitigation of any market impact. **Prices are purely indicative and do not reflect output pricing in the archetypes*	

Farms' decision making on future scheme uptake and subsequent system evolution would be linked to different elements following our scenario. First the enterprise orientation; the capacity in fodder production, the amount of stock carried on the farm and its orientation. The lower the stocking density, the easier it will be to spare land for environmental actions in the scheme without altering the farming system. Secondly, we need to take into account the amount of land rented in and its modalities, namely whether subsidies go to the landlord. Thirdly we must consider the social status and profile of family workers on the farm, which will influence their room for manoeuvre.

As for stocking rates and possible tiers there would be: a 1.5 LFU/ha limit for the higher tier and 1.3 LFU/ha for Organic/Tree planting. In terms of renting and status we will scan the possible evolutions/uptake linked to the first round of "theoretical" uptake. **We will compare possible AV/ha with assumed payments and AR per family worker against living and**

reproduction viability thresholds, giving us further hints of what changes could be witnessed. We set a goal of 50% of the land entering the low tier, 20% organic/tree planting and 30% high-tier for scheme uptake.

The results of this simulation with 4 different scenarios can be found in ***figure 7.***

Simulation of 4 scenarios on farm archetypes compared with the Baseline (with the adoption of the NVZ)	€ 2,018	Agricultural Revenue Per Family Worker K€	Added Value Per Worker K€	% of Subsidies in Revenue
Big Ridge - All Year Round 90 DC Org 6KL Low Yield - No buffer left	Reference	39	32	44%
	High Subsidies High Prices	39	31	45%
	Low Subsidies High Prices	36		42%
	Low Subsidies Low Prices	29	24	53%
	High Subsidies Low Prices	31		57%
Big Ridge - Autumn Calving 300 DC High Yield High Input - (Low Tier)	Reference	61	68	8%
	High Subsidies High Prices	62	68	5%
	Low Subsidies High Prices	57		4%
	Low Subsidies Low Prices	43	57	6%
	High Subsidies Low Prices	47		7%
Big Ridge - Spring Calving 400 DC Low Yield Low Input - (Low Tier) No buffer left	Reference	47	67	18%
	High Subsidies High Prices	47	67	10%
	Low Subsidies High Prices	37		10%
	Low Subsidies Low Prices	7	54	51%
	High Subsidies Low Prices	18		27%
Big/Small Ridge - All Year Round 1000 DC High Yield High Input - (Low Tier) No buffer left	Reference	48	59	5%
	High Subsidies High Prices	64	59	7%
	Low Subsidies High Prices	48		7%
	Low Subsidies Low Prices	3	47	102%
	High Subsidies Low Prices	19		24%
Small Ridge - All Year Round 90 DC Low Yield - Need to adapt	Reference	23	22	56%
	High Subsidies High Prices	16	22	40%
	Low Subsidies High Prices	12		38%
	Low Subsidies Low Prices	6	15	81%
	High Subsidies Low Prices	9		67%
Small Ridge - All Year Round 200 DC	Reference	51	52	13%
	High Subsidies High Prices	52	52	10%
	Low Subsidies High Prices	47		8%
	Low Subsidies Low Prices	38	46	10%
	High Subsidies Low Prices	43		12%
Small Ridge Beef 45 SC (Stores) - (High Tier) Need to adapt	Reference	11	3	100%
	High Subsidies High Prices	8	2	100%
	Low Subsidies High Prices	7		100%
	Low Subsidies Low Prices	1	-5	100%
	High Subsidies Low Prices	2		100%
Small Ridge - Beef Finisher 50/year - (Low Tier) Need to adapt	Reference	15	14	100%
	High Subsidies High Prices	16	13	100%
	Low Subsidies High Prices	14		100%
	Low Subsidies Low Prices	8	7	100%
	High Subsidies Low Prices	11		100%
Big Ridges - Specialized Beef Finisher 80 SC - Organic - Need to adapt (Organic Scheme)	Reference	22	11	100%
	High Subsidies High Prices	21	11	100%
	Low Subsidies High Prices	18		100%
	Low Subsidies Low Prices	10	5	100%
	High Subsidies Low Prices	13		100%
Big Ridges - Specialized Beef Finisher 180 SC - (Low Tier) Need to adapt	Reference	20	31	100%
	High Subsidies High Prices	16	31	100%
	Low Subsidies High Prices	12		100%
	Low Subsidies Low Prices	-5	19	100%
	High Subsidies Low Prices	-1		100%

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Figure 7: Result of the simulation of the 4 different scenarios on a range of archetypes, under a possible future Welsh Agricultural Policy. By the author.

With similar levels of market volatility farms will lose the buffer of CAP basic payments. In ***figure 7***. We can see the risk linked with the end of the CAP that was buffering farms' incomes during crises. If the conservative approach to future farm support scheme design is retained, most notably flat rate hectare payments, lowland farms will be at a disadvantage, particularly small holdings. And on beef and sheep enterprises there would be a need for rapid adaptation due to the extremely low incomes. Most would move part-time, combined with high tier/tree planting conservation options in the scheme (or exit from farming). Dairy farms could maintain

a sufficient income for them to subsist, with the exception of smaller conventional dairy farms which would have to adapt. Depending on landscape opportunities they could expand or move towards organic production. Dairy farming would be an option for struggling beef and sheep enterprises if they could access the land and loan market. At first the dependence on subsidy profile of farms would not change much, but there would be a need to change enterprise types within an evolving range of what is possible, in turn affecting subsidy dependence.

Considering options at hand we need to remember that the industry is market driven, in terms of volume and the characteristics on which advisors and investors have focused, as a way to increase farm income. But what is profitable for industrial actors isn't necessarily as profitable for family farms. Reducing cost, input use or going towards remunerated niche quality products tend to be more promising for long-term farm profitability than a strategy oriented towards volume production. From a Welsh point of view, the commitment (Welsh Government 2020) to have a strongly exporting farming industry with green credentials would require a shift away from imported inputs and towards more agro-ecological farming systems. This would offer better added value returns to farms; all the more as the oligopolistic processing industry is little based in Wales (thus not contributing to its global added value). Organic systems and low input archetypes with high added value products tend to better weather future evolutions in table 6., though sometimes with a higher reliance on subsidies than other ones.

Four more points need close scrutiny before understanding potential futures: the social position of the farms, their potential land access, their capitalisation and indebted status and most importantly their rapidly usable liquid assets. Each of these factors could lead to different choices concerning development and adaptation strategies, in the face of policy change. These factors will be further considered, as part of the research underpinning this paper.

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