Supplementary Material 2:
Narratives and Visual Summaries

UK Livestock Futures

Co-designing Shared Socioeconomic Pathways

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UK-Livestock-SSP1: Sustainable Transformation

Equitable, environmentally aware, cooperative pathway with low growth and sustainable, high-welfare livestock systems posing low challenges to climate mitigation and adaptation.

Abstract

By 2100, the UK's livestock sector has transformed, adopting sustainable, resilient, and equitable models driven by societal and policy shifts. Growing awareness of the environmental and health impacts of overconsuming animal-source foods leads to significantly reduced livestock numbers and a focus on well-managed, high-welfare systems. Governance reforms and Payments for Ecosystem Services schemes incentivise biodiversity enhancement, soil health, and water conservation, while reducing agriculture's environmental footprint and producing nutritious food. Diets shift towards fewer animal-source foods, with remaining production prioritising systems that protect nature, animals, and communities. Increasing plant-based alternatives and cultured meat reduce land pressures, enabling the expansion of rewilding, forestry, and horticulture that restore ecosystems and improve food security. Advances in green technologies, precision farming, agroecological methods, and some managed ruminant grazing, improve productivity and resilience while reducing reliance on synthetic fertilisers and agrochemicals, with their use eliminated by 2070. Short and local supply chains, cooperative markets, and reduced supermarket dominance ensure fair prices for farmers. Cross-sector collaboration establishes a circular economy with minimal waste and efficient resource use. These transformations create new opportunities for farmers, promoting sustainability while supporting healthier diets, reducing National Health Service pressures, and improving food equity.

Full Narrative

Governance

A consistent UK-wide approach to policy, tailored to local contexts, ensures clear direction and incentives for sustainable practices in the livestock sector. National frameworks set binding targets for environmental protection, biodiversity recovery, and animal welfare, while devolved administrations develop locally appropriate implementation plans. This aligns with widely supported sustainability commitments and long-established international cooperation on environmental and social goals, where effective multilevel governance supports integrated land use planning, resilient food systems, and long-term ecological stewardship across sectors. High levels of citizen participation shape food and land governance structures, with local authorities and community co-operatives taking on expanded roles in decision-making.

By 2040, Payments for Ecosystem Services (PES) schemes are fully embedded within agricultural policy frameworks, with initial teething issues resolved, and clearer, enforceable

performance indicators established. These improvements enhance biodiversity, soil health, and water conservation, while reducing agriculture's environmental footprint and producing healthy, nutritious food. In parallel, statutory transition plans become operational, providing farmers with access to low-interest loans, subsidies, and training to move towards higher-welfare, sustainable systems. Support is tailored to different farming systems: upland farmers receive targeted assistance to manage the impacts of reduced livestock numbers, including diversification grants and conservation payments, while lowland farmers are incentivised to focus on sustainable food production with reduced input reliance.

Meanwhile, recognition grows that animal wellbeing is closely linked to farmer wellbeing, with policy and advisory systems encouraging co-beneficial approaches to animal care, mental health, and labour conditions. Farmers experience some stress during the transition, particularly up to 2040, but maintain relatively good mental health overall thanks to supportive policies, community cohesion, and diversified livelihoods. Ongoing commitment to precautionary and inclusive innovation drives continuous increases in research and development investment in food and agriculture. Spending on innovation, sustainability, and resilience grows steeply up to 2070, then stabilises at a high level, supporting continuous improvements in sustainable practices and technologies.

By 2040, governance frameworks also extend to the regulation of ultra-processed foods, with labelling requirements, advertising restrictions, and fiscal policies such as levies and reformulation targets introduced to discourage their consumption and reduce diet-related health and environmental harms.

Between 2040 and 2070, public investment programmes intensify, supporting innovation grants, tax relief for sustainable practices, and infrastructure funding to develop shorter, regionalised supply chains. Additionally, transformative technological governance approaches are implemented, including support for open innovation platforms, public ownership models for key green technologies, and inclusive technology transfer schemes. These initiatives enable most farmers to benefit from higher prices for their products while maintaining productivity.

Agrochemical use becomes more tightly regulated through national environmental legislation, with restrictions on synthetic inputs and mandatory integrated pest management plans. These ensure environmental safety while maintaining agricultural productivity through natural pest control and organic fertilisation techniques. Strict biosecurity measures and antimicrobial regulations are also regularly updated and monitored to help manage disease outbreaks and combat antimicrobial resistance. Precision farming and genetics further support this effort by enabling more targeted use of antibiotics where necessary. Meanwhile, investment in renewable energy, supported by green technology subsidies and streamlined permitting

processes, strengthens the sector's resilience by lowering operational costs and offering diversification opportunities for landowners.

By 2070, governance reforms introduce regulatory safeguards to limit land acquisition by large farms and progressive subsidies favouring small- and medium-sized producers, preventing market consolidation and marginalisation of smaller operators. Land use regulation is increasingly devolved to local governance bodies, ensuring context-sensitive planning and fair access to natural resources. Further equity and inclusion measures are introduced, including land access reforms to support new entrants and marginalised groups, and strengthened labour protections for agricultural workers. Local governments and co-operatives facilitate access to markets for diverse producers, ensuring a resilient and inclusive food system. To ensure equitable access to sustainably produced food, targeted support mechanisms are introduced for lower-income households, including income-based vouchers, prescribed allowances, or other means-tested entitlements that help maintain the affordability of nutritious, high-quality foods.

By 2100, stringent governance reforms and regulations have led to significantly reduced livestock numbers, prioritising high-welfare practices that produce less but higher-quality animal-source foods while protecting nature and animals, and supporting communities through improved health. The livestock sector operates within a cohesive policy framework driven by public demand for sustainability and equity. This framework emphasises environmental stewardship and fairness, supported by continuous monitoring and adaptive management to address evolving societal and ecological priorities.

Society and Diet

By 2040, society is becoming increasingly aware of the environmental and health impacts of overconsuming animal-source foods. This awareness, alongside concerns about environmental degradation and agricultural vulnerabilities drives a shift in cultural values and consumption patterns. Education and governance systems evolve to embed sustainability values across all levels of society, encouraging awareness and commitment to responsible consumption and production. Example-setting through public procurement, such as sustainable food sourcing in schools and public institutions, reinforces these values by demonstrating practical commitment and driving market demand for ethical products. Social norms emphasise equality and shared responsibility, with egalitarian values driving collective action on health, environment, and animal welfare.

Rural and urban areas play distinct yet complementary roles in this transformation. Rural communities prioritise preserving agricultural landscapes as cultural heritage, with a strong focus on sustainable land use practices and environmental stewardship. Urban populations, meanwhile, are increasingly motivated to reduce their environmental footprints, becoming

more conscious of how consumer choices influence agricultural practices in rural areas. These dynamics drive demand for ethical and sustainable food systems, strengthening the interdependence of rural production and urban consumption. Urbanisation continues gradually until around 2040, accompanied by the rise of green cities, before stabilising as the value of rural areas gains renewed recognition.

Changes in consumer demand lead to a gradual decline in consumption of all animal-source foods. Chicken and fish consumption decrease more slowly than red meat, while egg and dairy consumption remain relatively stable up to 2040. Fish is initially perceived as a healthier and more sustainable option, contributing to its stability in the early period. However, after 2040, fish consumption declines as awareness grows about the environmental limits of fishing and aquaculture, prompting a shift toward smaller quantities sourced through more sustainable practices. Chicken follows a similar pattern, declining more gradually than red meat but eventually facing competition from cultured meat alternatives and plant-based proteins. Egg and dairy consumption also begin to decline slightly after 2040, as plant-based diets become more widespread, though some demand remains from a large vegetarian population. By 2050, overall meat consumption has fallen by around 35%.

In the second half of the century, a growing share of protein is derived from plant-based sources such as pulses and legumes, alongside cultured meat, which becomes economically viable and starts to outcompete some conventionally-produced animal-source foods, especially chicken. Consumption of highly processed meat substitutes remains low as diets shift toward healthier, sustainable options, driven by greater awareness of their health risks and regulatory measures that promote whole and minimally processed foods. Entomophagy, i.e., insect-based foods, also contribute to diversifying protein sources, though remain niche. Alongside dietary changes, broader societal trends contribute to improved health and wellbeing. Decreasing inequalities, increased public investment in healthcare and education, and a culture of collaboration encourage healthier lifestyles and improved overall wellbeing. Reduced material consumption and increased spending on infrastructure support these trends. Food waste also declines across households and supply chains, as consumption-conscious lifestyles become the norm.

From 2070 onwards, diets increasingly feature diversified, sustainable protein sources, including plant-based foods, cultured meat, and small amounts of high-welfare livestock products. By 2100, diets feature a greater share of plant-based foods, with smaller quantities of animal-source foods consumed, reflecting a shift toward balanced nutrition that supports food security, equitable access to healthy food, ecological restoration, and high standards of animal welfare. Healthier, more sustainable eating habits lead to improved public health, easing pressure on the NHS, while equal access to healthcare strengthens overall societal well-being.

Production Systems and Land Use

The UK's agricultural sector undergoes a transformational shift, as farmers respond to changing demands by gradually reducing livestock numbers and increasingly focusing on arable, horticultural, and permanent crops farming, alongside ecosystem services. Up to 2040, the sector prioritises building adaptive capacity through diversified production systems, integrating local and traditional knowledge, improving disease monitoring, and enhancing soil health and on-farm biodiversity. Precision technology and breeding for environmental and health traits becomes increasingly important, improving resilience and sustainability of livestock. Meanwhile, production of plant-based alternatives and cultured meat scale up, with facilities optimised for energy efficiency and integration with renewable energy sources.

A strong emphasis on animal welfare emerges as a core feature of sustainable livestock systems. Policies and market pressures promote natural behaviours, enhanced health care, and improved living conditions, reinforcing public trust in the sector. Ruminant production increasingly focuses on pasture-based systems in regions with suitable landscapes such as the Scottish Highlands, Welsh uplands, parts of South West England, and Northern England uplands, committing to extensive grazing and ecological benefits. The monogastric sector gradually becomes smaller in size and is split between sustainable intensification, achieving higher efficiency through precision feeding, welfare monitoring, and integration with arable or agroforestry systems (e.g., in the Midlands and East Anglia), and more extensive production within mixed farms. Meanwhile, bioenergy use rises modestly during the fossil fuel transition but plateaus after 2040, with solar and wind growth compensating.

By 2040, the use of synthetic fertilisers and agrochemicals are significantly reduced, improving soil and water health across the UK and reducing fossil fuel reliance. By 2070, synthetic inputs are replaced by sustainable soil management and green technologies such as organic amendments, crop rotations, agroecology, precision nutrient use, and advanced breeding to maintain yields and soil fertility. Efficient manure management processes are widely adopted, with technologies such as covered slurry storage, solid-liquid separation, and anaerobic digestion reducing nutrient loss and emissions while enhancing fertiliser value.

A sustainable and efficient transport infrastructure and stakeholder collaboration enhances supply chain efficiency. Agricultural water demand is significantly reduced through improved water management strategies, such as efficient irrigation and rainwater harvesting. Green technologies, including plant and animal breeding, urban hydroponics, and biotechnology, are harnessed to sustainably increase yields. Ownership issues around genetically modified organisms are resolved, enabling their use to support traditional breeding without encouraging corporate monopolies, with risks managed through research and controlled use.

From 2040 to 2070, agricultural land area required decreases significantly due to decreasing production of animal-source foods, reduced demand for animal feed, reductions in food waste, and the adoption of innovative sustainable practices. This enables large areas of land to be repurposed for arable, horticultural, permanent crops farming, and other uses that restore ecological balance and improve food security. More grains, fruits, and vegetables are produced domestically, improving crop self-sufficiency, while consumers increasingly embrace seasonal eating patterns. In western UK and Scotland, tree planting expands, restoring native woodland cover. However, some environmental and resource challenges persist.

By 2070, livestock systems increasingly shift to marginal land or integrate with mixed-use farms in circular models, freeing up more productive land for growing crops directly for human consumption. The smaller ruminant sector focuses on high-quality, grass-fed meat from well-managed pastures. Sheep decline but remain in some uplands like Wales, Northern England, and the Scottish Highlands, where low-intensity grazing supports ecology; other areas are rewilded. Cattle continue in regions such as South West England, Cumbria, and Northern Ireland, with reduced intensity and high welfare. Extensive grazing systems increasingly prioritise ecological functions such as carbon sequestration, soil health, and habitat provision. Land-use approaches become more integrated, with combinations like silvopasture and companion planting for livestock feed, often paired with renewable energy infrastructure.

The monogastric sector continues to contract, with remaining operations becoming more efficient and technologically advanced. Some farmers continue to adopt sustainable intensification practices, employing precision tools to monitor welfare, optimise feeding, and reduce environmental impacts, while others continue integrating monogastric animals into extensive mixed systems, such as pasture-raised poultry and pigs foraging within agroforestry landscapes. These smaller systems free up more land for rewilding and afforestation.

By 2100, the UK's agricultural and livestock systems are integrated into a circular economy characterised by lower waste, optimised resource management, and minimal environmental impact. Shorter, more transparent supply chains prioritise local and sustainable systems, while international cooperation on trade standards and diversified sourcing helps manage supply risks and ensures fair trade access amid changing global conditions. Through policy reform, tighter regulation of supply chains, and public investment in local food systems, supermarket dominance lessens. This shift in market power enables co-operatives and producer alliances to emerge as key actors, ensuring farmers receive fair prices while keeping food affordable for most consumers.

UK-Livestock-SSP1: Sustainable Transformation

UK-wide policy adapts to local sustainability needs

Biosecurity and antimicrobial rules curb disease

Rules on genetic technologies ensure fair use and limit monopolies

Some farmland transitions to rewilding and conservation

Reforms and regulations reduce livestock numbers by 2100

Fertilisers phased out for soil health and lower fossil fuel reliance

Green technologies improve yields, resilience, and environmental efficiency

Less land needed for livestock as meat demand and waste decline

Payment schemes support environmental protection, biodiversity, and food production

Health, environmental concerns and policy reform drive reductions in animal-source food consumption

Diets shift towards more plant-based sources, such as pulses and legumes

High-welfare mixed farming delivers 'less but better' meat

Farmers supported through low-interest loans and training

Ethical food demand links rural and urban areas, reshaping the countryside

Consumption of animal-source foods declines

Farmers benefit from innovation, circularity, shorter supply chains, and government support

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UK-Livestock-SSP2: Middle of the Road

Moderate-growth pathway balancing established livestock practices with gradual innovation, presenting medium socio-economic challenges for climate mitigation and adaptation.

Abstract

The UK's livestock sector continues to evolve along existing trends, balancing deeply ingrained established farming methods with gradual technological improvements and some increasing emphasis on sustainability. Public-private partnerships drive innovation in precision livestock farming, genomics, and agroforestry, enhancing efficiency and resilience. However, these efforts fall short of systemic transformation, with biodiversity loss and environmental degradation persisting despite Payments for Ecosystem Services schemes. Consumer demand slowly shifts toward more consumption of plant-based foods as they become more affordable, but uptake faces policy and industry resistance, and there are some health concerns over processed options. Land use becomes increasingly regulated, promoting sustainable intensification through efficient rural practices and a shift towards urban methods like vertical farming, as well as mixed-use systems, yet competition for land, rural infrastructure neglect, and labour shortages exacerbate inequalities. Smaller farms are increasingly replaced by larger operations, consolidating the sector. The UK maintains a competitive edge in agri-tech innovation and exports, but domestic food systems remain exposed to socio-economic pressures and resource constraints. Incremental progress defines the sector by 2100, but systemic challenges continue to limit its advancement toward broader sustainability goals and equitable outcomes.

Full Narrative

Governance

The UK continues decentralising, with more powers transferred to the devolved nations, alongside expanded decision-making authority for mayors in major cities. National and devolved governments implement a range of sustainability policies targeting agriculture and land use, though these remain largely modest and incremental rather than transformative. Regulation and strategic planning around resource use and land management steadily increase, but governance structures struggle to balance competing priorities such as urban development, food production, and biodiversity protection. Public-private partnerships, often led by large corporations, drive innovation and funding but face scrutiny over legitimacy and uneven regional and farm-level benefits.

By 2040, new policies begin to emerge to encourage more mission-driven public-private partnerships, such as targeted co-investment schemes, tax incentives for joint research and development, and regional innovation hubs, that aim to steer private investment toward public agri-tech goals, particularly in low-income or marginal farming areas. Meanwhile, the UK

government implements a series of modest policies to align agri-food systems with environmental, biodiversity and nutritional goals, though coherence and ambition remain limited. Meanwhile, policies promoting plant-based diets and animal-source food reduction are inconsistent and lack strong coordination. A proposed tax on processed meat is widely rejected, forcing the government to reverse its stance. At the same time, efforts to introduce subsidies for plant-based alternatives face significant pushback, supported by campaign messaging that emphasises the health risks associated with highly processed plant-based products. Regulatory frameworks for food labelling and health standards are slow to adapt, creating confusion among consumers and slowing the growth of plant-based markets. Conflicting policies between devolved nations and central government complicate the regulatory landscape, making it difficult to establish a unified, national strategy to promote plant-based diets.

Payments for Ecosystem Services (PES) schemes incentivise some environmental improvements, such as soil health, water quality, and biodiversity enhancement. However, decentralised administration, shifting eligibility criteria, and inconsistent enforcement create significant challenges. Many farmers struggle with the administrative burden and uncertainty around payments, resulting in uneven uptake, with tenant farmers and smaller operations particularly disadvantaged. While agricultural policies promote sustainability, the transition is gradual, and PES schemes only partially offset environmental degradation due to limited incentives, especially when short-term economic pressures and market conditions favour less sustainable practices.

From the 2040s, recurring agricultural challenges, including supply chain disruptions driven by geopolitical tensions, resource competition, and environmental degradation, prompt reactive surges of public investment in research and development, with a focus on food security and strengthening system resilience. Broader infrastructure investment expands, targeting transport, digital connectivity, smart city development, and urban food production initiatives like vertical agriculture. However, most funding and attention remains concentrated in urban and peri-urban regions. Land use planning becomes more coordinated as national and devolved governments introduce strategic frameworks aimed at balancing biodiversity protection with agricultural production. However, competition between land uses like food production, afforestation, housing, and bioenergy increases land pressures, so food security remains the priority over expanding protected natural areas during this period.

Regulations tighten around fertiliser use, introducing stricter limits on application rates and nutrient runoff, particularly near sensitive habitats and water bodies. These measures are supported by the gradual adoption of precision agriculture technologies, including sensor-guided input systems and site-specific nutrient management, facilitated through public-private partnerships. While these partnerships accelerate technological development and

dissemination, concerns persist regarding their governance, transparency, and equitable access, especially for smaller, more marginal producers. Efforts to improve transparency and coordination through formal oversight bodies and public reporting requirements are introduced, but uptake and enforcement remain inconsistent.

Also, around the 2040s, while the UK continues to experience overall economic growth, social inequalities gradually widen. These are partially mitigated by the introduction of a modest universal income scheme and strengthened worker rights, which improve food security and basic wellbeing for vulnerable rural populations. For the livestock sector, this support helps stabilise some farming households but does not fully alleviate the ongoing economic pressures driving farm consolidation.

Between 2040 and 2070, the sector increasingly depends on public-private partnerships to fund research in precision livestock farming, resilient breeding practices, and digital monitoring technologies, often with an emphasis on sustaining export competitiveness. These partnerships become central to tackling emerging challenges in agriculture. Yet, uneven benefit distribution, limited coordination, and transparency issues within these partnerships persist hindering effective technology transfer and equitable access across regions and farm sizes. While policies encouraging plant-based diets and animal-source food reduction become somewhat more coordinated and effective, they still face cultural resistance and inconsistent implementation across regions.

Land use planning becomes increasingly regulated, with incentives promoting sustainable intensification in rural and urban agriculture, particularly the expansion of vertical farming and increasing livestock productivity through improved genetics, precision feeding, and enhanced grazing management. Additional incentives encourage agroforestry, mixed-use agricultural systems, and solar-livestock farms. The effectiveness of these regulations varies, hindered by ongoing economic disparities between urban and rural areas. Challenges like labour shortages and limited support for new and young farmers deepen rural inequalities.

From 2070 onwards, changing diets and land-use policies reduce land-use pressures, enabling planning to better balance biodiversity protection with food production. Public-private schemes and transition grants support this shift for farmers as livestock declines, though access is uneven. PES schemes gradually strengthen, helping to better incentivise the delivery of public goods and support ongoing improvements in non-production functions, while policies work towards expanding protected natural areas. Citizen participation in governance grows, shaped by emerging autonomous city-states that emphasise urban agriculture and sustainability innovations. Although some rural investment continues, many rely heavily on grants and PES schemes but still receive insufficient funding.

By 2100, governance has delivered incremental improvements in sustainability, biodiversity, and efficiency. However, persistent challenges with inconsistent enforcement and a continued reliance on public-private partnerships that suffer from uneven resource distribution, limited transparency, and inadequate stakeholder engagement hinder a fully integrated and systemic transformation of the livestock sector. Despite moderate progress in environmental management and a slowdown in biodiversity loss, the sector remains vulnerable to economic pressures and broader environmental and market uncertainties, resulting in uneven social and environmental outcomes across regions and producer types.

Society and Diet

Up to 2040, the shift toward plant-based alternatives gains some momentum, driven by rising prices of animal-source foods and heightened awareness of the environmental and health implications, as educational programmes place greater emphasis on sustainable food systems, nutrition, and public health. However, the transition remains limited in scale due to inconsistent policies and lobbying from vested interest groups. Throughout this period, demand for poultry meat and fish continues to rise slightly, while other meats decline modestly and egg and dairy consumption plateau. The growing intake of non-dairy milk alternatives is largely offset by increased consumption of other dairy products. Cultured meat production sees slow growth during this period due to consumer perception challenges and high production costs. As overconsumption of animal-source foods and processed foods persists among parts of the population, the burden of diet-related health conditions continues to grow, placing pressure on the public health system.

Despite modest economic growth, social inequalities increase slightly up to 2040. Food poverty persists, and access to healthier food options remains unequal across socio-economic groups. Despite rising inequalities, overall material consumption and food purchases increase. Meanwhile, technological advances help reduce supply chain waste, but consumer awareness and behaviour change more slowly, so household food waste remains relatively high. Meanwhile, marketing continues to strongly influence food preferences, challenging informed nutritional choices. Calls for greater transparency and government action grow but see limited progress.

Meanwhile, local food production gains some prominence, with regional food branding becoming a notable feature of the food system, though mainly only accessible to those who can afford it. This trend includes a growing emphasis on locally sourced animal-source foods, as consumers seek to support sustainable and ethically produced options. The rise in demand for premium, traceable animal-source foods plays a role in reshaping some food landscapes.

From 2040, the introduction of universal basic income schemes helps to mitigate some social inequalities, although disparities continue. Material consumption and food purchases plateau

due to limited increases in purchasing power. Demand for chicken plateaus, while consumption of other meats declines due to rising costs. Meanwhile, plant-based alternatives gradually become more affordable and increase slightly in popularity. Egg and dairy consumption remain reasonably stable throughout this period. Cultured meat is increasingly available but remains costly and is slow to gain traction. Consumer education around nutrition and sustainability improves, but food labelling regulations continue to face implementation challenges.

From 2070 onwards, cultured meat becomes a more cost-effective and widely accepted alternative, supported by public-private partnerships and government incentives aimed at reducing land requirements for food production. This shift accelerates declines in all types of conventionally produced animal-source food consumption, particularly chicken due to the rapid scalability of lab-based alternatives. Plant-based products become more mainstream, aided by more coherent policies, though regional differences and cultural resistance persist. Fish consumption declines as wild stocks diminish, and aquaculture faces mounting sustainability challenges. Overall dietary patterns reflect a gradual move away from conventionally produced animal-source foods toward alternative protein sources, though the health impacts are mixed, with growing concern over ultra-processed options.

By 2100, the uptake of plant-based diets and cultured meat increases but remains uneven. Overall animal-source food consumption declines but continues to be a significant part of some diets. Cultural preferences and economic disparities influence dietary choices across regions and communities. Concerns persist over the health and environmental impacts of ultra-processed foods including some plant-based alternatives on nutritional quality. Social inequalities continue across society with pronounced disparities between rural and urban areas affecting access to healthy food, economic opportunities, and public services.

Production Systems and Land Use

Up to 2040, the UK livestock sector sees moderate economic growth, driven by rising exports and productivity gains through technology. While domestic consumption of most animal-source foods plateaus, poultry and egg demand rises slightly, supporting growth in those sub-sectors. Other areas remain stable, with a gradual shift toward higher-value, premium products.

Intensification of the monogastric sector increases slightly, with some adoption of sustainable intensification methods. Poultry and pig production intensify particularly in eastern and central England, where large-scale units cluster near processing hubs. Precision livestock farming, automated feeding, and feed innovations such as insect-based protein and synthetic amino acids help reduce some of the environmental impacts of the sector. Meanwhile, AI-driven health monitoring and other precision care technologies support animal health and productivity. However, uptake remains concentrated among larger, well-capitalised operations, while smaller farms often face economic barriers that hinder access to such innovations.

The ruminant sector experiences gradual change, with selective breeding for productivity and animal health, methane-reducing feed additives, and rotational grazing being increasingly adopted. Sheep systems remain largely extensive and situated in upland and hill regions across Wales, Northern England, and the Scottish Highlands. Cattle production becomes slightly more intensive in regions with established infrastructure, such as semi-intensive dairy farms in South West England and Cumbria, while high-value, extensive practices gain traction in other parts of the country. An expanding market for premium, high-welfare, traceable animal-source foods creates new opportunities for pasture-based and organic farming.

Fertiliser use declines gradually with improved efficiency and precision application, while water use rises initially to meet domestic food demand but plateaus by mid-century due to technological advances. Bioenergy production grows moderately, then stabilises as pressures to balance energy crops with food production increase.

Meanwhile, urban agriculture and vertical farming begin to complement rural production, especially near major cities, focusing on high-value crops and niche proteins. Though initially a small share of production, these innovations show promise in easing land use pressures and supplying fresh urban produce. Cultured meat production also advances but remains costly and struggles to gain consumer acceptance.

By mid-century, the livestock sector faces ongoing pressures from volatile markets, labour shortages, rising costs, and land use competition, alongside gradual shifts as some consumers choose more affordable plant-based options. While some producers adapt by investing in new infrastructure and emerging technologies, many struggle to stay viable amid inconsistent support and limited access to capital. Mental health outcomes for those working in the sector are mixed, with some coping well and others experiencing significant stress. Economic pressures and ongoing sector challenges create a difficult environment, with uneven responses and limited support contributing to uncertainty and anxiety.

Between 2040 and 2070, there is an increasing focus on exporting agri-tech through public-private partnerships. Emissions intensity of livestock animals continue to improve across all the board, driven by precision technology, gains in feed efficiency, improved genetics, and better manure management. Energy efficiency also increases, helped by automation and smarter energy systems on farms. Land use planning becomes more coordinated during this period, prioritising food production and biodiversity. Protected areas are not expanded during this period due to food security pressures but remain stable. On-farm water use plateaus due to technological improvements in irrigation and livestock cooling systems. Fertiliser use continues to decline, supported by improved nutrient management planning, precision application technologies, and greater use of organic amendments.

Urban and peri-urban farming technologies continue to develop, with vertical farms using aquaponics and hydroponics to increase production of protein-rich crops and leafy greens year-round. Increasing renewables and micro-energy infrastructure, such as solar panels and battery storage, provide reliable, low-carbon power for these methods, improving efficiency, sustainability, and local food supply while reducing land pressures. Meanwhile, cultured meat production technologies continue to advance and increase in scale, supported by renewables.

From 2070 onwards, protected natural areas increase as land is freed up from agricultural production due to efficiency gains, urban agriculture, and reduced consumption of animal-source foods. There is growing recognition of the need for nature-based solutions that address broad environmental challenges, in contrast to technological fixes that tend to target narrower problems. Water demand declines further, reflecting changes in dietary patterns, better storage, and reuse infrastructure.

Cultured meat and plant-based proteins become more mainstream. A large proportion of these plant-based proteins produced are highly processed to replicate the textures and flavours of meat. While large-scale production of alternatives is dominated by specialised facilities, some farmers with suitable land diversify into growing legumes, algae, or precision-fermented ingredients to supply this demand. Livestock production continues on a smaller scale elsewhere, with some producers focusing on premium, high-welfare products to maintain market value. Other activities, such as renewable energy schemes and participation in rewilding or conservation programmes, help supplement incomes for some farmers. Public-private schemes and transition grants support parts of this transition, but access and benefits remain uneven across the sector.

By 2100, the UK livestock sector has contracted due to lower domestic demand, though some producers maintain export markets. Public-private partnerships drive advances in technology and improve production efficiency, positioning the UK as a leader and exporter of agri-tech innovations. However, the benefits of these partnerships are unevenly distributed, often reinforcing existing inequalities, especially in rural areas. Meanwhile, urban agriculture continues to expand and cultured meat and plant-based protein operations continue to expand.

UK-Livestock-SSP2: Middle of the Road

Alternative proteins increasingly developed and consumed later in the century

Environmental degradation threatens food and livestock system resilience

Young farmers lack support and labour shortages increase

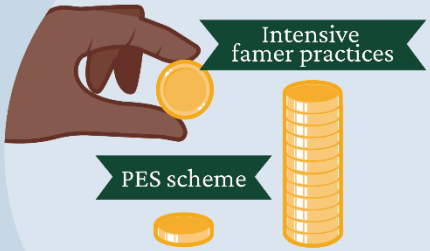
Sector consolidation squeezes small farms

Gradual sustainability transition but with continued biodiversity loss

Rising social inequalities despite economic growth

Local food and regional branding gain traction, especially for traceable high-quality meat

UK leads globally in agricultural technology and exports innovations



Inadequate incentives limit the impact of Payments for Ecosystem Services (PES) schemes

Moderate sector growth balancing established farming methods with gradual innovation

Shift to affordable plant-based foods is gradual, with some health concerns over processed options

Technological innovations and precision farming improve efficiency

Conflicting policies and slow labelling reforms create confusion around dietary guidance

Incentives encourage agroforestry and solar-livestock farms

Meat tax rejected; processed meat intake rises, worsening diet-related disease

Public-private partnerships drive agri-tech advances but reinforce inequalities

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UK-Livestock-SSP3: Regional Rivalry

A fragmented, regionally divergent livestock sector that is initially resource-intensive but increasingly strained facing high challenges to both climate mitigation and adaptation.

Abstract

Amid rising international tensions and protectionist policies, the UK's livestock sector becomes increasingly fragmented, with devolved nations adopting divergent agricultural strategies. Scotland and Northern Ireland initially maintain strong state support, while England sharply reduces payments under market liberalisation and Wales adopts a hybrid approach, resulting in uneven competition and widening regional disparities. By mid-century, Scotland declares independence triggering the eventual dissolution of the UK. Meanwhile, the rise of trade restrictions limits access to international markets, increasing domestic self-sufficiency but also heightening economic and supply chain vulnerabilities. As urban sprawl encroaches on farmland, early intensification gives way to declining input availability and environmental degradation, including soil depletion, water pollution, and biodiversity loss. In the latter half of the century, the collapse of high-input systems prompts a shift toward fragmented, low-input, and subsistence farming. As political structures weaken and governance structures erodes, the sector becomes increasingly uncoordinated and fragile, leaving it exposed to resource shortages, disease outbreaks, and social unrest. A fractured society grapples with increased competition for land and resources, inequality, and the breakdown of formal agricultural systems, leading to a future marked by food insecurity, poverty, and uncertainty.

Full Narrative

Governance

Up to 2040, compounding socio-economic pressures and environmental stresses contribute to localised conflicts, rising international tensions, and declining participation in governance. Global governance and transnational collaboration weaken as disinformation campaigns escalate, trade disputes intensify, and international agreements lose credibility. Trust between nations deteriorates, and geopolitical rivalry becomes more pronounced.

In this context, multinational agri-food corporations find it increasingly difficult to operate in the UK and elsewhere. Diverging regulatory frameworks, trade barriers, and rising transaction costs undermine their competitiveness, reducing their presence in domestic markets. As these companies withdraw, responses across the UK diverge. Some devolved governments intervene to take control of abandoned processing facilities, supply chains, and technological assets. Others defer to market-led responses. Demand increases for UK-sourced feed, breeding stock, and other primary agricultural resources. Nature protection quickly declines as governments relax land use restrictions and planning regulations to meet growing local demand for natural resources, prioritising short-term food security needs over conservation goals.

Within the UK, the combined pressures of international instability and uneven economic and environmental conditions reinforce the dominance of national and regional interests. By 2040, growing rivalry among the four UK nations intensifies, driven by rising nationalism and increasingly different political ideologies. The livestock sector fragments as protectionism and border controls disrupt trade, and devolved nations adopt divergent, uncoordinated strategies.

In England, market liberalisation drives a sharp reduction in agricultural support payments, which are refocused on strategic priorities such as domestic food production and critical supply chain protection. Scotland maintains a centrally coordinated, state-led agricultural system centred on national food security, with significant investment in livestock and food processing infrastructure. Wales adopts a hybrid governance model, with more state intervention than England but less than Scotland, blending public investment with market incentives to support food production. In Northern Ireland, the government maintains and expands investment and agricultural support payments to support rural stability and food security.

These diverging strategies create an uneven policy landscape. Farmers across the UK face increasingly different levels of support, regulation, and market access. Inter-UK trade and livestock movements are further disrupted by stricter internal border controls, complicating supply chains and exacerbating regional disparities.

By 2040, public services such as the National Health Service (NHS) experience severe decline due to prolonged underfunding. Meanwhile, rising food prices and supply instability prompt the rollback of remaining environmental and safety regulations, as governments prioritise domestic resource extraction and food production. Restrictions such as Nitrate Vulnerable Zones are abolished to permit increased agrochemical use, while food safety and animal welfare standards are also progressively weakened.

By the middle of the century, the UK begins to unravel politically. Scotland declares independence triggering the eventual dissolution of the UK. This fragmentation coincides with deepening global instability, as rising international tensions escalate into military conflicts, including in parts of Europe. Trade barriers and geopolitical rivalries severely limit access to international markets. Any remaining public and private spending on research, development, and infrastructure declines sharply in the second half of the century as economic resources are diverted to immediate security concerns and defence is prioritised over education, healthcare, and environmental protection. Rural areas suffer from severe service cuts as large parts of the population migrate toward cities in search of work and stability.

As governance structures and international cooperation decline, biosecurity measures weaken and communication between regions becomes sporadic and unreliable. This breakdown enables the spread of livestock diseases across borders, with limited coordinated response and

ineffective containment strategies. Without clear oversight or rapid information sharing, outbreaks become more frequent and severe.

By 2070, a weakening of effective national governance leads to the rise of alternative power structures that begin to exert control over land, food systems, and natural resources. Political and social institutions fragment, and overall institutional capacity declines sharply. Competition for land intensifies, driving local conflicts and displacement. Traditional governance mechanisms, including police and justice systems collapse, while public participation in decision-making completely diminishes.

By the end of the century, institutions in the UK have largely collapsed, leaving little to no effective governance or coordinated responses to challenges. The UK faces an unstable future marked by persistent food insecurity, widespread malnutrition, and deepening social inequalities. Resource scarcity fuels tensions and localised conflicts. Inequalities continue to worsen, and public services break down entirely.

Society and Diet

Up to 2040, society becomes increasingly fragmented, with growing tensions over food access and governance. The withdrawal of multinational agri-food corporations from the UK drives up food prices as supply chains take time to adjust towards domestic production. Trade barriers and rising input costs limit food variety and availability, increasingly making fresh and diverse foods harder to access. Processed products become more relied upon, due to being easier to produce, store, and distribute within constrained supply chains, and they are cheaper for consumers. This leads to worsening nutritional outcomes, with rising diet-related diseases. Food safety standards weaken, and the already underfunded NHS struggles to manage the increasing public health burden. Social inequalities deepen as vulnerable populations face greater food insecurity and poorer diet quality.

Animal-source food availability gradually declines due to disruptions in international trade, and eventually also problems with inter-UK trade and livestock movement, as well as livestock feed shortages. While meat is still consumed, unprocessed cuts increasingly become a luxury. Overall consumption of all meat types falls. Processed products, especially chicken- and pork-based, including reconstituted or scrap-derived forms, dominate the remaining supply because they are cheaper to produce, have longer shelf lives, and can be manufactured using lower-grade inputs and by-products. These products remain relatively cheap and available, but overall consumption still declines as household incomes fall. Sheep meat and beef intake drops more sharply due to higher costs and fragile supply chains, although those in remote rural areas closer to production still consume them, though increasingly as a luxury. Egg and dairy consumption decline gradually, becoming less affordable and less available, leading many to rely on processed or powdered alternatives where possible. Fish consumption declines due to

international tensions over maritime access and ocean degradation, and declining investment in aquaculture infrastructure.

By 2040, a growing number of people migrate to urban centres in search of work as rural livelihoods decline and essential services are increasingly withdrawn. However, intense competition for limited employment opportunities leads to widespread exploitation, informal, precarious work, and falling wages. Many struggle to secure stable incomes, and urban poverty deepens. Overstretched housing, transport, and public services in cities add to the pressures, fuelling social tensions, community breakdown, and rising crime rates. Meanwhile, rural areas face depopulation and neglect, with shrinking communities and collapsing local economies.

Between 2040 and 2070, social cohesion continues to deteriorate. Rural communities increasingly rely on informal economies and alternative sources of sustenance, such as hunting and fishing, while food and resources become points for conflict. Inequalities widen sharply as education and healthcare systems collapse, and the breakdown of public services deepens social unrest. Declining agricultural yields due to environmental degradation and disease outbreaks reduce food availability, leading to rising malnutrition and mortality rates. A growing dependence on domestic food supplies necessitates the minimisation of waste, with preservation methods, such as drying and storing, becoming essential.

Urban areas become increasingly overcrowded, further straining basic services and fuelling unrest. By the mid-century, the NHS collapses following decades of underinvestment and shortages of skilled staff. Poor living and working conditions cause a sharp decline in public health and the return of previously controlled diseases, leading to a population decline in the UK. The collapse of formal governance structures leads to a rise in informal economies. In some communities, this shift promotes local resilience and creative forms of self-sufficiency. However, in most, it deepens social divisions and economic insecurity, entrenching inequality and competition over scarce resources.

By 2070, the combined effects of environmental degradation and the breakdown of institutions, results in widespread food shortages and malnutrition. Many return to rural areas to adopt subsistence lifestyles, growing their own food and raising their own animals. While some communities succeed in building small-scale, locally adapted food systems, most struggle due to poor soil, lack of knowledge, or social fragmentation. Land value rises sharply, fuelling competition and causing local conflicts over access. Animal-source food consumption becomes mostly constrained to produce from species that are easier to rear, such as poultry, pigs, and small ruminants, though overall intake remains low due to limits on feed availability and degraded forage. Locally caught fish provide limited but vital nutrition for some communities.

By 2100, most people live in poor conditions and learn to live with less. Food systems have become highly localised and fragile, relying almost entirely on subsistence arable farming and

small-scale livestock rearing. Livestock numbers are greatly reduced, with only hardy, low-input species maintained for meat, milk, and labour. A small number of communities manage to maintain food access through strong local networks and accumulated knowledge, but most continue to struggle with chronic food insecurity, poor nutrition, and the health and social consequences that follow.

Production Systems and Land Use

Up to 2040, UK livestock production is increasingly affected by geopolitical instability, collapsing international trade, and growing domestic food security concerns. Production problems in the sector begin to emerge due to rising input costs, feed shortages, and disruptions to supply chains. As urban sprawl encroaches on farmland, there is a general trend toward intensification to maximise output on the remaining agricultural land, especially for monogastric systems. Environmental protection is deprioritised across all nations in favour of maintaining food production. Regulatory barriers are gradually dismantled to increase output, driving greater use of agrochemicals and genetically modified organisms, while food standards also decline. Selective breeding of livestock for productivity and efficiency accelerates alongside genetic technologies, aiming to maximise output amid growing pressures.

With multinational corporations withdrawing from UK agri-food markets, national and regional governments adopt divergent strategies in attempt to stabilise supply. In England, market liberalisation drives rapid intensification and consolidation in the livestock sector. Larger enterprises, backed by domestic investors, dominate, especially in lowland areas with strong market access, where logistics and processing infrastructure expand to meet increasing demand for cheap processed foods. Many producers focus on efficient monogastric systems such as poultry and pigs, utilising intensive housing systems and increasing emphasis on domestic feed production to maintain efficiency amid declining imports. While semi-intensive ruminant production grows in certain areas, less productive regions are deprioritised, particularly for larger commercial operations.

During this period, Scotland's centrally coordinated agricultural system supports livestock production through investments in infrastructure, processing, and support payments. Extensive ruminant systems continue in upland and marginal areas like the Highlands, Islands, and Southern Uplands, relying on natural forage and hardy breeds to reduce inputs needed. Meanwhile, monogastric production intensifies in the Central Belt and eastern and southern Scotland, backed by government investment.

In Wales, production systems vary between upland and lowland regions. In the northern and central uplands, extensive sheep grazing persists, initially supported by public payments to sustain rural livelihoods and output. Meanwhile, the more productive lowlands in the south and southeast shift towards intensified livestock farming, with increased investment in infrastructure and supply chains. These changes are driven by a mix of public spending and

market forces, encouraging agribusiness growth and the expansion of processing facilities to secure domestic food supplies.

In Northern Ireland, the livestock sector becomes heavily supported by targeted government investment and coordinated efforts to encourage domestic food and feed production and integrate supply chains to maintain food security. Extensive grazing continues in upland and remote western areas, while intensive pig and poultry production expands in the east and southeast, near major processing centres. These regions see a shift toward large-scale, industrial agriculture, leading to the displacement of smaller farms.

However, by 2040, livestock production across all four UK nations faces escalating systemic pressures. Rising costs, supply disruptions, and the prioritisation of crops for human food over animal feed severely limits feed availability. This leads to increasing reliance on alternative feeds such as insects and waste streams. At the same time, processing facilities increasingly focus on utilising by-products and scraps from livestock and crop production to maximise food availability. These challenges are compounded by escalating national security demands amid rising conflict that redirect much public spending away from agricultural support and innovation. Consequently, productivity declines, and research and innovation stagnate. Progress in plant-based and cultured meat development stalls due to a lack of funding. Investment and infrastructure for aquaculture also decline, while wild fishing suffers from low regulation, high ocean degradation, and declining stocks.

The relaxation of environmental regulations during this period leads to soil degradation, water pollution, and biodiversity loss. At the same time, antimicrobial resistance intensifies as prophylactic antibiotic use becomes more common, driven by weakened biosecurity measures and a lack of international coordination on disease control. As resistance grows, livestock diseases spread more easily, resulting in significant setbacks to production and heightened risks to human health.

From 2040 to 2070, domestic food demand continues to rise due to declining imports, driving greater prioritisation of agricultural land use across the UK amid increasing competition from urban expansion and other land pressures. In some regions, intensive systems remain dominant but grow increasingly vulnerable due to resource shortages, infrastructure decay, and water scarcity. Elsewhere, particularly in rural and marginal areas, there is a gradual shift toward more fragmented, low-input, and subsistence-based livestock systems, relying on hardier breeds and mixed livelihood strategies such as hunting and fishing.

By mid-century, chronic underinvestment leads to the collapse of water distribution systems, causing conflicts over scarce water resources and forcing communities to rely on rainwater harvesting and reduced consumption. By 2060, agrochemical inputs become unavailable, placing further strain on both arable and animal feed production. Those working in the

livestock sector, as is also true for rest of society, face high stress and poor mental health due to social unrest, economic instability, weak support, and limited access to resources. Isolation and institutional breakdown exacerbate anxiety and feelings of helplessness.

By 2070, intensive livestock production has largely collapsed across the UK. Many return to rural areas to produce their own food, driven by the breakdown of formal supply chains and persistent food insecurity. The majority rely on subsistence farming, focusing on arable and easy-to-rear animals such as poultry, pigs, and small ruminants, while informal economies become vital for survival. Although lower-input farming systems ease some environmental pressures, the cumulative damage to soil, water, and biodiversity in previous decades remains severe. This results in unstable and unpredictable yields, increasing expansion and competition for land. Meanwhile, energy systems revert to traditional sources like coal and wood, increasing pressure on natural resources and exacerbating some environmental degradation.

By 2100, livestock production has drastically declined and become highly localised, with most systems operating at a subsistence level. Formerly intensive operations have been abandoned, replaced by low-input, labour-intensive practices. Yields are minimal and unpredictable due to degraded soils and limited resources. Increasing competition for land, combined with social instability and the collapse of formal agricultural systems, has severely constrained production capacity, leading to chronic shortages and unstable livestock outputs.

UK-Livestock-SSP3: Regional Rivalry

Accelerated soil degradation, pollution, and biodiversity loss

Food safety standards erode

Informal economies emerge as rural communities struggle

Urban sprawl encroaches on farmland; land competition fuels unrest

Environmental regulations removed to enable increased domestic resource use

Public health declines as food security deteriorates for many

Collapse of infrastructure and the breakdown of public services increases social divides and poverty

Environmental degradation accelerates, reducing agricultural land quality

Rising international tensions and protectionist policies lead to sector fragmentation

Devolved nations diverge with poor coordination weakening resilience

Meat increasingly becomes a luxury as availability declines due to trade barriers and rising costs

Sector vulnerable to resource shortages, disease, and political unrest

Trade barriers increase subsistence and self-sufficiency but heighten supply risks

Diverging policies and weakened governance stifle innovation and crisis response

Fragmented policies and trade limits reduce food variety, worsening nutrition

Increasing regional inequalities

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UK-Livestock-SSP4: Inequality

An elite-driven pathway marked by high-tech agricultural innovation alongside widespread inequality, facing low to medium climate mitigation challenges but high adaptation challenges.

Abstract

The UK's focus on economic growth through decentralisation promotes technological innovation in agriculture and the livestock sector but drives growing monopolistic power in the agri-food sector and exacerbates inequality. The National Strategy Development Plan supports automation, green energy, and precision technologies in farming, leading to growth but concentrating wealth and land in the hands of a few large agribusinesses and multinational food corporations. As highly efficient, industrialised farming expands, smaller, family-owned farms are increasingly displaced or consolidated into larger operations. This contributes to widening inequalities and rural-urban divides, as investment and opportunities concentrate in urban centres and large farms. Social inequalities intensify, with market power, political influence, and resources concentrated among corporate elites, while a growing number of producers and workers face increasingly precarious conditions. Diets diverge, with the elite accessing high-quality, diverse foods while the masses rely increasingly on processed, nutritionally poor foods. While public and private investment focuses on efficiency, clean energy, and productivity, the intensification of livestock systems also contributes to soil degradation, water pollution, and biodiversity loss. Later in the century, as environmental regulations weaken, agribusinesses adopt sustainability practices only when they serve commercial interests.

Full Narrative

Governance

Up to 2040, the UK prioritises economic growth through decentralisation plans that promote low-carbon business opportunities, including within the agricultural and livestock sectors. The National Strategy Development Plan drives technological innovation and entrepreneurship, with increased investment in STEM subjects in the educational curriculum, and high government funding for research and development. The UK promotes itself as a leader in the green transition to gain public and international support. However, policies increasingly favour large corporations as the primary drivers of growth, cementing their influence over markets, policymaking, and regulatory systems. Public participation in decision-making begins to decline, and social inequalities deepen both across and within UK nations, leaving many communities feeling disengaged and disempowered.

Government support payments to landowners, including those for ecosystem services, are phased out across all UK nations, aiming to promote a more efficient, technology-driven, and profit-oriented agricultural sector. Instead, public and private investment focuses on

supporting technological innovation and emerging agri-tech solutions. At the same time, environmental protection weakens as governments prioritise business interests and economic growth. Although the number of land-use regulations initially increases up to 2040, these largely serve corporate interests, with agribusiness and allied industries exerting monopolistic influence over their design and implementation. Meanwhile, public protected areas decline, and organisations like the National Trust are gradually privatised.

By the 2040s, the UK government and businesses have collaborated closely for several decades, with public-private partnerships and a handful of powerful multinational corporations dominating entire supply chains, from input provision to retail. The private sector increasingly takes over much of the spending on technological development. Access to public land declines as more is transferred into private ownership or consolidated by large operations. By the 2050s, nearly all farmland is owned by corporations. The dominance of larger companies in food production also leads to an increase in international trade.

From 2040 to 2070, government investment in education and health declines, becoming increasingly privatised. Living conditions worsen for the majority as access to quality services becomes more unequal. By the 2060s, the welfare state has been fully dismantled. By 2070, the health service is fully privatised, and access to high-quality education is also privatised. Public participation in governance continues to decline, as the power of corporate elites increases. The growing power of large agribusinesses, backed by free-market policies, drives increased land acquisition for intensive farming infrastructure and related developments.

From 2070 onwards, governance in the UK continues to prioritise corporate-led growth, further consolidating power among agribusiness and technology giants. The state no longer plays a meaningful role in supporting public good. Instead, regulatory systems are designed primarily to protect commercial interests. Public participation in land-use and food system decision-making is negligible, and rural communities have little recourse to challenge corporate activity. Beyond the low-carbon transition, other escalating environmental challenges, such as biodiversity loss and soil degradation, are addressed only when doing so aligns with corporate interests.

By 2100, the UK functions as a decentralised corporate state, where the primary role of governance is to enable investment, enforce order, and protect commercial interests. Power is highly concentrated in a small number of corporate conglomerates, with limited democratic oversight. The absence of a welfare state and the elimination of public agricultural support have entrenched deep inequalities, both within the agricultural sector and across wider society.

Society and Diet

From the present day, increasing economic prosperity for some, driven by the National Strategy Development Plan, initially increases overall demand for goods and food. Early increases,

however, mask deepening inequality. By 2040, rising inequality and prices push much of the population toward cheaper, highly processed diets with lower nutritional value. Consumption shifts toward affordable staples and processed meats like poultry and pork, while beef and sheep meat consumption decline due to higher costs, slightly reducing the overall per capita meat consumption. Dairy consumption declines as fresh milk and dairy products become less affordable, while egg consumption remains stable due to low-cost intensive production keeping them an accessible protein source. Low-cost plant-based foods also gain popularity as alternatives. In contrast, high-income groups continue to access prime cuts, high-quality fish, and local or exotic artisanal products, which become increasingly out of reach for many households. Despite advances in technology, cultured meat initially remains a niche product, largely confined to wealthier consumers due to high costs. Food waste decreases in low-income households due to economic pressures but remains high among the wealthy.

The dominance of corporate actors in food governance and marketing begins to entrench public disillusionment and disengagement from environmental and sustainability issues. For most, the priority remains access to affordable food. Society becomes increasingly characterised by individualism and decreasing opportunities, and migration to cities increases as people compete for a shrinking number of jobs. Meanwhile, infrastructure in remote rural areas, especially where corporate interest is low, deteriorates, accelerating urban migration and increasingly disconnecting consumers from agriculture and rural life.

Between 2040 and 2070, inequality deepens across the UK, with southeast England, especially London, firmly established as a wealthy hub tied to government and corporate power. Inter-regional, intra-regional and rural-urban divides widen, reflecting growing disparities not only between but also within urban and rural areas. In rural regions, high-tech agriculture drives economic growth but intensifies inequality as large agribusinesses consolidate land ownership. The mental health of many farmers and rural workers deteriorates due to increasing economic pressures, social isolation, and uncertainty about the future.

By the 2050s, growing inequities in healthcare, education, and social services deepen rural disparities, as automation and efficiency gains in agriculture reduce jobs, driving outmigration and community decline. Meanwhile, skilled workers emigrate abroad in search of better opportunities, causing a slight population decline. The gradual erosion of the welfare state culminates in its complete dismantling by the 2060s. High supermarket power and influence dictate food prices and availability as retail markets consolidate under a few dominant chains. Reduced purchasing power for the majority leads to declining living standards, limited access to quality food, and high levels of food insecurity, further deepening socio-economic divides and worsening health outcomes.

As technologies mature and costs fall, cultured meat production expands significantly in the 2050s. This creates a divergence in consumption patterns: the price of conventional animal-

source foods rises, transforming them into premium products and reducing their overall consumption, while affordable cultured meat becomes increasingly accessible to many. Later in the century, processed alternative proteins also gain wider acceptance due to their affordability and marketing by multinational corporations, but concerns emerge around their health impacts. The poorest populations remain largely unable to access even the cheaper cultured meat or alternative proteins and instead rely on low-cost, nutritionally poor staple foods and limited fresh produce.

From 2070, inequalities deepen as rigid social structures and exclusive gated communities create physical and social divides between the elite and others. Poor living conditions expose most residents to frequent disease outbreaks. Diets worsen among disadvantaged groups due to limited access to healthy food. The health service becomes fully privatised and accessible only to those who can afford it. Most jobs are low-paid, with a highly mobile workforce chasing job opportunities that keep wages low and job competition high.

By the end of the century, society is deeply divided. Most people face low incomes, poor health, and limited access to nutritious food. In contrast, the wealthy elite maintain diets rich in fresh fruits, vegetables, and high-quality animal-source foods. Rising unrest places growing pressure on the police, prompting governments to introduce military conscription to maintain control.

Production Systems and Land Use

Up to 2040, the livestock sector prioritises high-tech solutions as part of a so-called green transition. However, the focus remains on energy, efficiency, and economic growth, driving advances in renewables, carbon capture, and clean technologies, while attention to natural resources, soil health, water, and biodiversity remains limited. Following the removal of all government agricultural support payments, land use shifts and pressures intensify. Less productive and less profitable land near urban areas is converted to housing, some high-quality arable land is redirected toward bioenergy crops, and marginal land is increasingly afforested for biomass harvesting. Large-scale renewable energy projects also occupy significant areas.

As land pressures and environmental degradation grow, many livestock farms intensify, while extensive grazing persists on some remaining marginal lands, and nearly all available land is used to sustain a stable food supply. Public and private funding increasingly favours large intensive operations, leading to the dominance of industrial-scale farms by 2040 and accelerating market concentration. This shift pushes many smaller farms to consolidate, form co-operatives, or exit the sector as agribusinesses expand their landholdings. Strong incentives and weakening regulatory barriers encourage innovation in gene editing, producing more disease-resistant, high-yielding animals, alongside selective breeding livestock for low-input efficiency and resilience. Emissions intensity of animals gradually declines due to improved genetics, precision feeding, and enhanced manure management. Energy-efficient technologies and machinery become increasingly powered by renewable-sourced electricity.

Despite some technological advancements, intensification places considerable strain on water resources due to the high demands of intensive livestock systems and their contribution to nutrient runoff and river pollution, particularly from slurry. High stocking densities and continuous feed cropping compact soils, reduce organic matter, and degrade soil structure. Intensive land use, large-scale housing, and simplified feed production reduce on-farm biodiversity, while reliance on imported feed drives habitat loss abroad. Concerns about zoonotic diseases also rise as confined, intensified production increases transmission risks. Although antibiotic regulations are eased, advances in genetics and precision technologies enable more efficient, targeted use, reducing some reliance. Meanwhile, animal welfare in intensified systems presents a complex picture: higher stocking densities and fewer farmers per animal limit attentive care, while precision technologies support monitoring and treatment. However, welfare is increasingly deprioritised unless it improves productivity, with broader wellbeing often overlooked in favour of output-focused measures.

Up to 2040, monogastric livestock production grows, driven by demand for lower-cost products. Intensive poultry and pig operations expand rapidly within large, vertically integrated systems, especially in eastern and southern England, hubs of economic activity with existing infrastructure, supply chains, and access to major markets. Though a large proportion of feed is imported, declining soil quality and land pressures threaten both domestic production and import reliability, raising feed shortage risks. Production systems prioritise feed efficiency, rapid growth, and year-round output to reduce inputs and costs. Supply chains centralise, using automation and advanced processing to cut labour costs and increase throughput. Production increasingly focuses on processing lower-value cuts into affordable, convenient produce.

Ruminant production declines slightly but continues despite land-use pressures. Extensive grazing persists on marginal land not used for forestry or biomass, particularly in the Highlands of Scotland, the Welsh hills, and northern England, where large agribusinesses increasingly manage land. Semi-intensive dairy systems, combining grazing with supplementary feeding and supplying male calves for beef finishing, continue to dominate regions such as the South West of England and Wales, the West Midlands, and parts of Scotland and Northern Ireland. Although domestic beef and lamb consumption falls, overall production declines only modestly due to exports of high-quality cuts and a niche domestic market for premium local meat.

Meanwhile, policy and investment also accelerate development of ‘landless’ farming methods, including hydroponics and vertical farming, which carve out a niche in urban areas where land is scarce. Aquaculture also grows steadily, while wild fishing decline due to ocean degradation. A small premium market for wild seafood remains for wealthy consumers.

Between 2040 and 2070, corporate control over supply chains tightens, with vertically integrated agribusinesses dictating prices and contractual terms in ways that stifle competition

and reinforce dependency on a few dominant buyers. This increased concentration of ownership leads to reduced competition, lower prices for producers, and lowering food standards. In addition, the growing reliance on data-driven and AI-powered farm management further widens the gap between large, well-capitalised operations and smaller farms. Control over data infrastructure deepens technology access inequalities and market power gaps.

From the 2050s, cultured meat and plant-based alternatives become more affordable and widespread due to increased investment in alternative protein processing. Overall livestock numbers decline, especially in monogastric sectors easily replaced by cultured products, while ruminant production shifts to luxury markets supported by premium feed and quality. Productive land previously used for feed or livestock is gradually converted to arable use, with urban and controlled-environment agriculture also expanding to meet demand. Meanwhile, weakened regulations and reduced monitoring allow continued agrochemical use for arable and animal feed production, though innovations like precision application, organic waste recycling, and soil sensors improve efficiency as rising costs encourage careful use.

By 2070, cultured meat and plant-based alternatives further reduce demand for conventionally produced animal-source foods, especially milk and monogastric meat. Fewer intensive operations remain, facing lower demand, feed shortages, and rising costs. Large-scale alternative protein facilities expand under multinational control. More land shifts to plant-protein crops despite soil degradation, while algae and fungi cultivation grow in controlled environments. Extensive ruminant grazing continues as a niche for high-value local products, supported by eased land pressures from reduced livestock, urban food production, and less bioenergy cropping. Other land is repurposed for tourism and elite recreation.

By 2100, agri-food systems are highly productive and technologically advanced, but these gains come at the cost of deepening social inequalities and environmental degradation. Livestock production persists on a smaller scale, focused primarily on high-value markets. Much of the land formerly used for livestock has been repurposed for alternative protein production, renewable energy projects, and other commercial uses. Urban agriculture continues to expand, while cultured meat and plant-based processing facilities dominate agri-industrial zones, supported by highly efficient supply chains.

UK-Livestock-SSP4: Inequality

Large agribusinesses control most farmland

Some farmland is repurposed for housing and bioenergy

Biodiversity loss and soil depletion increase despite technological advances

Relaxation of antibiotic rules raises antimicrobial resistance concerns, but innovation reduces some reliance

Reliance on agrochemicals grows but technology increases their efficiency

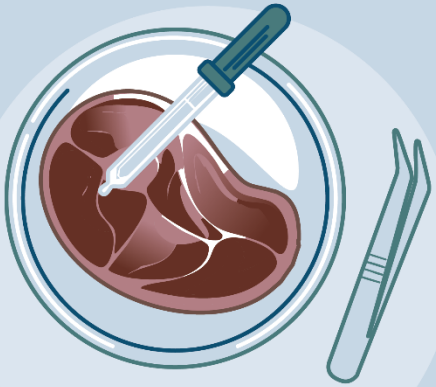
Intensive farming expands, with extensive systems primarily occupying marginal lands

Automation, precision farming, and breeding drive productivity gains

Animal welfare declines in priority, despite developments in precision care

Economic growth driven by decentralisation and promotion of agri-tech

Absence of agricultural support increases financial uncertainty



Meat consumption drops initially but rebounds with cheaper cultured meat

Inequalities deepen, rural-urban gap widens

Corporate control over supply chains and food marketing

Small farms struggle, many close, others consolidate to survive

Whole cuts of meat are increasingly a luxury; most rely on cheaper processed options

Agricultural jobs decline due to automation and changing labour demands

This research is part of the TRAnsforming the DEbate about livestock systems transformation (TRADE) project, funded under UKRI grant number BB/W018152/1.

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UK-SSP5: Fossil-Fuelled Development

A tech-optimistic, high-growth, and emission-heavy pathway with rapid livestock intensification, leading to high mitigation challenges but low to medium adaptation challenges.

Abstract

The UK's livestock sector undergoes rapid intensification driven by fossil-fuelled economic growth, cheap domestic energy, and technological innovation, especially in lowland regions, as environmental protections weaken and agri-environmental schemes are dismantled. Large-scale, energy-intensive production systems sustains high output for several decades, masking growing environmental degradation including biodiversity loss, soil depletion, and water stress. Despite precision advances, animal welfare is deprioritised unless it enhances productivity, while antimicrobial resistance rises, partly offset by genetic and technological innovations. The UK's reliance on food imports heightens vulnerability to global supply disruptions, though high incomes shield many consumers from immediate shocks. Economic growth supports sustained public investment in services, reducing many social inequalities, especially in urban areas, though rapid city expansion and reduced rural investment contribute to some regional disparities. Diets remain rich in animal-source foods, and with high incomes, overconsumption exacerbates public health problems. Towards the century's end, cultured meat and plant-based alternatives gradually replace some animal-source foods. By 2100, technological solutions fail to prevent widespread ecological decline, exposing deep vulnerabilities in UK society, food systems, and the livestock sector.

Full Narrative

Governance

A series of shocks in international financial services reduces public support for carbon taxes and green infrastructure, resulting in continued reliance on cheaper, readily available fossil fuels. Public support for a strong production sector, especially livestock, driven by its role in job creation, rural livelihoods, and economic stability, shapes government policies that prioritise growth and economic opportunity. By 2040, this drives increased fossil fuel use, including new oil and gas extraction in the North Sea and shale gas production in northern England, with direct impacts on the livestock sector through greater dependence on fossil fuel-based inputs.

To meet rising demands for food and resources, UK governance prioritises technological intensification, especially in the livestock sector. Policies favour large-scale, energy-efficient operations while rolling back agri-environmental schemes and weakening environmental protections. Regulatory oversight of pollution, land use, and water stress is reduced, enabling the conversion of sensitive areas to production. Dedicated support for renewable energy is largely absent, with policy instead promoting technological upgrades that increase

productivity. The UK withdraws from international commitments like the Paris Agreement, and fails to enforce emissions targets.

The government strongly promotes international trade, encouraging growth in the livestock sector through trade liberalisation and integration into global multilateral trading systems that reduce barriers to disruptive technologies. Public and private investment accelerates precision livestock farming, genetic editing, and automation, increasing productivity. Meanwhile, public spending prioritises infrastructure, healthcare, education, and technology innovation to improve living standards and opportunities, strengthening the UK's global competitiveness.

Between 2040 and 2070, UK governance remains market-driven but increasingly responds to social pressures by using market tools to keep housing affordable and address other social issues. Urban areas rapidly expand into interconnected technology hubs, leading to "city-states" and widespread urban sprawl. Government intervention focuses mainly on essential services like education and healthcare to support growth and reduce some disparities. Despite low taxes, strong economic performance, including fossil fuel revenues, provides sufficient public funding to invest in social programs, improving living standards for most.

By 2070, major private corporations have come to dominate the establishment of technological, production, and trade standards within the agriculture and food sectors. This dominance drives greater market integration and intensifies competition both domestically and internationally. As a result, governance increasingly shifts toward enabling these corporate-led frameworks, prioritising regulatory alignment and creating conditions that support innovation and competitiveness in a globalised market.

From 2070 onwards, rising energy demand and shrinking shale gas supplies push fossil fuel prices higher. UK policies continue to support innovation, maintaining competitiveness in technology and manufacturing sectors, which remain export-driven. Strategic investments ensure ongoing access to global fossil fuel markets, helping to mitigate some peak oil impacts.

By 2100, a handful of large international high-tech corporations dominate the agricultural and food technology sectors, controlling most innovation, production, and distribution. These companies have significant influence over global supply chains, standards, and market access, shaping the future of food systems worldwide.

Society and Diet

Society holds strong faith in technological and economic progress to solve food security and environmental challenges, leading both the public and the food industry to pay little attention to sustainability concerns. Up to 2040, lower unemployment and increased public revenue drive greater investment in healthcare and education, improving overall health and life expectancy. Universities, especially those leading in STEM subjects, grow in importance as more young people pursue higher education to meet the demand for skilled workers. Rising

incomes and lower energy costs further increase consumer spending, driving greater demand for goods and food in line with the national plan. Meanwhile, fossil fuel development in northern parts of the UK helps ease the North-South divide.

Diets continue to be rich in animal-source foods, with a slight increase in overall consumption. Meanwhile, cultured meat and plant-based alternatives begin to gain market share. Rising disposable incomes increase demand for a wider variety of foods, including exotic superfoods and nutrient-rich options, which drives an increase in food imports. Meanwhile, fish consumption rises slightly, with wild-caught preferred by the wealthy and aquaculture products meeting most other demand. While global shocks impact food systems, high incomes enable most consumers to absorb short-term price spikes with little disruption.

Rapid urban expansion is fuelled by strong growth in technology, manufacturing, and energy sectors, combined with high population growth and relaxed planning regulations. This growth, however, weakens the connection between food production and the wider society as urbanisation increases the physical distance between farms and areas of consumption.

Between 2040 and 2070, urbanisation accelerates further across UK city-states and sprawling metropolitan areas that become key economic hubs. Population growth continues, supported by rising international immigration. Urban living spaces focus on maintaining the appearance of biodiversity, landscape features, and recreational areas, prioritising aesthetics over genuine concern or action to protect biodiversity, especially in rural areas and globally.

A well-educated and prosperous population drives rapid economic growth in urban areas, resulting in low unemployment and greater equality of opportunity within key UK cities. Social and technical infrastructure develops swiftly to meet the needs of a growing population and expanding urbanisation, creating more job opportunities. In contrast, remote rural areas experience population decline and some experience a slight decline in quality of life, as public investment in these regions is deprioritised. These regions face reduced services and opportunities, deepening some regional inequalities. Only rural areas connected to metropolitan supply chains maintain better infrastructure and economic prospects, highlighting widening divides between connected and isolated communities.

The UK remains a highly consumerist society, marked by increasingly individualistic lifestyles and a weakened sense of community. Reduction of food waste is not a priority for most, and environmental concerns play a minimal role in food choices. For the majority, price and quality are the key factors influencing what they buy. Animal-source foods remain a dominant part of diets, alongside a growing consumption of exotic imported foods. While cultured meat and plant-based protein markets expand, these products coexist alongside conventionally produced animal-source foods, which remains popular. Food choices become ever more focused on novelty and personalisation, enabled by technology that tailor diets to individual

preferences and health needs. However, rising health issues linked to overconsumption of food and also air pollution contribute to a surge in heart disease, diabetes, respiratory illnesses, and other chronic conditions. Significant investment in the National Health Service, alongside advances in medical technology, helps to alleviate some, but not all, of these health challenges.

From 2070 onwards, UK cities continue to expand, driven by an influx of highly skilled migrants attracted by vibrant economic opportunities and advanced urban infrastructures. Despite escalating environmental degradation both nationally and globally, city residents remain largely disconnected from the natural world. Nature is mostly experienced through carefully curated green spaces, which offer aesthetic and recreational value but reinforce a sense of separation from ecological realities.

High incomes and low unemployment underpin lifestyles that remain resource-intensive and individualistic. Convenience dominates daily life, with automated home delivery and advanced online shopping services offering personalised nutrition and food options tailored by sophisticated AI systems. These technologies give consumers unprecedented control over their diets, optimising for health, taste, and novelty. Yet environmental sustainability remains a low priority for most, overshadowed by preferences for variety and convenience.

Cultured meat consumption surges, gradually overtaking some conventionally produced meat, which increasingly struggles under mounting environmental constraints. Plant-based alternatives diversify and gain popularity, aided by continual technological improvements that enhance flavour, texture, and nutritional profiles. Food culture becomes ever more experimental, with an emphasis on novel flavours and highly customised diets. Despite these advances, the environmental impact of the food system remains substantial.

Energy prices rise sharply due to reduced fossil fuel supply, but technological adaptation and economic resilience help maintain living standards for most urban dwellers. Smart grids, advanced energy storage, and energy-efficient infrastructure buffer the short-term impacts, allowing city life to continue with minimal disruption, while less-adapted rural areas struggle.

By the late 21st century, cracks begin to show beneath this seemingly prosperous surface. While economic inequality remains relatively low within metropolitan hubs, divides are growing between these urban centres and isolated rural communities facing decline and neglect. Within cities, social cohesion faces growing challenges primarily driven by cultural fragmentation. Increasingly personalised lifestyles and hyper-individualism erode shared social values and common goals, weakening the sense of community and collective responsibility. Supply chains become more volatile, with price spikes and occasional shortages that, while absorbed initially by most consumers, fuel anxieties about future security and fairness. Such disruptions reveal

the limits of technological fixes and deepen public distrust in institutions seen as failing to protect people from systemic risks.

By 2100, these trends create a UK that is highly urbanised and technologically advanced, yet increasingly divided and challenged. Vibrant cities contrast sharply with declining rural areas, where reduced services deepen the urban-rural divide. Environmental degradation intensifies, sparking debate over technology's limits. The public grows fractured, with some calling for radical change and others holding onto technological optimism.

Production Systems and Land Use

Up to 2040, urban sprawl steadily reduces agricultural land around UK cities. Competition for land also reduces forested areas as urban expansion and agriculture take priority. Livestock production intensifies across monogastric and some ruminant systems, relying more on high-input, technology-driven methods. Farm machinery remains fossil fuel-dependent, and although emissions intensity falls for some species, rising animal numbers offset these gains. Agricultural intensification also drives higher water use and increased fertiliser application.

Domestic feed crop yields improve overall in this period, supported by rapid technological progress and better management practices, helping to meet the growing demand to support increasingly intensive livestock production. However, the limited availability of suitable agricultural land in the UK, combined with rising competition from urban development, means that a significant proportion of feed ingredients, such as soy and maize, continues to be imported from global markets. These imports provide the protein-rich feed essential for intensive livestock systems but also expose the sector to global price volatility and supply risks.

Cultured meat and plant-based alternative production begin to scale, initially supplementing rather than replacing conventionally produced animal-source foods. These systems are largely urban and industrial, located primarily near major population centres to serve growing consumer interest and niche markets. Cultured meat production relies on bioreactors and controlled environments, demanding significant energy and resource inputs. Plant-based alternatives expand through large-scale cultivation in vertical farms, supported by advances in plant breeding and processing technologies, alongside bioprocessing facilities that maximise output and texture replication. Meanwhile, technological advances drive aquaculture growth. Wild capture fishing becomes increasingly unregulated, with market-driven priorities undermining conservation, leading to ocean degradation, overfishing and declining stocks.

From 2040, tightening global agrochemical supplies push the sector to adopt advanced feed and production strategies like advanced breeding, precision feeding, and technologies that improve nutrient efficiency. New approaches include RNA interference pesticides targeting pests genetically, engineered biologicals enhancing pest control and nutrient uptake, gene drives managing insect populations, and synthetic biology increasing nitrogen fixation to

reduce fertiliser use. However, the impacts of these technologies on the environment and human health remain unclear.

Despite technological advances, livestock systems and feed production face ongoing challenges from soil degradation, water stress, biodiversity loss, input dependence, and land-use pressures. Innovations ease some issues, but reliance on technological fixes grows, driven by confidence that future advances will sustain productivity.

By 2040, land use pressures continue with rising demand and urban expansion near major UK cities. Monogastric farms in protected lowland areas, particularly in South West England, the East Midlands, and parts of South Wales, expand with targeted investment, benefiting from existing infrastructure and proximity to demand centres. Meanwhile, some dairy-beef systems shift increasingly toward more intensive or semi-intensive models. These systems increasingly rely on feed supplements such as imported soy and regionally grown silage, with notable growth in Northern Ireland, South West Scotland, and eastern England, where land availability, suitable conditions for feed crops, and access to processing facilities support expansion.

Technological innovation enables continued intensification, maintaining high yields through advanced precision breeding enabled by 'omic' and other technologies, targeting not only productivity but also health, resilience, and efficiency as precision and genetic gain accelerate. Automation reduces labour, creating a specialised but smaller workforce. Animal welfare declines in priority, increasingly defined by productivity metrics. Precision tools support individual monitoring, but high stocking densities and fewer farmers per animal limit attentive care. Workers face growing stress from production demands, environmental degradation, and technology complexity. Despite higher wages, mental health challenges persist, especially for isolated workers.

Despite efficiency gains, these intensive systems place mounting pressure on natural resources. Water demand increases sharply, driven by both livestock and feed production, while agrochemical use and poor waste management further degrade water, soil and air quality. Precision feeding and advanced manure treatment technologies mitigate some impacts, but they fail to fully address rising nutrient pollution and long-term ecological degradation. Environmental health in lowland farming areas declines quickly.

Antibiotic use remains widespread to sustain productivity in densely stocked systems, contributing to growing antimicrobial resistance concerns. Precision care and genetics help reduce some antibiotic use, but public health concerns remain high. Densely populated livestock systems also elevate the risk of zoonotic disease transmission. While surveillance technologies and biosecurity measures are deployed to manage risks, concerns over future outbreaks persist.

The sector becomes more vulnerable to environmental degradation and resource pressures, with fluctuating feed crop yields and rising input costs undermining system stability. Technological adaptations, such as automated feeding systems, improved housing, and resilient crop varieties provide short-term relief but fail to address underlying systemic issues. Meanwhile, limited infrastructure, accessibility, and market opportunities contribute to the decline of commercial upland farming operations. Some upland areas, including culturally significant sheep systems, are retained for conservation and tourism, especially within increasingly privatised and commercially managed National Parks. Elsewhere, land is repurposed for timber production, outdoor recreation, or consolidated under large private estates, reducing space for traditional farming and accelerating rural depopulation.

Supply chains and food processing become increasingly streamlined through big data, integrated logistics, and advanced processing technologies. Consumer-facing technologies also evolve, with the rise of personalised nutrition, 3D-printed foods, and AI-curated diets delivered via automated systems. The production of cultured meat and plant-based proteins also grows steadily during this period, gradually increasing their share of total protein supply. Advances in bioprocessing efficiencies, improved energy efficiency, and scaling of plant protein crop cultivation help ease land and resource pressures, particularly around urban hubs. These alternative protein systems start to reduce demand for conventionally produced animal-source foods but do not fully replace them.

By 2070, rising energy costs place increasing pressure on all food production systems, including the highly technology-driven livestock sector. Energy-efficient infrastructure and alternative fuels help mitigate some impacts, but technological fixes alone cannot solve its deepening environmental challenges. While water availability is maintained in the short-term through abstraction and advanced treatment, ongoing soil degradation and biodiversity loss undermine long-term land productivity. The limits of the high-input, high-output model become clear, causing livestock numbers to decline due to degraded land and input constraints. Demand for cultured meat and alternative proteins rises, but cultured meat's high energy needs strain already pressured energy systems, raising concerns about its long-term sustainability.

By 2100, these pressures intensify, causing a marked drop in agricultural productivity. The sector's vulnerability to environmental degradation and resource constraints prompts renewed calls to rethink land use, diversify farming systems, and restore degraded ecosystems. Despite short-term economic gains from intensification, the unsustainable trajectory of the livestock sector becomes clear. Without strategic interventions to improve ecological resilience and regulate environmental impacts, the UK's livestock industry faces mounting risks and diminishing returns in the decades ahead.

UK-Livestock-SSP5: Fossil-fuelled Development

Increased stocking densities and automation

Relaxation of antibiotic rules raises antimicrobial resistance concerns, but innovation reduces some reliance

Technological solutions fail to prevent long-term ecological damage

Trade disruptions and supply shocks threaten food security

Animal welfare declines in priority, despite developments in precision care

Healthcare innovations improve outcomes, but diet-related diseases remain a problem

Precision farming and genetics initially boost productivity

Growing reliance on food imports exposes vulnerabilities

Weakened environmental protections and greater reliance on technology

Diets are meat-rich with rising overconsumption contributing to increasing health issues

Livestock sector intensifies with fossil-fuelled growth

Economic growth reduces inequalities, but environmental degradation threatens long-term social cohesion

Economic growth prioritised over environment, undermining long-term productivity

Cultured meat and plant-based alternatives consumed alongside conventional meat

Poorly managed high-input lowland farming degrades biodiversity, soil, and water

Urban expansion reduces farmland, accelerating intensification

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