CAAV Discussion Paper

Future Rural Land Uses in the United Kingdom

A Review of Pressures and Opportunities

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FOREWORD

We face a period of accelerated change for farming, the environment and rural land management with changing markets, technologies, climate and policies. What changes in rural land use might they bring?

This paper is offered to open up that discussion. It is an extraordinary piece of work by Jeremy Moody, Secretary and Adviser to the CAAV, for which I offer my congratulations and thanks on behalf of our Association.

Framed against the UK's withdrawal from the European Union and its Common Agricultural Policy, the paper explores the future use of the finite area of our land, reviewing a variety of accumulating pressures against a background of how these may affect rural land management and use.

The author takes the reader on a historical journey of six thousand years of land use in Britain before focussing on change with historical and non-agricultural drivers and then to the here and now of climate change, its impact, mitigation, and adaptation. With an overview of current agricultural economics, it then focuses on the dynamics for agricultural change and thoughts on future changes in land use.

The paper closes reminding the reader of the coming decade of change and the need for advice. As the Welsh Government has said *"advice should be seen as an investment in the capacity of farmers and farms, rather than a cost"* (Sustainable Farming and our Land, Paragraph 1.48).

The Agricultural Valuer is central to the provision of this advice to farmers and land owners. The CAAV's Future Skills programme, implemented by our Association, will underpin the delivery of this advice by members as trusted advisers.

Andrew Thomas
President, CAAV **March 2021**

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LAND USE

EXECUTIVE SUMMARY

A Discussion Paper – This is a review paper considering the near future for land use change in the United Kingdom, a country with its land uses made and re-made by man over time now facing new challenges. It is offered to illuminate the issues and be a starting point for practical discussion on how we best approach the coming years with their pressures and opportunities. The CAAV intends to take that debate forward.

This paper is not prophecy and does not offer hard conclusions; we can make our future. Rather it takes the background and factors that can now be seen and explores both their potential and their limits, some illustrated by history. It is necessarily a general paper reviewing a large range of topics at this important time; specialists may see much to challenge or develop in their own areas. Different readers with different situations and interests will give different weightings between these and form other judgements. That is the debate that will improve our understanding and management of what looks to be the very demanding task of a generation's change in a decade, one that bears not only on land but on people.

Some aspects of this are fixed, such as the country's geology and geography. We have a full landscape of existing people, farm structures and resources. Other factors are changing, from the climate to public policy, especially now the UK has left the European Union. All these factors only have outcomes because of the decisions that individual farmers, landowners, foresters, environmental bodies and others take in managing land.

The Pressures for Change – Farming uses some 70 per cent of our land area. Many will see the immediate prompt for change in agricultural uses being the withdrawal of the Basic Payment inherited from the EU in England, and then in Wales, with the redeployment of its funds to new purposes. However, there are larger pressures such as:

- climate change with its impact and then both its mitigation and adaptation to it
- within that the direct issues of carbon sequestration and displacement (as with renewable energy generation and management)
- changing trade patterns for food and public tastes, both domestic and international and with the possibilities of other food technologies
- the rapid development of agri-technology
- the increasing focus on biodiversity, air and water quality by both regulation and the development of markets
- a growing population with urbanisation, infrastructure and markets
- greater regulation and scrutiny.

The Ways of Change – Such changes generally look likely to put pressure in many areas on patterns of commodity farming that the CAP has framed for nearly 50 years, with area payments working in the UK (and probably also Ireland) to accommodate a decline in relative productivity (business efficiency rather than output) and so competitiveness. Movements in produce prices are, in reality, more likely to be significant than changes in support. The changes in who is farming what enterprises on which sorts of land and in what ways to meet the Government's productivity goal of matching competitor nations by 2030 are themselves likely to be substantial. That includes how the land occupation market can be open and flexible enough for the right people to find the land they will farm well. Taxation will be one of the factors in that.

The paper looks back to how farming's land uses have changed over the last 150 years as a basis for insights into how we might naturally use land now outside the CAP with

its historic bias to cereals and beef. While commodity farming will continue, economics would point to an accelerating shift to speciality, higher value and more added value produce and also more indoor production, with the search for ways to increase value added and margin. This points to a much less standardised, more varied agricultural economy, likely to take us out of the patterns we have seen since the 1960s.

Change will not bear uniformly across the country. Of itself, the withdrawal of Basic Payment may tend to put the greatest pressure on the more marginal arable areas as well as the less productive parts of the grazing livestock sectors but at least some of those areas will be those that can make more of the new opportunities, whether environmental ones or as businesses recast to meet the new markets.

Technology – The new technologies, from data to automation, should offer substantial efficiencies and environmental gains but require new and improved skills and investment. Those who can best use them will have the advantages they bring. Available round the globe, if we do not adopt them our competitors will.

Environmental Uses – Both markets and public policies are increasingly focused with growing urgency on environmental and climate change goals, whether by regulation, environmental schemes, through supply chains or by the intervention of private finance. The scale of the change for rural land management in meeting the net zero and other goals should not be underestimated, requiring an eye to be kept on the direction of travel as much as on the immediate requirements.

Where, if we move from the EU's compensation basis of income foregone/costs incurred to a more market-oriented approach, environmental land management can be seen by a landowner as an enterprise, alongside wheat, lamb and milk, that will open up more positive, voluntary, innovative and successful engagement and delivery.

Soils – Improved soil management unites the strands of productivity and the environment, supporting good farming while sequestering carbon, managing water and improving biodiversity. There is much to be learnt and done for this, for grassland as well as arable. Reversing the depletion of soils will take some time and effort that should be recognised.

Forestry, Peat and Renewables – Despite the public focus on tree planting, history tends to suggest that this will continue to be seen more in Scotland and Wales than in England or Northern Ireland. The restoration of peatland, now perhaps excluding trees, is becoming a priority to reduce carbon emissions with issues in both uplands and lowlands. Renewable energy generation, with its associated storage and other facilities, along with the upgrading of the grid for the more comprehensive electrification of the economy will all have their impact on land, as electricity demand is forecast to double by 2050.

Restructuring through Markets – In turn, as change unfolds so it will bear on and be driven by changes in values of inputs, outputs, land and other assets, all the natural processes of adjustment in the marketplace with an openness to innovation. Withdrawing Basic Payment, anyway a prompt to business review, can be expected to put pressure on farming's costs and structures while markets might choose to discount the values of assets and businesses that are not seen to meet "green" expectations or are otherwise vulnerable. New income streams could enhance the value of other assets though it will be important to understand the terms on which they are available, their consequences and the extent to which they may offer real value.

Decisions by People – At the heart of this are the people now using the land – and those who aspire to – who take the decisions that will shape the outcomes of these forces. Some may choose not to react but absorb the pressures or find ways like part-time farming to soften them. Others will be, indeed already are, looking for decisive change in efficiency, enterprise choice, investment, adding value, diversifying, generational change, letting land out and the many other ways of adapting to be ready for a more commercial and environmental future. A simple way to bring this together is to ask where a farmer wants to be in ten years time. The answers will all be individual ones; their accumulation will shape our landscape and its uses, the success of farming and other rural enterprises.

The Place of Advice – The CAAV sees the demand for and reliance on advice as a powerful call on the resources of agricultural valuers as professionals and as a profession with our ability to give appraisal and advice in round, synthesising the specialisms and understanding the circumstances as trusted advisers. The Welsh Government has put this well:

> "… advice should be seen as an investment in the capacity of farmers and farms rather than a cost …".

With issues from land occupation arrangements and taxation to development control and schemes alongside farming and business practices, agricultural valuers will be called on to provide both specific advice and services but also the holistic advice and support that will help a family get to where they realistically want to be in ten years time.

The CAAV Future Skills Programme – With that expectation, the CAAV has been developing its Future Skills programme to support members and so their clients to manage change over the coming decade. Starting with awareness and understanding of the issues and coming pressures, that moves forward with business review, environmental resources, technology and other areas. As well as conferences, workshops, webinars and podcasts, we have published:

- *Beyond Brexit: A Review of the UK's New Agricultural Policies*
- discussion papers such as this paper, *Taxation: Agricultural Productivity, Land Occupation and Use After Brexit* with allied papers on such subjects as the potential of the Irish Republic Income Tax relief for letting land and on capital allowances for investment, and the review published in *Retirement Housing for Farmers in the United Kingdom: A Review of the Issues, Experiences and Possible Answers*
- *Reviewing a Business*
- website materials on soils and natural capital with work on biodiversity gain and carbon agreements
- a CAAV Centenary Scholarship report, *The Value of New Technologies for the Profession*.
- texts on tenancies and farming agreements including, for example, the extension of the contract farming approach with *Contract Farming Agreements for Breeding Livestock*

We have developed Facilitating Dispute Resolution as a service with a *Dispute Resolution Charter*, *Appropriate Arbitration* as a review of timely and cost-effective approaches and *Rural Arbitration in the United Kingdom*.

A Conclusion – Our land uses are likely to change over this decade and longer as a result of all this, partly in ways that cannot be clearly foreseen. Nonetheless, the land will be here and it will be used. The more that the processes of change are considered, advised and managed with an eye for opportunities, the more they are likely to be successful for those involved, their businesses, the environment and the landscape. We have much to do and England is given the framework of the Agricultural Transition Period as a means of framing this. This paper is offered to help open these issues for further discussion.

HOW MIGHT FUTURE RURAL LAND USE CHANGE?

A DISCUSISON PAPER

CONTENTS

1. Introduction to Land Use Change

1.1 A combination of factors and accumulating pressures competing for the use of the finite area of our land point to the potential for substantial changes in rural land use which are reviewed in this paper. Land uses and farming patterns ebb and flow as changing markets, technologies, competing land uses and now climate change issues are seen to exert increasing pressures on land management at a time when, post-Brexit, policies are changing. Following the UK's withdrawal from the European Union (EU) and its Common Agricultural Policy (CAP), area payments are to be phased out in England and then to go in Wales. There is a greater official focus on environmental matters. However, these are by no means the only pressures on rural land use.

1.2 This paper reviews a variety of those pressures and how they might bear on rural land management and use, doing so against the background of how land has been used and how that has changed in the past. Constrained by geology and circumstance that history shows both how much has changed and what might be constant constraints either on what is physically possible or in the decisions that people take in working with natural systems and economics. In that, it offers a guide when speculating about what looks to be a time of signal change. In immediate terms, moving away from the CAP, essentially a policy originally designed for the north European plan around cereals and beef onto which support for sheep was grafted, opens the question of what patterns of enterprises would be adopted for agriculture, once without that background of support that has been carried forward over decades and most recently expressed as aid for broadacre land occupation.

1.3 The ways in which land is used and how they evolve is the outcome of human decisions, influenced by many factors, including geology and climate, economics, social preferences, public policy and technology, balancing competing pressures and opportunities.

1.4 However, changes in land use never start from a clean sheet but always evolve from where we have been. There is always a backstory and always constraints with forces for inertia as well as for change. That is especially true in the United Kingdom where man has made and repeatedly remade the landscape over the millennia since the final end of the ice ages, seeing the balance of uses shifting and adapting as circumstances change. While new challenges mould future uses, they do so not only with that physical inheritance but also within a framework of existing ownerships, occupations, businesses, investments and preferences and the varying reactions of the people involved. One of the characteristics of the English landscape is its continuity of boundaries, often carrying forward landholdings long pre-dating current arrangements. This is, thus, primarily about how existing owners adapt the use and occupation of land leaving the consequences of changing ownership, such as development or forestry, to come with family life events or the mix of economic pressure and opportunity.

1.5 A basic point is that the management of land and buildings is a cost required to maintain them against decay and reversion, requiring resources to do this before earning a return. Even where land is not managed for a commercial use, an eye has to be kept on that cost and how it is met. More commonly, land is occupied with a view to providing income on a commercial basis in whatever might be the current and prospective circumstances. A warning though lies in those rural cottages, houses and mansions that would now be cherished but which were left derelict and demolished as late as the 1970s for want of demand.

1.6 Involving fundamental issues such as land, food and water, rural land management has long been subject to a complex web of government intervention by regulation and financial action. Regulations may range from disease and development control to environment and food production standards and such legislation as for enclosures and tenancies. Financial action has ranged from protective support, whether the Corn Laws, deficiency payments, intervention support, coupled and area payments, to payments to change behaviour as with agri-environment policies and, of course, taxation. Each action can have direct, indirect and sometimes perverse consequences in the matrix in which individuals take decisions. As they change over time in responding to new issues, now such as climate change, that too will influence those decisions.

1.7 In a liberal society and a market economy, the price signals given by changing values and the perceived opportunities for gaining or protecting income and capital will be a fundamental factor in interpreting, easing and adapting to the larger pressures. Changing values will reflect pressure and opportunity, prompting (but not forcing) decisions which in turn will see further adjustment through the myriads of individual choices, lubricating change and enabling innovation. Foreseeing that we will have a generation's change to be managed in the coming decade, it is exceptionally important these processes can flow as freely as possible to achieve better outcomes.

2. A Brief Review – Six Thousand Years of Land Use in Britain

2.1 Land or Sea?

At its most basic, the boundary with the sea is always moving, now with the prospect of further rises in sea levels. Medieval Dunwich on the Suffolk coast has been lost; land is still being lost by erosion along the eastern coast but being deposited further south. On the other side of the country, Fairbourne in Meirionnydd is at risk of abandonment to the sea. Much hard won land lies behind successive embankments and sea walls with significant recovery of land over the years around the Wash, Thanet, Lympne, Romney Marsh and elsewhere. Now, the tendency is more to soft landscape management of salt marsh to buffer and attenuate the force of the sea. This is not necessarily just a coastal issue as was dramatically indicated by the 1953 floods when the Wash reached almost to Cambridge.

2.2 Farming Changes

2.2.1 Prehistory saw much woodland cleared, a project entailing much hard work, and most of the rest kept by being brought into management for economic needs, often by coppicing as regrown shoots were generally more useful. Land moved between arable cultivation and pastoral uses with Neolithic ard marks under Bronze Age barrows and signs of a revival in pastoralism. Kinder climates in the Bronze Age or 1000 AD saw farming go up the hill where it might also be driven by population pressure but then recede in other circumstances. Improving plough technology saw heavier land brought into cultivation while the heathlands waited for later centuries. The valuable mediaeval wool trade with its international markets shaped landscapes in much of England as much as iron working and clay did in the Weald. In Scotland, after the reconstruction of borders farming in the eighteenth century, the Highlands changed with economic challenge, the clearances and the rise of sheep farming while sharing the scourge of potato blight with Ireland.

2.2.2 The centuries-long hard work of drainage, starting before the Romans, made more land useable and productive and made large areas of wetlands, notably the Fens, Axholme and the Somerset Levels, more conventionally farmable. The technology of eighteenth century agricultural improvement and a greater focus on improving crops and stock by selection and breeding was followed by the high farming investment of the mid-nineteenth century before bulk grain ships and refrigeration brought price competition from the Americas with agricultural depression. The railways enabled liquid milk supplies to the cities while those further afield preserved food for sale as cider and cheese. The Napoleonic Wars and the two World Wars required their own shorter term changes with more land under the plough. In the reverse direction, Irish conacre seems to have been a generally arable arrangement in the early nineteenth century, becoming a grassland one in the twentieth.

2.2.3 With field patterns back to the Bronze Age, landscapes were made by enclosures and then remade by the efficiency imperatives of modern machinery and the wave of hedge removal from the 1950s to the early 1980s. Mechanisation came with the steam and internal combustion engines while electricity became more general in the 1950s. Land used to feed oxen and then horses with oats and hay could be put to other uses though horses could plough land too steep for tractors. The 1970s brought portal frame buildings with their scale and the more universal use of silage, more easily and reliably produced than hay. The manually handled two hundredweight sack was replaced with front end loaders and material handlers (with the first electric ones now appearing). Maize became a new fodder crop. Orchard and horticultural areas have shrunk but cherry and cider orchards have grown in recent years. Hop growing is now substantially limited to Herefordshire and Worcestershire.

2.2.4 Structures of ownership and occupation have changed over the years. While people have entered and left farming, our view of those changes is often coloured by a strong survivor bias. Surveys show that some 30 per cent of businesses have continuity from before 1900, a pattern not seen elsewhere in the economy, though masking the many that that have gone. Nonetheless, some ownerships have been continuous within families since the Domesday Book (some perhaps with longer continuity) making them, unremarked, the longest-lived businesses in the country. The Church of England still holds land granted to Augustine in 597.

2.2.5 The centuries of the enclosure movement saw the creation of a more general landlord-tenant system, as smaller occupiers found they could farm a larger area of rented land. In Great Britain, tenancies covered 90 per cent of farmland before the First World War but that then declined with economic hardship, taxation and then the avoidance of restrictive legislation. Initially reluctant, tenants bought their freeholds which have now been inherited by later generations. Periods of hardship created new opportunities for entry as with the movement of Scottish farmers into East Anglia and south western farmers into the south east between the wars.

2.2.6 The concept of the farming ladder was developed in the mid-twentieth century and, while declared dead by the 1966 Wise Report, has lingered in farming's imagination. In England and Wales, the tenanted sector's collapse was halted by the more liberal 1995 tenancy legislation which saw a recovery, then halted in its tracks by the CAP's Single Payment and its dependence on land occupation. Scotland, without substantial reform, saw its let sector fall further though now apparently stabilising at around 20 per cent of the farmed area but, as elsewhere, with bare land lettings now predominating as a function of the economic pressures for restructuring for continued commodity production.

2.2.7 The specialisation of farm businesses, especially in the last 40 years, has had its effects, particularly with a geographical separation of arable and livestock. Efficiency of management, cost of machinery, easier transport of feed, the move to fertilisers from manures and the focus of farm management accounting on unit costs have all encouraged this as natural part of the logic of commodity production, giving what scale could be achieved within the farm as a management unit. Dairying activity concentrated on fewer larger herds as dairy parlour technology advanced from the milking bail to robotics. Simple post-War changes in the appearance of the landscape have been the shift from spring planting, dominant until the early 1970s, so that arable land is green in the autumn, the move to black and white dairy cattle with the adoption of the higher yielding Friesian and Holstein Friesian breeds, and much shortened straw of cereals crops when compared to the old staples, such as Squareheads Master. Irrigation has made it possible to grow vegetables on light land that was once only sheep walk.

2.2.8 One consequence of these changes is a working landscape without significant human presence. The once ubiquitous ploughmen (used in a Thomas Hardy poem as an unchanging symbol while empires fell), hedgers, ditchers, shepherds and others have gone as mechanisation has sharply reduced the workforces for rural land management. One of the largest categories of employment at 900,000 even in 1923, it dropped to 700,000 by 1940, recovering to 900,000 during the War. It then declined steeply, giving the improvement in labour productivity held to mark agricultural improvement as large areas of farming became family-only businesses with employment now concentrated in dairying, horticulture, pigs and poultry.

2.2.9 While in Kipling's *Puck of Pook's Hill* Hobden the hedger's family had plausibly worked on that particular land since before the Conquest, many of those now working in farming and its processing industries come from abroad as domestic recruitment has fallen away. Rural populations have changed with fewer of working age and often low unemployment while, in many areas, farmers may often now be the only people with local ancestry. Workers came from across the world, Morocco and Brazil, but especially since the A8 accession to the EU in 2004 from central and southern Europe as an invaluable facilitation of business but perhaps also delaying further automation. The availability or otherwise of such staff has consequences for land use, higher value production and essential downstream processing. At sharper moments in the debates over immigration, it was asked whether we should import apples or apple pickers. Post-Brexit immigration policy seems likely to exert a slow restriction on numbers of those who are available for farms, slaughter houses and vegetable processing, with its own influence on how these businesses and their land uses develop.

2.2.10 That touches on a further point. Much production is inter-related with its proximity to processing capacity. That is perhaps most obviously demonstrated by sugar beet and its factories with production collapsing in areas where factories have been closed. More generally, we have the concentration of food processing in prime arable production areas, milk processing in the dairy fields and slaughterhouses in the livestock areas. In part, this is natural association and, in some areas, an important self-reinforcing clustering of activity and investment. As the sugar beet example shows, where the processing capacity ceases the production reliant on it risks becoming even more of a commodity now disadvantaged by being further from its possible market. Thus, dairying in Aberdeenshire has gone in a few decades from having its own Milk Marketing Board to near extinction.

2.2.11 One Illustration of Longer Term Land Use Change – A review in the 1987 RASE Journal of a 3,000 acre estate in east Devon near Cullompton observed the changes seen since the seventeenth century in its landscape of hills and valleys:

> "to return the estate to a landscape of two hundred years ago, it would be necessary to clear fell nearly all the existing timber and plough up a lot of the pasture! To complete the picture a few hedges would need to be replaced and some orchards planted, together with a few fields of "furze" or gorse."

With hedgerow trees used for estate repairs and fuel, the 1650 survey indicated that there might have been only a tree an acre. Having been run down by the 1730s, the 1788 survey recorded:

> "some of farms are consolidated, a great many acres of furze are grubbed up, and the wet parts have been drained, so that rents are now advanced …"

The woodland area rose from 5 acres to 100 by 1900, mainly by neglect in the later nineteenth century agricultural depression with a further 70 added since for amenity. The agricultural use swung from arable to pasture:

	Arable	PP	Temp P	Orchard	Wood	Furze
1788	1754	751	0	63	5	123
1855	1758	751	0	63	5	123
1986	957	1271	674	0	169	0

2.2.12 Changes in the opposite direction over that period would be seen in what are now our principal arable areas, with the loss of livestock and the conversion of land to arable. Perhaps particularly noteworthy in that shift is the great reduction in the number of arable and beef farms, with a one-off release of capital but with the associated loss of infrastructure and skills.

2.3 Woodland Change

2.3.1 The remaining areas of woodland, often small enough to be named as islands marked out by boundary features in a farmed landscape, were once managed intensively, largely by repeated coppicing and allied techniques for all the daily uses from tools and ladders to hurdles and laths as well as arrow shafts. The large volumes of charcoal needed for metal working in the Weald, the Forest of Dean, Wyre Forest and other areas required sustained management of underwood and attracted industries to them. On many farms, hedges were a source of wood as well as stock proof boundaries. Timber from the overstorey was reserved for construction (still with a preference for the small stems that are easier to work) and ships' timbers but much, especially larger timbers, was also imported from northern and eastern Europe. Withy and osier beds were also specifically managed for their produce.

2.3.2 That woodland has long been a limited feature of the landscape is shown by the assessment that, of the Domesday Book's 12,580 entries in 1086, just 6,208 had woodland with those concentrated largely in the Home Counties. Even including wood pasture, as for pigs, this may have been 15 per cent of the land area. Much of that went over the next 200 years as the population increased.

2.3.3 While what is now classed "ancient woodland" (there being little if any of true antiquity) may have been continuously wooded since 1600, it will generally have been closely managed by man for much of that time – woodlands creating perhaps a third of the income of some estates around 1850. The demand for oaks for shipbuilding from 1780 to 1860 and, as importantly, its bark for tanning, saw little woodland grubbed out in the Napoleonic Wars even with their high cereal prices. As new materials displaced wood and oak bark was no longer used for tanning, so the woodland area fell to 5 per cent by 1900 (in Ireland already down to 2 per cent by 1650). Coppicing essentially ceased in the generations either side of 1900. What remained was preserved by inertia (especially where bought with land by an uninterested tenant), sporting interest and the substantial cost of grubbing them out (only really seen as viable with the climate of cereals farming in the early 1980s). The replacement of longstanding woodland parcels with conifers was a major loss of those woods without affecting the overall area.

2.3.4 That area of woodland has more than doubled since, especially in Scotland and Wales, largely as a result of public policy interventions from creating the Forestry Commission after the First World War, partly out of the Crown Estates and now holding 27 per cent of UK woodland, to tax relief and grants but also where upland farming was outcompeted or abandoned, albeit now producing wood more as a commodity. With the shift from coppicing and loss of value in underwood, that has seen more discussion of forestry, with plantations of trees managed to be to be harvested as trunks in early maturity. The concept had become more familiar with imperial experience in places such as India and Cyprus and drew on long developed German forestry practice.

2.3.5 While forestry economics were long in the doldrums, recent years have seen improved demand and confidence strengthen timber and forestry values and returns. Forestry buyers are now more able to take on land, though still generally the poorer land. Estates that can, with their time horizon and scale, see forestry as a component in their portfolio are already likely to have it. However, in west Scotland, land is moving after farm tenancies end into forestry and there are some purchases of farms in mid Wales for forestry. While there will always be exceptions, that illustrates the thought that the significant transfer of land into forestry seems more likely to be achieved by a change of ownership, or perhaps occupation, than by continuing owners making a major change in their land holding. Agricultural and forestry planting values are still well apart in much

of England so excluding this change of use so far as economics are a factor. The potential for sustained hard times to drive such a change in ownership might be indicated by the scale of change in ownership of rural estates in the years before the First World War after 30 years of hard agricultural depression, and then their break up by sale to tenants.

2.3.6 Forestry expansion relies on an infrastructure, initially of tree nurseries, at present seen as well short of capacity for the numbers of trees canvassed, and contractors. With growing concern about the narrowness of the genetics of nursery stock, sourcing more varied trees to plant while minimising disease risk is a challenge.

2.3.7 Grey squirrels and deer are a perpetual issue. As witnessed by Dutch Elm disease in the 1930s and again in the 1970s (with its particular impact on the nature of hedges) and now ash dieback, trees are vulnerable to new pests and diseases. *Phytophthora* has shown the potential weakness of monocultural planting and *Xylella* appears a future challenge. While we might now be more sensitive to tree stress and tend (perhaps unreasonably) to expect vigorous health to be the natural condition of trees, climate change now brings drought stress and storms (as perhaps in 1987) as new challenges while requiring trees planted now to be able to thrive in a warmer climate so changing what might be planted where. With the extremes of a more continental climate, not only has Cambridge University's Geography Department described the period 2015 to 2019 as the driest four years in central Europe for two millennia (*Nature Geoscience*, 2021) but 2020 brought the pressure of the worst drought in 500 years on that region's forests and produced great stress, forest fires and conditions favourable to pests, all adverse to forestry as a major land use there.

2.4 Urbanisation

2.4.1 Throughout history, patterns of settlement and then accelerating urbanisation with its supporting transport and other infrastructure have taken land from agriculture, whether the market gardens and orchards that were once Chiswick or the farms now under Milton Keynes. Population growth has required more housing which transport has allowed to be more dispersed. Tides of urbanisation swept into northern England, the Welsh Valleys, Scotland's central belt and Belfast in the nineteenth century and then into south eastern Britain over the twentieth century and since. At the other extreme, St Kilda was evacuated in the 1930s.

2.4.2 While the figures for urbanisation can be presented variously as the small footprint of each building or the larger impact of new settlement areas with their roads and other features, the later sections of this paper, especially population growth and movement, develop the prospect of substantial further development of agricultural land.

2.4.3 Urban areas reach, as with their night-time glow, beyond their physical footprint in several ways, often seeing more mixed uses of land in peri-urban areas with more economic opportunity for that in both proximity and economic activity. However, that can also bring adverse pressures such as more fly-tipping and trespass. It is sometimes remarked that Green Belt land can look more ragged and decayed on its inner boundary against urban areas. Beyond that are housing opportunities for the diaspora of commuters, more now perhaps to be part-time commuters with some now going further afield, and the demand for infrastructure joining and serving urban areas.

2.5 Planning Control

2.5.1 Particularly since the end of the Second World War, changes in land use, especially as regards urban development, have been more closely regulated by the state.

Partly in reaction to ribbon development, town and country planning set in hand the comprehensive control of development tending to limit it and make it more dense. The exception then lay with the conscious approval of areas of new settlement with new towns and urban extensions. This has come under the competing pressures of local political resistance to new development and powerful economic and social drivers for more housing in new locations with the result being an accumulating shortfall of new housing and palliative counter-measures addressing symptoms, not causes. The outcome of that process is expressed in prices.

2.5.2 The one policy from the post-War approach that remains firmly, if misunderstood, in the public's mind is the concept of the Green Belt. Intended as a restriction on development around major urban areas to prevent them from coalescing, it is more widely seen as a landscape preservation policy, even if Green Belt land can get shabbier on its margins and development leapfrogs it. Politically, it has long been attractive to extend the outer perimeters of Green Belts, even if that is irrelevant to their purpose. While they (to an extent deliberately) fossilise past patterns and are subject to criticism, attempts to revise or reshape this policy have generally been abandoned as politically toxic.

2.5.3 While development control was intended by some to promote rational development, public policy has also acted with a clearer intention of conservation with the introduction of National Parks, now enlarged, Areas of Outstanding Natural Beauty and conservation areas as well as SSSIs (ASSIs in Northern Ireland) and Environmental Impact Assessments for development.

2.5.4 In combination, those state controls and the market pressures for change have seen dramatic increases in the value of land approved for development, albeit much of that not received by landowners but pre-emptively taken by the state through taxes, charges and obligations.

2.5.5 England is now proposing to move to a zoning-based system with planning authorities to identify growth zones with approval for development proposals meeting the design codes that those authorities are also to establish. Outside growth zones, protection zones are to include protected landscapes with policies possibly much as now, but also to include flood risk areas, and may well be closely influenced by the local nature recovery strategies that the present Environment Bill would require from local planning authorities in what looks to have the potential to be a parallel land use control system for species and habitats.

2.5.6 The Government is looking to use this zone-based approach with national targets to deliver the number of houses required across England but its initial attempt to allocate that number on the basis of housing market pressure is already being reworked in the face of political opposition. The imperative for the underlying number may well remain.

2.6 Leisure Change

2.6.1 Over the centuries, land has been made available for leisure as well. The open royal hunting forests, such as the New Forest, with their relevant legislation created and preserved their own landscapes. These were not "forests" as that word would now be understood. Here, "forest" was the separate legal regime of forest law governing an array of uses and protections, notably for game and hunting, particularly of deer and wild boar with that law reaching well beyond the area of covert, while some were simply heath or moor. Over time, the Forest of Dean, Wychwood, Epping, Sherwood, Dartmoor and other areas fell within variations of this regime preserving rights to hunt deer (or more

often to take it for ceremonial food) overlaying all other property rights with fines being a source of revenue. The hunting aspect of this survives in the forests of the Highlands.

2.6.2 More recently, grouse moors have been managed with supporting sheep grazing while the hunting and shooting interests of owners have governed and promoted much tree planting, hedge management and the wider preservation of game and, often with that, much wildlife. The latter is now also carried on by conservation bodies. The great parklands and gardens of Stourhead, Stowe, Chatsworth and elsewhere succeeded mediaeval paled deer parks, taking land out of farming and, as at Nuneham Courtenay and elsewhere, even moving villages.

2.6.3 An urbanising Britain also saw recreation for leisure, inspiration, health and, with the influence of romantic poetry from Wordsworth onwards, escape in access to the countryside, especially its more coastal or rugged parts. As was strikingly demonstrated in the 2001 Foot and Mouth outbreak, tourism is a major generator of economic activity in many rural areas albeit tending to provide lower paid and seasonal work. It brings its own pressures on what visitors come to see such that both the Lake District and Snowdonia have seen talk of restricting or charging for access while there is also a potential tension with biodiversity.

2.6.4 The Open Spaces Society was founded in 1865 as the Commons Preservation Society, later merging in 1899 with the National Footpaths Society, and stimulated the founding of the National Trust in 1895 by Octavia Hill and others to "promote the permanent preservation for the benefit of the Nation of lands and tenements (including buildings) of beauty or historic interest". Some areas saw specific measures, such as the Epping Forest Act 1878, the conservation of Hampstead Heath or the establishment of the Malvern Hills Conservators by statute in 1884 to protect and manage the Malvern Hills and the adjacent commons, providing preservation and access.

2.6.5 The concern for access saw the Youth Hostels Association founded in 1930 and the 1932 mass trespass by walkers at Kinder Scout in the Peak District. The post War governed than enacted the National Parks and Countryside Act 1949, creating national parks in England and Wales and formalising much of this concern in policy so that, for example, development control in these areas would not be a purely local matter. There is a wider network of Areas of Outstanding Natural Beauty and specific designations for as areas such as the Norfolk Broads. The Countryside and Rights of Way Act 2000 followed. The original, more upland, national parks have now been joined by the South Downs and the New Forest with the Government's response to the Glover Review awaited. While national parks have been resisted in Northern Ireland for fear of their impact on the local economy, Scotland designated Loch Lomond and Trossachs and Cairngorm as national parks in 2002.

2.6.6 The last century has then seen leisure and visitor facilities developed in many rural areas, from caravan parks to Centre Parcs. The 1980s saw farmland converted to golf courses, often in the hope of enabling other development. Other offers ranged from the commercial ones of paintballing, tolled horse paths and farm parks to the Forestry Commission's development of free access for cycling. Many have found limits to achieving substantial profitability.

2.6.7 The statements by the Prime Minister and the Scottish Government in late 2020 that 30 per cent of the land areas is to be managed for nature by 2030 has been generally taken as a commitment to enlarge the area covered by national parks but with unknown intentions for land management.

2.7 Minerals

2.7.1 Agriculture and forestry are not the only primary industries. The winning and working of minerals has driven the landscapes of districts from Cornwall to Snowdonia and Fife. That stone worth quarrying and the ores found around igneous rocks are often found in more dramatic or attractive landscapes makes their winning more contentious. While surface quarrying with its direct visual and other impacts is particularly so, the need for careful management of the wider effects is illustrated by the underground proposed working of potash and polyhalite in the North Yorks Moors and the super quarry within the mountain at Glensanda in the Highlands, itself easing the pressure for aggregates production from other areas.

2.7.2 Lime burning was once widespread for agriculture and construction with old kilns in limestone landscapes (as in the Pennines) or by quays (as on the Mawddach). Pits and quarries brought work and new populations when viable and disappeared as easily, whether early twentieth century lead mining in upper Swaledale or Neolithic flint mining in the Breckland. Farmworkers and others came from Somerset and mid-Wales to the burgeoning coalfields of South Wales from which almost no coal is now produced. The scars of coal mining are now disappearing from memory but subsidence from all forms of underground working remains an issue – even from seventeenth century limestone caverns but form Cornish copper mines to old coal workings. More recently, large scale sand and gravel working in the Thames Valley and other areas has brought its own landscape changes just as peat digging led to the Norfolk Broads.

2.8 Peatland

2.8.1 Peatland, formed since the Ice Ages, figures as an issue for climate change (restoring it to reduce its significant contribution to carbon emissions), water management (holding water and attenuating its flow) and habitat improvement while under threat from drying out through land management practices and climate change. Work for its restoration seems likely to take peatland out of general agricultural or business use and exclude it from forestry planting.

2.8.2 In England, the Government has a target for 35,000 ha of peatland restoration in England over the next five years, partly through the 10 intended landscape recovery projects. Scotland is committed to funding the restoration of 250,000 ha of peatland by 2030.

2.8.3 Lowland peat raises more questions as it is often higher grade cropping land. The Climate Change Committee's January 2020 Land Use report discusses its sustainable management as an alternative to restoration, including requiring cover crops in the winter and maintaining the water table. While 40 per cent of the Somerset peats are grazed, only 2 per cent of the Fens are, an observation leading the report to consider that the restoration of more valuable cropland could be by the purchase of carbon credits. The Committee also suggests that the Peatland Code would need to be broadened from its upland focus.

2.9 Looking Ahead

2.9.1 So, with this tapestry worked and reworked by cumulative change, what might happen next? How might agriculture, as the dominant rural land use, change? How far might land move out of agriculture into other uses?

2.9.2 With the same matrix of underlying factors, this paper looks at:

- the non-agricultural or external pressures for change in land use generally
- the internal dynamics of farming economics, markets, policies and technologies as they bear on existing structures

before continuing to see how those might work out in terms of land use, potentially over quite a short period of time.

2.9.3 It is not coincidence that Brexit is the moment for reviewing these changes but Brexit is far from the sole driver. Brexit does specifically bring new policies and potentially changed trade. As a clear point in history, it is more generally both an occasion and a prompt for taking stock. The larger changes in world markets and public tastes and the rapid acceleration of agricultural technologies may yet be more important. The potentially conflicting pressures for major change have been building up and seem likely to drive substantial changes over the next decade.

2.9.4 At root, there are the twin questions of:

- how fit farming is to face this and
- whether we can now turn round what might be seen with hindsight as two generations of declining agricultural profitability, a decline implicitly managed by previous policies.

Tackling the first and reversing the second calls for more radical measures. The parallel may be with the manufacturing sector in the UK, driven out of complacency by economic exposure and major reform in the 1980s and now the world's ninth largest manufacturing exporter.

2.9.5 With the topic of this paper, one prism through which to view this is whether the outcome will focus on:

- wider rural land management, albeit still largely using agricultural means as one way to do this
- a thriving and more productive commercial agricultural sector.

This paper explores some of the ways in which both might happen and the balance between them.

3. What Changes Have There Been?

3.1 Land Use Changes

3.1.1 The Centre for Ecology and Hydrology (CEH) has reported on changes in land use across Great Britain between 1990 and 2015.

3.1.2 It records further losses in agricultural land over that period with:

- 1.9m fewer acres of grassland, described as an area equivalent to Surrey and Sussex but with the greatest transfer in Argyllshire, presumably with the note below to woodland
- 200,000 fewer arable acres, again mostly in Scotland for forestry but also East Anglia, presumably mainly with urbanisation

3.1.3 The uses of land that saw substantial growth over that period were:

- woodland, with 1.3m more acres (equivalent to Norfolk), mostly in Scotland and particularly in Argyllshire. Forestry cover grew from 10.3 per cent in 1990 to 12.5 per cent in 2015.
- urban uses, with 840,000 more acres (equivalent to Cornwall), mostly in England with a particular change in Kent (taken to follow its new economic position following the opening of the Channel Link). While there are various measures, the CEH reports the built-up area as increasing from 5.8 per cent to 7.3 per cent of the UK (8.3 per cent of England) over this period.

3.1.4 It is noted that this increase in the built-up area is over a period when the housing targets were not met.

3.2 Agricultural Use Changes

3.2.1 Agriculture is fortunate in having largely consistent June census data since 1875 on the scale of major enterprises in Great Britain and the United Kingdom (the difference between those series being small).

3.2.2 Those last 145 years:

- run from the beginning of the long agricultural depression with its collapse in cereal prices to the First World War
- followed by the interwar years
- the "War Ag" period of the Second World War
- the post-War years of the Agriculture Act 1947 until 1972
- the period of European Economic Community (EEC), European Community (EC) and European Union (EU) membership from 1973 to 2020.

3.2.3 Over that period, much agricultural land has been developed and some land has gone to woodland.

3.2.4 The Arable Area – Starting in 1875 at 7.3 m ha, this area of crops, bare fallow and temporary grass fell steadily over the years to 5.2m ha just before the Second World War, with a brief but significant rise in the later years of the First World War. By 1945 that area had increased to 7.8m ha with the ploughing up of land from 1940, often for the first time since the Napoleonic Wars, if not in some cases for much longer, as part of the war effort. Since then, the area has declined with a slight revival between 1955 and 1965 and stood at 6.2m ha in 2018, the smallest area since the end of the War.

3.2.5 Within that area, the crops that grew substantially were wheat and barley:

- together forming 32 per cent of the arable area in 1875 but 24 per cent in 1900
- still at 23 per cent in 1950 it was 45 per cent in 1970 and 54 per cent in 1980 and since then tending to be just below 50 per cent and 48 per cent in 2018.

3.2.6 This is, in part, the decline of oats as a crop, in turn taken to be associated in part with the decline of the horse as motive power. In 1946/47, 2.95mt of oats were produced compared with 2mt each of wheat and barley but by 1970 the oats yield had reduced to 1.3mt while wheat was 3.4mt and barley 8.7mt. In 1986 13.9mt of wheat were produced, 10mt of barley but just 0.5mt of oats.

3.2.7 The balance of the area would be other crops in the rotation (including potatoes more generally), temporary pastures and fodder crops. Fodder crop and potato areas declined, oil seed rape came in the early to mid-1970s (and perhaps now in retreat with the ban on neonicotinoids) while sugar beet concentrated steadily on East Anglia. A wider range of crops was grown. Flax was once grown for linen fibre but disappeared; its brief revival as linseed for oil was largely an artefact of the pre-2005 subsidy system. Poppies were grown in the Fens in the nineteenth century for laudanum. There is now some limited experimentation with other cereals such as tef but England still appears unsuitable for substantial growing of soya. Some long strawed wheat is now grown primarily for thatching.

3.2.8 Returning to the larger picture and as just indicated, the stories of wheat and barley differ:

- **wheat**, initially on a larger area than barley, halved in area from 1.3m ha in 1875 to 700,000 ha before the First World War. Apart from wartime spikes (reaching some 1.5 m ha in 1945), the area grew gently from the early 1930s to 1m ha in 1970. That then doubled to 2m ha by later 1980s since when it marginally declined to 1.8 m ha in 2018. With the CAP's support for cereals, this was largely a switch from barley with wheat's potential then for productivity. The area under wheat had overtaken that under barley by 1990.
- the **barley** area also fell with the lower cereals prices after 1875. With a major post-1945 expansion reaching some 2.5m ha by the later 1960s it then fell as precipitately from the later 1970s to 1.5m ha in 1990, 1.1m ha in 1994, a low of 900,000 ha in 2006 and then recovering slightly to 1.2m ha in 2013 and 1.16m ha in 2018. At the start of the 1980s, the barley area was 60 per cent greater than the wheat area but 25 per cent smaller by their end.

3.2.9 A further observation is that arable and pasture uses were much more interwoven in each part of the country but, especially since the Second World War and more so since, say, 1970, they have separated out, largely on an east-west division with arable farmers withdrawing from livestock production (notably from beef) and livestock famers focusing on grass and fodder crops (increasingly maize). It became easier to buy in feed or fertiliser while enterprise scale was a means to cut unit cost, so driving specialisation. The classic argument of spreading risk between corn and horn was countered by the then stability of subsidies while exposure to international markets and exchange rates may have made the risks of agricultural enterprises more related than they might once have been. Such diversification of risk, if feasible at farm level, might now be more often achieved by non-agricultural income.

3.2.10 Permanent Pasture (Over 5 Years Old) – In 2018 this too covered 6.2 m ha having increased since 1970 but still well below the 7.4m ha at the end of 1920s.

3.2.11 For livestock:

- **cattle** numbers (beef and dairy combined) grew consistently from 6 million in 1875 to 12.6 million in 1970. A sharper rise in the early 1970s to 15.2 million has then reversed with steady decline to 9.9 million in 2018, partly as losses from Bovine Spongiform Encephalopathy (BSE) and foot and mouth have not been reversed and partly the reducing number of dairy cattle with rising yields and volume control from milk quotas and then the marketplace.
- **sheep** numbers varied between 25 and 30 million from 1875 to the early 1970s, with reductions during wars and slow recoveries after them. At 26 million in 1970 and 31 million in 1980, numbers then grew rapidly to reach 44 million in 1990 but have fallen with and after Foot and Mouth back to around 34 million.
- **pig** numbers have been more volatile between years, varying between 2 and 3 million before the First World War and then expanding to 4.6 million by the mid-1930s but sharply reduced in the Second World War. In the seven years to 1954 numbers rose four-fold and then more slowly to reach 9 million in 1973. Numbers stabilised under economic pressure at around 8 million until the late 1980s. Falling prices and diseases then saw numbers drop 40 per cent between 1998 and 2003. There were some 5 million in 2018. Perhaps more than other sectors, pig farming specialised and intensified from the 1970s. With the sector split between outdoor operations on light land and intensive high health status indoor units, international competition, comparative animal welfare legislation and the threat of disease (now African Swine Fever) are running challenges alongside the enormous impact of variations in the circumstances in and policies of China.

3.2.12 The recent evolution of the **poultry** sector, whether for eating or laying, bears some comparison with pigs. Probably more vertically integrated with close contractual arrangements in supply chains, it faces international competition and sees substantial technical advance. Now in large sheds, notably in Northern Ireland and the Welsh borders, often as a second enterprise on a farm, sometimes as a separate enterprise for the next generation, it requires careful management but now delivers a value of output close to that of the cereals sector. Free range eggs have established a strong market recognition in the UK but much product goes into processing and catering. Aside from perpetual animal welfare interest, there is now concern about the pollution of water courses from poultry waste.

3.2.13 Orchards Etc – The area under orchards, with production then less exposed to international competition, grew steadily from 63,000 ha in 1875 and, with only a check in the First World War, reached 111,000 ha in 1950. Declining sharply from 95,000 ha in 1960, it appears to have stabilised around 25,000 ha since 2003. This is partly with the development of cherry orchards and the revival of cider prompting new plantings though this has now turned. Labour remains an issue, while downward price pressures counter improved physical productivity.

3.2.14 Hops are now much less grown in Kent but there has been some recovery in production in Herefordshire and Worcestershire on either side of the Malverns with the growth of craft beers for which British hops and climate are held to be particularly apt but this is in competition with synthetic alternatives.

3.2.15 For comparison, while English vineyards finally failed with the Little Ice Age, the recent revival now sees some 2,000 ha of vineyards, perhaps also illustrating how value and investment may be concentrating on particular sites.

4. Non-Agricultural Drivers for Change in Land Use

4.1 Population Growth and Movement

4.1.1 The United Kingdom has a growing population, partly with continuing immigration from within and outside the EU. That growth is heavily concentrated in the south eastern portion of Great Britain following the dynamics of the economy and a re-orientation from the western ports to the eastern ones with the move from the global trades of the Empire to Europe. With smaller households and that shift of geography, not only is more housing needed in new areas but also all that goes with that from employment to leisure and all the associated infrastructure.

4.1.2 At the same time, house prices have been rising, not only because of tighter supply but also with long run falls in interest rates and the general diversion of loose monetary policy into asset values. (When there was much less planning control to limit housing numbers, the then relatively loose monetary policies of the 1930s saw significant housebuilding in the more buoyant area of the country.)

4.1.3 Ever since the 2004 Kate Barker report, the view has been held that some 300,000 new dwellings a year are needed to counter those pressures. That number has not been built since the 1950s and so, logically, there is an accumulated shortfall of a few million homes.

4.1.4 That would be more acute still if there were not some countervailing inertia acting against movement within the UK, perhaps with a population with an increased median age reluctant to move and, more recently, increased property transaction taxes adding a further friction for those buying homes.

4.1.5 The forecasts by the Office of National Statistics for population change are for:

- the UK to grow by 4.5 per cent between 2018 and 2028, from 66.4m to 69.4m
  - England by 5 per cent
  - Scotland by 1.8 per cent
  - Wales by 2.7 per cent
  - Northern Ireland by 3.7 per cent
- one quarter of that would come from net growth and three quarters from net migration
- it to pass 70m in mid-2031 and be 72.4m in 2043
  - again with growth concentrated in England
  - slowing with rising deaths following an aging population
- 14 per cent growth by 2040, compared with 2 per cent for the EU.

Based on 2018, these are lower than the forecasts issued in 2016.

4.1.6 That growth drives more urbanisation, likely to be largely concentrated in the greater south east of Britain, roughly, and with exceptions both ways, south and east of a line from Poole to York, with the expansion of existing settlements and the creation of new ones. One notable focus for this is the Oxford-Cambridge Arc (Ca-MK-Ox) intensifying already strong market-based development pressures.

4.1.7 The responses to the Covid-19 pandemic and the counter-measures have included some people finding that working from home is both feasible and preferable to commuting with a new demand for rural housing, perhaps especially revealed in some areas with good communications links to give the best of both worlds. While potentially significant for those marketing such properties, this may be limited to the smaller

number of larger and better properties without fundamentally reworking future development pressures. Where it has an effect it might, with the current English planning proposals, simply increase the development expectations of those areas where demand is now stronger.

4.2 Wider Environmental Concerns

4.2.1 However important it might be, climate change is not the only environmental concern with consequences for rural land management. Under David Cameron, Theresa May and Boris Johnson, the government has repeated its intention to be the first to leave the environment in better condition. The framework for this is not only in, for example, the Natural Environment White Paper of 2011 and the Clean Growth Strategy of 2017 but also now the 25 Year Environment Plan. In July 2020, George Eustice affirmed that:

> "This Government's pledge is not only to stem the tide of loss, but to turn it around – to leave the environment in a better state than we found it"

with the United Kingdom's ability to "chart a new course" after the end of the EU withdrawal Transition Period.

4.2.2 Water Quality – Alongside water quantity with flooding and drought, (reviewed below) water quality is a prime concern. Past regulation has done much to prevent point source pollution (save perhaps by water companies) with attention now on background, diffuse pollution, much of it from agriculture with run-off from fields of silt and nutrients as well as more specific pollution incidents with slurry and sheep dip. Livestock buildings and anaerobic digestion (AD) plants are also issues. Agri-environment schemes have been used to keep livestock away from water courses, to have grassed buffers between farmland and water courses and to limit soil loss from fields as well as improve slurry management. These pressures will grow both to save costs for water companies in removing clostridium and pollutants and to sustain biodiversity. Particular land management initiatives for water quality are pursued by bodies such as the Wye and Usk Foundation, the Tweed Forum and other rivers trusts.

4.2.3 That concern is now illustrated by the Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 that now make all of Wales a Nitrate Vulnerable Zone (NVZ) rather than the previous 2.3 per cent and will require five months slurry storage. In defending those Regulations in the 3rd March 2021 Senedd debate, the Minister Lesley Griffiths said:

> "… our natural heritage is under threat from agricultural pollution … with the cost of any damage being passed on to others—the costs of water treatment added to customer bills, the cost to the reputation of the sector, and the price we're all paying in the loss of fish, insects, sensitive habitats and the character of our countryside. This has been a blight on the reputation of Welsh farming for many years.
>
> "… Unfortunately, there has been no consistent downward trend in agricultural pollution. Since 2001, there have been almost 3,000 substantiated acute agricultural-related pollution incidents across Wales, continuing at an average rate of more than three each week in the last three years. In 2020, when fewer reported incidents were investigated due to the COVID pandemic, numbers were still higher than in 2015, 2016 and 2017. There were more recorded incidents in 2018 than any other year in the last 20 years. Even with the current media attention since I announced these regulations on 27 January, NRW has received 49 pollution reports related to agriculture, of which 20, as of 1 March, have been substantiated. These are the substantiated incidents where NRW has been able to confirm an incident reported to them. However, acute pollution incidents are only the most visible example of agricultural pollution. Diffuse

pollution occurs over time and is damaging water quality, contributing to air pollution and increasing greenhouse gas emissions."

4.2.4 Those same issues, with the much greater post-Brexit exposure of policy makers to domestic scrutiny, are reflected in a consultation in Scotland and discussions in England while Northern Ireland revised its nutrients management rules in 2019 with air quality also on its mind. We may have passed a tipping point in tolerance on both water and air quality.

4.2.5 Air Quality – With its continuing health effects, air quality may yet be the largest single concern of the Department for Environment, Food and Rural Affairs (DEFRA) – with its vulnerability to legal action (as shown by the March 2021 conclusion of the CJEU against the United Kingdom (C-664/18)). Agriculture's part in this is largely in producing some 88 per cent of the UK's atmospheric ammonia from slurries, housed livestock and nitrogen fertiliser with its contribution to forming PM2.5 particles a long way downwind as well as nitrifying protected environmental areas nearer to hand. Already an issue in Northern Ireland for several years, improved air quality is now a key object of DEFRA's 25 Year Environment Plan and, more specifically, of new capital items in the Countryside Stewardship Scheme 2022.

4.2.6 Biodiversity – For overall land use and its interaction with other goals, biodiversity is increasingly seen as a key issue. It is also one where the potential for improvement increases disproportionately with physical scale. With its range of concerns from invertebrates and the soil biome to farmland birds, fungi and hedgehogs, it has perhaps been a more elusive goal than might be imagined with competing and very varied targets, the difficulties of definition and measurement and the problems of working with natural systems with their variability, subtlety and interactions. However, the government is bringing forward what appear to be potentially powerful tools in England for what has been a relatively intractable topic:

- the principle of biodiversity gain as one of the prices for development now coming forward in the Environment Bill. With the requirement on all development in England that it is to result in 10 per cent more biodiversity (on a standardised metric) whether on-site, off-site or through the purchase of biodiversity units through the local planning authority, this could harness the market in conjunction with the expectations of the planning authority to this goal (subject to the constraints imposed by other objectives and forms of land value capture). In principle, that discourages development of higher biodiversity value sites (subject to the value of their development) and provides money for biodiversity improvement. That logic could point to more development on managed arable or silage land than on brown field land – the former often having a lower biodiversity value to be managed and greater potential to offer improvement.
- the Environment Bill would also require the local planning authority to develop a Local Nature Recovery Strategy assessing its area's habitats and species and how they might be improved with that strategy then sitting alongside the local development plan
- as well as DEFRA preparing a national habitats map for England, amendments made to the Environment Bill would empower Natural England to prepare Species Conservation Strategies and Protected Site Strategies, which in this developing approach might come to have a role for biodiversity akin to national planning policy
- those strategies are then likely to interact with the proposals in the 2020 Planning White Paper for a move to a zoned approach to development control

with the likelihood that areas important for biodiversity (and so biodiversity gain) would be in protected zones and the possibility of this informing the design codes for development in growth areas.

– they could also be part of spatial framework for the Local Nature Recovery and Landscape Recovery components of Environmental Land Management with their offers of contracts to land managers for delivery of environmental outcomes.

4.2.7 The Prime Minister's "30 by 30" speech of November 2020 called for 30 per cent of the country to be managed for nature by 2030. At its simplest, this appears to mean an extension of National Parks and Areas of Outstanding Natural Beauty with little said about what might follow. In England, this points to the possible adoption of recommendations of the Glover Review on the management of these areas and their possible extension to the Chilterns, Cotswolds and Dorset/Devon coast. A commitment to the "30 by 30" goal has since been given by Rosanna Cunningham of the Scottish Government.

4.2.8 The early 2021 Dasgupta *Review of the Economics of Biodiversity*, commissioned by the Treasury, sets out a substantial review, global rather than national, of the interactions between the economy and nature – indeed, ultimately, the dependence of the economy on nature – and the causes and implications of biodiversity loss. This is ahead of the coming UN summit on biodiversity.

4.2.9 This topic is seen to overlap with climate change issues, as the conservation and restoration of peatland, forests and coastal habitats can also reduce emissions, sequester carbon, build resilience into ecosystems and assist adaptation to climate change.

4.2.10 The concept of "rewilding", given varying meanings, lies at one end of the debates in this area, generally importing the more or less total withdrawal of management across an area so that in some sense it reverts to a more "natural" condition. As the pragmatic (perhaps rather than purist) approach taken at Knepp Castle in Sussex shows, this will usually require a level of human intervention and the innate place of some larger mammals and their grazing as part of the landscape as what can be seen as, in effect, very extensive, low pressure agricultural use, rather than abandonment. However, as developed at Knepp it sees nature finding its own place, often where old naturalists found it, and not the niches where it has survived that are more conventionally the focus of conservation activity. Dieter Helm, with the argument that natural capital only has value for people, has observed that:

> "There is no wild, there is not going to be any wild, and nature without people is not something we can benefit from and hence not desirable in itself" (Blog, 16th March 2021)

4.2.11 This leads to a structure of argument as to whether agricultural production and environmental goals are better reconciled by:

– "land sparing" – with environmental uses predominating on some land and agricultural ones on other land and so perhaps commercial agriculture tending to concentrate on its more productive areas and environmental uses tending to be elsewhere

– "land sharing" – in which they are more intermingled with a greater emphasis on all farming continuing with environmental commitments.

In practice and with the synergies of some environmental improvements (such as soils and pollinators) with good farming and agricultural practices needed for some environmental outcomes, these may perhaps often be less alternatives than different emphases.

4.2.12 However, some of the issues here are hinted at in the January 2020 Land Use report of the Climate Change Committee, linking this issue to the larger productivity agenda:

> "Sustainable productivity growth is a key driver in our land use scenario: it allows more to be grown with less land and other inputs – and free up land for other uses. In our scenario this is driven by good agronomy practices and crop breeding rather than by intensification of farming (which would involve increasing inputs into land)."

4.3 Infrastructure

4.3.1 National infrastructure has long been a factor in rural land use. The great prehistoric trackways and Roman roads preceded the canals, railways and motorways in both crossing rural land to connect settlements, convey resources and create new points for economic activity and change, facilitating markets but taking land from those who used it previously. More recently, services such as telegraph, telephone, electricity, gas and fibre as much as water and drainage affect the land they cross.

4.3.2 Alongside larger and longer term projects such as HS2 and Hinkley power station, a large and growing programme of infrastructure development has been progressively laid out, notably since the 2016 Referendum. With the attraction of funding it by borrowing at ultra-low interest rates, the aim is to increase the productive capacity of the economy outside the EU. The economic shock of the measures taken to manage the Covid-19 pandemic has now strengthened the intention to focus on recovery and that it should be a green recovery, particularly building climate change measures into its shape.

4.3.3 Much of that work will be on or across rural land while new transport nodes, such as motorway junctions or railway stations can, sometimes intentionally, become foci for new development pressure.

4.3.4 One particular prospect driven by climate change is for the substantial upgrading of the power grid, not only to bring electricity from the many locations where it is to be generated but to supply the much increased demand that will come in all parts of the country, rural as well as urban, for electricity as the prime means of heat, power and transport. The Committee for Climate Change, using Imperial College figures estimates that electricity demand will double by 2050 (*Net Zero Technical Report,* May 2019).

4.4 "Green Finance"

4.4.1 As noted above under both climate change and biodiversity, there are reasons why significant private finance and commercial activity could be relevant to rural land use. Insurers, prospectively released from the EU's Solvency II Directive, are increasingly sensitive to the risks of climate change. Larger companies in particular are being influenced by the shifting attitudes of investors, the work of bodies like the Task Force on Climate-related Financial Disclosure (TCFD) and the desire to protect supply chains and reputations. Lenders are also being prompted to review their portfolios for energy and carbon issues as well as becoming wary about the future course of values for some assets offered for security.

4.4.2 That touches on the issue of "stranded" assets, often reviewed in the context of fossil fuel sources (like oil fields) that have had substantial value but might come to have no use with the move from fossil fuels. That could have a wider application with the economic transition ahead and these resulting re-evaluations will be revealed through markets, particularly those in finance as investors and lenders shun some sectors or assets. Such shifts in values, if disorderly or abrupt as might arise from sudden reputational change as much as from other reasons, could have such effects as credit

risks for lenders and challenges for those managing pension funds. The Bank of England accordingly favours taking early and decisive action to set a framework for change rather than reacting later requiring sharper adjustments more swiftly with greater risks across the financial system (Bank Discussion Paper, *The 2021 Biennial Exploratory Scenarios on the Financial Risks from Climate Change* (2019)).

4.4.3 There is a developing structure ("taxonomy") for classifying investments for their environmental credentials to help inform those decisions. "Green bonds" are being developed as means to raise finance for such projects.

4.4.4 That substantial but conditional supply of finance will have an effect. The challenge for rural land use in the United Kingdom lies in being able to respond with parcels of environmental goods large enough to minimise transactions and monitoring costs and to attract the minimum sums that would be regarded as efficient by financiers. The scale often needed by investors is more readily available abroad than in the United Kingdom; Microsoft's carbon deal with Wilmot Farm in Australia covers 10,000 acres (but is below the average size of its deals) while other financial institutions' deals can be on hundreds of thousands of acres of rain forest. The oil company, Total, has just agreed to plant 100,000 acres of forest in the Congo, hoping to do so at a cost of less than $10/t of carbon. Those constraints may see supply chains and biodiversity gain deals as the means of channelling those funds rather than them in coming directly to most areas. That would still make such private and market activity powerful alongside the proposed government schemes, whether as a complement to them ("blended finance") or as an alternative.

4.4.5 Carbon Tax – Allied to these moves, there is the prospect of the development of carbon taxes, a policy of interest to both the UK and the EU, perhaps as a border adjustment charge on goods in, at least at first, certain sectors that are easier to assess and monitor, so both putting a cost on importing carbon rich goods that have been outsourced and adding to the forces crystallising market recognition of carbon in the economy. It is perhaps too difficult to apply this approach across the board in the nearer future because of the issues of assessment and to keep it distinguished from protectionist pressures. In the same way, agriculture is outside the UK's newly developing Emissions Trading System (ETS), as it is outside the EU's ETS.

4.4.6 At one level, such a border adjustment tax would be relevant with the search for ways to generate tax revenue to replace fuel duty, landfill tax (with the biodegradable share of landfill) and other sources of revenue that would dwindle with the expected changes in the economy. Leaving aside the financial measures taken with the Covid-19 pandemic, the coming decades are one of an aging population putting demographic pressure on the public purse for social care and health services, even if this is not as extreme as in some continental countries seeing less population growth.

4.4.7 One aspect of its relevance in policy terms is an answer to the challenge of "carbon leakage", the offshoring of inefficient carbon use by substituting carbon-rich imports for domestic production which might be more pronounced as differences in carbon pricing appear. A carbon tax would place a value for purchasers on that embedded carbon. In an agricultural context, this might particularly be seen as an issue for beef for which it is represented that UK beef production is a much lower user of carbon than that in Brazil. However, the government will not want this to detract from the benefits of trade.

4.4.8 In looking at future tax policy, agriculture contributes a lower share of employment and corporation taxes than it does emissions, though its position in this is not as stark as power supply, transport and storage, and manufacturing.

5. Climate Change – Impact, Mitigation and Adaptation

5.1 Introduction

5.1.1 Climate change is now a major and increasingly important force for change in land use and business practice with:

- its direct impact on land use in the United Kingdom, notably from flooding
- the measures taken to mitigate its scale, following the Paris Agreement and as analysed and advised by the UK Climate Change Committee, particularly with the demanding commitment to achieve net zero greenhouse gas emissions by 2050
- the need to adapt to it in response to more frequent and widespread flooding and periods of extreme heat and drought.

The scale what will need to be done for these ends does not yet seem to have been fully appreciated and will in some instances be difficult both practically and politically, perhaps especially as regards owner-occupied dwellings. It also brings a need to review the now dated tool and methodology of Energy Performance Certificates (EPCs), no longer fit for the developing regulatory burden of credibly distinguishing which properties can be let, which receive a grant and what the terms of secured loans might be.

5.1.2 These issues bear on rural land use and on built property with many of the steps arising likely to drive change in the 2020s. The developing scale of Government endeavour in this area should not be underestimated with a proximate focus on the COP26 summit in Glasgow later this year and more generally on the green nature of the post-Covid-19 recovery.

5.1.3 While this paper is concerned essentially with rural land management, much value and activity in that relies on buildings, making it worth noting that ABN Amro, the international Dutch bank, has said that there are more emissions from its secured lending portfolio than from its mining and industrial lending combined.

5.1.4 The Treasury's *Net Zero Review: Interim Report* (December 2020) noted that the most rural households in England (that is, in local authority areas where 80 per cent or more of the population live in rural settlements or "rural related" hub towns) have an average overall carbon footprint of almost 16tCO_2e, around 35 per cent larger than most urban households (at, say, 11tCO_2e). That is reported to be primarily due to their consumption of electricity and heating, though it would also be affected by income levels and property type – transport seems to vary less as a factor. 14 per cent of houses in Great Britain are off the gas grid with a much higher proportion in Northern Ireland (where the average household footprint is some 20 tCO_2e).

5.1.5 The government is soon to publish (and Scotland already has) a Heat and Buildings Strategy to set out the immediate actions seen as necessary to reduce emissions from buildings and the programme of work needed to enable the strategic decisions to be made in the first half of the 2020s on how to achieve mass transition to low carbon heating. At some £7 bn a year, remedying the position for buildings is expected to take the lion's share of the capital investment required, perhaps more than half of it.

5.1.6 Multi-faceted and increasingly driving government policy in ways that will influence most aspects of the economy, climate change is treated here with a separate section for its inter-relationship with rural land use and the business decisions that will affect land use. This is a complex, subtle and contested area, partly with the great

uncertainties in accounting for carbon releases and sequestrations from and in soils, plants and trees and the management of land and livestock. This concerns the variability of natural systems and the inability to observe carbon movements directly.

5.1.7 Economically, the path to net zero in 2050 is likely to see quite substantial structural change in an economy of which agriculture and rural land use are but a small part with a contribution to emissions that is both disproportionate and, in parts, hard to remove completely. This path will see much investment, the complete re-orientation of energy generation and use, new technologies, the rise and fall of sectors and their geographical movement within the economy. While the Treasury paper suggests that overall costs may well be marginal, the redistribution of economic activity could be substantial. Changing price signals (including the more explicit pricing of carbon) and asset values will be among the ways in our market economy will manage this process.

5.1.8 With Government's *Ten Point Plan for a Greener Industrial Revolution* (November 2020), the aim is to achieve the necessary sustained and better growth in productivity in the economy by stimulating innovation and innovation in low carbon sectors. That is seen as more supportive for competitiveness and living standards than simply discouraging higher carbon intensive activity.

5.1.9 The Treasury's *Net Zero Review Interim Report* observes:

> "The transition to net zero will be capital intensive. This new capital equipment will have different – and in many cases lower – running costs to the high carbon equipment it replaces."

That appears consistent with the view below that an increasing share of food production is likely to come from buildings that will be increasingly sophisticated and technological.

5.1.10 The Larger Picture – Greenhouse gas emissions are typically compared with the "pre-industrial" level, generally meaning the early eighteenth century. Atmospheric carbon dioxide is now seen to be 50 per cent higher than that base line. Under international agreements, the base line for reductions in emissions is set at 1990, enabling wider comparison between sectors and countries.

5.1.11 The 2050 target now adopted by most major economies would see no new net additions to greenhouse gases from that date with the residual emissions would be balanced by sequestrations.

5.1.12 The UK sees itself as being at forefront of this process with the fastest rate of reduction in carbon intensity in the G20 as:

- the economy has grown by 80 per cent between 1990 and 2019
- emissions have reduced by 43 per cent since 1990 when the G7 as a whole has reduced by 5 per cent and Australia's emissions have increased by around 50 per cent.

That reduction in the UK has been led by the power sector with a reduction of some 70 per cent, with renewables and the near elimination of coal but still a reliance on gas. The manufacturing sector's emissions have fallen by 25 per cent with reduced energy intensity, a shift to less carbon intensive energy sources and changes in structure. Emissions from agriculture, land use and land use change, however, rose gently towards 2008 since when they have been level. Emissions from international transport (mainly aviation) have increased by 90 per cent.

5.1.13 However, the emissions associated with what is consumed in the UK economy are greater than those produced in it; that can be seen as either the UK importing carbon emissions from abroad or as exporting what would otherwise have been emitted at home. This comes to the issue of carbon leakage noted above in considering a carbon border adjustment tax and the complex interaction with the larger reasons for trade. Some form of carbon border tax could indeed be one way of putting a price on the purely carbon aspects of that.

5.1.14 Regarding agriculture, the Treasury's *Net Zero Review Interim Report* summarised the Climate Change Committee's (CCC) December 2020 advice on the Sixth Carbon Budget as:

> "Agriculture also remains challenging to decarbonise fully in the CCC's scenario. It retains a large proportion of its 2018 emissions level and will require significant offsets according to the CCC."

5.1.15 That Review identified a number of what it refers to as market failures as part of the picture for agriculture, including:

- ruminant livestock as the primary source of agricultural emissions with their particular contribution to methane
- high or inefficient use of fertilisers releasing the still more powerful nitrous oxide
- fuel use in machinery and heating accounting for only some 10 per cent of emissions

with the wider costs of each not captured in the present financial costs of food production or in land values.

5.1.16 It sees answers not only in changes in land use and restoring peatlands but also in improved farm management practices with:

- greater resource efficiency
- innovative technologies
- different feeding practices for livestock
- selective breeding
- improved animal health
- more fuel efficient machinery
- more efficient fertiliser applications.

While potentially competing with other policy objectives, much of such change is consistent with improved productivity. The Report suggests that such changes could in turn release marginal land for other uses while maintaining output – an argument used by the Government in other contexts for innovation, notably in the consultation on gene editing. Those other uses might be afforestation, peatland and flower meadows providing ecosystem services and carbon sequestration. The Report observes that land prices do not reflect the positive externalities of such other uses. It also wonders about where land use change might be discouraged by subsidy, tenancy law or the new skills and knowledge needed.

5.2 Climate Change Committee Recommendations for Agriculture and Land Use

5.2.1 In *Land Use: Policies for a Net Zero UK* (January 2020), the UK's Climate Change Committee put the emissions from agriculture, land use and peatlands at 58MtCO_2e in 2017, comprising:

- 46MtCO_2e from agriculture (9 per cent of the UK total. While the Treasury's *Net Zero Review Interim Report* puts it at 7.1 per cent in 2018, both figures are much larger than its share of GDP but might also be seen in the context of the share of land area involved)

- 23MtCO_2e of emissions from peatlands. The figures for peatland emissions appear to have been increased by a recent change in methodology by the International Panel on Climate Change (IPCC)
- offset by a saving of 10MtCO_2e for land use and forestry.

5.2.2 The Committee's report's first key conclusion is that:

"The way land is used must change to meet the UK's net zero target. The current approach is not sustainable. Fundamental change in the use of land across the UK is needed to maintain a strong agriculture sector that also delivers climate mitigation, adaptation and wider environmental objectives."

It considered this can be reduced to 21 MtCO_2e by 2050 with a further 25MtCO_2e achievable by using harvested timber and energy crops elsewhere in the economy.

5.2.3 The EU's LULUCF (Land Use, Land Use Change and Forestry) accounting framework settled for a minimum requirement on member states to ensure that net emissions from the land sector (accounted separately from agriculture) are in balance ("no debit"). Thus, the ploughing of grassland or deforestation should be matched by emissions removed.

5.2.4 The forestry baseline is made more complex by differing planting rates in the past influencing net emissions after felling as much as current management regimes. There is concern that substantial afforestation could encourage food imports from land cleared abroad with associated larger emissions. Moreover, the discussion of new forestry elsewhere is increasingly avoiding planting on peatland but also distinguishing the substantially higher carbon sequestration reported as possible from naturally regenerated woodlands over planted ones. The Dasgupta Report takes the same view for biodiversity.

5.2.5 Sequestering carbon in soils is seen more simply with accompanying benefits for agricultural resilience, soil health, water retention capacity and biodiversity.

5.2.6 The Treasury's *Net Zero Review: Interim Report* draws particular attention to the forthcoming England Tree Strategy and England Peat Strategy as setting out the medium to longer term approaches to secure carbon and natural capital benefits from these areas through public and private finance and non-financial measures. The March 2020 Budget allocated £640m to these ends.

5.2.7 The UK's Climate Change Committee's reports consider agriculture together with land use and forestry. In setting out policies for its Sixth Carbon Budget in December 2020 and building on its *Land Use: Policies for a Net Zero UK* (January 2020), the Committee looks for:

- a strong post-CAP baseline, supported by legislation (including nitrates and clean air) to reduce on farm emissions, including ruminant emissions
- comprehensive delivery mechanisms for landscape scale changes and low carbon farming practices, including
  - increasing annual "afforestation" rates to 30,000 ha by 2025 and 40,000 ha in the 2030s – recommending auctions of contracts, as in renewable energy. The Treasury's *Net Zero Review Interim Report* gives "woodland creation" as its example of decarbonisation change with capital investment in planting trees and operating costs of management and upkeep
  - restore or stabilise 60 per cent of upland peat by 2035 and the remainder by 2045. Water companies and SSSI owners should be obliged to restore peatland they own. Rotational burning of heather (whether on peat or mineral soils), cutting of peat and its sale for horticulture should be banned.

- re-wet 20 percent of the lowland peatland area (this text actually says cropland but that appears better read as meaning peatland) and sustainably manage a further 18 per cent by 2035
- plant trees on 10 per cent of farmland while maintaining its primary use, extend hedgerows by 20 per cent and better manage hedgerows by 2035
- plant bioenergy crops (meaning miscanthus, short rotation coppice and short rotation forestry) on 30,000 ha per year across the UK by 2035; the January 2020 paper looked to expand these by 23,000 ha annually leading to 0.7m ha by 2050 in addition to forestry and compared to 10,000 ha now.
- high take-up of low carbon agricultural measures covering:
  - livestock – diets, breeding and health with cattle health seen to have farming benefits; however, livestock breeding improvements have seen only limited adoption for farming practice
  - soils – cover crops (again seen as beneficial), grass legume mixes
  - waste management – AD and slurry covers recognising that has upfront costs

  The January paper also referred to the use of controlled release fertilisers
- a clear path to incentivise the take up of zero or near zero emission options for agricultural machinery and to develop options where these are currently not available, such as the electrification of tractors which is seen as still at the proto-type stage

all using mechanisms for private and public financing, such as a trading scheme or auctioned contracts, and giving co-benefits such as flood alleviation, improved health, recreation and improved air quality as well as biodiversity gains.

- measures and funding to avoid a hiatus in delivery in the transition to post-Brexit measures to give the time needed to scale up the work required. As well as incorporating this into the design of ELM, Countryside Stewardship should be adapted to support the reduction of emissions.
- measures to address non-financial barriers to change, suggesting:
  - knowledge exchange
    - regarding low carbon practices
    - contractual issues for tenant farmers with the suggestion of reviewing lease renewal arrangements (an implication of the January 2020 report is that this may simply mean looking for tenants interested in sustainable farming) and aligning incentives between owners and tenants, as by compensation arrangements, to encourage tenants to undertake long term investment decisions. Parallel concerns are noted with common land but with the difficulties seen here for the landowner
    - supporting skills
    - scaling up supply chains
  - barriers to investment in research and development
    - to improve productivity and resilience – crop and tree yields
    - to develop low carbon machinery – tractors.

More generally a lack of relevant knowledge, experience and skills for low carbon farming even among new entrants is seen as an issue with lack of awareness, cultural resistance and risk aversion all as factors.

- policies to encourage a shift in diets and food waste reduction with measures to encourage:
  - a 20 per cent shift away from all meat by 2030 and 35 per cent by 2050
  - a 20 per cent move away for dairy products by 2030
  - a 50 per cent reduction in food waste by 2030 and 60 per cent by 2050.

5.2.8 The Report recognises that, for afforestation, peatland restoration, bio-energy crops, agro-forestry and hedges, the cost to the landowner outweighs the benefits or are too substantially front loaded to be attractive and so would require some funding. The January 2020 Report's appraisal of perennial bioenergy crops did though include land acquisition as a cost of the operation.

5.2.9 A separate paper, *Economic Impacts of Net Zero Land Use Scenarios* (February 2020), produced for the Climate Change Committee, put the lifetime net private costs of land use change and the adoption of low-carbon farming practices to achieve the 2050 goal at £17bn. It observed that that cost outweighed the private benefits of those changes. However, the wider social benefits were put at £96bn with 64 per cent of that being from greenhouse gas reductions, while issues such as biodiversity were not considered in this study. With that mismatch of high upfront costs and long-deferred income, it suggested that the creation of woodland, the restoration of peatland and the planting of bio-energy crops required significant financial support to overcome their lack of revenue. The overall support needed was put at 42p for every £1 spent on net zero land use change and that funding was best provided on a credible and long term basis.

5.2.10 The rural land management challenges in this have been confirmed by Scottish Government figures for 2018. Agriculture is seen to be responsible for 7.5 per cent emissions compared with the residential sector at 6.2 per cent and other business at 8.4 per cent. Within that beef forms 46 per cent of agriculture's emissions, crops 21 per cent, dairy 16 per cent and sheep 14 per cent. While the total has fallen by 15 per cent from 1990 (assisted by some reductions in livestock numbers), the aim of a 28 per cent reduction by 2030 means a four-fold increase in that pace of change. That is a substantial challenge for policy makers, requiring new and significant policies to be put in place, and for the farmers who would have to make this change within their businesses.

5.2.11 With those proposed programmes, this note now looks at the current understanding of the impact, mitigation of and adaptation to climate change.

5.3 Impact of Climate Change

5.3.1 The direct impact of climate change in the United Kingdom is largely the increased intensity of rainfall and so flooding, especially where rivers come together but potentially also from the sea. Flood risk is potentially a driver of changes in values and so land uses.

5.3.2 On present Environment Agency assessments:

- 10.5 per cent of England is Flood Zone 3, assessed as seeing either river flooding once in a 100 years or sea flooding once in 200 years, and, of that 5.8 per cent is developed land
- 4.7 per cent of land is assessed as at high risk of flooding, that is more than once in 33 years and 3.3 per cent is developed land.

5.3.3 An informal CAAV survey of members' observations after one round of flooding saw it tending to drive a shift in the use of exposed land from arable to pasture and of development from residential to employment uses with their lower and less costly mitigation requirements. While the Flood Re scheme provides possibly temporary assurance to some as to household flood insurance, the investment data company MSCI is already reporting on the exposure of property investments to flooding. If, with growing flooding incidence, lenders, insurers and buyers become more reluctant to be involved with property in such areas, that could have a powerful effect on values and

uses – the concept of a "stranded asset" (as used for fossil fuel reserves no longer seen as exploitable) might here be joined by the "submerged asset" (property with negligible or steeply discounted values).

5.3.4 Landscape fires are occurring more often even in the winter, though mainly of moor and heath, but, having few naturally flammable trees, with nowhere near the extent, scale and ferocity of the fires seen in Siberia, Alaska, California or Australia.

5.3.5 More generally and pertinent to farming and forestry is the greater volatility of weather with more extreme periods of drought and heat with stress for crops and trees. Increased average temperatures and milder winters change growing conditions and the types of diseases and pests. Those pressures begin to change what is cropped and how it is managed. One signifier of that is the development of a successful and growing wine sector with vineyards in the southern counties. Varietal improvement, investment, improved skills and the warmer climate have all made this possible and able to support the associated infrastructure for training, advice, marketing and exports. Similarly, the limit on maize production is moving north.

5.3.6 In relative terms, the impact on the United Kingdom with a tendency towards milder, wetter winters and hotter, drier summers, even with intense storms and flooding, is modest compared to effects in many other parts of the world. While Arctic latitudes may have the greatest warming, Europe's Mediterranean states are seeing temperatures that begin to exclude wine production in some areas and storms leading to substantial soil erosion. To that extent, this offers the United Kingdom with its temperate Atlantic coast position some comparative advantage as an agricultural economy at least for a while to come.

5.3.7 An early 2021 National Trust report on its modelling for England, Wales and Northern Ireland considered the impact of climate change by 2060 were no measures effective in achieving mitigation (and so perhaps a worst case scenario). That exercise foresaw:

- heat and humidity rising dramatically, with the south east particularly susceptible to "drastic increases". A third of National Trust sites in the region would experience at least 15 days of over 30ºC degrees a year, with that exacerbated in urban areas like London by the Urban Heat Island effect. The number of days with temperatures above 40ºC would increase.
- storm damage, landslides and flooding becoming common occurrences and more widespread, particularly in Wales and the North of England
- coastal erosion and flooding increasing in Northern Ireland, potentially leading to more landslides around locations like the Giants Causeway.

More specifically:

- the number of National Trust sites at high or medium risk of climate related hazards could increase from 20,457 (30 per cent) in 2020 to 47,888 (71 per cent) in 2060 out of a total 67,426 sites.
- the number of National Trust sites in the highest threat level area could rise from 3,371 (5 per cent) to 11,462 (17 per cent) in the same period.
- the number of National Trust scheduled monuments at high or medium threat risk projected to increase from 1453 (27 per cent) today to 3861 (72 per cent) out of a total 5388 by 2060.

5.4 Mitigation of Climate Change

5.4.1 The effects of climate change in the United Kingdom may be more immediately felt from the measures taken to mitigate it and, in particular, to meet the net zero greenhouse gas emissions target by 2050 when remaining annual emissions have been so reduced that they are balanced by annual rates of sequestration.

5.4.2 While the measures for that bear across the economy, they have an early force for rural land management and buildings with:

- the pressure for carbon sequestration, whether:
  - in soils by increasing the soil organic matter (SOM), as with the 4 per 1000 initiative under the Paris Agreement that for 10 years SOM would be increased by 0.4 per cent each year
  - peatland restoration, upland and lowland, to minimise the net carbon losses from peatland
  - in new tree planting with the political attractiveness of that illustrated by the competition between the political parties for higher targets for planting in the 2019 election campaign
- minimising the production of other greenhouse gases, such as methane from ruminants
- increased reliance on renewable energy with land moving to solar parks as well as other forms of energy production
- the use of crops to substitute for more energy intense forms of production, as with plant materials substituting for fossil fuels as a source of plastics
- a heavy emphasis on the improved carbon efficiency of both dwellings and commercial buildings.

5.4.3 It is understood that depleted non-organic arable soils can sequester as much carbon as could be done by tree planting but also that there is much less potential on organic soils and pasture management should not be overlooked in this.

5.4.4 More generally, this pressure for mitigation will also bear on production techniques with carbon-free electricity and hydrogen displacing fossil fuels as energy sources for motive power and other uses. Within the UK's general net zero objective for 2050, the NFU has declared that a goal for agriculture in England and Wales is to be net zero by 2040 while supermarket chains are moving ahead of that. Morrisons is on its website:

> "pledged to be the first supermarket to be completely supplied by 'net zero' carbon British farms by 2030" and so working "with its 3,000 farmers and growers to produce affordable net zero carbon meat, fruit and vegetables … Morrisons expects that the first products to reach net zero carbon status will be eggs as early as 2022, followed by lamb, fruit, vegetables, pork and beef …".

With beef seen as both the proportionately largest issue and perhaps the hardest, Morrisons hopes to have the first carbon neutral beef by 2025. Other supermarkets are said to be aiming for 2035. Those supply chain pressures will drive change on farms.

5.5 Adaptation to Climate Change

Finally, as climate change has been happening and, on general assumptions, will continue even if the 2050 target is met, measures will be taken to adapt to it. These might include:

- measures to manage flooding from downpours by attenuating water flows with water held back, as has long been the function of the washlands at Tewkesbury for the Severn and Avon, but now by taking steps such as:

    - increasing soil organic matter to promote water retention
    - encouraging cover crops to reduce silt and other run off
    - "soft" engineering with leaky dams and reconfiguring canalised water courses to slow water flow
    - tree planting in parts of the uplands to buffer the impact of heavy rain on headwaters
    - accepting that some land will be used to hold water in at least some seasons with consequent changes in its management, typically from arable to pasture. In previous centuries water meadows were positively used in this way, sometimes with the infrastructure of sluices to manage warping and weiring to accept the warmth and silt brought by the flooding to achieve improved summer grass.
  - coastal management against rising sea levels and storm surges, as perhaps by managing coastal areas to buffer the advance of the sea
  - adapting properties to become flood resilient with measures from protecting doorways, air vents and drains to more fundamentally enabling dwellings to withstand being flooded
  - accepting that, as with coastal erosion, some houses and settlements may become unviable through repeated flooding and finding ways to ease and accommodate that, helping those affected to best manage this. Environment Agency forecasts point to 3.6 million people living in homes at risk of annual flooding by 2050.
  - managing periods of drought with their pressure on water supplies. For agriculture (and indeed other uses) this means greater buffering of water supplies with reservoirs sufficient not only for a year but to carry stocks over between years and so the associated irrigation infrastructure. More domestic and commercial properties will harvest rainwater or retain grey water. This appears most of a challenge in the greater south east with the combination of the demand for water from increased development and declining supply from rainfall and reducing aquifers.
  - enabling properties to manage periods of more intense heat to avoid not only discomfort but also the sharp increases in deaths seen during such periods (as seen in France in the extreme heatwave of 2003). Periods of hot drought are also likely to see soil movements affecting buildings and place a premium on shade.
  - measures to manage the pests and diseases that may find the new circumstances more attractive or which can more readily over-winter.

6. An Overview of Current Agricultural Economics

6.1 There is an argument that British agriculture, set on a bold course of improvement after the War, has been in economic retreat since the 1960s, struggling on a treadmill of commodity production with margins steadily eroded. Substantial gains in physical productivity, notably in labour productivity with mechanisation, have been offset by reducing product prices with margins squeezed and overall income and profit falling in real terms.

6.2 While supporting farm incomes was an express object of the CAP, it instead proves to have managed decline, at least in the British Isles. It is then worth noting that the historically unsupported sectors, such as pigs, poultry and horticulture, have more often made money from farming while supported sectors have tended not to but be (or become) dependent on subsidy income to retain a surplus.

6.3 While the current Total Income From Farming (TIFF) figures only go back to 1973, illumination is given by previous Net Farm Income figures (from the Centre for Agricultural Strategy Report *The Changing Financial Structure of Farming*, Harrison, January 1989) which showed a real terms decline in total UK returns from agriculture predating the TIFF figures. Showing sample figures from both series in 2018 prices:

	NFI	TIFF
1964	£8,957m	
1978	£7,070m	£6,737m
1986	£3,461m	£3,892m
1991		£3,313m
1994		£6,603m
2000		£1,949m
2005		£2,811m
2010		£4,399m
2015		£4,332m
2018		£4,697m

6.4 That report took that further in showing movements in the relative values of net farm incomes and the net stock of capital in agriculture (buildings, plant and machinery, appearing to exclude land), taking 1950 as the starting point for the two indices, deflated to real terms, resulting in a capital intensive, low yield sector:

	1950	1960	1970	1980	1986
Net Farm Income	100	87	97	50	45
Net Stock of Capital (all assets)	100	136	199	244	233

6.5 Real economic efficiency (total factor productivity) in converting the value of inputs into the value of outputs (the biblical parable of the talents) has broadly gone sideways since the 1960s and more so since 2000. With an average improvement of 0.9 per cent a year since 1964 and 0.7 per cent a year since 2000, the overall fortunes of pure agriculture have, as seen in the 1990s, been more a function of the exchange rate than anything else. That is in stark contrast to competitor countries as not only has the UK

fallen behind the generality of major European producers since 1992 but over the years since 1964:

- Holland has seen annual productivity growth of 3.5 per cent
- the USA 3.2 per cent
- France 2.5 per cent
- Germany 2 per cent.

While Ireland has mirrored the UK, the compounding effect of those differences over 55 years makes for a significant cumulative difference and a competitive handicap if farming is to be expected to provide incomes and reinvestment. The Agriculture and Horticulture Development Board (AHDB) has noted that, had the UK matched US's productivity performance since 2000, farming income would have been £4.3bn more: effectively doubled but three times the ex-subsidy income. While other states subject to the CAP have sustained better performances, several have systems that make pensions and Basic Payment mutually exclusive.

6.6 Aside from overall economic data, this decline relative to the general economy is shown by the way that farmland rents have not kept pace with inflation and, indeed contrary to many preconceptions, that farmland values have not over time kept pace with asset values more generally.

6.7 A very disaggregated production sector has met increasingly concentrated commercial food processing and retail sectors with a picture that has been simply summarised as the processors taking farming's margins, the purchasers taking the processors' margins and then the supermarkets cannibalising their own margins.

6.8 With living standards rising across the economy and the demands of investment, individual farmers' endeavours to square this circle have generally focussed on commodity production with specialisation and scale to contain or reduce unit costs, with an increasing concentration of commercial farming in larger units (though still small businesses in operational terms).

6.9 As an indicator of increased specialisation which both pre-dates and post-dates this illustration from the CAS Report *The Changing Financial Structure of Farming* (Harrison, January 1989), these figures show how farming became less mixed between 1970 and 1987 with smaller percentages of holdings operating these enterprises:

	1970	1987
Cereals	45.9%	36.3%
Potatoes	26.4%	12.9%
Dairy Cows	36.4%	19.7%
Beef Cows	33.4%	27.7% – having grown in the 1960s
Breeding Sheep	29.2%	33.3%
Breeding Pigs	21.9%	6.2%
Laying Fowl	44.0%	16.6%

6.10 Previous farms have typically become smaller units around a house while transferring land to those larger operations sharply eroding the number of middling-sized farms – and what might once have been seen as larger farms. That pattern of division is itself a barometer of the economic pressures faced by pursuing a strategy of commodity production.

6.11 Those economics have seen further restructuring with land let and taken on short term tenancies and business restructuring by much greater use of contractors, each

offering scale without the overhead of land purchase. In competitive markets, both tenants and contractors may not only have brought the value of skills and machinery for a contract with mutual benefit but also often transferred value from their businesses to the other party with the optimistic bids made for the propositions which then face the risks of the real world. They may have gained less, if at all, from the deal but maintained their place on the treadmill.

6.12 While that pattern of restructuring would be widely recognised, what is less widely perceived but begins to offer answers is that these overall, and so average, figures mask an enormous range of physical and financial performance between farmers so that the performance of the top quartile in each sector is generally positive. As a simple illustration, England's Farm Business Survey (FBS) figures for the 19,000 farmers recorded as combineable cropping over the four years from 2013/14 to 2016/17 showed:

- the average to lose £71/hectare from farming before subsidy, agri-environment income and other on-farm activity
- the top quartile to make over £200/ha
- the bottom quartile to lose over £300/ha, in principle destroying value by farming unless this is required for a larger other income.

Over those four years the average cereals farmer lost slightly more money farming than did a Less Favoured Area (LFA) grazier.

6.13 DEFRA figures suggest that little more than half of cereals and grazing livestock farmers turn a £100 of inputs into more than £100 of farming outputs, with the bottom quartile of graziers again noticeably destroying a significant fraction of that value of inputs by their activity. Work on commodity production businesses by the AHDB and Andersons ascribes almost all the responsibility for this to the farmer's business management. The potential of the better performers indicates the potential to improve matters.

6.14 That this picture has survived so long is a mark of farming's resilience and farmers' commitment to survival. It is not of itself a hallmark of economic progress and does not give the capacity to reinvest and innovate – indeed possibly aided by a lack of recognition of the cost of depreciation. It might suggest a significant difference between those who are managing land by farming as opposed to those who are running commercial farming businesses. That distinction may come to be more obvious and important as we confront the challenges reviewed in this paper.

6.15 A question underlying that is how far the UK can, as a high cost country, continue to expect agriculture to retain its overwhelming reliance on commodity production, simply producing and selling undifferentiated commodities almost inevitably as a price taker, on which it has probably focussed more since the Second World War. This approach does not require UK producers to be the cheapest in the world but does need them to be able to sustain business at the prices at which markets clear. The data suggest that the better performers in each sector, including cereals and dairy, can do that though others do not presently achieve that.

6.16 That then sets the commodity trap, as now exemplified for cereals farming where margin is more than ordinarily simply the difference between two figures:

- output is simply the achievable yield (with skill, equipment and timeliness part of that) multiplied by the price received (largely a function of external factors)
- the overall total of costs per tonne of that output, perhaps the aspect most under management control and studies show great differences between farmers.

There currently seem few ways for a cereals farmer to do better than that with the average farmer relying on Basic Payment for income. They and the land they use now face particular challenges. The underlying dynamics will mean that good commodity farmers will still need to seek appropriate scale but only from land that will genuinely add margin to the business, not any land at any price. That re-appraisal may see movement of land between businesses as land shed by one may serve the purpose of another with a different location, enterprise base or other factors – or be re-priced until it does.

6.17 It appears that the top performing livestock farmers do better than top performing cereals farmers by being able to sell produce that is not a pure commodity. That begins to indicate the question of how far farmers, looking at the future, can be or want to be so dependent on commodity production. The routes out of this can be grouped as:

- agricultural diversification, producing and selling produce that is in some way differentiated whether by its nature (a rare grain, a specific milk composition), production method (organic and other approaches), market (finding higher value outlets) or a new enterprise
- adding value to agricultural produce, often with associated marketing
- non-agricultural diversification, using the assets of the farm and its business to earn what may often be unrelated income and so both developing opportunities and spreading risk.

6.18 One way or another, such alternative approaches in answering the productivity challenge have been summarised as no longer doing more for less but rather moving to do less for more. As with many epigrams, that might not encapsulate matters fully but it is capable covering several of these routes and has at its core the search for efficiency and profit for farming to be competitive rather than just working ever harder. With that last point, it could also be encapsulated as a focus on business rather than busy-ness.

6.19 Non-agricultural diversification is considered below. It is harder to assess the extent of "agricultural diversification" but it often faces challenges of scaling up to achieve commercial viability. The capacity to exploit niches is limited by their size as illustrated by the collapse of the goat milk market caused by over-supply.

6.20 Meanwhile and in contrast to extensive cereals and livestock, the value of farming output disproportionately lies in the more intensive sectors more reliant on physical protection and less on subsidies. The poultry sector's share of the value of farming's output at 14 per cent is close to the 15 per cent from cereals. In combination, dairy, pigs, poultry, horticulture and general cropping provide towards two thirds of the value of farming output, much of it from under some form of cover using a fraction of the land area and taking a low proportion of the subsidy which is concentrated on grazing livestock and cereal farming. Dairying produces more value than beef and sheep combined with a fraction of the support payments. For pigs and poultry with almost no subsidies, the move to indoor production has been for production efficiency and, especially for pigs, to protect high health status. Nothing has though been projected in the UK to match the scale of some of the indoor dairies and pig units in China.

6.21 While and as the future evolution of these matters are substantially issues in the market place, the powers given to ministers under s.29 of the Agriculture Act 2020 to regulate fair contracts with first business purchasers may, if useful and if used, have

relevance to this developing world. Confidence in fair contracts could itself underpin investment, innovation and business. However, the Scottish government review of dairy contracts was sceptical as to the value of intervention.

6.22 If that change did happen, past behaviour by farmers points to the challenge then being to hold that new margin rather either competing it away or absorbing it in costs.

6.23 With that background, this paper now looks at some of the, often interlocking, pressures for change in agriculture as the dominant rural land use.

7. Some Dynamics for Agricultural Change

7.1 Markets and Public Tastes

7.1.1 Economic activity only has a point if people want to buy what it produces. While food is an essential, that principle holds nonetheless as tastes change and markets move. Other things being equal, people will tend to pay more for what they especially value while the long run experience is for the values of commodities to tend to fall in real terms.

7.1.2 UK agriculture sells produce into three markets:

- the UK itself, with its growing and affluent population that is familiar, on the doorstep and with the cost of international transport but with margins constrained by competitive retail markets and with one of the world's three lowest shares of income being spent on food and still much of that spent on convenience
- its current prime agri-food export market in the EU
- the growing world markets outside the EU.

7.1.3 In all three, people will seek enjoyment from food but see price as a key factor with raw commodity produce taking only a low share of the value.

7.1.4 Recent Trends in the UK – Some indications of recent trends are given by DEFRA's *Family Food Survey 2018/19* for the reported quantities of differing types of food bought by households each week over the years since 1974 (including takeaway meals eaten at home). This table gives a selection with the potential to give further or more detailed figures.

	1974	2000	2010	2018/9
Liquid milk (ml)	2687	680	352	329
Cheese (g)	105	109	111	123
Carcase Meat				
Beef and Veal (g)	189	113	111	96
Lamb (g)	113	54	45	25
Pork (g)	91	68	55	47
Non carcase meat/				
Meat products (g)	630	779	787	794
of which Chicken (g)	115	170	183	212
Fish (g)	123	144	161	146
Eggs (no)	4	2	2	2
Butter (g)	147	37	40	33
Sugar/Preserves (g)	535	167	127	93
Fresh/process veg (g)	1141	1147	1118	1139
Potatoes (g)	1437	1002	776	620
Fresh/processed fruit (g)	731	1189	1199	1106

7.1.5 This can only be a partial view as it excludes food eaten out of the home, an increasing trend over that period. Average household sizes have fallen and the population has grown.

7.1.6 As an aside, matching sheep numbers over this period with the sharp decline in in-home consumption figures for lamb points to the importance of both "food service outlets" and exports for this production. For beef, the strong prices seen during the Covid-19 pandemic are thought in part to reflect the extent to which there was a move

in buying from the suppressed food service sector with its greater use of imported beef to the retail market more strongly buying British.

7.1.7 Expected Trends – Especially in western markets, the discussion of food will have an increasing focus on issues such as health, greenhouse gases, the environment and animal welfare but those might not be fully or coherently integrated into buying decisions by consumers. Companies, anxious about reputational risk and "the next campaign" (as was seen with single use plastics) might be more influenced by this mood. Virtue becomes a marketing tool and an assurance to investors and lenders. That still leaves a significant part of the market for which price is not just essential but absolute as a factor, to some extent expressing itself in the emergence and increased use of food banks. More generally the pressure on price becomes more important in times of economic pressure with more confidence in affording other values shown in times of economic growth.

7.1.8 To illustrate the point about value for money in the different context of buying British, the 2018 Government survey of attitudes by food consumers showed:

- 78 per cent thinking it important to support British farmers
- 59 per cent saying they buy British when possible
- 38 per cent prepared to pay more for British food

that, of course, implying the ability to identify it accurately.

7.1.9 That shows a segmentation of markets with mass markets more driven by convenience and price, albeit coloured by health and other issues, but specific segments much more driven by values. These segments might offer more potential for rebuilding margin from non-commodity farming but are more likely to be larger markets in more affluent periods. Purely as an illustration, the US has the largest organic share of any major market. However, the markers for values change over time, with more concern in the UK now about local provenance than about organic production.

7.1.10 A useful caution is provided by a review of UK food consumption for DEFRA:

> "Some individuals care about the origin, sustainability and ethical production standards of their food. Some individuals are increasingly socially conscious, particularly in terms of the ethical, environmental and social impacts of their food chains. There has been an increase in the sales of ethical and sustainable produce, such as Fairtrade and Royal Society for the Prevention of Cruelty to Animals (RSPCA) Assured products. However, total sales are low, representing only 11 per cent of all household food purchases. Some producers also increasingly care about the provenance of their food and production methods but this mainly relates to certain food groups (e.g. meat) and the evidence is unclear. However, it likely that most consumers are unaware of the social and environmental consequences of their consumption and how this impacts on wider issues. Moreover, a common challenge when conducting research on food preferences and drivers of food practices is the "value-action gap", whereby individuals do not necessarily act in line with their stated beliefs." (*Food Consumption in the UK: Trends, Attitudes and Drivers*, Rand Europe, 2015).

7.1.11 However, and perhaps with a role in moving market shares among affluent buyers, promotional efforts are likely to include a focus on such perceived underlying values. Even those essentially motivated by price will often want some sense of comfort on this score. Some perceptions of taste and convenience may also be more consistent with a higher fat and sugar content than others.

7.1.12 The Covid-19 pandemic and its partial dislocation of normal food purchasing patterns has seen strong gains by local food sellers such as farm shops, grocers and butchers – and strong livestock prices. It cannot yet be guessed whether this will be sustained but a number of farmers and others have successfully developed box schemes, both meat and vegetable, and there are now more automatic milk vending facilities. One involved with a successful milk vending facility has expressed relief at no longer being a price taker for the milk he produces.

7.1.13 The new information technologies might become one more tool for control of the food chain with blockchain commanding supply and the ability to personalise approaches, perhaps powerfully for health, to customers interacting with demand. That personalisation might be particularly powerfully done for health and wellbeing but such food might not be any the less processed for that. It could see more synthesised functional ingredients and a specific market for functional foods.

7.1.14 As with the discussion below of meat substitutes, this rests on consumer acceptance of science though that is more trusted for medicine and health factors which, with supporting arguments of sustainability and potentially reinforced by the response to the Covid-19 pandemic, are capable of attracting more confidence than those of cost saving and efficiency.

7.1.15 The UK's per capita consumption of calories has fallen over time. There has been a shift to more diverse diets. More food is now consumed out of the home through food service outlets, increasing from 21 per cent of food spending in 1990 to 26 per cent in 2010, reaching 28 per cent in 2018.

7.1.16 The publicity around vegetarianism and veganism may overstate the picture but there are shifts from red meat to white meat and towards vegetable and plant-based consumption as part of more flexible patterns of eating. Whether at home or not, that is often convenience food, prepared with substantial processing (perhaps to the point of being inconsistent with "natural" branding), further reducing the share of value for the basic food ingredients used. Consumption of carbohydrates now draws on rice and pasta as well as potatoes.

7.1.17 The forecasts are for growing markets in alternatives to livestock production, whether milk alternatives or meat substitutes while one in four of those between 16 and 24 are now said to be teetotal.

7.1.18 Trends in European markets will be broadly similar but with populations that are more generally aging.

7.1.19 Further abroad, the most striking change is the new affluence of large numbers in the far east. The Organisation for Economic Co-operation and Development (OECD) foresees two thirds of the world's global middle class being in the Asia Pacific region by 2030. Those are people with choice over food and capable of driving markets across the world. Who will feed them? AHDB work suggest that markets there see British food as a marker of assurance and quality.

7.1.20 In reviewing these issues, the cereals sector should be seen as substantially a supplier of feed to both the beef and white meat sectors though wheat and barley do also go for milling and malting. It is probably also the sector least directly responsive to changes in public taste, with livestock and its products and also horticultural produce

being more directly exposed. However, farmers generally (and perhaps livestock farmers in particular) are rarely in a position to change business models swiftly, it taking time to build or change a herd or adapt a rotation.

7.1.21 EU Forecasts – For comparison and in summary, EU forecasts (for the EU as a whole, without the UK) are that 2030 would see:

- the arable area reduced by other land uses and the continued expansion of forest and pasture
- a reduced cereals area giving a stable output with a shift within that from wheat (principally durum wheat) and barley to maize for feed
- rapeseed declining slowly, possibly underestimating the impact of the neo-nicotinoid ban but arguing its value in the rotation
- lower demand for biofuels as overall use of vehicle fuels falls
- strong growth in both the area (up by 37 per cent) and volume of protein crops with demand for innovative plant protein products and for more locally sourced protein, mostly for human consumption
- slow growth in milk production with increased segmentation of production systems (pasture-based, GM free feed, organic)
- reduced production of pork and beef with a small per capita fall in meat consumption
- stable sheep and goat production
- poultry as the only meat sector growing, perceived as more convenient, affordable and healthier.

Those forecasts pay little attention to the underlying CAP support system. England and then Wales is expecting to dispense with that, removing that element of buffering the pressures from change.

7.1.22 The forecasts consider the possibility of food waste as a base for insect farming for protein feed and oil in place of vegetable oil for the production of fish, meat and milk production. It sees insect farming as using very little land but with a consequent downward pressure on cereal prices.

7.2 Trade

7.2.1 Now that the UK-EU Trade and Co-operation Agreement has been settled with its tariff free provisions (status quo) but new regulatory controls at the borders, it is easier to look at trade issues.

7.2.2 That outcome is an unambiguous relief for lamb with the large share of production exported almost solely to the EU and balancing imports coming from New Zealand. More generally, the UK is overall a net importer of food, especially from the EU but many products, as with grain and poultry meat, see trade moving both ways – for meat, enabling carcase balance. However, regulatory friction may provide some opportunities for import substitution perhaps especially in horticulture and dairy.

7.2.3 Free trade agreements with third countries, such as those already struck with Japan and Canada, would see tariffs reduced over time allowing transition both for export opportunities and any new challenges from imports, especially where agreed with major food exporting nations such as Australia and New Zealand. Again, though this comes back to the recognised and important need to improve the competitiveness of UK agriculture.

7.2.4 Much of the public discussion of trade competition has focused on the meat sectors, notably beef and chicken from the USA and Brazil (with arguments over both

about production approaches) and antipodean lamb. Larger movements in global commodity markets such as cereals in which the UK is a small player, such a continued growth in Ukrainian production, will have effects in a more open world trading environment. Those will also be influenced by the trends in climate change.

7.2.5 Thus, at this point less may now have changed with the EU agreement than might have been the case but where there are effects they will be sector-specific ones, advantaging some and disadvantaging others. Future agreements might change that review, though AHDB studies tend to point to fewer effects in the shorter term. Longer term, other countries, if seeing the UK market as attractive, would meet the UK's standards while the scale of markets such as the USA can offer the UK good markets for high value produce.

7.3 Labour

7.3.1 While there is now relatively little direct non-family labour employed in large areas of farming, more specialist enterprises including dairy, pigs, poultry, fruit and vegetable production rely substantially on migrant labour drawn since 2004 essentially from within the EU. The same is true for vegetable processing and slaughterhouses.

7.3.2 Many EU citizens doing such work are already here with rights to remain but this number will tend to erode, whether as they are promoted, find other jobs or return home, when they will be less easily replaced. The new migration policies do not facilitate staff for low paid hard work while the limited tolerance (now increased to 30,000 for 2021) offered for farm labour is seasonal only (six months) is useful (to the extent that it allows) but not where permanent staff are needed. Early indications that this might be extended to flower farms, such as Cornish daffodils, appear unrealised.

7.3.3 Alongside rising rates of pay, that adds to the pressure for investment in automation, where feasible, and may affect some lines and some methods of production. In turn, that automation and the increasing sophistication of machinery requires new skills.

7.3.4 That points to the larger and long-term changes in the relative costs of and returns from labour and capital as factor in change. Studies have shown that, even without the last decade, long run interest rates have fallen since the Middle Ages while labour has become more expensive. The most striking historic example of this was perhaps the increased wage rates after the Black Death but the late nineteenth century movement of labour from farming to industry and mining following wages also saw increased automation with the application of steam engines.

7.3.5 Labour productivity by mechanisation has been the most successful area of improvement in UK farming's efficiency over the decades. Access to workers from abroad will variously have eased that constraint, helped bridge the gap until useful automation becomes available for particular work or delayed the move to productivity improving investment. The rising cost (as with the National Living Wage) of labour may make already marginal businesses less viable while scarcity of labour in areas of low unemployment may challenge any affected business.

7.3.6 Another aspect of this is the willingness shows by farm accounts of some business principals to work, not only in bad years but over time, for minimal or even negative returns on their labour, whether overall or per hour. That is a personal choice and, in reality, is at the cost of the reserves and value in the business or is supported by other income. Equally, it can be seen as transferring value to purchasers of produce and, at least at the margin, potentially tending to depress some prices more widely.

7.4 Regulation

7.4.1 Regulation has been a developing feature of farming and land use for some decades with the twin perceptions of burden (especially as new regulations are brought in) and assurance (increasingly important in today's markets). Despite the suspicions expressed in some quarters, there is little economic role for the UK, as a high cost country, in any "race to the bottom" on standards. As with the rest of UK manufacturing as it has adapted, both markets and regulation can together point to moving focus to higher value added production sold on the basis of assurance.

7.4.2 In England and then Wales, the direction of new policies will see land management schemes and productivity policies underpinned by a regulatory baseline (in part to replace cross compliance, clarifying its relationship with the law) setting the standards for what farmers must do with the potential then to be paid for agreements to meet higher standards, as where the market will not reward that achievement: "public money for public goods". That regulatory baseline seems likely to rise over time for slurry storage and spreading, pesticides, animal welfare and extending the environmental permitting regime from other industries, pigs and poultry to dairy and intensive beef.

7.4.3 Regulation can impose constraints with a recent example being the reduced oil seed rape area following the EU ban on neo-nicotinoids, albeit that derogations have been given in 10 EU countries and the UK for sugar beet.

7.4.4 As that indicates, these issues can become sharper where they bear on trade competition with animal welfare being an obvious example as the market will often not pay more for higher standards. That can be illustrated with the example of the pig sector with sow stalls banned here but not in Denmark and so facing commercial consequences from lower productivity without the market paying more for the welfare benefit.

7.4.5 Regulation can simply impose costs in ways that do not aid production at all or (at least immediately) influence produce markets, as with the expected increasing requirements for slurry storage to answer problems of water pollution and air quality (though, as argued by the Welsh Government, might come to support the Welsh brand as founded on sustainability). This has perhaps been seen most substantially as an issue for dairying where the large costs that can be involved in meeting higher storage requirements may drive decisions to cease the enterprise entirely. With attention now also on poultry, this pressure can be seen in other sectors.

7.4.6 Regulation can have indirect effects through the supply or costs of inputs. As an example, the controls by the EU and others on the development of new crop protection products make this so costly as to see their progressive loss save for the three great crops, wheat, maize and rice, that have volumes large enough to justify the development costs and risks. This might sometimes be answered by alternative management techniques, whether husbandry, biological or other, but sometimes it might simply make a crop unviable.

7.4.7 Wider Goals – In at least some parts of the country there have been moves to frame approaches to land use and related matters on a more comprehensive societal basis.

7.4.8 In Wales, the Well-Being of Future Generations Act adopts a broader sustainability approach but directly relevant mainly to the public sector. However, that Act with the Environment (Wales) Act 2016 is being used to frame the sustainable land management strategy of the post-Brexit policy consultations and the Agriculture (Wales) White Paper.

7.4.9 A more sweeping stance is developing in Scotland through "land reform" measures and, more particularly the creation by the Land Reform (Scotland) Act 2016 of the Scottish Land Commission and, under that Act, the preparation and publication in 2017 of the Scottish Land Rights and Responsibilities Statement. Considering all land, urban as well as rural, it aims both:

- to inform the development of the Scottish Government's economic, land use and planning policies and so its actions in relation to land, as for planning, housing provision, urban regeneration, farming, caring for the environment or otherwise
- more broadly, to encourage and support those with significant responsibilities over land, such as local authorities and large private landowners, to consider how their decision making powers could assist a vision based around community involvement and social values. That vision has expectations of greater collaboration and community engagement in decisions about land with more diverse land ownership and tenure and the holders of land rights exercising them in ways that achieve high standards of land ownership, management and use.

Where such an approach tends to build in procedural burdens and political impediments to or limitations on change it may delay or jeopardise the effective and innovative decision making required for business adaptation and investment, perhaps especially where involved are not directly exposed to the financial issues. Equally, it may offer a means for necessary changes to be better explained, understood and supported as they occur.

7.5 Water: Quantity and Quality

7.5.1 Agriculture and rural land management depend on water, are affected by the extremes of flood and drought and pose one of the challenges for improving water quality.

7.5.2 **Water Quantity** – With rainfall varying from the extremes of the very wet Western Highlands, Lake District and Snowdonia to the dry conditions of parts of the Essex and Suffolk coasts, and water bodies from the chalkland winterbournes to lakes, agriculture and rural land use are profoundly influenced by the water needed for crops, livestock and processes. Managing and protecting that supply has become more important with competing demands from industrial and domestic use and development, while climate change means we are now seeing more extremes of torrential storms and droughts. These were not unknown with the Lynmouth disaster of 1952 echoed by Boscastle in 2004, while Martinstown in Dorset had over 10 inches of rain on 18th July 1955 and the summer of 1976 stands in many memories for its long hot dry spell (at a moment when Times leaders had contemplated a new Ice Age).

7.5.3 The excess of water represented by flooding and waterlogged land is an immediate problem for affected areas and may drive changes in land use to help attenuate it and its damaging consequences in flooding housing and urban areas. The sustained flooding of crops, as seen for example in February 2020 sees substantial farming losses while more ordinary waterlogging frustrates plant growth and makes land unworkable with effects from sowing to harvest and denying land and feed to livestock.

7.5.4 Beyond that, flooding can leave much debris, as seen with the Cumbrian flooding around Cockermouth in 2009 where fields were covered with stone that was expensive to remove and river courses were changed at the expense of fields.

7.5.5 With repeated droughts putting pressure on high value crops, water has been contained in reservoirs, enabling it to be taken in the winter, without affecting water courses or aquifers, for use in the summer, delivered to crops by irrigation systems with technology now helping this become more efficient. These systems now increasingly see the need not only to manage water within a year but to buffer stocks between years to be able to respond to repeated droughts, so requiring more reservoir capacity and those improvements in delivery so that more water reaches the plants than evaporates. Meanwhile, background regulation of abstraction licensing tightens. Without that facility to irrigate, many high value crops would now be unviable as enterprises, particularly on sand land that may have no equivalent farming use.

7.5.6 Ensuring continuity of water supply at the abstraction points for Exeter was the object of South West Water's interest in the re-wetting of the Exmoor Mires. The more that area could retain water, the more the water would be released evenly year round, rather than concentrated in the winter.

7.5.7 Improving soil organic matter can help both water retention and drainage, also aided by management to avoid compaction and panning. In turn, that holds back and slows the passage of water relieving those further down the catchment. While that soil improvement supports productive agriculture, further measures that may be proposed include tree planting above headwaters, management of streams with leaky dams, restoring meanders to canalised rivers and other measures that attenuate the flow of water, before recognising the potential of riverbank land and water meadows to hold flooding away from urban areas where it would be much more damaging with that tending to promote pasture rather than arable uses. Where this results in land becoming more permanently wet or planted with trees, that land might move from agricultural uses to be effectively ungrazeable.

7.5.8 **Water Quality** – That overlaps with the concerns about agriculture's extensive use of land as a source of background diffuse pollution of watercourses with soil and slurry, as well as nutrients, chemicals from metaldehyde to sheep dip and pathogens such as clostridium with environmental effects, including eutrophication and threats to biodiversity, and costs to water companies in meeting standards for water supply. Measures being taken to manage that range from banning metaldehyde to encouraging ploughing across slopes, but particularly by establishing and maintaining grass buffer strips for water courses and ensuring arable land is not left bare. That sees continuing challenges to crops such as maize and potatoes near streams and rivers. While much of this is being handled by regulations and official schemes, where water companies primarily rely on surface water abstraction their interest in agreements with farmers over land use is typically more focused in the lowlands, as the main water abstraction points for urban areas are often located well downstream. South West Water has noted that less than 10 per cent of the catchment of the Exe is upland. The uplands can offer more value per acre where abstraction is from them and managing grazing for Clostridium remains a concern around upland reservoirs.

7.5.9 Away from water courses, action bears on slurry with water separation, improved and covered storage and spreading regimes, including Nitrate Vulnerable Zone (NVZ) rules. As now seen in Wales, greater demands for slurry management to protect water quality is likely to be a key part of the regulatory baselines for the new post-Brexit regimes. Such measures will come with severe penalties where pollution occurs.

7.6 Tax Change

7.6.1 The tax system has an important potential to change circumstances for agricultural and rural land management, perhaps most obviously to change adversely for the taxpayer. Typically having low returns on substantial values of assets held long term, owners (and their advisers) feel exposed to capital taxation with a concern to secure the reliefs available for business and agricultural property under Inheritance Tax to avoid significant damage to business from either disposals or debts to pay tax. This background has been appreciated by policy makers with Baroness Penn assuring the House of Lords for the Government:

> "While we recognise that there are some concerns, the policy intention behind those exemptions is to allow family farms and businesses to be passed on without having to be broken up to pay Inheritance Tax. We think that that is an important aim." (Hansard, 20th May 2020, cols 1103-4)

7.6.2 The tax environment for agricultural and rural land has been relatively stable (albeit with the shape of CGT shifting regularly) and has tended to become less challenging, both since the early 1980s. However, the ravages from taxation of the previous decade with Capital Transfer Tax as first introduced and high levels of Income Tax, especially on rents, were as important as the introduction of agricultural tenancy succession in England and Wales in the decline of the let farm sector and echoed the previous impact of death duties at the beginning of that century.

7.6.3 Some consider that those tax reliefs are part of the forces that have sustained land values. However, there are many other reasons for farmland values to be as they are while they have over recent decades underperformed most other assets (save in the period 2006 to 2015 on the back of strengthening commodity prices). With values being the interplay of supply and demand, that points to a real issue for values being confidence which could be undermined by a variety of actions, including tax changes, in thin markets before finding a new floor and, from the history of the early 1970s and early 1990s, then recovering.

7.6.4 With much commentary seriously underestimating the role of Business Property Relief for farming, changes that might affect agriculture would generally affect other business asset classes. If changes were focussed specifically on Agricultural Property Relief they would be more likely to burden let land and farmhouses, so affecting farm structures as more would come to be farmed under other arrangements, as in hand land would continue to have Business Property Relief.

7.6.5 Farming has been fully exempt from business rates since 1929, partly because of the way that, for farming, land, as a means of production, is more akin to plant and machinery than to premises. An extension of business rates or a replacement system to farming would impose a recurrent operational cost related to the area of land in occupation, applying as an equal extra charge on owner occupiers and tenants – potentially reducing the rents on which they are based but without effect on existing mortgage payments. While it might then appear likely to have similar effects to the withdrawal of Basic Payment, much of its impact would depend on the interaction with reliefs for small business ratepayers, and so at this point perhaps again at the margin tend to encourage contractors rather than increases in the areas of land directly occupied by any one ratepayer. The gain for the Exchequer or local government or the relief for other ratepayers would be limited.

7.6.6 A possible carbon tax is discussed briefly elsewhere but the diffuse and varied nature of faming's emissions might well mean it is not a sector on which it would be particularly focused.

7.6.7 One change that could bring significant benefits in answering the productivity challenge and the core question of having the right people farming would be to use the tax system to encourage the letting of land so that those wearying of farming and not ready to face what is coming can be prompted to make their land available to better farmers while retaining ownership. The obvious example of a way to do this is offered by the Irish Republic which, in 2015, much enhanced its Income Tax relief on rents from land let at arm's length for at least five years. In its first four years in a country with no familiarity with letting land, it appears that some 8 per cent of the agricultural land had moved into letting with some 11,000 new landlords. That points to a way in which much positive change could be achieved in the UK and is explored further in the CAAV paper, *Taxation – Agricultural Productivity and Land Occupation – The Irish Republic's Use of Income Tax Relief to Promote the Letting of Farmland: The First Three Years' Experience Lessons for the United Kingdom* (September 2019 but being updated) available on the CAAV website.

7.6.8 Considering rural land management more broadly and the prospect of a greater environmental role in land management, the important interaction of the tax system and environmental uses is considered below. While environmental management will often be within the framework for and consistent with a continuing agricultural business, there could be aspects where the focus on environmental goals is such that there is neither an active business nor a properly agricultural use. Possible instances noted above could include peatland restoration or the permanent wetting of land for water management. That is potentially relevant to Income Tax and the reliefs from Inheritance Tax and Capital Gains Tax while the place of VAT has been little considered. If it becomes perceived that participation in environmental work can be disadvantageous in taxation terms, that will be an impediment to owners and farmers engaging in it and stand in the way of some of the Government's environmental ambitions.

7.7 Technology

7.7.1 Technology can be considered to bear on these questions in two ways for this paper:

- as a potential aid to improved production here
- the extent to which it is instead used by competitors, either abroad or in different forms of food production.

7.7.2 Precision Farming – The development of precision farming with all its tools to improve management and for resource efficiency, improving genetics, using big data, remote control of autonomous machinery, livestock monitoring, field sensors and other technologies are all advancing at pace with benefits in yields and costs for those who can use them well and corresponding comparative disadvantages for those who do not. Over time, this may come to be a difference of the nature of that between the horse and the tractor. This may again bear on the crucial productivity question of who is farming the land.

7.7.3 These tools may also give a better knowledge of the land being farmed such that other, possibly environmental, uses are found for some parts where this would earn a greater return.

7.7.4 Autonomous machines may alter other established dynamics as they might often not need to be large and, where that is the case, no longer give extra advantage to scale. Part of the logic of commodity production, highlighted by the standard structure of farm management accounting, has been the spreading of overheads over scale, here needing to spread the costs of a man on a machine by having a larger machine and the larger area to carry that larger machine.

7.7.5 As in other sectors, such autonomous machines need not have the same work rates as current machines since they can continue ceaselessly but may need to be nearer power sources or points for resupply.

7.7.6 To the extent that technologies such as gene editing are not available here, they will be a comparative advantage for those countries that do use them. The Government's 2021 consultation paper argues that gene editing of crops could result in the release of marginal land for other uses while maintaining output.

7.7.7 Data – Precision farming can simply be seen as an illustration of the application of the much enhanced volume of data and their management that is now possible to assist better farming and aid decisions in rural land management. From monitoring the gait of cattle to field temperatures, sensors can provide sustained flows of data that can be analysed to support better stockmanship and more timely and appropriate actions. Soil nutrient status and compaction, the diet of dairy cows and states of oestrus can all be understood in much closer detail. Technology for remote sensing whether by satellite or drone is becoming available. Managing this flow effectively will become one of the skills needed of management and itself be supported by technology.

7.7.8 More generally, data can aid the understanding of rural land, with its potential uses from vineyards to environmental improvement with technologies like Light Detection and Ranging (LIDAR) giving more information about land and what is under it – even through a tree canopy – that can be seen by eye or practice.

7.7.9 If data are "the new oil" and their application the motive power of the new economy, that brings such issues as:

- knowing what is relevant and the scale at which it becomes useful
- understanding whether information derived from data has used appropriate data and has been processed in a relevant way
- making decisions from it
- its inter-operability and transferability as between different systems, and on changes of user as where the owner changes a contractor or a tenancy ends with data that may assist a successor in such roles
- what happens on a data holder's insolvency or death?

7.7.10 Data is also increasingly likely to be a feature of supply chain relationships, already seen to an extent with open book contracts in the vegetable world. The Agriculture Act 2020 and the Agriculture (EU Retained Law and Data) (Scotland) Act 2020 provide for the authorities to require data on the food supply chain and to regulate supply contracts with farmers. The demands of assurance and to cement value chains are likely to see this whole area develop, possibly quite rapidly. It brings the potential for blockchain to be used for transactions from fields to foreign purchasers, with the accompanying information available to assure a supermarket and perhaps ease border controls on export. The transparency that seems likely to come with that may again bring consequences for rural land management, the location and manner of enterprises and other outcomes.

7.7.11 Oliver Dowden, the Secretary of State for Digital, Culture, Media and Sport has written of:

> "a bold new approach that capitalises on all we've learnt during the pandemic, which forced us to share data quickly, efficiently and responsibly for the public good. It is one that no longer sees data as a threat but as the great opportunity of

our time. … Right now, too many businesses and organisations are reluctant to use data – either because they don't understand the rules or are afraid of inadvertently breaking them. That has hampered innovation … The next information commissioner will … also be empowered to ensure people can use data to achieve economic and social goals. … The UK has an opportunity to be at the forefront of global, data-driven growth." (*Financial Times*, 1st March 2021)

7.7.12 There are also property questions, such as whether ownership of data is even a meaningful concept with such developments as well as any policy changes to unlock data for a post-Brexit economy. How might this play between say:

- the suppliers of machinery and IT, such as John Deere with its Blue River project or Lely receiving real time data on robotic dairy parlours to help their management
- the supermarket or processor buyers downstream

and how might that affect where value lies?

7.7.13 If the awkwardness, cost and management of acquiring land has been a major friction resisting the development of much larger farming businesses or vertical integration, do such changes overcome that in a different way? Might it also give genuine opportunities for new innovators to establish themselves as new businesses or is that a technological illusion?

7.7.14 Meat Substitutes – While milk substitutes are an established and growing market (with the Swedish plant-based "milk" company Oatly looking for a stock exchange listing), the larger technological challenge might come not only from the indoor production of crops (colloquially "vertical farming") considered below, but other means of producing foods such as:

- meat substitutes based on plants, often relying on pea fibre, or mycoproteins but also tending to be highly processed to achieve their effect. These have been developing where minced meat would be used (classically burgers) and finding a market (forecast to grow) among those who want the sensation of meat without it coming from animals. There are forecasts for substantial market growth in these substitutes.
- the production of proteins using cultivated cells (sometimes "cellular agriculture") is still really an emergent technology only first seriously experimented with since 2000 with its possible uses still unclear. It can involve different approaches:
  - tissue engineering in which, for example, chicken muscle could be grown by differentiating stem cells taken from a feather and put in a growth medium. Partly a development from medical engineering, this sees the more efficient production of biological meat without bones, organs and other lower value or inedible parts. The first major public experiment was again with a burger and the use of very thin cultivated tissues suitable for mince. Some are now reducing costs by using plant-based feed as nutrients for the cells rather than a bovine serum.

    Singapore has approved for consumption nuggets of cultured chicken mixed with plant protein.

    Cuts of meat are harder to replicate, requiring a structure and an attention to the feel, texture, taste and appearance of meat while the required inputs

can be expensive with the inner parts of the developing cut needing nutrients supplied and waste removed. However, the Israeli company, Aleph, now appears to have achieved proof of concept with a 5mm thick steak grown with these qualities.

- fermentation based systems which, rather than using cells from animals, make products by fermentations using yeasts, bacteria or algae (probably genetically modified) to yield such products as gelatine, casein (for milk) and collagen (for leather) with work also on products from egg white to rhinoceros horn.

Investment in this sector is now growing fast with $3.1bn reported in 2020 ($1bn in 2019) in 170 alternative protein start-ups, mostly in "meat", "eggs" and "dairy" alternatives but also in cellular technologies. With experience, technical development and scaling up, "griddle parity" for the pricing of burgers may be within two or three years with the possibility that alternatives could undercut meat thereafter. While not yet understood to be producing recognisable meat on a commercially efficient basis, this is seen to have economic potential though possibly in ways not yet foreseen.

7.7.15 If either of these approaches, bypassing concerns about animal dignity, welfare and slaughter and possibly the environment, achieve scale and market traction, they could be disruptive of the meat sector, perhaps especially in competing for supplying processed foods and catering markets.

7.7.16 It remains unclear whether such traction would, as usually discussed, displace red meat or cheaper but higher volume white meat. It might, alternatively, add to the overall scale of the "meat" market if both forms of meat prove attractive to growing populations or are used complementarily in processed products. The balance of outcomes might in part depend on how markets react to the scale at which some, especially plant-based alternatives, are highly processed with complex ingredients in their manufacture.

7.7.17 The selection of animals from which cells would be drawn might be very different from now, no longer needing to focus on qualities such as yield or growth but on points that might include meat quality, flavour or others not yet recognised. These might be qualities more consistent with the slow growing, extensive breeds or those with variable conformations that have not been favoured for conventional production. That might give a particular value to a small number of the favoured progenitor animals.

7.7.18 With such a development the current arguments over animal origins might move on to consider nutritional issues (rather than appearance and taste), with the complex nutritional qualities of meat perhaps harder to replicate but maybe easier to supplement. Such arguments might also be difficult for the highly processed plant-based meat substitutes.

7.7.19 Some speculate that these techniques might make more varied meat production possible in ways akin to cheeses, wines and craft beers. Something in that might turn on the scale at which the technologies worked economically and how effective marketing would be achieved: will the equivalent of micro-breweries be feasible alongside large food companies? Would intellectual property rights be a restriction or would this need a scale of operation and capital to produce efficiently? Is the comparison with pharmaceuticals and car making or with the opportunities for craft beers and cheeses able to operate alongside the big dairy companies and brewers? If the former, some of the debate might also lie around a wary reaction to large corporations or near monopolies – not that this has stood in way of global food and beverage companies.

7.7.20 This technology, if successful, might have the potential to open up a much wider range of meats as it could remove the practical obstacles of boniness, scale, management and so forth for meats such as rattlesnake, squirrel, crocodile or other birds and fish to be produced.

7.7.21 While there are arguments as to the relative energy requirements of these approaches and livestock (though, subject to the work such as that considered below at 7.8.5-7), beef is generally at a disadvantage in almost all current comparisons, they:

- use buildings rather than needing agriculturally suitable land and so have greater freedom as to location, subject to power supply
- are likely to use less water and pose less risk to water bodies
- have standard enclosed production techniques managing biosecurity, disease and risk.

7.7.22 The issues here might not simply be a matter of direct competition but also of destabilising carcase balance, whereby the sale of all parts of an animal make the whole carcase viable. Thus, even if a market for recognisable cuts and joints existed, higher prices might be needed for them to make animal production viable for just that market alone.

7.7.23 That then touches on the contention between grain-fed and pasture-fed production systems. While aesthetics might suggest that such alternatives could better replace grain-fed systems, that might not be how it would work with consequences for naturally grassland areas if they proved less competitive.

7.7.24 With the current concerns about issues as South American soya production and the feeding of farmed fish, some of this technical development might be as much about the feed for livestock as the meat itself.

7.7.25 Alternative Approaches to Plants? – With the low efficiency level of chlorophyll photosynthesis in converting sunlight to plant material, similar approaches are conceivable for plants, whether:

- improving that efficiency to enable better growth rates in areas with less direct sunshine as might matter if climate change drives production away from the equator
- develop cell cultivation techniques to replicate specific plant materials or, for example, grow wooden components to a particular design, concentrating on the material desired rather than diverting energy into leaves, bark and roots.

7.7.26 Insect Farming – This is being developed, again as an indoor system of farming, as a means of producing protein efficiently and reusing food waste with the current focus on black soldier flies. The main market for this is seen as an ingredient in animal feeds, asserted as a means of displacing soya (with effects in Brazil) rather than home grown feed but the resulting protein could also be used in producing processed human foods.

7.7.27 Controlled Environment Farming – On the cropping side, there is the emerging possibility of more production coming under cover, as has already been the case for mushrooms, some fruit and plant nurseries. Polytunnels have been in use for some decades but not only are large areas of glasshouses going up with a reliance on automation but there is further experimentation with various forms of controlled environment farming (sometimes "vertical farming") using enclosed and clean environments, controlled nutrients and managed shades of Light-emitting Diode (LED) lighting to stimulate fast, precise and even growth and very low microbial loads – in

essence, higher tech hydroponics. With high capital costs when done at "warehouse" scale and needing good supplies of energy and water, much current work is with salads and herbs. It may yet prove more useful for natural pharmaceuticals and cosmetics while the technologies might be adaptable to other environments.

7.7.28 At whatever scale, they could be sited much closer than most production to urban markets (one early operation used underground tunnels in south London) and could even be sited next to major retailers as a facility like an in-store bakery. At container-scale, these are already being used for self-supply by restaurants where the cost is absorbed within the overall enterprise.

7.7.29 Save for accelerated breeding, they appear less apt for conventional cereals or roots and might form part of larger production systems such as producing strawberry plugs for outdoor use.

7.8 Carbon Neutrality (Net Zero)

7.8.1 The regulatory and commercial pressures for carbon neutrality are going to intensify across the economy and seem likely to bear earlier on rural land use and farming for which it may be hard. While overall farming's emissions have tended to track activity and output, UK agriculture with static output has reduced emissions since 1990 by around 16 per cent, mostly since 2000.

7.8.2 As noted above, with supermarkets will be looking for carbon neutrality from their supply chains as part of their own branding to markets, investors and lenders. Of itself, this becomes a driver for change, investment and innovation with particular challenges for sectors, such as beef and vegetables. Morrisons, holding itself out as British farming's biggest supermarket customer, has set 2030 as the date when its British food supply is to be carbon neutral – just nine years away for "affordable net zero carbon meat, fruit and vegetables".

7.8.3 This could be seen as an exemplar of the "green recovery", making the necessary changes for future economic success by green methods. That does not though minimise the scale of what is entailed or the challenge for existing businesses with new skills, changed practices and investment.

7.8.4 Morrisons' work on this is expected to include:

- rearing different animal breeds
- using low food-mile feedstuffs
- using renewable energy
- reducing fuel and fertiliser use.

As well as offsetting emissions by improved soil health, grass/clover management, restoring peatland, trees and hedgerows.

7.8.5 Beef is seen to produce 45 per cent of greenhouse gas emissions (half from methane) for 5 per cent of farming produce sold. Morrisons envisages that this transition will see the use of smaller breeds of cattle and low methane feeds with supplements such as seaweed.

7.8.6 Much of this may build on the work done by Devenish Nutrition in conjunction with Wageningen University and Research on the farm at Lands of Dowth in the Boyne valley being used to develop techniques for low carbon beef and lamb farming. This applies precision techniques for the management and measurement of soils, nutrients,

swards, livestock and emissions to gain a greater understanding of managing natural systems to achieve carbon neutral production. The combination of applying science and farm management sees a process of measuring, managing and then measuring again.

7.8.7 For that end, the aims at Lands of Dowth include:

- soil improvement, raising the organic matter in its brown soils from 5.3 per cent to 7 to 9 per cent and raising pH levels from 5.5 in 2014 to 6.1 in 2018.
- matching nutrient applications to soils
- reducing the flow of water over the land with the associated loss of nutrients
- increased carbon sequestration, using soils and hedges/trees for on-farm sequestration so honouring the "rectification principle" for environmental policy, that if environmental damage cannot be prevented, it should be tackled at its origin
- species section of swards with red clover improving water filtration
- optimising grass use, the rising pH level reduces the need for phosphate
- extending the grazing season, with improved soil biology, some agro-forestry and aerating soils.

Devenish is also working on the livestock nutrition aspects of this with modest seaweed or algae supplements seen to reduce methane emissions from cattle.

7.8.8 The object is not only to show that and how carbon neutral grazing livestock production can be done but that it can be profitable. The report, *Delivering Our Future, Valuing Our Soils: A Sustainable Agricultural Land Management Strategy for Northern Ireland*, produced under the chairmanship of Devenish Nutrition's Dr John Gilliland, showed how much scope there is for improved grassland management to support profitable production combined with environmental gain. It requires positive interest, management and skills.

7.8.9 Some support for this transition may come from government, in England perhaps by some of the offers within ELM and Wales thought the Sustainable Farming Scheme, as well as other means.

7.9 Soils

7.9.1 While a concern with soil fertility was one of lasting legacies of an earlier age of agricultural improvement, carefully supported in tenancy agreements and practice, that has been increasingly side-lined since perhaps the 1960s with the commercial imperatives of commodity agriculture relying on machinery and purchased inputs of fertiliser and sprays to sustain production, often tightening rotations, with the effects of depleting soil organic matter and damaging soil structure but also of increasing pest and disease loads, all as problems for the future that we are now in.

7.9.2 The last handful of years has seen a renewed attention to issues with soils, especially among arable farmers. The issues equally relevant, if perhaps less obvious, to grassland farming, with the benefits of improved soil management drawn out by the report, *Delivering Our Future, Valuing Our Soils: A Sustainable Agricultural Land Management Strategy for Northern Ireland*. That is now additionally driven by the concern, just reviewed, to achieve carbon neutrality. The government has subscribed to the Paris "4 per 1000" commitment to increase soil organic matter by 0.4 per cent a year for 10 years.

7.9.3 However, the remedies required to improve soils may be seen to constrain current cropping patterns and the income hoped for from them or to promote the

establishment of grass with no economic function. Extending roots or horticultural rotations to allow soils some recovery requires consideration of the relationship between overheads and production contracts, while pests and disease may remove land from such cropping indefinitely. The cost and effort in recovering soil status over a period of years can be a substantial hurdle in preparing any plan to do so, even over say three or five years. Again and as shown above, the science of this and its practical demonstration are now advancing apace.

7.9.4 Climate change may though also extend the northern limits for some crops making them viable in new areas with clean soils.

7.9.5 With the wider concern about soil health, much focuses on the benefits of improved soil organic matter as a unifying proxy measure. Improvements in this can aid workability, germination, water holding capacity, resistance to compaction and so support increased productivity. That is likely to be accompanied by carbon sequestration, improved soil structure and a more resilient and diverse soil biome.

7.9.6 These issues feed into the discussion of regenerative farming approaches with carbon sequestration as one by-product from improved soils supporting better farming. Something in that concerns the balance to be managed between animal manures promoting soil health and them risking pollution.

7.10 Infrastructure

7.10.1 Farming needs its own infrastructure, both on and off farm.

7.10.2 Infrastructure Supporting the Farm – It is easy to point to a livestock farm's need for fencing and water and dairying's need for a parlour and housing while, more generally, much land needs underdrainage to be workable and productive. On or off the farm, storage is generally needed. Much of this physical infrastructure will now have seen some re-investment since the great wave of grant-aided building and drainage in the late 1970s and early 1980s but much will also be inadequate for current or future needs whether for housing larger animals, achieving bio-security, providing sufficient slurry storage and water separation or accommodating the technology and energy efficiency that will be sought. In less stable soils, regular re-investment in underdrainage may now be needed.

7.10.3 Beyond the farm, skills and supporting facilities are needed. As well as skills among those on the farm in the enterprises pursued and the machinery used, arable farming relies on agronomists, livestock farming on large animal vets and both on machinery engineers. Beyond that are buying groups, livestock markets and slaughterhouses.

7.10.4 Infrastructure off the Farm – Higher value produce in particular can benefit from proximity to processing plants whether Bird's Eye freezers or wineries. The large food processing operations within reach of the Fens support an entire ecosystem of food businesses that in turn aid continued production in that area.

7.10.5 Where that infrastructure has been lost, that is an impediment to re-establishing the uses it supported. An easy example is the consolidation of sugar beet as British Sugar closed its factories in the west midlands and York. It is more generally the case where the skills, fencing, water, large animal vets and the support trades for livestock management have disappeared from what have become purely arable areas, posing an obstacle to any significant revival of farmed animals in those areas.

7.10.6 Housing – A related point for managing structural change concerns housing, typically harder to solve in open countryside. Often given, genuinely or not, as a reason for a farmer not retiring, it might often actually be an issue for a new entrant farmer taking land when the retiring farmer wishes to remain living where he always has. Planning policies in both England and Wales recognise the case for new housing where it will enable such change (Paragraph 79 of the English National Planning Policy Framework (NPPF) is possibly little used; Wales' Technical Advice Note 6 – Planning for Sustainable Rural Communities (TAN6) is more used than anecdote suggests) while England and, now, Scotland have permitted development rights for the conversion of farm buildings into dwellings.

7.10.7 These issues and potential approaches are discussed more fully in *Retirement Housing for Farmers in the United Kingdom: A Review of the Issues, Experiences and Possible Answers*, available on the CAAV website.

7.11 Other On-Farm Activities

7.11.1 While DEFRA surveys point to a high fraction of farms having other on-farm income, described as diversification, inspection suggests most is essentially letting for storage and relatively little is entrepreneurial. Cottage lettings, renewable energy lettings and, for the time being at least, telecoms masts provide other property income. More active income earning may be from offering farm contracting services, whether as a genuinely commercial service or a minor and perhaps under-priced extra. Bed and breakfast accommodation and then holiday lets were developing in livestock-based tourist areas in the 1960s but are less seen, even now, in many arable districts. Many horse enterprises provide low returns.

7.11.2 That said, a range of genuine and positive added value or additional activities exist from butchery and cheese making to wedding venues and farm shops. Usually, the goal is to strengthen income but it might also be to create or protect capital value. These initiatives typically call on new skills (often from other members of the family), management and capital as well as reversing the decades old tide of specialisation and so risking distraction from the core business. That is a basic and initial matter for choice but a badly managed farm business may be no basis from which to expect good management of a new business. Earning money off-farm (whether moving to part-time farming or not) may even remove any incentive in the new pressures to improve the farm business.

7.11.3 Even where there are on-farm resources to do this well, opportunity may also depend on location. That might lie in accessibility to a paying public, the acceptability of proposals to the planners, the availability of good broadband or other constraints. Almost inevitably and possibly tautologously the largest supply of commercially valuable opportunities are likely to be nearer major population centres. However, and as elsewhere, the real constraint is having the people with the will, skill and ability to make the change.

7.12 Support Policy

7.12.1 Changes in subsidy policy, with the phased removal of Basic Payment first in England and then the proposed move away from it in Wales, are the most obvious post-Brexit drivers for change.

7.12.2 The CAP initially supported production by intervention prices, largely targeting cereals and beef with further policies for milk and sheep. The strong support for cereals farming as the UK was phased into the CAP in the 1970s saw farmers concentrate on it, giving up beef so releasing capital and labour, but not always doing so as skilled arable

farmers. With the MacSharry reforms, the CAP moved in 1993 to area constrained policies for arable and livestock payments that were converted to the Single Payment, even more expressly a payment for occupying qualifying land, in 2005 and carried forward with changes as the Basic Payment from 2015.

7.12.3 Now, in England, that Basic Payment is first eroded in 2021, with progressive reductions thereafter seeing it at least halved by 2024 when its link to occupying land will be broken (after an earlier limited option in 2022 for some to take the remaining payments as a lump sum). The last payments will be made for 2027. The money is to be redeployed largely to a "public money for public goods" policy largely focused on Environmental Land Management (ELM) with the Sustainable Farming Incentive, Local Nature Recovery and Landscape Recovery schemes but also animal welfare and other goals as well as supporting productivity improvement. However it might be priced, a current matter of debate, ELM will not offer anything like the margin offered by Basic Payment and requires contractual commitments by the agreement holder to changing farming practices, if not land use.

7.12.4 Wales looks set to offer a similar path a little later, perhaps from 2024 with a move to replace Basic Payment with the Sustainable Farming Scheme (SFS), again a "something for something" policy of contracts for land management change, here intended to be priced to be attractive for outcomes expected, as well as support for economic resilience. With its agriculture overwhelmingly based on livestock, this will have a large impact on many businesses.

7.12.5 In England, the Basic Payment supplements sales from the average grazing livestock farm by 34 per cent and the average cereals farm by 22 per cent. It has remained the corn and beef policy that was originally at the heart of the CAP with the UK's additional interest in sheep. It supplements sales from the average dairying and general cropping farms by 6 or 7 per cent and gives barely anything to pigs, poultry or horticulture. As a payment for occupying land, it has rewarded that occupation for broadacre farming across larger areas of land when it has then formed a significant fraction of profits, indeed for some more than their profit. As the CAAV's Agricultural Land Occupation Surveys suggest, it has encouraged those claimants to stay in situ as the way to obtain this money and so enabled the retention of businesses structures and enterprises that might otherwise have changed.

7.12.6 At the same time, the Basic Payment has, as with previous subsidies, tended to be passed on to suppliers in costs. Thus, while, on a snapshot assessment, subsidies might typically form three quarters of Total Income From Farming (TIFF, akin to profit rather than gross income), much of that may in practice have led to costs that would now have to be wrung out of the system, whether by greater efficiency, enterprise change or structural change. Farming history is that necessity is the mother of such achievement.

7.12.7 The withdrawal of Basic Payment is a powerful economic tool for change but it does not dictate what that change might be or the balance between those who absorb the pain (whether or not taking an off-farm income to insulate themselves from it) and stay as they are to those who make positive changes to their business. In short, it may be a necessary condition for a better agriculture but it is not a sufficient condition for that important goal of productivity improvement. The crucial question is to enable the right people to have access to the land that they need.

7.12.8 ELM and SFS may or may not prove to encourage farmers to sell public goods to receive public money. As well depending on the terms and pricing, the analysis above

might simply be taken to point to these being more likely to be of greater more interest to grazing livestock and cereals farmers than other sectors and, in that, to those who are below the top quartile of performance. In practice and with the already higher take up of agri-environment agreements by grazing livestock businesses and the issues of additionality noted below, average to poorer arable famers may have cause to tend to be more interested than many others.

7.12.9 FBS and DEFRA analysis combine to point to the current position with:

- grazing livestock, especially in the LFAs, already securing markedly higher agri-environment payments and that these may be priced so that, on the whole, they do more than compensate for income foregone or losses incurred
- cereals farmers having much lower agri-environment receipts which are thought to do little more than compensate for the costs involved
- the schemes being found to offer little to dairy farmers.

7.12.10 It is suggested that the pressure from BPS withdrawal on average to poor cereals farms has been under-recognised. Potential markers for this could be those areas that:

- were more heavily committed to arable set-aside when that was an option, briefly in the late 1980s at 100 per cent of the arable area, then capped to 50 per cent
- have moved in recent decades from dairying to cereals, often on unsuitable land
- dropped out of arable between 1875 and 1940.

7.12.11 In 1988, before the MacSharry/"IACS" regime required set-aside, the EU required member states to offer farmers the voluntary option to set at least 20 per cent of their "arable" land (as at 1986/87 with vegetables but excluding potatoes and fodder crops) aside for five years with payments of up to £200/ha (slightly less in the LFAs). It was initially possible to put their whole arable area into this set-aside scheme. The land was to be maintained as fallow with a green cover crop, could be put to woodland or used for non-agricultural purposes but not used for livestock or feed. A production control measure (in apparent conflict with the then intervention support), this was at time of deteriorating cereals economics. In the first year, some 2,000 UK farmers entered with a third setting all their eligible land aside, most as permanent fallow, though this might often have been smaller areas on small mixed farms.

7.12.12 Once account is taken of the number of farms and arable area in each county, a review of the *Adoption of the Arable Set-aside Scheme in England* (Brian Ilberry, *Geography*, January 1990) found that the counties with disproportionately high commitments to set-aside in the first year of that scheme were Bedfordshire, Berkshire, Buckinghamshire, Hertfordshire, Oxfordshire, Northamptonshire, Suffolk and West Sussex with a more south-westerly centre of gravity in central southern England than that for arable farming overall and a bias to more urbanised or peri-urban counties. Other analysis withdrew Suffolk from that list and added Surrey with extensions into Wiltshire and Northamptonshire. At the time, the impression was of a heavy commitment to set-aside across a central belt of the Cotswolds.

7.12.13 A further view on this issue is that on the location of set-aside in England in 2004 as summarised by the *Environmental Monitoring Baseline Project OBS1* report of October 2006 issued as part of the Agricultural Change and Environment Observatory Programme. It uses the probably more relevant analytical unit of Landscape Character Areas rather than counties. The wheat price was again low and 2004's compulsory rate of set-aside was 5 per cent. That report shows that more than 11 per cent of the land area was in set-aside in these Landscape Character Areas:

- the Thames Basin Heaths, running from Woking to Newbury
- the Chilterns
- Rockingham Forest
- Kesteven Uplands, between Stamford and Grantham

while between 8 and 11 per cent of the land area was in set-aside in these areas

- the Low Weald, a horseshoe shaped area from north of Eastbourne to Haslemere and back to Ashford
- a large block of south central England from Wiltshire and the Cotswolds running to Essex and Northamptonshire, then with a northern extension through the centre of Suffolk and Norfolk and another larger northern extension through Nottinghamshire and inland Lincolnshire to the Southern Magnesian Limestone, a narrow belt from Bolsover to Ripon.
- the Vale of Pickering and Howardian Hills
- the Durham Magnesian Plateau and the South East Northumberland Plain.

This is only one snapshot and is potentially complicated by the use of some set-aide for non-agricultural crops but the comparison with the low compulsory 5 per cent base appears to give it relevance in looking for the areas of greatest arable stress on the withdrawal of Basic Payment.

7.12.14 However, its illustrative use can be suggested by the contrast with core arable areas where set-aside in 2004 was less than 5 per cent of the land area, such as the Fens and east Yorkshire (the Holderness land character area).

7.12.15 Permanent (Over 5 Years) Pasture – A perhaps minor feature of the end of greening in England is that there might no longer be the sense, widespread with scheme rules since 2005, of five continuous years in grass marking a potentially significant change in the status of that land, possibly removing a disincentive to land being in grass for longer. This is a distinct issue from the rules for Environmental Impact Assessments.

7.12.16 What Might Changes in Support Policy Achieve for Land Use? – England's Agricultural Transition Plan talks more generically of the policy principles to be achieved by 2028 when farmers are to be

- "running sustainable businesses that do not need to rely on public subsidy
- managing their whole business in a way that delivers profitable food production and the recovery of nature, fusing the best modern technology available today with the rediscovery of the traditional art of good farm husbandry
- able to access public money to help them deliver environmental and animal welfare outcomes on the land they manage and to help their businesses become more productive and sustainable
- meeting clear, relevant and outcome-focused legal standards that champion UK food internationally, prevent environmental harm, protect biosecurity and protect animal welfare."

However, the Agriculture (Wales) White Paper does venture more of a future retrospect for land use as the outcome of its proposals, expecting them to "result in some visible changes at landscape scale in Wales" which would include:

- increased woodland cover
- an increase in arable and horticultural production
- increased farm and landscape-scale habitat resilience
- changes in how agriculture operates with shorter supply chains, a new emphasis on localism and better data management
- a reduced carbon footprint
- improved public health with better air and water quality.

7.13 Self Knowledge

7.13.1 So far as the pressures for change are economic, much turns on those making the decisions having an accurate understanding of the economics of their own positions and of their costs as they are if not the possible costs and benefits of change. In particular, that knowledge of costs and alternative incomes will help make informed decisions about options such as those to be offered under Environmental Land Management and equivalent public and private schemes, especially where they prompt significant change in land use. In valuation standards terms, the farmer or owner needs to have a confident knowledge of the worth of the current uses to be able to judge the acceptability of the offered transaction prices for any new use. The need is to determine whether the suggested new use is actually advantageous when compared to the present position or other alternatives.

7.13.2 All too often, costs that are not directly seen in cash flow are overlooked or underrated. Depreciation of machinery is less evident than fuel costs until there is a need to replace machinery. The full value of the farmer's own labour is rarely priced. This can lead to over-optimistic pricing of tenders for contracting and tenancy opportunities, especially where the argument about spreading fixed costs to reduce unit costs has been over-bought.

7.13.3 Dairying with the long legacy of National Milk Records and costings may often be most aware of these issues, now probably joined by the close attention to management detail required by pigs and poultry. However, they are all too often overlooked in other sectors which may understand costs and income at the margin but not apply general overheads when making decisions.

7.13.4 The level of awareness of costs will play a significant part in how farmers react to new possible opportunities from the contracts offered by new environmental land management schemes to reappraising their land base. If there is extensive under-pricing, parts of the sector will be set back for years having again transferred value to those whom they supply.

7.13.5 A larger part of self knowledge is having a perspective on the outside world, whether:

- taking time off the farm to look at the problems of others and the solutions they have found, discussing issues in ways that help make considering matters at home more manageable
- the larger economic dynamics around agriculture, including those reviewed in this paper, with realism about its place in the rural and national economies and the direction of policy travel.

7.14 Natural Capital and Decision Making

7.14.1 There has been much discussion of the concept of natural capital, essentially a story about the environment that compares it to a balance sheet of all natural things, with assets and liabilities, and an encouragement to increase the total value rather than run it down. This has recently been relatively clearly expressed in the Dasgupta Report, commissioned by Treasury, recognising that the depletion of nature has been an unrecognised cost to the economy with:

- the simple point that the sale of timber from the Amazon would be seen as income but the associated loss of rain forest would not ordinarily be accounted as a cost
- the larger point that natural systems, from the soil biome to the Gulf Stream, underpin the economy help it function and give it resilience and so their depletion is a long run cost and should require replenishment – a point illustrated by the discussion above of soils.

The cost of that previously unaccounted replenishment lowers the resulting rates of return.

7.14.2 A recent review of case studies comparing the value of services provided by sites with conservation measures outweigh those provided by pre-conservation uses (so including intertidal habitat compared to agricultural use of the site) concluded, with slightly awkward phrasing, that:

> "we have typically passed the point where the benefits of further change from nature towards human-modified uses exceed the costs to society". (*The Economic Consequences of Conserving or Restoring Sites for Nature*, Bradbury et al, Nature Sustainability, 2021)

While that shifting balance was likely to favour higher value production and be adverse for lower value production, the benefits generally lay in reversing that process.

7.14.3 One resulting challenge has then been to find the tools to help turn such judgements into actions and change. In the United Kingdom, much has been done by the Government's Natural Capital Committee.

7.14.4 Natural Capital – Natural capital, a phrase apparently coined in EF Schumacher's 1973 book, *Small is Beautiful,* and then variously adopted for further and wider use, tends to be used as a loose metaphor to offer one of several attempts to put prices on environmental damage that is not otherwise recognised by the market place ("externalities") and so do not weigh economically in influencing decision making by those causing the damage, save where the matter is covered by regulation or good conscience. With economics as the study of allocating scarce resources, this applies economic tools to environmental choices in making decisions about interventions.

7.14.5 A natural capital approach would look at the environmental assets and problems of a farm and consider how they might be improved, with a view taken as to the potential relative benefit of each action. There are then structures of arguments as to various methods to deduce a value, expressed in monetary terms, for each action, probably one to be judged against others, that gives a measure of the worth of the change in question to the buyer, often but not necessarily the state acting for society. That assists choices between different options with different costs but also frames the discussion with the potential seller, here the owner or farmer. However, a common weakness is that the derivation of some values can be by fairly remote and tortured means, sometimes producing very high values with enormous sensitivity to changes in assumptions.

7.14.6 In simple terms, if one option for change is found to have a value of £500,000 and another of £250,000:

- if they can each be bought for £50,000 of real money, the first option would usually be taken first with less valuable option (if still possible, only taken if there were more money available
- if they both cost £300,000, the second option would not be taken and there might be closer scrutiny of whether the first had been accurately assessed enough for it still to offer value for money

This illustrates how it can offer a basis for decision making by those wanting that change as it identifies relative values between options, even if no one value is likely to have objective reality in itself. It also illustrates the importance of the potential seller of that change understanding the approach as well as the potential buyer might. A potential seller used to being paid, say £10,000 under an agri-environment agreement as compensation for an equivalent agreement might not imagine that £50,000 was feasible.

7.14.7 While that applies the concept to transactions to deliver outcomes, natural capital assessments can be used presentationally where a case is being made that an organisation or activity offers (or can offer) a wider societal benefit than its financial accounts would show. While less discussed, it could, contrariwise, be used to discuss relative harms.

7.14.8 Payments for Ecosystems Services – A related structure of argument, often loosely jumbled together with it, discusses the slightly older 1960s concept of payments for ecosystem services (PES) which can recognise those supplies or potential supplies already rewarded wholly or partly in the market place (such as food or timber) as well as those like clean air and clean water that are not. Analogies can then be drawn for other topics such as animal welfare. Similar approaches can again be applied to identify relative values.

7.14.9 Rural Land Management – That bears on rural land management in a number of possible ways, including:

- where environmental enhancement is a management objective for the farmer or owner when a closer understanding of the way in which it works will be needed in order to make better rather than worse decisions.
- the way it might shape proposals (and potentially pricing) for changed land use put to the owner or farmer under public schemes (such as Environmental Land Management or the Welsh Sustainable Farming Scheme) or by private companies or independent environmental bodies.

That latter point will overlap with the need to understand the official metrics for biodiversity gain when discussing an agreement over land for that.

7.14.10 This then is one of the many reasons why that owner or farmer of rural land needs to have an accurate knowledge of costs and opportunities to establish the worth to the body or person wanting change of the change proposed. The scope for a transaction lies between the buyer's sense of worth and the seller's sense of worth, provided the former is higher than the latter. This can ensure that any transaction can then be one that gives value to both parties, not disadvantaging the farmer or owner and without the buyer overpaying. It can be applied in the spirit of bringing the market with its voluntary potential for innovation and experiment to environmental goods and so can weave these issues more effectively into decision making over rural land with the resulting dynamics of price signals to influence future actions.

7.14.11 Additionality – This has so far essentially been a perhaps simple discussion about the value of change, whether the benefit of improvement or the cost of harm. It becomes a little more complex in the real world with its tensions and constraints. For public policy (and, indeed, private spending), the concept of additionality is central to this, that in principle payment should only be made to achieve something better than now exists – consistent with the notion of a "something for something" policy. A purchaser will not ordinarily pay to create something that already exists.

7.14.12 Public policy may though find it has to recognise the value of maintaining an existing natural asset lest it be destroyed or allowed to decay, perhaps of an application for its recreation.

7.14.13 One answer to aspects of that is that nothing would be paid where a point of land management is required by law, as with England's proposed regulatory baseline and Wales' national minimum standards.

7.14.14 That recognised, maintaining land to a higher standard might give access to a lower rate of payment than would be given for its creation, but enough to support the appreciation of its value for retention.

7.14.15 A more difficult area is where an agreement to achieve one improvement brings other improvements with it which are secured by the primary agreement but perhaps not paid for by it. A strict view of additionality would mean that those other benefits would not then be bought by anyone else. To illustrate this point, a biodiversity gain agreement with a developer might not only achieve biodiversity but other associated gains in, say, water quality and carbon sequestration. The present legislation would give the developer no interest in buying those benefits but they might not be separable from the biodiversity gain actions that have been bought. It might, though, be possible to enter into a separate agreement with payment to offer public access where this was not in conflict with the intended biodiversity gain.

7.14.16 To put that more sharply and with saying that nothing can be done, what more benefits might be additionally possible from some areas of the uplands to warrant increasing the already high levels of environmental payments that are on average made there? Their qualities already exist in many cases and the possession of significant natural capital is not necessarily a ground for payment when improving it is. Peatland restoration is one answer with its potential to limit carbon emissions. Some scrub regeneration or tree planting might in some places assist with the attenuation of high water flows. Uplands farmers will, though, often be anxious about the balance of their out-bye and their in-bye land, commonly close to water courses.

7.14.17 In contrast, there might be substantial additional natural value to be achieved from some areas of marginal arable land because they will start from a low base for these assessments while their farming economics may not be so dissimilar to many in the uplands.

7.14.18 In either case, the first driver will what a buyer wants to purchase, more than what a seller wants to offer. The market will settle whether and where the two come to agree. Farmers who have farming value in their grazed (and perhaps hard won) pastures and also see potential carbon sequestration value in them might be reluctant to agree to convert that land to trees or re-wetting, even before considering the possible inflexibilities those options bring.

What changes might the constellations of forces reviewed in this section drive?

8. Initial Thoughts on Future Changes in Land Use

8.1 Overview

8.1.1 There appear to be a number of basic themes that can be seen with neither denying the obvious nor simply projecting trends forward in a time of change.

8.1.2 If the present policy proposals or suggestions for house building, woodland, solar energy and re-wetting land reviewed below were fully realised by 2030, that could be between 2 and 3 million ha of land put to those uses in the coming decade (albeit that re-wetting is not necessarily seeing land leave agriculture). The discussion (as in the March 2021 Budget as well as others noted above) of bio-energy crops such as miscanthus and short rotation coppice appear to be in addition to this ambition.

8.1.3 Those though overlie larger pressures and changes on both the demand for and supply of rural land for its varying uses. That particularly but not solely includes what agriculture will produce and how it will do that as circumstances, markets and technologies change within a crowded island.

8.1.4 Change may be driven by long run pressures continuing to apply but also where existing patterns of and relationships factors change. While prices of commodities have generally moved downwards in real terms over time, forestry products have been on a new upward course in recent years in response to changing markets. Changes in labour availability or developments in technology might close or open opportunities. The changing balance between population and food production has seen the UK as a net gain exporter before the Roman Conquest and in parts of the eighteenth century but a major importer in the late nineteenth century when developments in shipping enabled the UK to import grain and refrigerated meat from the Americas, exposing domestic markets to new competition. Now, it might be the money and the markets emerging for environmental goods or those created as a price for carbon becomes more obvious in the economy that trigger new changes.

8.1.5 Deeper than that are the basic constraints of our climate and varied geologies, all resolved by the decisions of individuals in their circumstances. These are the pressures that have made and remade the British Isles while occupied by man since the Ice Ages.

8.1.6 While we may sense we are facing a step change, a generation's change in a decade, this will not be a single change of state but a move into the restless waters of continuing change that are mediated by markets. There will not be a single synthesis but a new kaleidoscope pattern with its own unresolved tensions, new opportunities and new challenges. If we manage this well, we should be better placed to face that.

8.2 Urban Uses

8.2.1 The obvious point is further urbanisation, especially in the greater south east of Britain (now including much of East Anglia) with a particular stress on the Oxford Cambridge Arc. That is potentially increased by the greater commuting range that may be associated with any growth in part-time attendance at urban offices after the pandemic. Were the 300,000 houses a year target to be met over a decade that would be 3 million houses. While some of this might now be met by conversion of current retail space, even assuming 5 to an acre overall, that would be 600,000 acres in a decade before considering all the other uses for employment, leisure and so forth that would go with that. The Office for National Statistics (ONS) population forecasts suggest no remission in this pressure for the foreseeable future.

8.2.2 Excluding protected landscapes, sensitive habits (including those newly made so by the various prospective policies) and flood risk land while ensuring water resources will constrain where this development can be.

8.3 Woodland and Forestry

8.3.1 For political rhetoric, tree planting has to some extent become a simple proxy for being green. With the Climate Change Committee urging an increase from the as yet unmet target of 30,000 ha of planting a year to 40,000 ha in the 2030s, the area of woodland seems set to continue to grow, if not by those figures. That might still essentially be in the uplands and predominantly in Scotland and Wales. With the history of woodland turning on its economic function in competition with other land uses, the mystery remains as to what will be the commercial drivers for revived lowland woodland. Specific public interventions may achieve something in England but it is assumed that anything resembling current land values will generally preclude the purchases to enable the large scale transfers of ownership that seem required for this to be significant.

8.3.2 Something of a model may be offered by the New National Forest, a major endeavour of the 1990s in a post-mining and industrial but also farming area across parts of Leicestershire, Derbyshire and Staffordshire with varied concerns from economic stimulus to landscape improvement and biodiversity. The intention was to create a landscape mosaic framed by the new woodlands. Landowners bid competitively for funds for the capital costs of fencing and planting, facilities for public benefit or new business generation, planning and building work as well as maintenance and an inducement to plant (perhaps something for a reduction in land values). It required both a business plan and a woodland management plan. Planting choice depended on soil type but some schemes included poplar for short rotations.

8.3.3 Looking back now from 2020, some agreements in this project have been successful in transforming declining farms and have delivered structural change within the family and business while it has changed a partially despoiled landscape, created jobs and provided huge areas for public access. However, there have also been many who took the money and planted trees but have not then managed the new woodlands with vermin spoiling the potential timber value and disease a problem. At the end of some contracts, permissive public access has been withdrawn and poorly run attempts at diversification have closed. Little of the planting was with the final crop in mind, just the initial payment terms. An essential deficiency was the simple point that farmers are not foresters and do not readily make the shift of mindset from annual cropping or the life of dairy cow to production over a lifetime.

8.3.4 That experience appears consistent with the larger view that a significant shift of land to forestry will depend on changing landownership (or follow the end of a tenancy). Such a scale of change of ownership required for the scale of the official ambition was seen with the sale of estates in the years just before the First World War, after a generation of agricultural depression. While continuing estates, tending to have longer time horizons and greater scale, can more readily consider forestry, many of those where it is relevant will already have done so and so typically have reasons not to move much more land that way in their portfolios.

8.3.5 A conflict is increasingly seen in planting on peat soils, once a major part of planting land but now contrary to peatland restoration as carbon is released by planting. As that comes to bear on decisions, so new land would have to be found even for current

levels of tree planting. More generally, the larger reviews of carbon sequestration and biodiversity now see natural regeneration having a major advantage over formal planting.

8.3.6 New research reviewing past studies by Stanford University (*A Trade-Off between Plant and Soil Carbon Storage under Elevated CO_2,* Terrer et al, Nature, 24th March 2021) indicates a further tension between plant biomass (such as trees) and soil carbon with plants mining the soil carbon and not conserving it when decaying. Observing that "when a plant dies some of the carbon that is accumulated in its biomass may return to the atmosphere", the study moves the emphasis back to soils with the report's authors saying:

> "Soils store more carbon worldwide than is contained in all plant biomass. They need much more attention as we project the fate of forests and grasslands to the changing atmosphere"

and regarding natural grasslands

> "Our results suggest these grassy ecosystems with very few trees are also important for storing carbon in soil." (*Stanford News,* 24th March 2021)

8.3.7 Even with conversion to forestry, would this be to produce anything more than woodchip as a commodity? However, the alternatives to that are not clear when it has long been conventional to import high quality construction timber from countries with well-established traditions in producing it. Even if they are adversely affected by climate change, pursuing a quality forestry programme with consistency over several generations runs counter to much of the history of British woodland and land use while we can only guess as to the quality markets beyond the foreseeable future. However, there is currently more talk of using timber, perhaps more often in laminated beams, for construction which would further conserve the embedded carbon after the trees were felled.

8.3.8 Although the political interest appears simply to be in more trees, little has been said about what might be the right trees where. What might be the positive commercial motive for an owner to establish woodland and for what markets, when it might prove illegal or expensive to remove it, so closing off future alternative uses, whether known or as yet unknown?

8.3.9 While apparently (and with the November 2021 COP26 meeting ahead in Glasgow) addressed more to a global audience than to the UK, the recent report by the Royal Botanic Gardens Kew and Botanic Gardens Conservation International set out ten rules for restoring forests on the "right trees, right place" principle:

- protect existing forests first, being major carbon sinks in their own right
- put local people at the heart of tree planting projects, as this tends to improve outcomes
- maximise biodiversity to meet multiple goals, again better done by existing forests
- select the right area for reforestation, usually previously forested land
- use natural forest regrowth where possible, more efficient and cheaper than planting while capturing more carbon
- where planting, select the right trees that can maximise biodiversity, with a mix of species
- make sure the trees are resilient to future change, particularly noting wider genetic diversity
- plan ahead, to ensure infrastructure, seed supply, etc
- learn by doing

– make it pay, the income streams generated (including from carbon) need to exceed those from alternative land uses.

8.3.10 With its simple, if consequential, remit of reducing net emissions, the Climate Change Committee's Land Use report of January 2020 did observe that:

> "policy should also reflect the need to make sure the right changes happen in the right places, particularly the planting of trees that are suitable for the current and future climate in specific areas."

8.3.11 The climate change and indeed the more general economic forecasts assume that good forestry practice is successfully sustained over the life of the plantation but, while recent decades have seen that emphasis on increasing the woodland area, much less has been done to prompt the proper management of much existing woodland. More generally, the January 2021 report of the Taskforce on Scaling Voluntary Carbon Markets observes that a half or three quarters of potential carbon offsetting could be lost by "mobilisation challenges", implementation failures and subsequent events. While UK projects might be thought to be typically much better than this, they are also likely to be more costly.

8.3.12 However, it is still the case that the once-farmed lands of New England reverted to natural woodland as a default option when agriculture moved west. That typically occurs where there is a local collapse of population and economic activity as:

– is happening in parts of rural France
– has seen the expansion of Estonia's forests from 21 per cent of its land area in 1920 to 54 per cent in 2010, largely by natural regeneration
– followed the successive wartime mass deportations by first the Germans and then the Russians from Poland's Białowieża forest area
– on the land around Chernobyl.

A much more densely populated Britain may not be the place where so much land will lapse out of use, though the remains of Welsh hill farm steadings and stray apple trees under Coed y Brenin and other forestry offers a precedent in the UK.

8.3.13 A recent modelling exercise for Wales points to some transfer of land use from pasture to woodland, particularly broadleaved woodland and perhaps as much by natural regeneration (perhaps silent abandonment) as planting:

> "It is likely that rural areas of Wales, especially in the uplands, will face land abandonment and the return of natural ecosystems. Among the many drivers, socio-economic factors and public policies are known to drive land abandonment. Evidence from Europe shows that abandoned land is rapidly re-colonised by trees, initiating a cascade of effects such as the loss of cultural landscapes or the loss of biodiversity associated with open landscapes. In Wales, the land no longer exposed to grazing pressure is likely to be reseeded by a variety of native broadleaf tree species, with a contribution of non-native trees currently grown in Wales. Just as elsewhere in Europe, lowering the economic viability of agriculture thus has the potential to enact a swift and profound alteration of the landscape towards natural ecosystems." (*The Return of Wooded Landscapes in Wales: An Exploration of Possible Post-Brexit Futures,* Manzoor, Griffiths, Rose and Lukac, Land, 2021)"

8.3.14 Wooded pastures, now attracting some interest, are an unstable use that, outside the New Forest, has been in retreat with woodland regrowth in tension with grazing pressure, now compounded by large deer populations in much of the country, and hostile to woodland flora.

8.4 Renewable Energy

8.4.1 The transfer of farmland to solar farms seems a trend set to continue, even if there is now less impetus behind the onshore wind that is more compatible with continued agricultural production. The Solar Trade Association has estimated that 10,000MW of capacity would use 0.1 per cent of the UK's agricultural land area, probably understating the actual impact if that includes the Highlands). The installed capacity in 2019 13,000MW, thought to produce 4 per cent of UK electricity against a target of 15 per cent.

8.4.2 As the currently projected solar farms are now for much larger areas, some moving above 1,000 acres, with ancillary provision for time-shifting and balancing the power generated, these are now even more likely to be developed by other businesses. They usually lease, rather than buy, the land, making a change in its use for perhaps 40 years or more.

8.4.3 Renewable energy is reported as the largest category of carbon offsetting projects in terms of millions of tonnes of carbon dioxide equivalent with, globally, a lower cost per tonne than the other main category of forestry and land use (Ecosystem Marketplace, *State of the Voluntary Carbon Markets 2020*).

8.4.4 Miscanthus and short rotation coppice (recognised to qualify for Agricultural Property Relief (APR)) were seen as a way for husbandry techniques to provide bio-mass for energy, now more done by straw and maize, albeit with questioning in some quarters of the case for growing crops solely for this use.

8.5 "Re-Wetting"

8.5.1 This, also mentioned below, is specifically picked up here with the December 2020 proposal by the Climate Change Committee that 20 per cent of lowland peatland (it actually says "cropland" but this seems better read as a typo) be "re-wet" by 2035, because of scale and focus of that call.

8.5.2 As peatland is where it is, this would obviously be a geographically focussed change, but one that is not only for the Fens as peat soils occur in other fenland areas and in pockets across the country such as near Newport in Shropshire and Abingdon in Oxfordshire. There is already the Great Fen project south of Peterborough seeking major peatland restoration over 14 square miles of land, including some surviving wet fens, going beyond this policy and either the aims of supporting fenland biodiversity and reducing the loss of peat, carbon emissions and flood risk for neighbouring settlements. Significant re-wetting is likely to have wider, if not landscape scale effects, in the most affected areas given the difficulty of not affecting neighbours.

8.5.3 While not flooding, it may limit such land for sustained arable cropping but could be compatible with spring crops or stimulate options little in use now for paludiculture, such as a revival of reed cultivation or essentially new options such as water buffalo. This might allow blueberries or, subject to a market, sphagnum moss.

8.5.4 Nonetheless, this seems likely to bear on values in the areas affected unless there are countervailing factors.

8.6 Agriculture

8.6.1 Where Now? – Allowing for those external pressures, agriculture is the current and default use and so the dynamics return to farming decisions, especially farming is often an identity driven activity in which established business are inclined to see through immediate economic adversity.

8.6.2 With the five broad options for developments in respect of currently farmed land seen as:

- focused commercial commodity farmers increasingly based only on land that suits them individually
- businesses built on land and farming but finding ways to do so with more value
- more food production under cover
- land management by using more extensive agricultural means in conjunction with other income streams
- more directly environmental land management by other means.

it is speculated that:

- real agricultural activity by value might diverge further between:
  - high value intensive uses increasingly within or reliant on buildings
  - the extensive and low value broadacre uses, most of which become more extensive
- in between, dairy and field scale vegetables sitting closer to the former, might also expand
- the cropped area falls with that reduction geographically concentrated, releasing land for other uses
- there is downward pressure on grazing livestock numbers, either grazing more extensively or releasing land
- non-commodity activity focuses on differentiation and adding value.

8.6.3 Behind all these changes, and with the ability of farming businesses to endure, lies the crucial question for the productivity gains needed to make farming competitive: who is farming the land?

8.6.4 Arable Land – In combineable cropping that might see:

- something above 30 per cent of current farmers as able, if they wish, to be viable commodity farmers and who will look to have the land that supports them in that. These would be primarily concentrated in core arable areas and may be one of the earlier ways in which land occupation changes.
- the remainder looking at land management usually with agriculture, often still arable, playing a role in that with options including winning other income from the assets and resources of the farm and business. That may raise particular issues for tenants.

8.6.5 It is possible that maize may come under further pressure for both the soil run-off from bare land associated with it and the acceptability of its production as feedstock for AD plants.

8.6.6 One underlying question is what happens to the land that is released by such an outcome on currently arable land.

8.6.7 The options include:

- grass – but what economic use could that grass have?
  - short of serious expansion of export markets (requiring much improved productivity from this sector), it is not clear that there is a market for additional meat production – the recent falls in cattle and sheep numbers seem to confirm that – while if production comes to these areas it will be by drawing it down from the hills. The January 2020 Climate Change Committee report considered its recommendations (reviewed above) would, as offset by population growth, see a further 10 per cent reduction in cattle and sheep numbers.
  - land use in Surrey shows that horse uses can take up land but perhaps not to this extent for sufficient value
  - grass could be grown for use in AD plants but it is not the highest value source of energy and there are pollution and transport cautions about AD plants.
- an increase in horticulture, fruit and vegetables with the perception that public demand could grow while there will now be more trade friction. In reappraising its potential land uses, Wales has identified more arable and horticultural land than it had expected, much in small areas. Aside from labour constraints and indoor techniques, how might such a growth be achieved, whether by existing businesses spreading to new areas or new start-ups? In both the Vale of Evesham and the Lea Valley, small horticultural units offered an entry to farming for post-War refugees and others from Poland, Italy, Cyprus and elsewhere. Yorkshire's rhubarb triangle shows another enterprise in an area where liquorice was once grown. There is a green argument that small intensively managed units can achieve a higher output per acre than conventional farming but this faces the problems of scaling up to achieve an income to keep a family and reinvest. Direct retail sales can give benefits outweighing the production inefficiencies of small volumes but scaling up remains an issue.
- by extension, flowers might also have a larger place in this with climate change and any border friction for incoming produce from the Dutch markets. In addition to the established production areas such as Spalding and Cornwall, there has been a growth in quality flower production for direct sale, both fresh and dried, but these often take only limited areas of land. Alongside that there are now a number of lavender farms. Labour may be too critical a constraint.
- new crops whether made possible by:
  - climate change, as is at least partly the case for vineyards
  - by new markets, as perhaps plants grown for their ability to make plastics with the potential problems of achieving a large enough volume of material to sustain a substantial market or to be more than a marginal contribution and the ability to produce a more uniform product synthetically.

  The story of miscanthus illustrates the problems in establishing a substantially different crop. It was principally intended to be feedstock for power generation source and faced the "chicken and egg" issue of the investors in the power generation plants needing an assured supply at scale and growers needing the assurance of those plants as a market to commit themselves to a perennial crop.
- biodiversity gain and other environmental management agreements

8.6.8 Grassland – While that model might see a basis to creating more grass in arable areas even with an uncertain use, pasture in the hills appears under pressure from:

- peatland restoration (though there may be some lowland peatland restoration as well) likely to remove land that may now be lightly stocked.
- forestry, perhaps especially in Wales and Scotland
- biodiversity gain and equivalent agreements.

8.6.9 Where grazing livestock recedes from an area, what happens to land that then has less or no grazing pressure? Without such management, bracken advances, scrub can return and wooded ghylls might revive with differing environmental and landscape impacts. As our upland landscapes show, land can revert in such ways. What might be wanted and by whom with what incentives? In the Highlands, Anders Povlsen has accumulated a large landholding based on estates with them increasingly managed for "rewilding" but this might be harder to replicate at scale in other areas with more disaggregated ownerships. Dieter Helm has criticised complete re-wilding in remote areas as risking declining biodiversity while natural capital, as a concept, only has value to the people it benefits: "nature does not care ... only we care".

8.6.10 Opportunities in livestock may be increasingly limited by the reducing number of abattoirs, perhaps particularly the smaller ones that can be more accommodating in handling small batches or specialities (such as organics), as for onward sale in boxes or through local outlets.

8.6.11 More Generally – Poultry seems to be the one substantial area of expansion in livestock production, whether on livestock farms or for its synergy with arable production, but is now an increasing focus of pollution concerns.

8.6.12 For both livestock and horticulture, developments in public procurement policy outside EU State Aid rules may have some local influence. Some Welsh local authorities are looking at this which might prompt some to see how to exploit land with horticultural potential found by the Welsh Government, but issues over volume and continuity of supply and tight budgets may be obstacles.

8.6.13 Both arable and pasture could see some movement of land to:

- more purely environmental uses with the question for some as to how that generates an income
- added value and higher value production.

8.6.14 Higher Value? – If looking at a move from commodity production to seek a better margin, one question will be how to protect that margin, sustaining the differentiation as by building a brand, building strong supply chain links, creating barriers to others entering or sustaining innovation. Scale remains an issue: is the business capable of doing that on its own or should that be as a consortium? That latter becomes more likely when considering overseas markets.

8.6.15 Environmental Uses – More environmentally-oriented uses include

- uses under environmental schemes, whether some medium term transfer or using short term options to marry with cereals cropping on an every other year basis and a focus on achieving first wheats. 55 per cent of land in rotational set-aside (about half the area but 37 per cent of fields) in 2003 was reported as being between wheats, the set-aside being used as a break crop mostly in place of field beans (*Change in the Area and Distribution of Set-aside in England and its Environmental Impact*, 2007).

- more fundamental change away from an exclusively agricultural use, as under the more demanding options of future schemes with such labels in ELM as Nature Recovery and Landscape Recovery
- the use of land for biodiversity gain and equivalent agreements
- other services like flood management (linking to the Climate Change Committee's call for 20 per cent of lowland cropland to be rewetted by 2035), with the arbitrage possible of the difference in values between the loss to farmland from flooding, the loss to urban land from flooding and the cost of protecting that urban land
- in some places, the private creation again of new landscaped parklands, akin to the creation of such properties as Stourhead and Stowe, extending the amenities of country houses with extensive gardens and light grazing, possibly in the form of "villa estates" or a parallel to mediaeval deer parks which served both ranching and sporting purposes, but tending to serve private amenity.

8.6.16 Might this become more radical with the potential for a concept of "climate change mitigation parks" with specific encouragement of carbon sequestration by soil management and trees?

8.6.17 Commons – Commons inevitably provide a particular area for consideration, with their overall large land area and ability to provide a challenge for every change. In England and Wales, commons, potentially with roots in pre-Roman practices and more recently manorial waste, see an owner's land subject to defined rights by others to have some use of it, typically for grazing, but giving them no control beyond their rights but limiting the owner's use. Disproportionately in the uplands, they can be found in most areas and are not solely grazing land with some being cropped. Some commons have few or no one left with rights to use them; others have active commoners, some with commoners' associations. Scotland has a different arrangement of common grazings and there seems no parallel in Northern Ireland.

8.6.18 In practice, their structure makes positive change, whether agricultural or environmental, at least laborious to achieve, so hindering reactions to the pressures sketched in this paper. Recent years have tended to see reduced activity on many commons. In addition to underlying economic and practical pressures, some have not been restocked since the Foot and Mouth culls of 2001. On others, stocking rates have been under pressure from environmental agreements and controls with reports of greater bracken cover as a result. With other factors, structural changes in the farming of those who have common rights, commercial pressure, environmental concerns and pressure for peatland restoration all appear to tend to leave commons outside the processes of change for land use save it may be that, overall, grazing may continue to reduce.

8.6.19 Taxation – For private owners of rural land, consideration of more substantial diversion of land into essentially environmental uses, whether peatland restoration, minimal grazing, biodiversity gain or full re-wilding, will be heavily influenced by its treatment under the tax system.

8.6.20 Particular headline points are:

- if the land is no longer agricultural, then Agricultural Property Relied from Inheritance Tax (IHT) will not be available with no relief for any otherwise qualifying farmhouse.
- more generally and often more importantly, if the activities being undertaken are too passive to be seen as a trading business to qualify for Business

Property Relief from IHT, the business reliefs for CGT might also not be available.

In the absence of change (such as an extension for APR to land subject to qualifying environmental commitments along the lines of the now largely expired s.124C of the IHT Act for land in Habitats Regulations agreements), these concerns of themsleves might deter private owners from taking this extra step away from agricultural business.

8.6.21 There would need to be clarity as to the deductible costs for Income Tax and as to the VAT treatment (how analogous is carbon sequestration to landfill?).

8.6.22 The Climate Change Committee's December 2020 report, *Policies for the Sixth Carbon Budget and Net Zero*, recommended a review of the tax treatment of woodlands so that it could be amended as necessary to ensure there was no disadvantage for farmers converting to forestry.

8.6.23 Equally, such a disparity in tax treatment might give a further role to environmental and related charities, whether directly (perhaps even a parallel with the former monastic lands though they were typically run on a commercial basis?) or in agreements and joint ventures with private owners.

8.6.24 Deeper Issues – Deeper than taxation may be emotional commitment to the hard work of land improvement over the generations. Land reclamation and drainage to create productive land or the sustained effort in wrestling a living from the hills have been regarded as virtues in their own right. Where a proposed new use can be seen as letting the fruits of that work go that can be felt as more than the abandonment of the piece of land in question but reneging on a larger principle and the ceding of a way of life. In those areas where farming is still not considered in transactional terms or the people who did that work are still running the business, that may be an impediment to change in use. Something of that has been seen where the Environment Agency has ceased to support drained arable land; more was seen in the reaction in mid Wales to the Summit to Sea rewilding project between Plynlimon and Cardigan Bay.

8.7 Leisure

8.7.1 A similar unwillingness might come with any erosion of country sports. Not only has fox hunting preserved the fox but it has given its devotees an interest in the associated landscape, with coverts and the exclusion of wire fences, sometimes against their immediate economic interests. More widely perhaps, the interest of many farming landowners in shooting has driven patterns of land management with game cover, woodlands and stubbles that have had wider benefits for wildlife and seen willing co-operation in agri-environment agreements. In some places, this is a recreational and social matter but in others, such as north Devon, west Somerset and some upland areas this a significant part of the rural economy, giving an economic reason for maintaining the supporting landscape.

8.7.2 Other leisure uses may grow or emerge but finding ways to monetise them well is likely to be a challenge when looking at overall land use. Walking and cycling do not generate substantial spending for the areas used while almost all such visitors stay on marked paths or close to their cars, leaving the remainder of the land. A limited number can exploit a market for outdoor activities such as quad biking, archery, paintballing and the like; the spending on shooting is probably significantly greater and with more impact on rural land management. Knepp Castle may show that there is some potential for higher value safaris with supporting accommodation such as glamping in conjunction

with land uses warranting that but the size of this market as a substantial generator of income seems limited. The 1980s expansion of golf courses went further than was sustainable commercially with a few reverting to farmland and many looking for value in ancillary development. Festivals of any scale involve substantial management and cost. This may be more a matter of seeing rural land as the supportive setting for a higher value activity in more concentrated location, as with creating the overall ambience (including estate produced foods) of a hotel able to command the prices that support that. In summary, the commercial goal for rural land management would be for it to support higher value tourism and social spending on it or in premises benefiting from it.

8.7.3 The contentious re-introduction of the sea eagle to Mull has brought substantial new income to the island but has not allayed concern from sheep farmers losing lambs. The economy may have gained but the affected sheep farmers will not see the tourist income unless they also provide facilities to visitors. That model might be more difficult for the less visible lynx.

8.8 A Conclusion

The way this kaleidoscope moves will be the outcome not only of large forces and policies but also of the choices of individual owners and occupiers in their own situations, reconciling the present with the pressures and opportunities for the future, in ways that will be diverse within each of the 159 Landscape Character Areas in England, the 48 in Wales, the 130 in Northern Ireland and the large number of Landscape Character Types in Scotland, let alone between them. While some aspects such as upland peatland restoration will be more locationally focused, that points to outcomes as varied as they have been in the past provided that public interventions are not too prescriptive. That variegated outcome would be the one most consistent with the innovation, experimentation and evolution of the market place in finding suitable answers in changing times.

9. Action, Advice and Change

9.1 Change in Context

9.1.1 This paper outlines the prospect of a decade of change, looking ahead at the multitude of issues and also back to illustrate how we have tackled such matters before. That perspective gives a broader canvas and more possibilities than the experience of the last half century but ones that are not necessarily unfamiliar. The challenges in this also bring opportunities with the best outcomes more likely to be achieved by active preparation and management, rather than just taking the buffets of change.

9.1.2 That will be better done with an understanding of the larger picture, not just meeting the immediate requirements for, say, slurry storage or the EPC for letting a cottage, but recognising the demands that will increase and preparing for them.

9.1.3 While the removal of Basic Payment in England and then Wales is often seen as the significant change, it is but one among many. It does though give the occasion and motive for looking at the full picture and using the Transition Period to frame a programme of review and change.

9.1.4 At a national level, achieving the outcomes required to meet the Government's important goal for improving farming competitiveness to match other countries, to deliver the net zero target for climate change, and the ambitions for biodiversity, air and water quality will require significant changes in the approach to business and land use with investment, skills, technology and structural change.

9.1.5 The answers are likely to be varied as individuals react in the ways that suit them and their circumstances best.

9.2 The Need for Advice

9.2.1 While it can be easy to see the role of markets in managing the dynamics of change across an economy, markets merely supply and use information. They express human behaviour but do not take decisions. That is for individuals in their own predicaments, resolving competing tensions to arrive at their own answers, from inertia to radical change, and all points in between. Those choices then in turn ripple through markets, creating further change.

9.2.2 In such circumstances, effective advice is crucial. That is particularly so in such a sector of small family businesses operating in a complex environment as farming, often with what for them are substantial capital assets accumulated over generations, especially when those assets typically yield low returns but are also home.

9.2.3 As the Welsh Government has said:

> "… advice should be seen as an investment in the capacity of farmers and farms rather than a cost …" *Sustainable Farming and our Land*. Paragraph 1.48, repeated in the *Agriculture (Wales) White Paper* 2.77

9.2.4 That will not only be specific advice on particular questions such as a planning application, a scheme application or agronomy but also advice that can take full, holistic account of the complex of issues in seeing the best for the farm in the round, synthesising and balancing the issues rather than dealing with them separately. That larger view helps bring perspective, realism and a sensitivity to circumstances.

9.2.5 That is especially important at this stage when a key question for any client is where they realistically want to be in ten years time, with the following consideration of how to achieve that. That is a fundamental question about the whole business, the family and the farm.

9.2.6 The client will need such good quality rounded advice for which agricultural valuers are trained. That will be best delivered where there is a personal chemistry between the adviser and client, with the value of a trusted adviser and, with the outside perspective, also of a safe challenger. That role can call on:

- the ability to understand the client and draw out where that client would realistically want to be in ten years time
- understanding all the factors involved in the present position and in moving forward
- helping the client understand and appreciate the issues
- heling the client to take decisions
- supporting the implementation of those decisions.

The time often needed for the process is a key practical use of the seven year agricultural transition period now starting in England, alongside the adjustment of values in response to the changes unfolding. Other parts of the United Kingdom may have more fore-notice of changes in public policy though not of the other pressures for change.

9.2.7 This all points to the need for the agricultural valuer's skills of rounded, holistic advice for farmers and landowners.

9.3 CAAV Future Skills Programme for Agricultural Valuers

9.3.1 Starting in early 2017, the CAAV has been developing its Future Skills programme to support and prepare members for a coming decade of change in the way that agricultural valuers have adapted to previous waves of change from the introduction of development control to the advent of on-farm renewables.

9.3.2 Building on the old skills of appraisal, analysis, advice, facilitation and dispute resolution this has been taken forward with emphases now especially on:

- business review
- environmental resources
- technology.

Continuing to raise awareness among members of the prospects for change and the issues in play, this has been taken forward by publications, conferences, workshops, webinars and podcasts.

9.3.3 This discussion paper itself fits within that programme that includes:

- awareness with publications such as *Beyond Brexit: A Review of the UK's New Agricultural Policies*
- discussion papers such as this paper and *Taxation: Agricultural Productivity, Land Occupation and Use After Brexit* with allied papers on such subjects as the potential of the Irish Republic Income Tax relief for letting land and on capital allowances for investment
- *Business Review*
  - the publication of *Reviewing a Business* as a manual to analysis of the financial and physical performance and prospects for a business, issues of finance and valuation, questions to ask and approaches to facilitating change
  - followed by a conference and now workshops

- environmental resources with analysis and material on the website covering a range of topics including:
  - soils
  - natural capital

  while work continues on biodiversity gain and other environmental agreements
- technology with the publication of a CAAV Centenary Scholarship report, *The Value of New Technologies for the Profession*.

These have been supported by publications developing older themes for the new world, such as:

- on farm business structures with *Arable Farming with Contractors* and *Contract Farming Agreements for Breeding Livestock* with a coming paper on *Joint Ventures*
- the review published in *Retirement Housing for Farmers in the United Kingdom: A Review of the Issues, Experiences and Possible Answers*
- *Rural Arbitration in the United Kingdom* accompanying the development of the CAAV's Facilitating Dispute Resolution Service, its Dispute Resolution Charter and *Appropriate Arbitration* reviewing ways for arbitration to be timely and cost effective.

9.3.4 The aim is for the valuer to have a clear view and ability to advise and support the client in the round, with skills to appraise an environmental scheme application or agreement, consider the business with its taxation, land tenure and other concerns. Where specialist skills are then drawn on, the valuer needs to be able to instruct that effectively, appraise the resulting report or work and advise the client in the wider context.

9.3.5 Assisting the client to see the wider picture, achieve a perspective and manage change will be critical if agriculture and land management are to move forward with the larger economy. Just as in previous centuries and millennia, those choices by individuals and families will, with the support of that advice, make the land uses that will be our future landscape and rural economy. Those changing land uses and economics will then frame the activities and businesses of those on the land.

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