# Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP)

## ERAMMP Technical Annex-1 Report-72TA1: ERAMMP FABLE-Wales Scenario Results Slidepack

Smith, A.[1], Harrison,.P.A.[2], Jones, S.[2,3], Leach, N.J.[1]

[1] University of Oxford, [2] UK Centre for Ecology & Hydrology, [3] Lancaster University

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Mae'r adroddiad hwn ar gael yn electronig yma / This report is available electronically at: **www.erammp.wales/72TA1**

Neu trwy sganio'r cod QR a ddangosir / Or by scanning the QR code shown.

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**Title** ERAMMP Report-72TA1: ERAMMP FABLE-WALES Scenario Results Slidepack

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**Client reference** C210/2016/2017

**UKCEH contact details** Bronwen Williams
UK Centre for Ecology & Hydrology (UKCEH), Environment Centre Wales, Deiniol Road, Bangor, Gwynedd, LL57 2UW
01248 374500
erammp@ceh.ac.uk

**Corresponding author** Paula Harrison, UKCEH
paulaharrison@ceh.ac.uk

**Authors** Alison Smith[1], Paula A. Harrison[2], Sarah Jones[2,3], Nicholas Leach[1]
[1] University of Oxford, [1] UK Centre for Ecology & Hydrology, [3] Lancaster University,

**Contributing authors & reviewers**
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**Approved by** Bridget Emmett (UKCEH)
James Skates (Welsh Government)

## Abbreviations Used in this Report

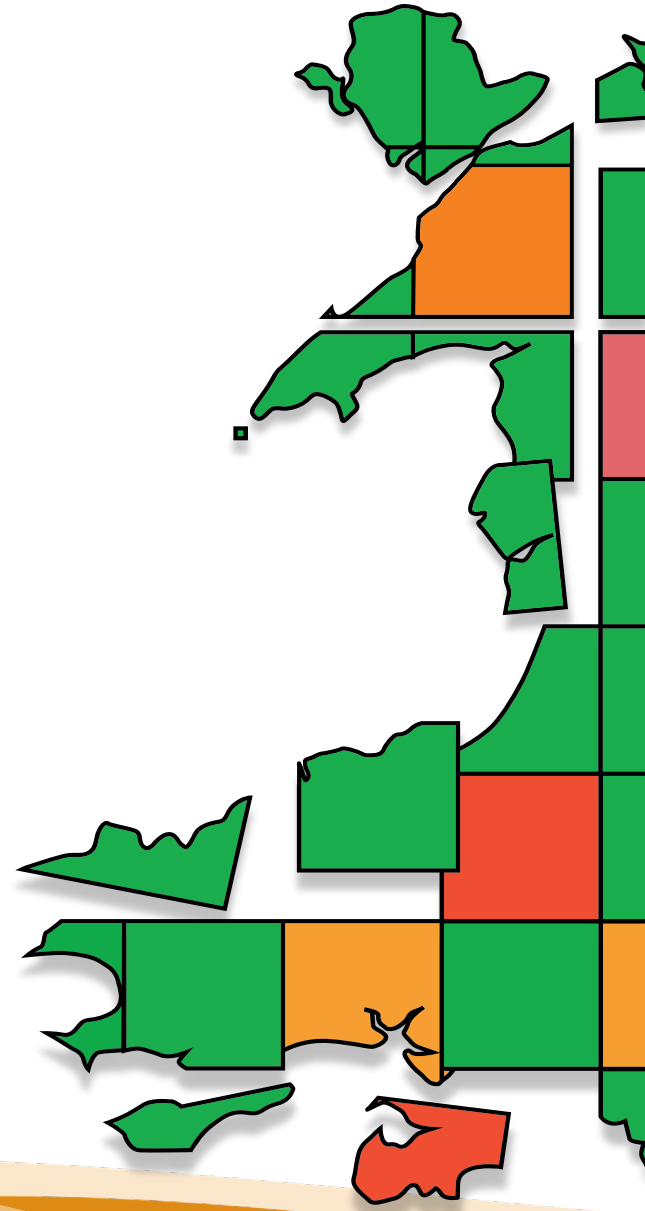
| | |
|---|---|
| AFOLU | Agriculture, Forestry & Other Land Use |
| AONB | Area of Outstanding Natural Beauty |
| CCC | UK Climate Change Committee |
| CCI | Climate Change Initiative |
| ERAMMP | Environment and Rural Affairs Monitoring & Modelling Programme |
| FABLE | Food, Agriculture, Biodiversity, Land use and Energy |
| FAOSTAT | A comprehensive digital platform of food and agriculture statistics by the Food and Agriculture Organization of the United Nations |
| GEPIC | A Crop model |
| GHG | Greenhouse Gas |
| LCM | Land Cover Map |
| LU | Land Use |
| ONS | Office for National Statistics |
| SQ | Status Quo |
| TLU | Tropical Livestock Unit |
| UKCEH | UK Centre for Ecology & Hydrology |
| WRAP | Waste and Resources Action Programme |

Abbreviations and some of the technical terms used in this report are expanded on in the programme glossaries: https://erammp.wales/en/glossary (English) and https://erammp.cymru/geirfa (Welsh)

# FABLE-Wales

## Scenario Results

Alison Smith, Paula Harrison, Sarah Jones, Nicholas Leach



FABLE The Food and Land Use Coalition
Food, Agriculture, Biodiversity, Land-use and Energy Consortium

UK Centre for Ecology & Hydrology

University of Oxford

Lancaster University

Llywodraeth Cymru Welsh Government

Canolfan Ecoleg a Hydroleg y DU
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# Description of the scenarios

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# Overview of the Scenarios

## Scenario 1 – Status Quo

- Continuing with no changes to current policies.

## Scenario 2 – Improvement on current trends

- Continued improvements in line with current trajectories, reflecting current trends in policy.

## Scenario 3 – Land Sparing

- Using sustainable intensification techniques, the land sparing pathway sees increases in production to release land from agriculture for biodiversity restoration and carbon sequestration.

## Scenario 4 – Land Sharing

- Using land management techniques, the land sharing pathways delivers biodiversity restoration, carbon sequestration and production simultaneously on the same land.

Full list of Underlying assumptions and justifications can be seen in Annex 1.

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# Scenario 1 – Status Quo

Corresponds to the lower boundary of feasible action:

- No constraints on agricultural expansion except for in protected areas (not including National Parks, AONBs and Heritage Coast)
- No deforestation of existing forest (same for all scenarios)
- Assumed 300 ha/yr of woodland creation
- Livestock and crop productivity remains the same
- No changes to post harvest losses or food waste reduction
- Peatland restoration in line with current Peatland Action Plan (600 ha/year 2020-25)
- No changes in current diet, as derived from FAOSTAT

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# Scenario 2 – Improvement on Current trends

Represents slight improvements to the current system:

- No agricultural expansion in protected areas, including National Parks, AONBs and Heritage Coasts.
- Afforestation targets of 2,000 ha/yr, rising to 4,000 ha/yr as soon as possible, planting 20,000 ha by 2030 and a further 80,000 ha by 2050.
- Crop productivity remains the same, livestock productivity for beef and poultry remains the same, dairy yield follows incremental improvements in productivity .
- Stocking density increases by 32%.
- Existing trends in food waste reduction, but no change for post harvest losses.
- Peatland restoration in line with extended Peatland Action Plan (800 ha/year 2020-35)
- Uses the same target diet as Status Quo

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# Scenario 3 – Land Sparing

Represents the policy for Wales Land Use advocated by the UKCCC. Intensifies agricultural production on the most productive land, allowing land to be released for carbon sequestration and biodiversity:

- No agricultural expansion in protected areas, including National Parks, AONBs and Heritage Coasts.
- For afforestation: 43,000 ha planted by 2030, rising to 180,000 ha by 2050.
- Crop productivity increases by 65% before accounting for climate change impacts (CCC).
- Livestock productivity increases for dairy, through improved breeding, housing, and optimising of cow diet. Beef efficiency increases. Increases in lambing rates due to sheep systems improving efficiency through technology improvements.
- Shift towards 100% of herd on intensive grassland, no extensive grassland.
- Stocking density doubles.
- Food waste: 50% reduction in avoidable food waste by 2025, 60% reduction by 2030, zero avoidable food waste by 2050.
- Post harvest losses reduced by 50% by 2050.
- Diet: population move to a healthier diet, captured as the ‘Eatwell’ diet, by 2050.
- All peatland (90,000 ha) restored to a natural state by 2030

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# Scenario 4 – Land Sharing

Land Sharing Pathway based on principles consistent with SMNR and the Environment (Wales) Act 2016, that these objectives can be tackled at the same time on the same land:

- No agricultural expansion on any existing semi-natural habitats (this allows the use of semi-natural grassland for extensive grazing). Aspiration to create 500,000ha of habitat on agricultural land (to check against model outputs).
- Afforestation and Food Waste targets the same as Land Sparing Scenario.
- Crop productivity increases by 39%.
- Livestock productivity is in line with Improvement on Current Trends Scenario, with additional increases in lambing (41%).
- Increase to 50% of herd using extensive (semi-natural) grassland (from ~25% today)
- Post harvest losses reduced by 50% by 2030.
- Diets: population move to a healthier diet, captured as the ‘Eatwell’ diet, by 2050.
- All peatland (90,000 ha) restored to a natural state by 2030

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# Disclaimer for Results

The following results are indications of how policy changes will impact land use change and diet to 2050.

- FABLE is designed to model entire countries that have a full set of FAO statistics for the commodity balance, including production, imports and exports. We have had to make assumptions to downscale these initial statistics from the UK to Wales, based on factors such as population ratio, cropland ratio, animal numbers and forest area ratio. See Annex 2 and 3 for details.
- There are limits to what FABLE can model. For example it is not currently able to model a shift towards housing more livestock indoors.
- Although some of the assumptions are still open to discussion, and improvements could be made to the model in future, we are confident in the overall messages. The slides show the level of transformational change needed to achieve a sustainable food and land use sector.

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# PART 1: Land use change

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# Summary of changes to inputs for Wales cf UK

## General

- Input CEH LCM data for Wales.
- Scaled data to match the total desired for Wales (2,077,000 ha).
- Commodity production and consumption, imports and exports downscaled from UK to Wales using assumptions.

## Grassland – Extensive vs Intensive split:

- Split the current grassland land cover class (=pasture) into two distinct types: intensive and extensive grassland.
- Intensive grassland is “Pasture” in the following slides and extensive grassland is “Extensive”

## Forest

- Divided into forest for biodiversity, and plantations. Different carbon stocks and time to regenerate.

## Peatland

- A very basic model of peatland restoration is included. All peat is divided into ‘intact’ and ‘degraded’. There is no separate treatment of peatland used for forest, grazing, etc.

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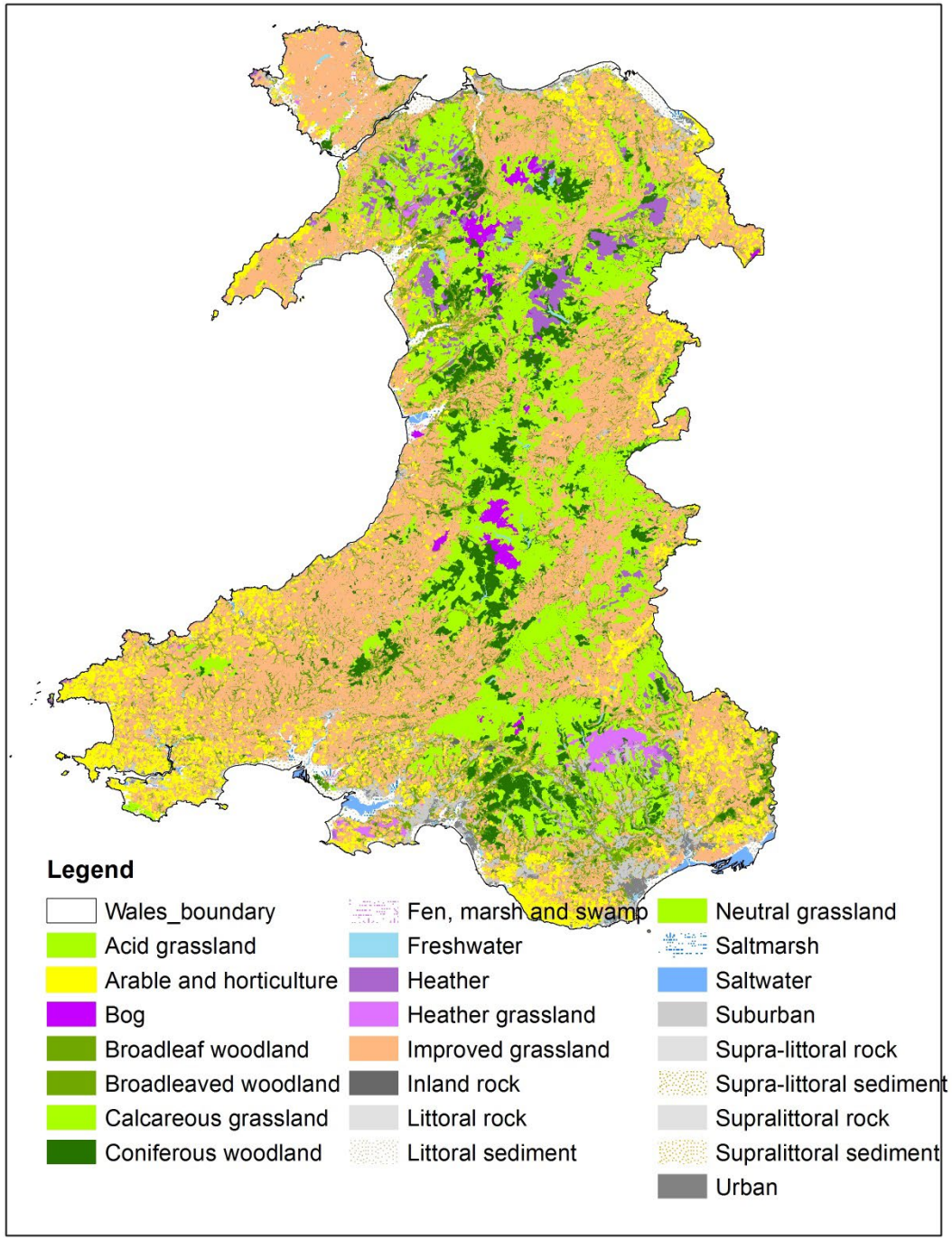
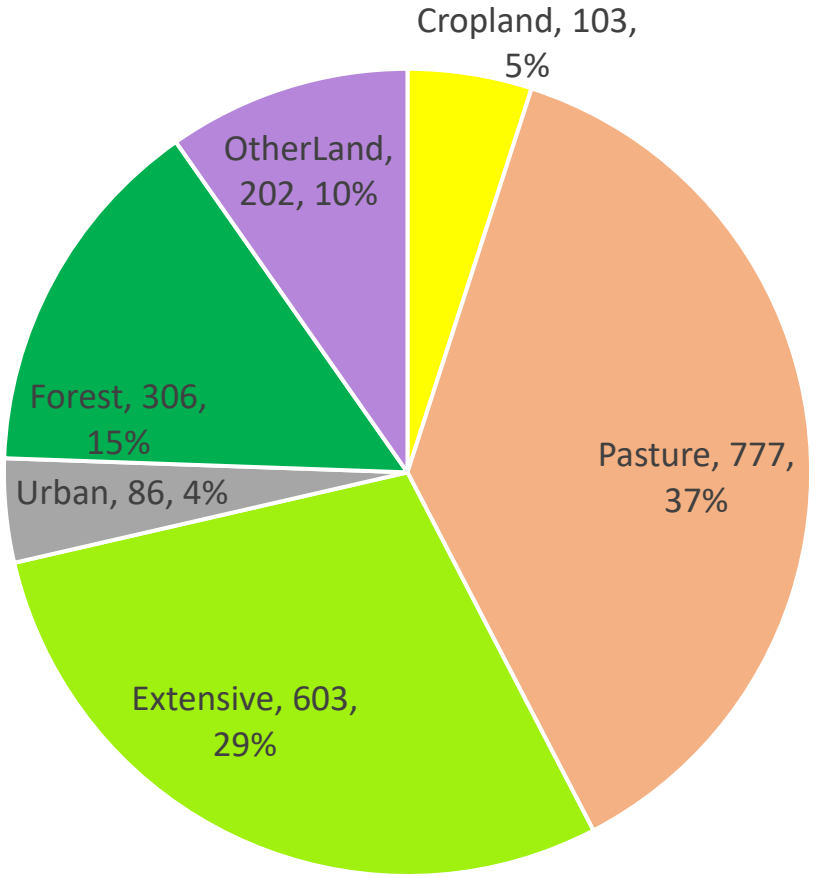
For more detailed information related to land use change calculations see Annex 2.

# Land Use from LCM 2000

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# Stocking density

| Year 2000 | Intensive grass | Extensive grass | Total or average |
|---|---|---|---|
| Area 1000 ha | 777 | 603 | 1380 |
| Stocking density assumed 2000 | **2.2** | **0.92** | **1.64** |
| 1000 TLUs if fully stocked | 1710 | 555 | **2,265** |
| Split of herd if all available area fully stocked | **75%** | **25%** | |

**1000 TLUs in 2000 should be:**

| | |
|---|---|
| In FABLE TLUS | **2,265** |
| In Welsh LUs | 1,235 |

**Average stocking density in 2000 should be:**

| | |
|---|---|
| In FABLE TLUS | **1.64** |
| In Welsh LUs (on LCM intensive & extensive grassland) | 0.89 |

**Ratio of intensive to extensive stocking density is 2.4**

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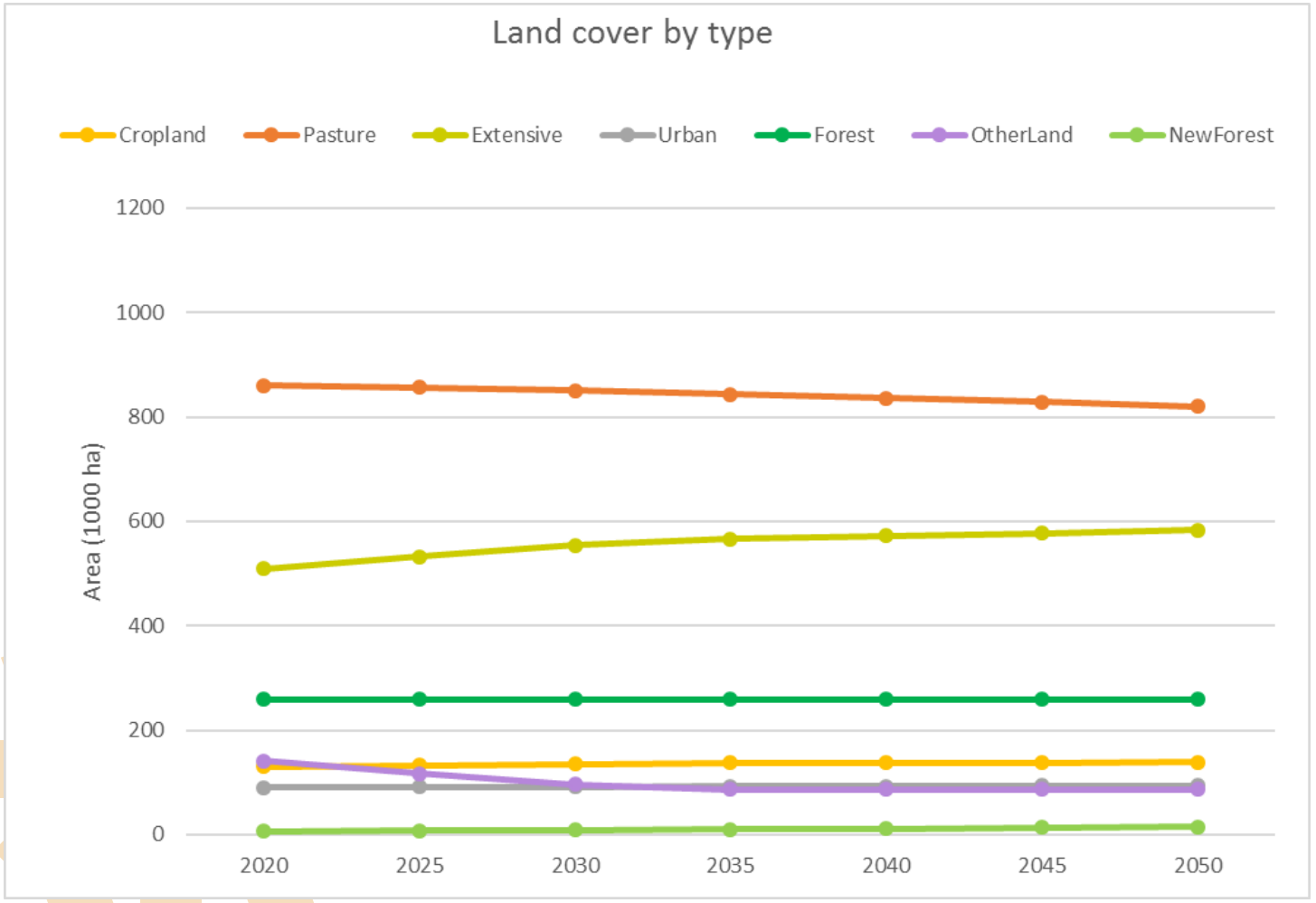
# Land Use Change – Status Quo




- The Status Quo scenario represents minimal policy changes.
- The apparent changes in the first few time periods relate partly to inconsistencies in the land cover maps.
- Total area of cropland and grazing land increases slightly in line with population growth.
- There is also a slight increase in urban area and new forest.
- These changes result in loss of natural land.
- There are land constraints from 2035 onwards (demand for agricultural land not fully met)

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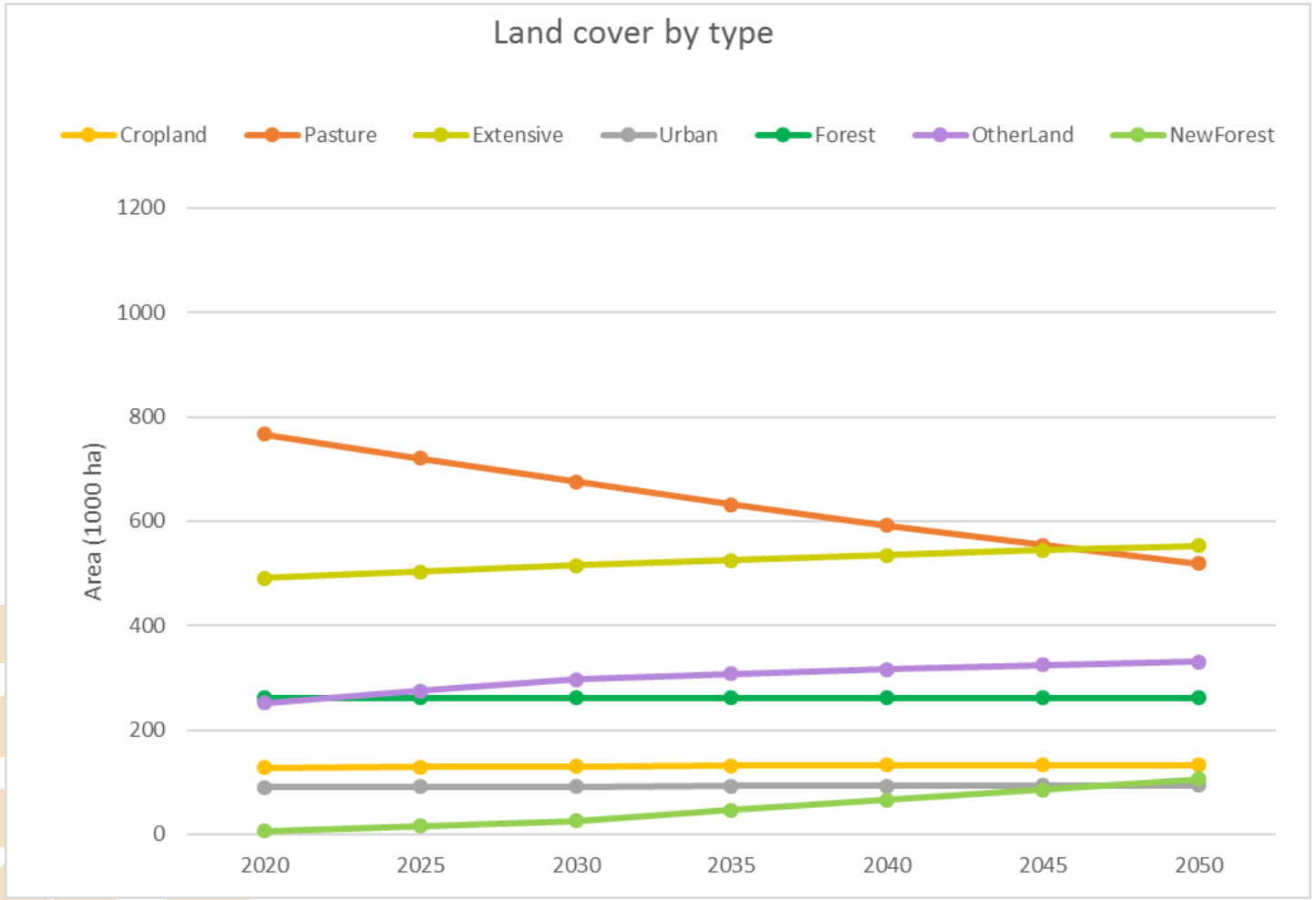
# Land Use Change – Improvement on Current Trends




- Increases in productivity of livestock leads to an overall decrease in grassland area. Some intensive grassland is converted to extensive grassland due to a slight decline in the herd fraction on intensive grassland between 2010 and 2050.
- New forest and other natural land increases.
- Changes are driven by productivity increases, increases in stocking density and reductions in food waste (diet does not change for this scenario).
- No land constraints occur

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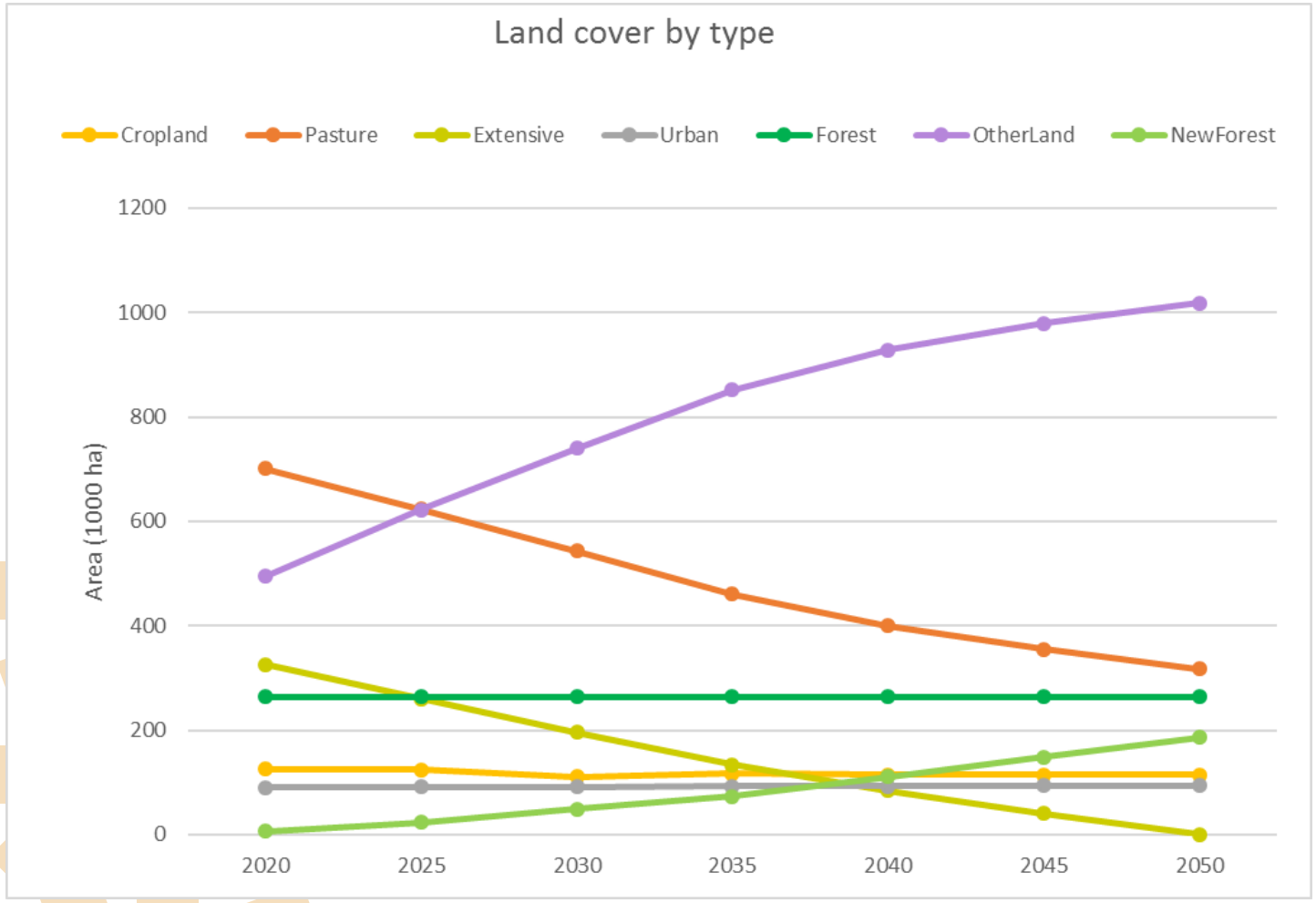
# Land Use Change – Land Sparing




- Large decreases in both types of grassland, with extensive reaching zero by 2050. This is driven by:
  - Changes in diet to be more healthy (to the EatWell Diet);
  - Optimistic productivity changes and doubling of stocking densities: implications for use of agro-chemicals;
  - All livestock on intensive pasture by 2050;
  - Optimistic zero food waste.
- This frees up land for new forest, mainly plantations, and other natural land for biodiversity.
- Land constraints occur only in 2030

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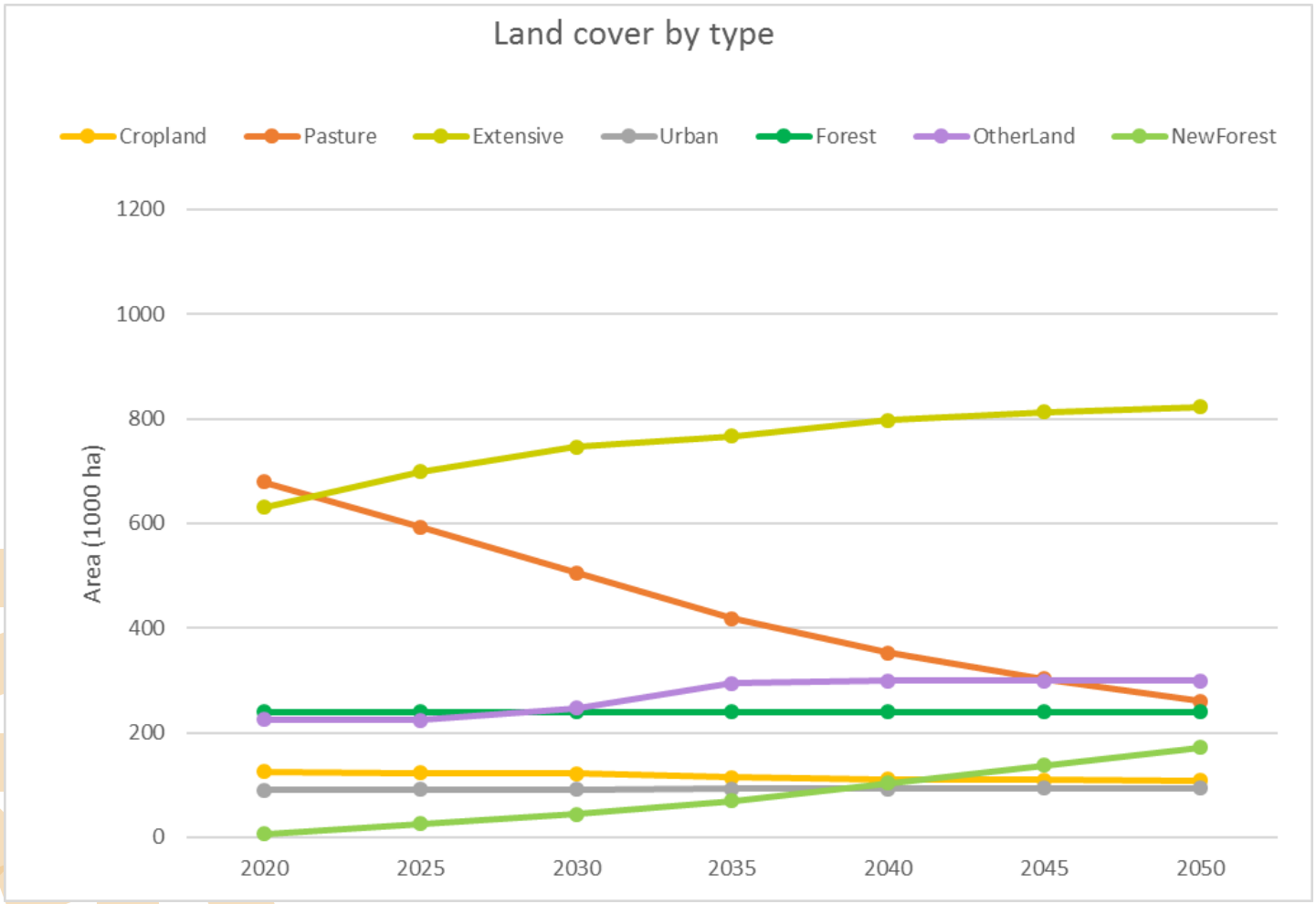
# Land Use Change – Land Sharing




With the assumption that the percentage of herd on extensive grassland increases from 25% to 50% by 2050:

- Large increases in extensive grassland coupled with decreases in intensive grassland.
- Increase in new forest.
- All semi-natural land is protected for biodiversity, and can increase due to diet change and productivity increases.
- Land constraints occur from 2040 due to high protected area and afforestation targets, but less than in status quo

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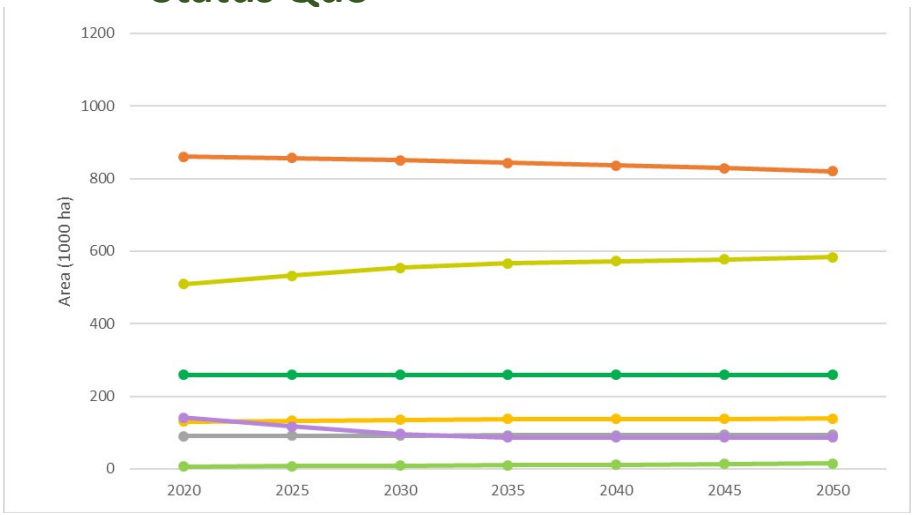
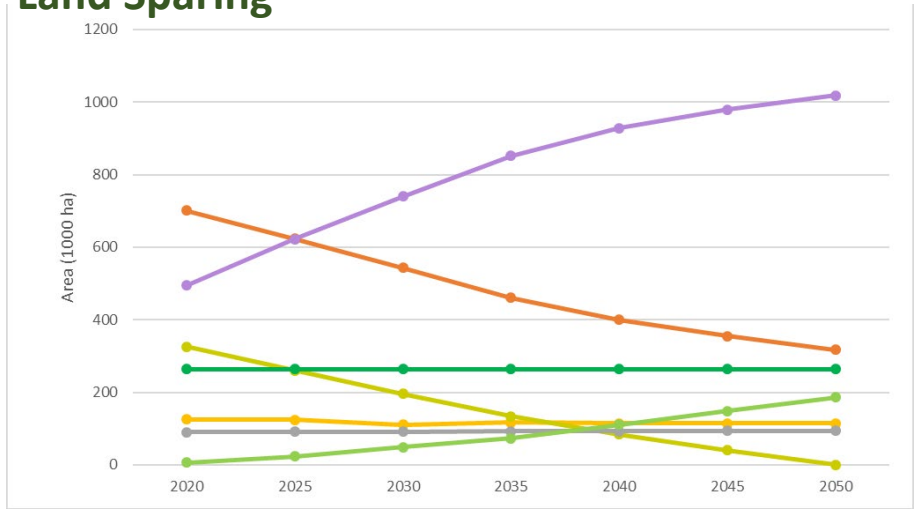
# Land Use Change – Comparison

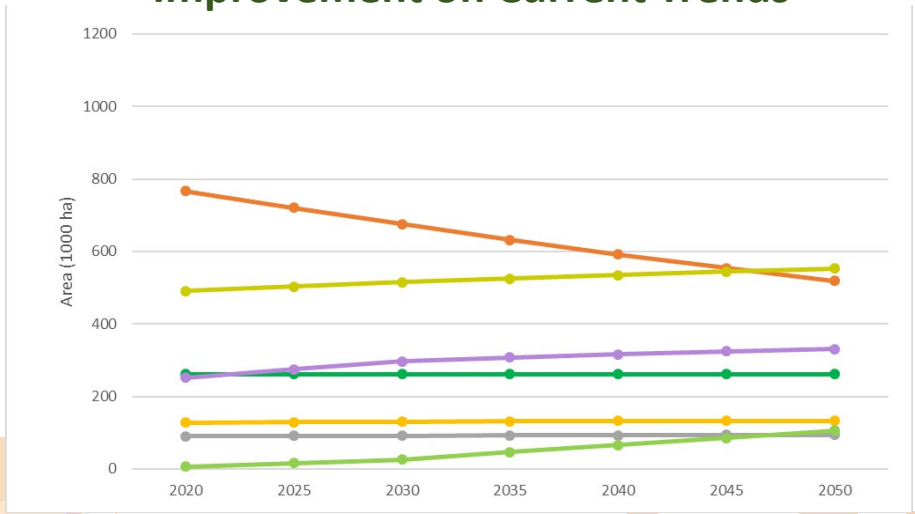
## Status Quo



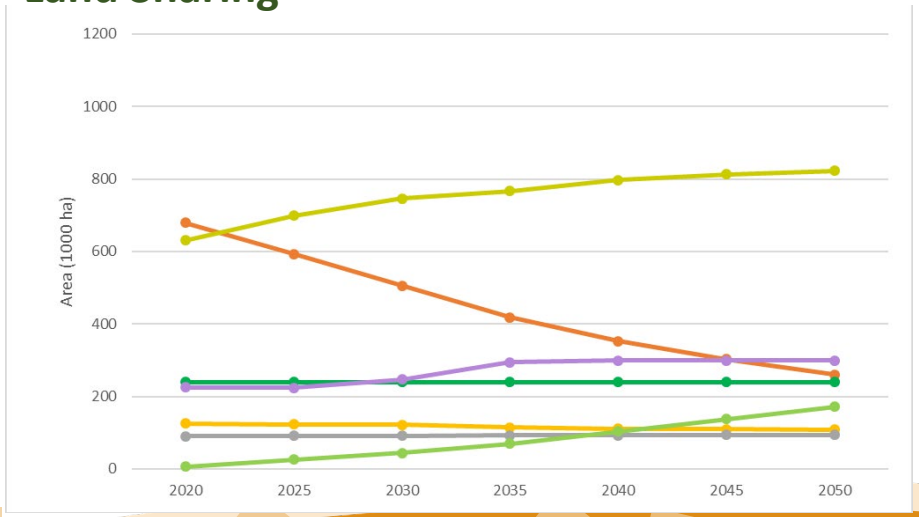

## Land Sparing




## Improvement on Current Trends




## Land Sharing

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Cropland Pasture Extensive Urban Forest OtherLand NewForest

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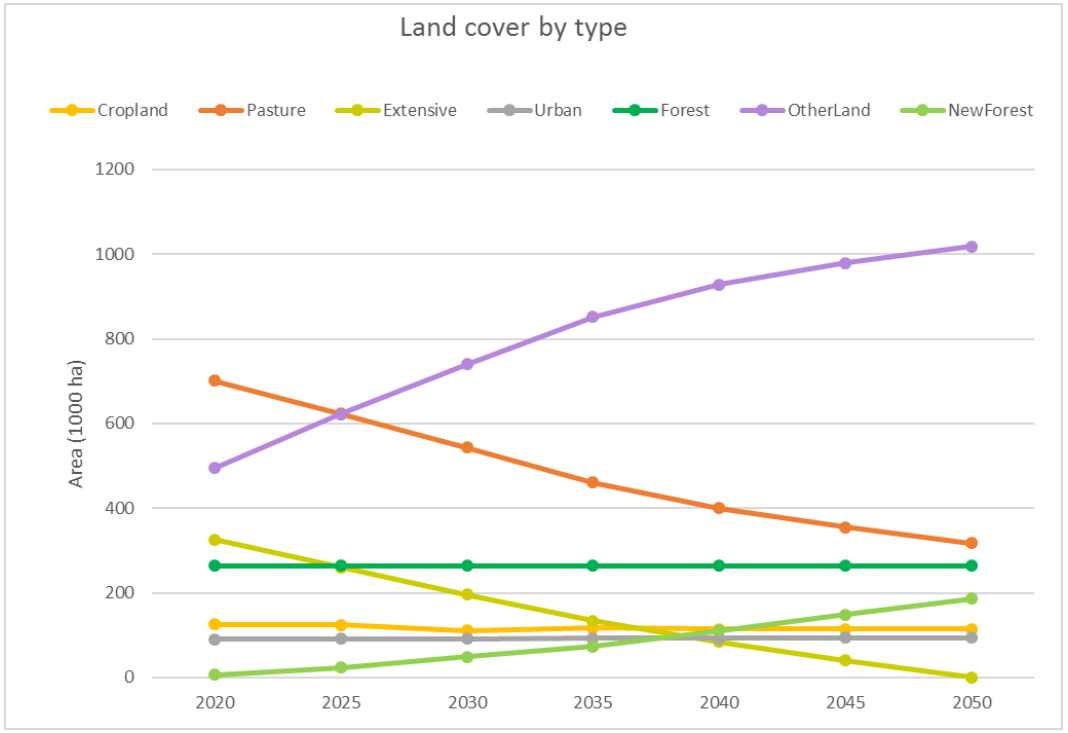
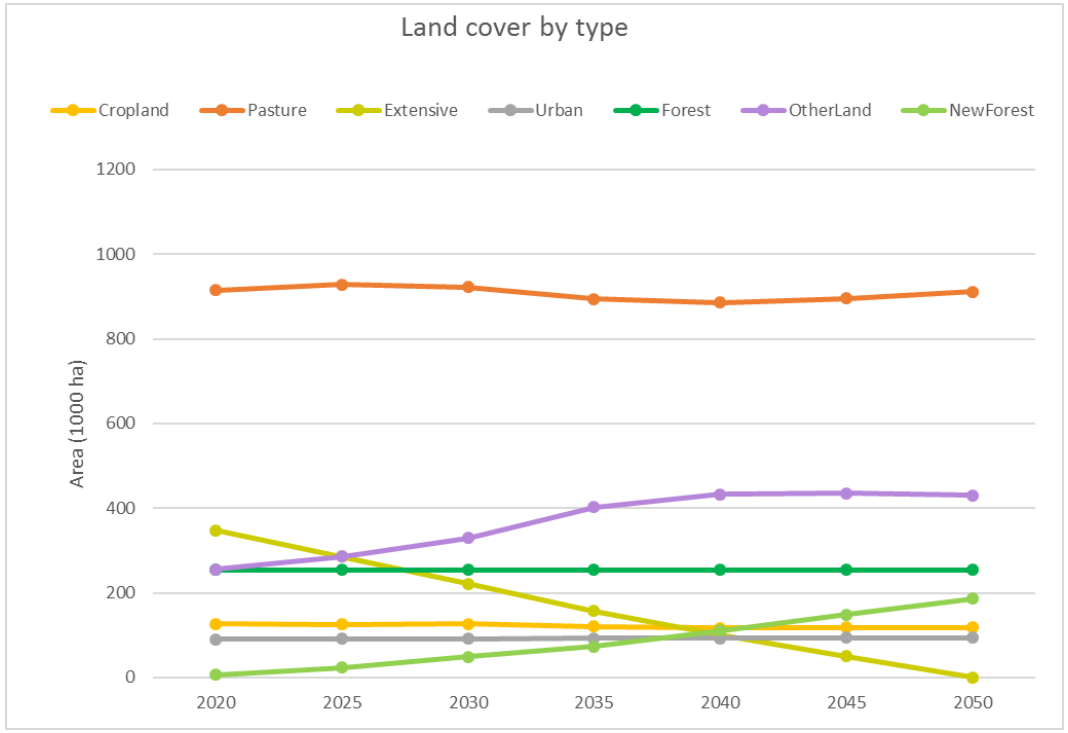
# Impact of productivity on land use change – Land sparing

## Land Sparing – full scenario




## Land Sparing – without productivity and stocking rate increases




Changed the livestock productivity and stocking rates to match SQ (i.e. no change)

- Drastic changes in land use show high dependence of this scenario on assumptions of productivity and stocking rate increases
- Pasture area remains high to 2050, much lower increases in other natural land

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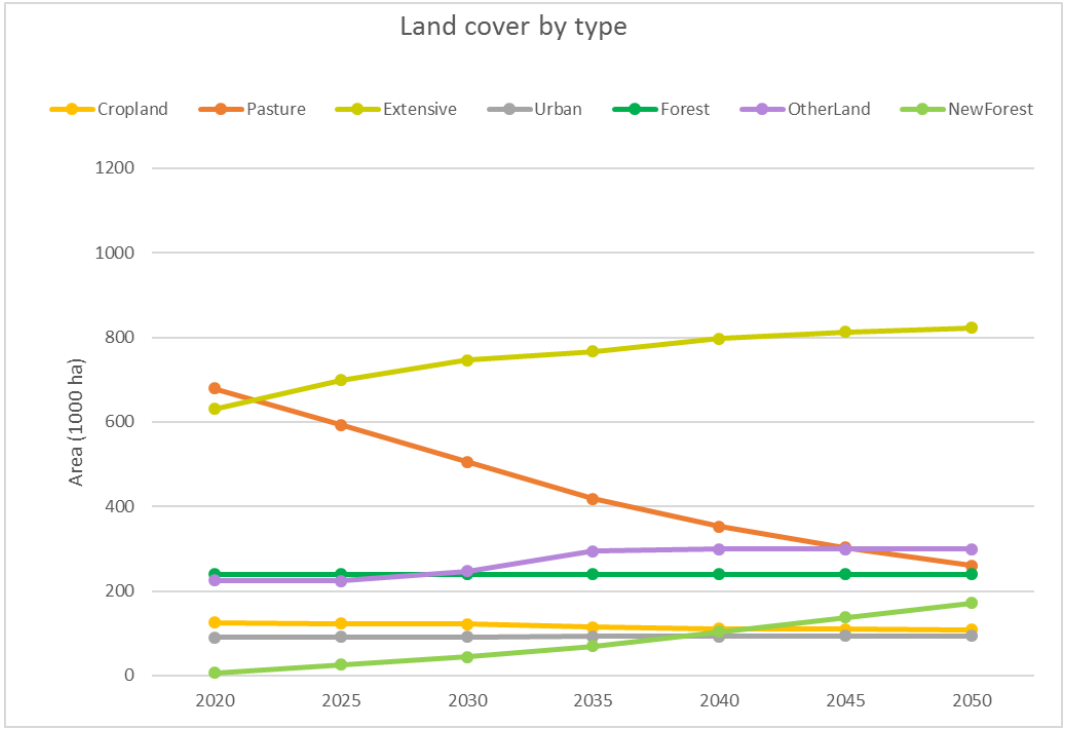
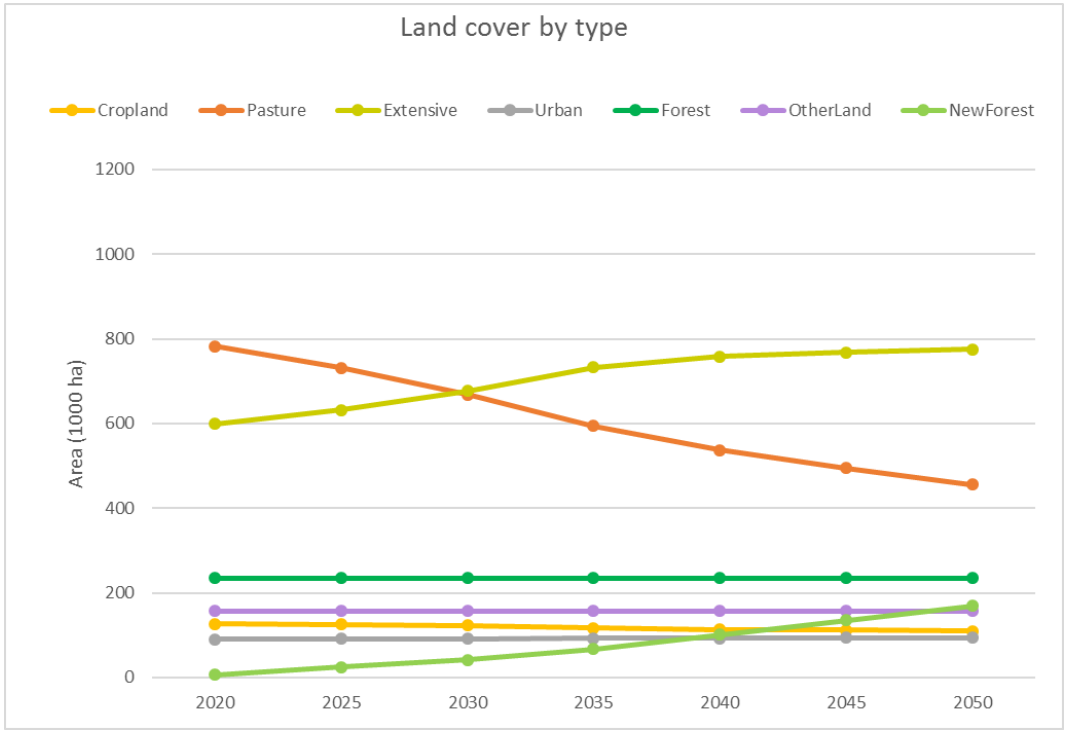
# Impact of productivity on land use change – Land sharing

## Land Sharing – full scenario




## Land Sharing – no productivity and stocking density increases




Changed livestock productivity and stocking rates to match SQ (i.e. no change):

- Less drastic changes than Land Sparing because less reliance on increased stocking rates and productivity
- Still decreases in intensive pasture and increases in extensive grassland, but not as large
- No longer an increase in other natural land

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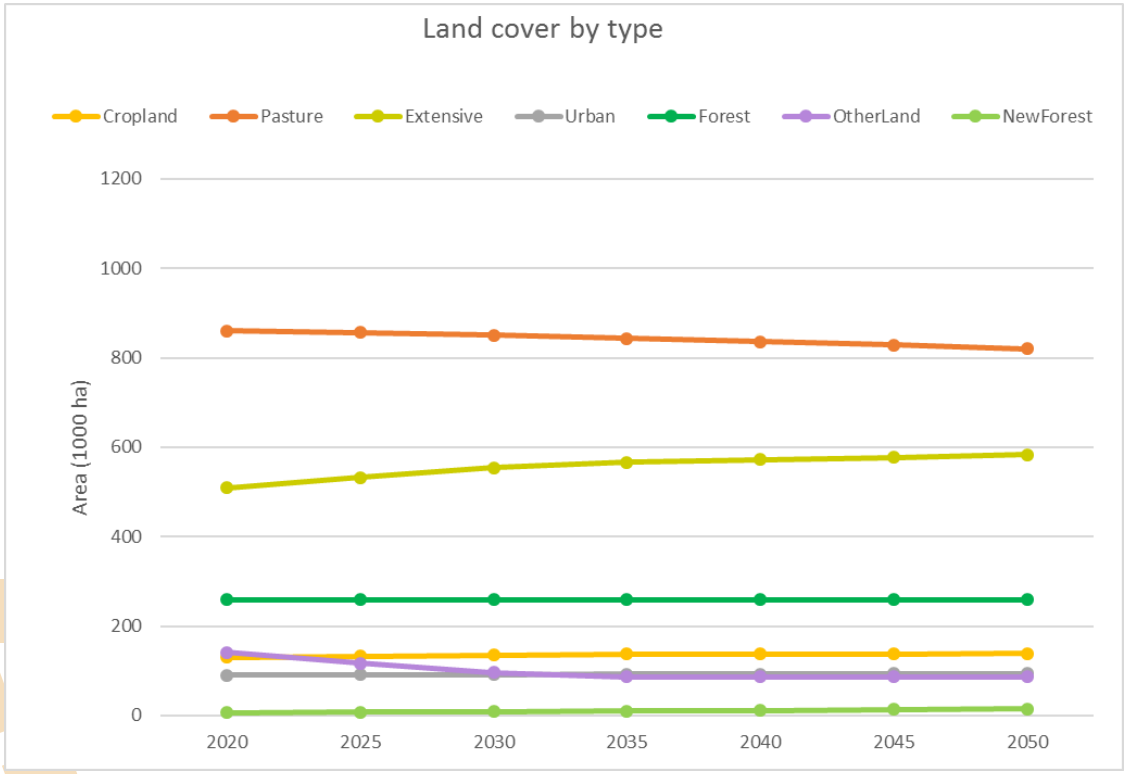
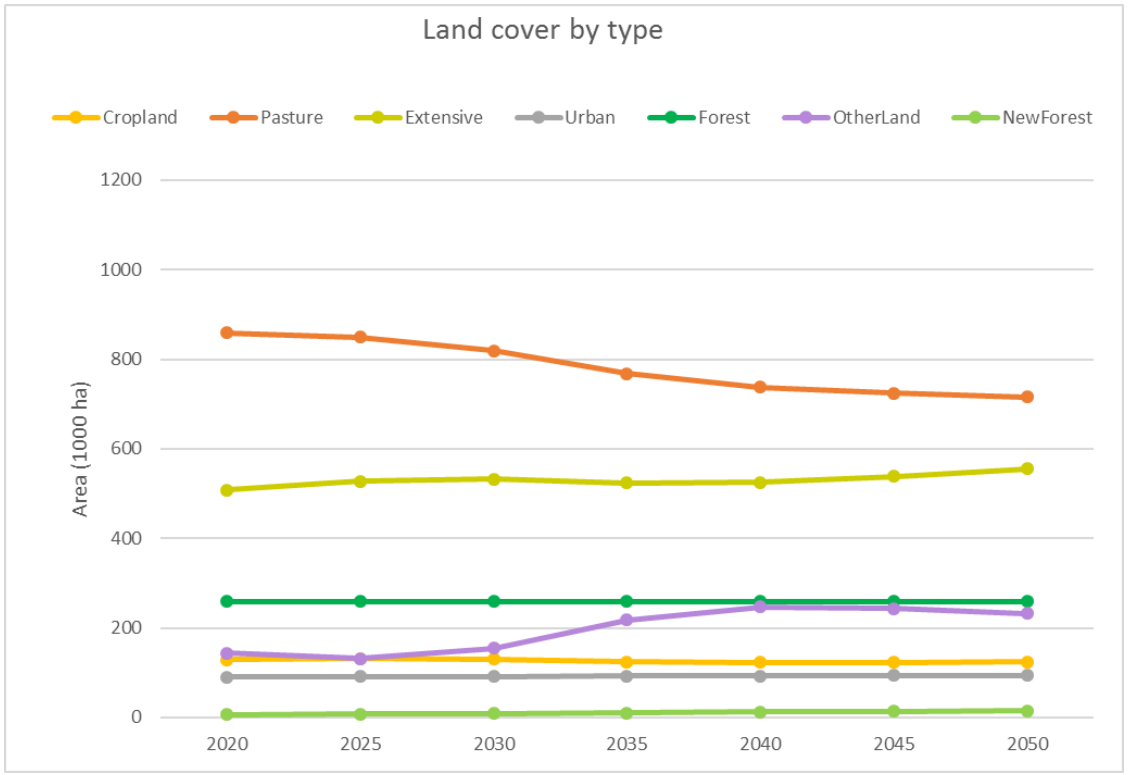
# Impact of diet on land use change – Status quo

## Status Quo – no change in diet




## Status Quo – Eat well diet




Switching to a healthier diet reduces meat demand and therefore pasture area, and allows an Increase in other natural land. The impact is limited because most of the meat production is for export.

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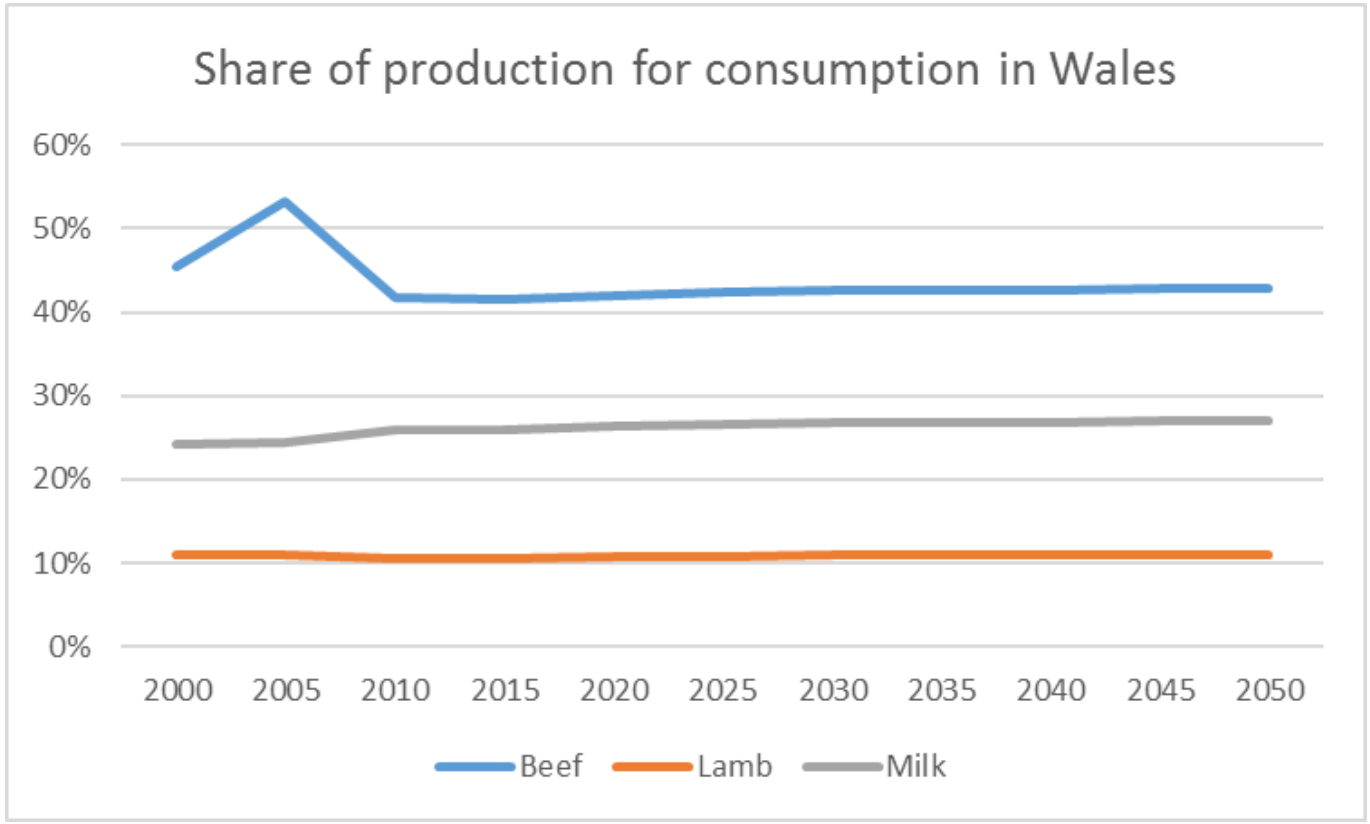
# Imports and exports are similar for all scenarios, based on FAO data downscaled for the UK. Exports are fixed in tonnes at the 2010 value; share of imports is constant at the 2010 value

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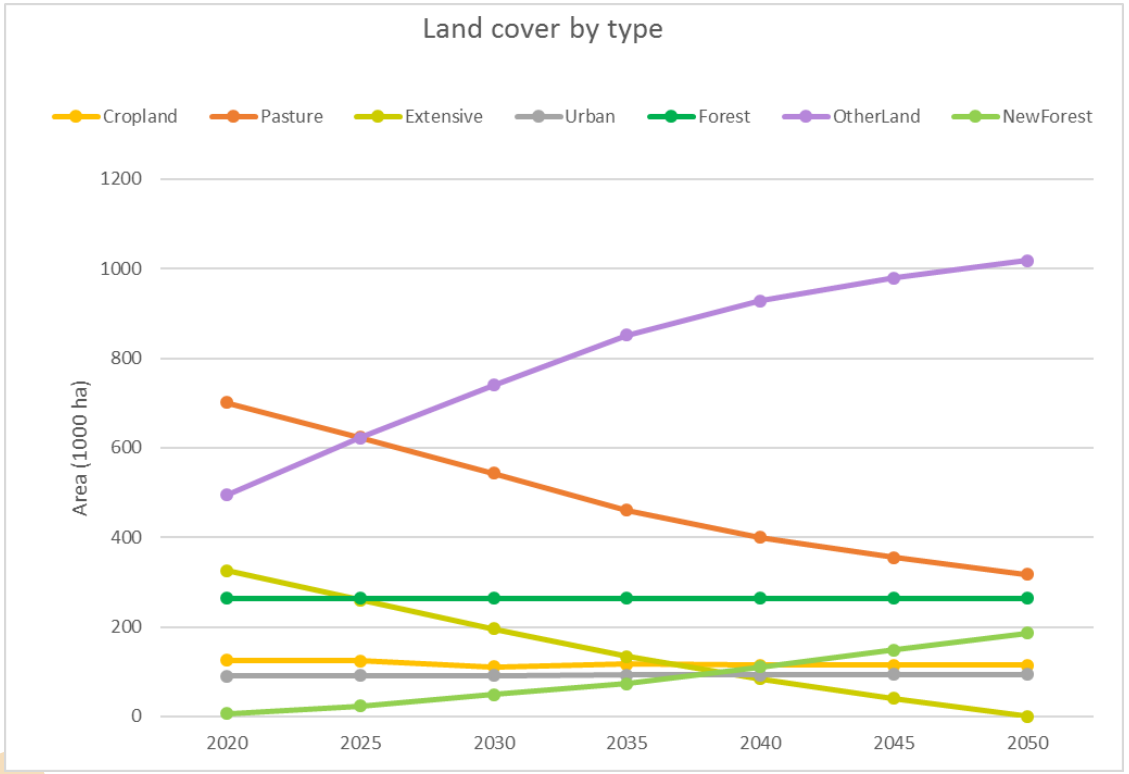
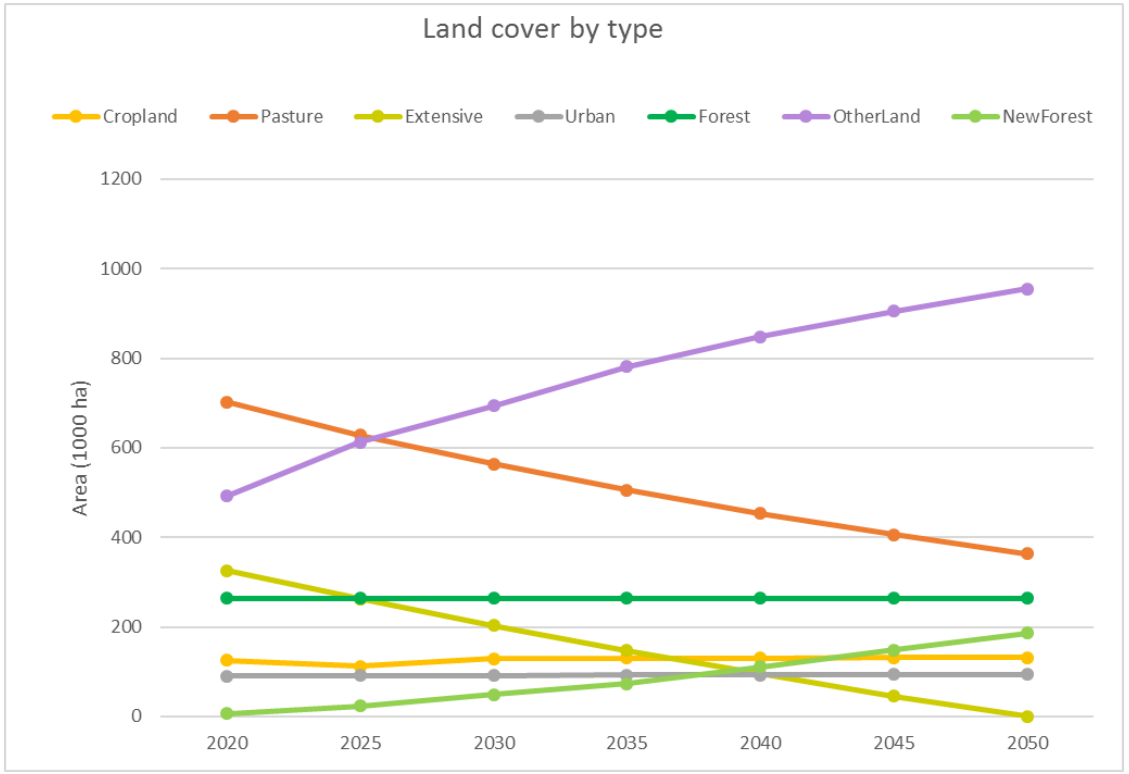
# Impact of diet on land use change – Land sparing

## Land Sparing – Eat well diet




## Land Sparing – no change to diet




Slightly less other land, slightly more intensive pasture
Changes are small, because most meat production is for export

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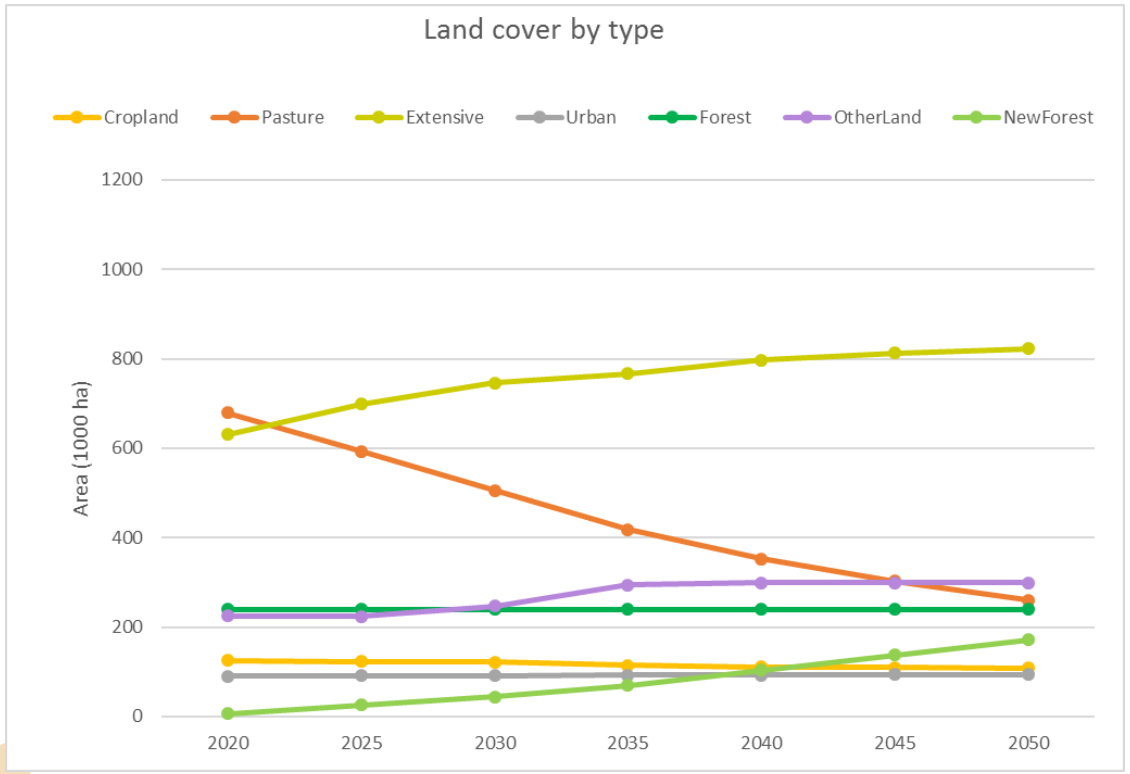
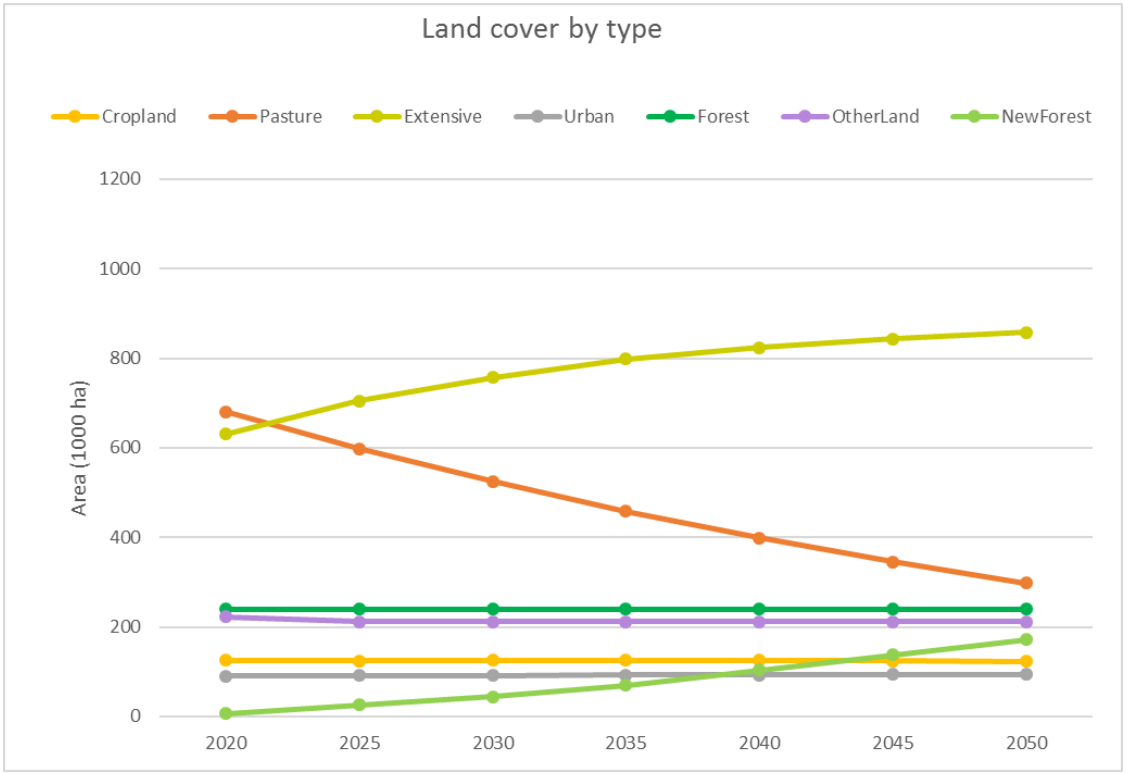
# Impact of diet on land use change – Land sharing

## Land Sharing – Eat well diet




## Land Sharing – diet changed to no change




Reduction in other natural land as slightly more pasture is required. Changes are small because most meat production is for export.

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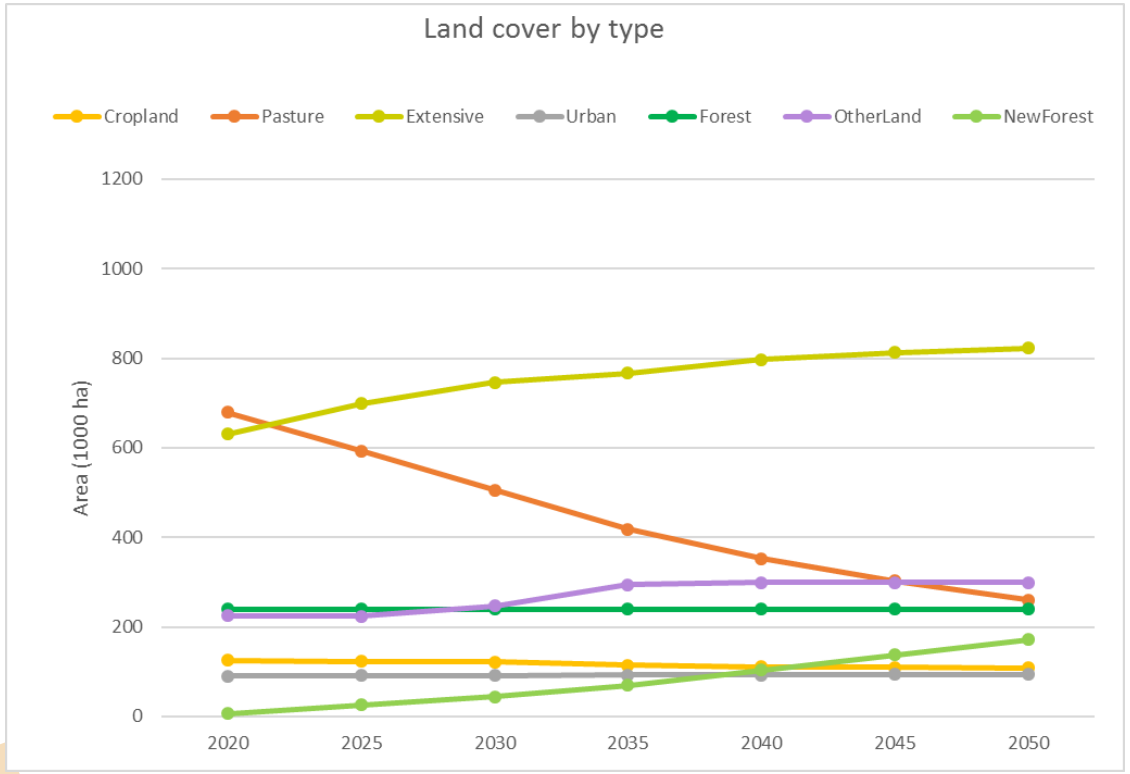
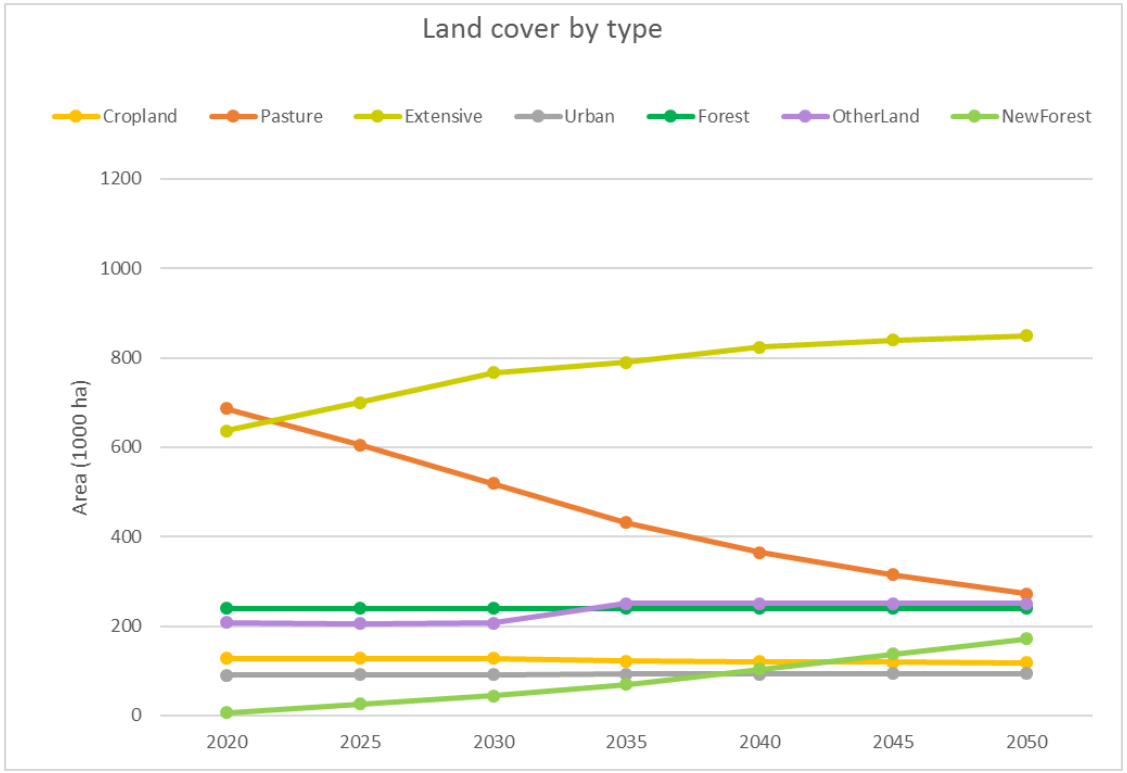
# Impact of changes in food waste – Land sharing

## Land Sharing




## Land Sharing – no change in food waste




Reduction in other natural land as slightly more pasture is required. Changes are small because most meat production is for export.

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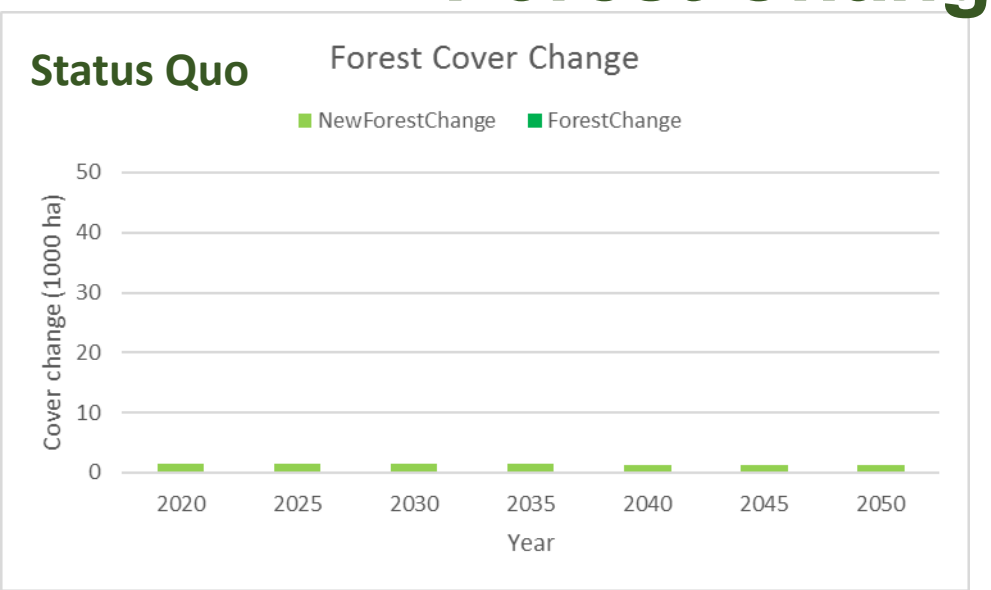
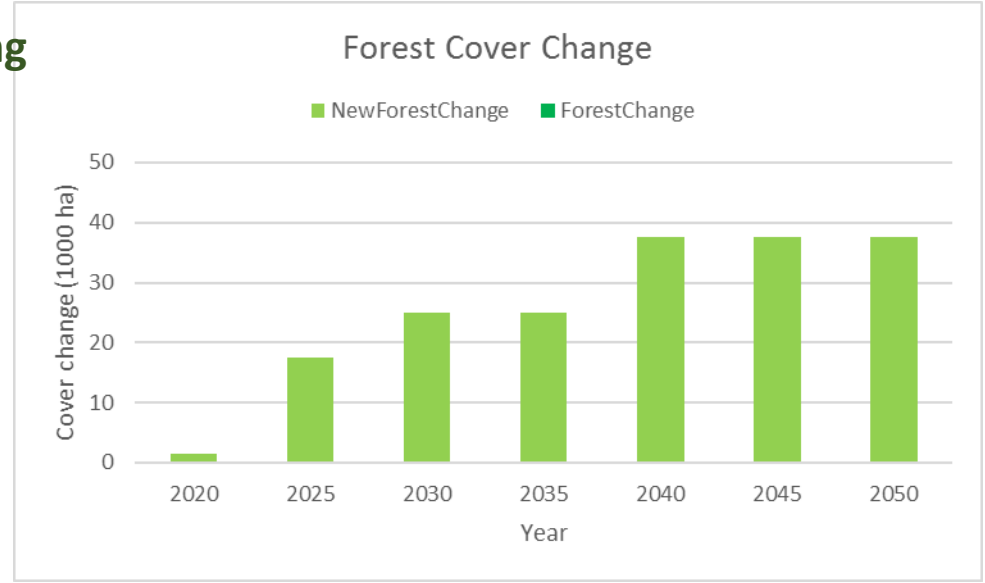
# Forest Change – Comparison

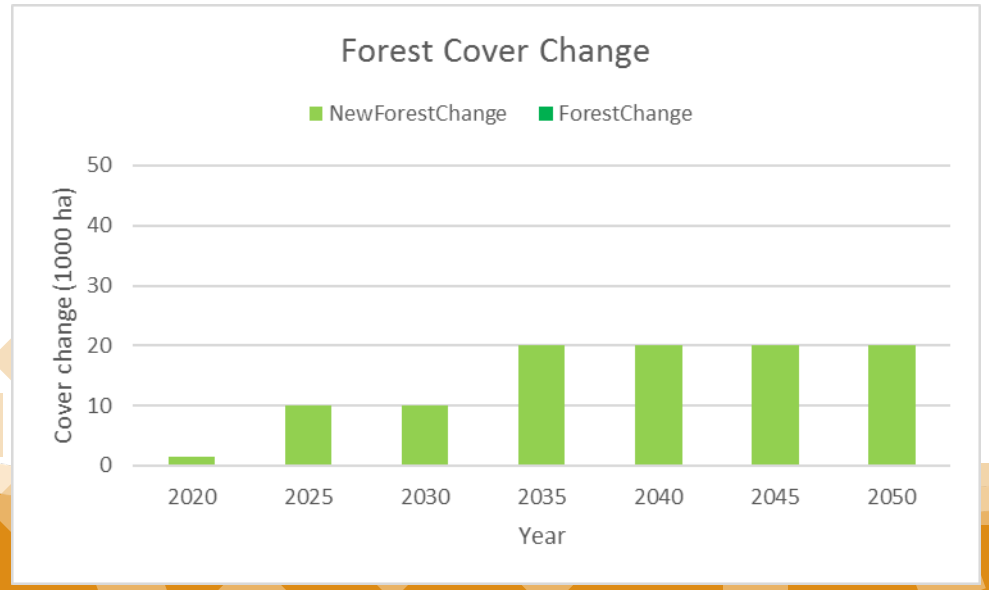
## Status Quo



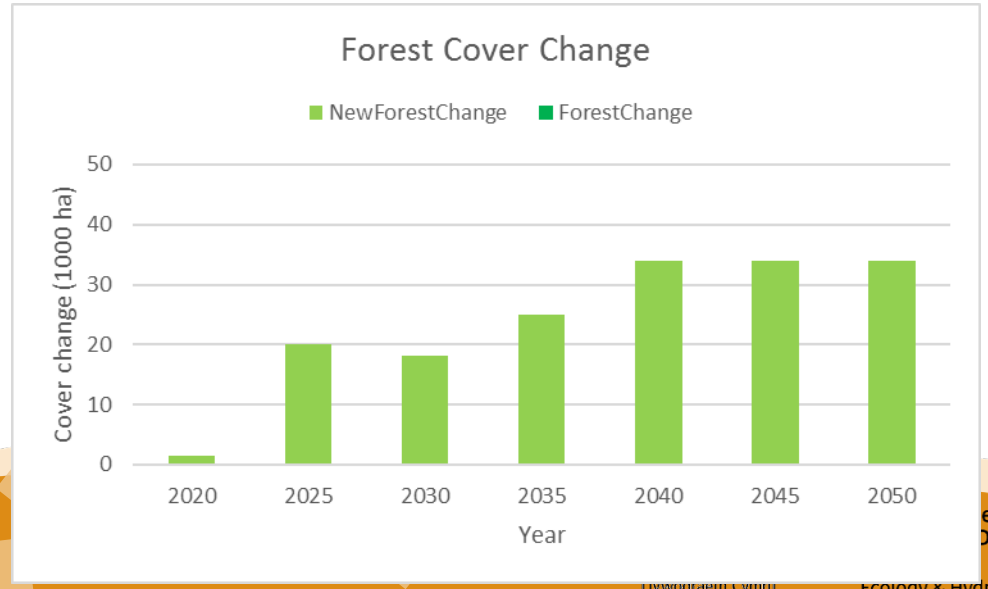

## Land Sparing




## Improvement on Current Trends




## Land Sharing

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# PART 2: Greenhouse Gases

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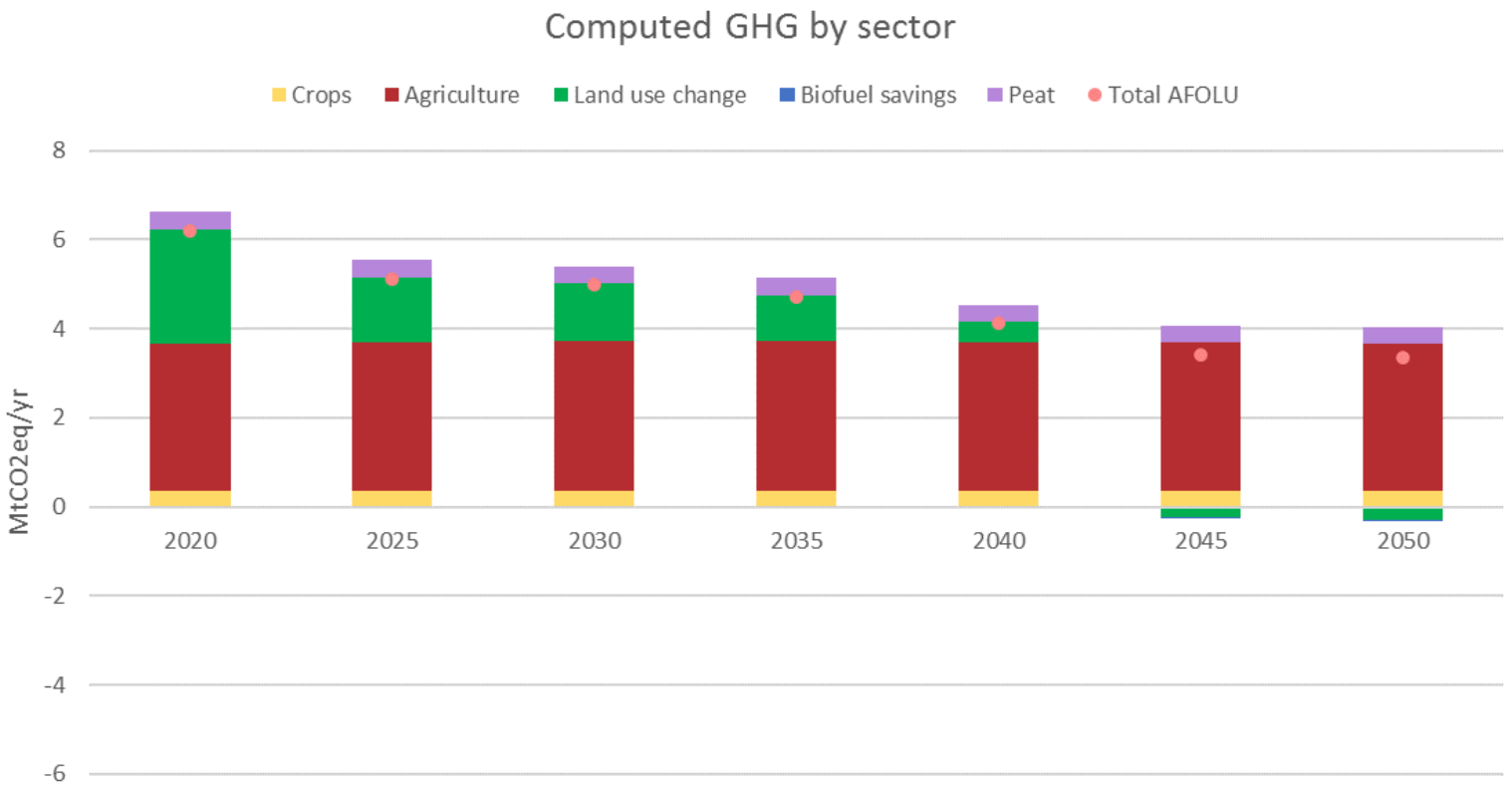
# GHGs – Status quo




- The apparent land use change emissions in the early years are mainly related to discrepancies in the historic land cover maps and can be ignored.
- As this levels off, the small sequestration benefit from afforestation is revealed
- Emissions from livestock and cropland increase very slightly with population
- Emissions from degraded peatland reduce very slightly due to restoration

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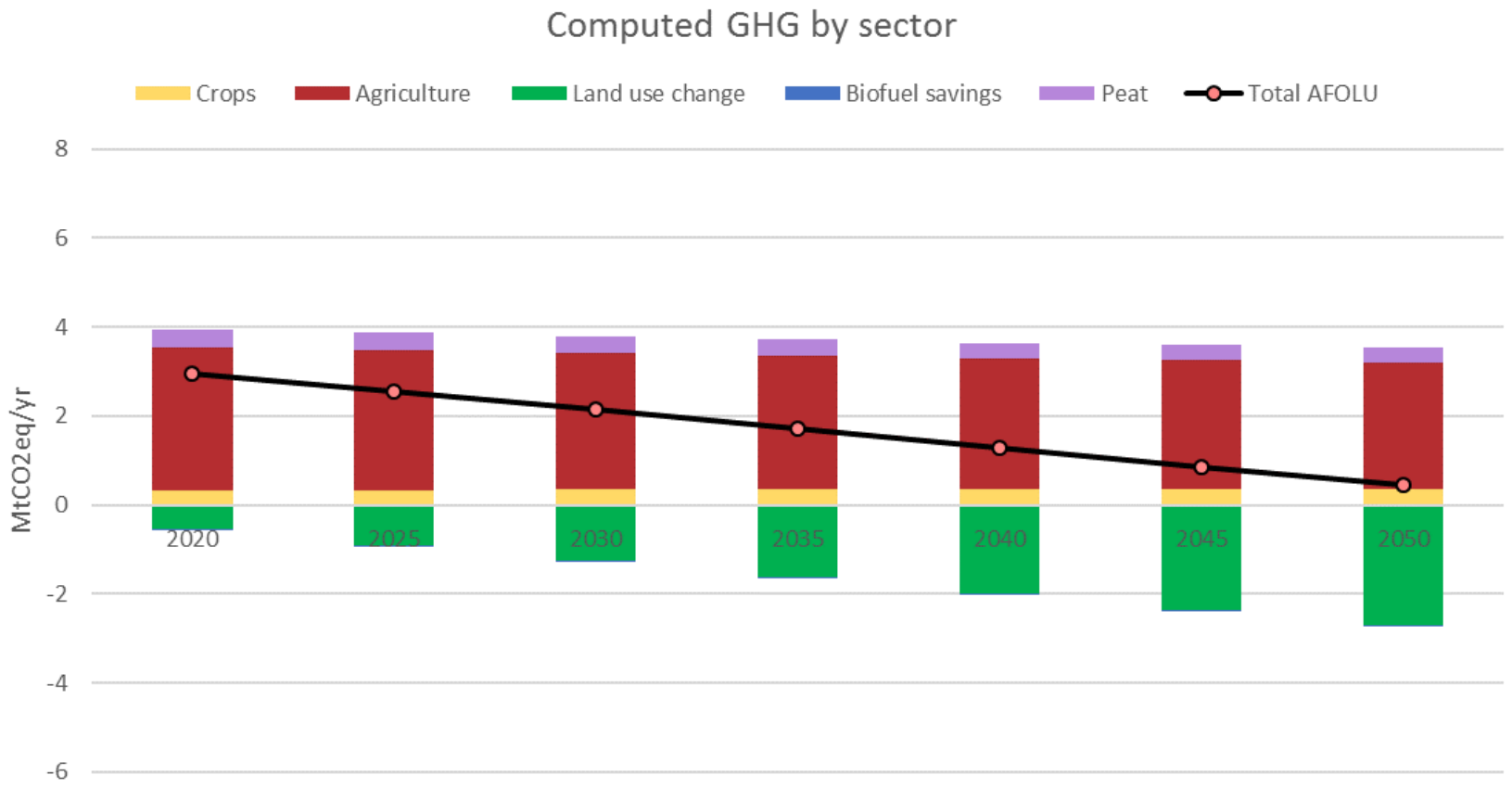
# GHGs – Improvements to current trends




- Emissions from livestock and cropland decrease slightly due to productivity improvements
- Emissions from degraded peatland reduce slightly due to restoration
- Land use change emissions change to net sequestration due to conversion of pasture to natural land (due to productivity increases) and afforestation.

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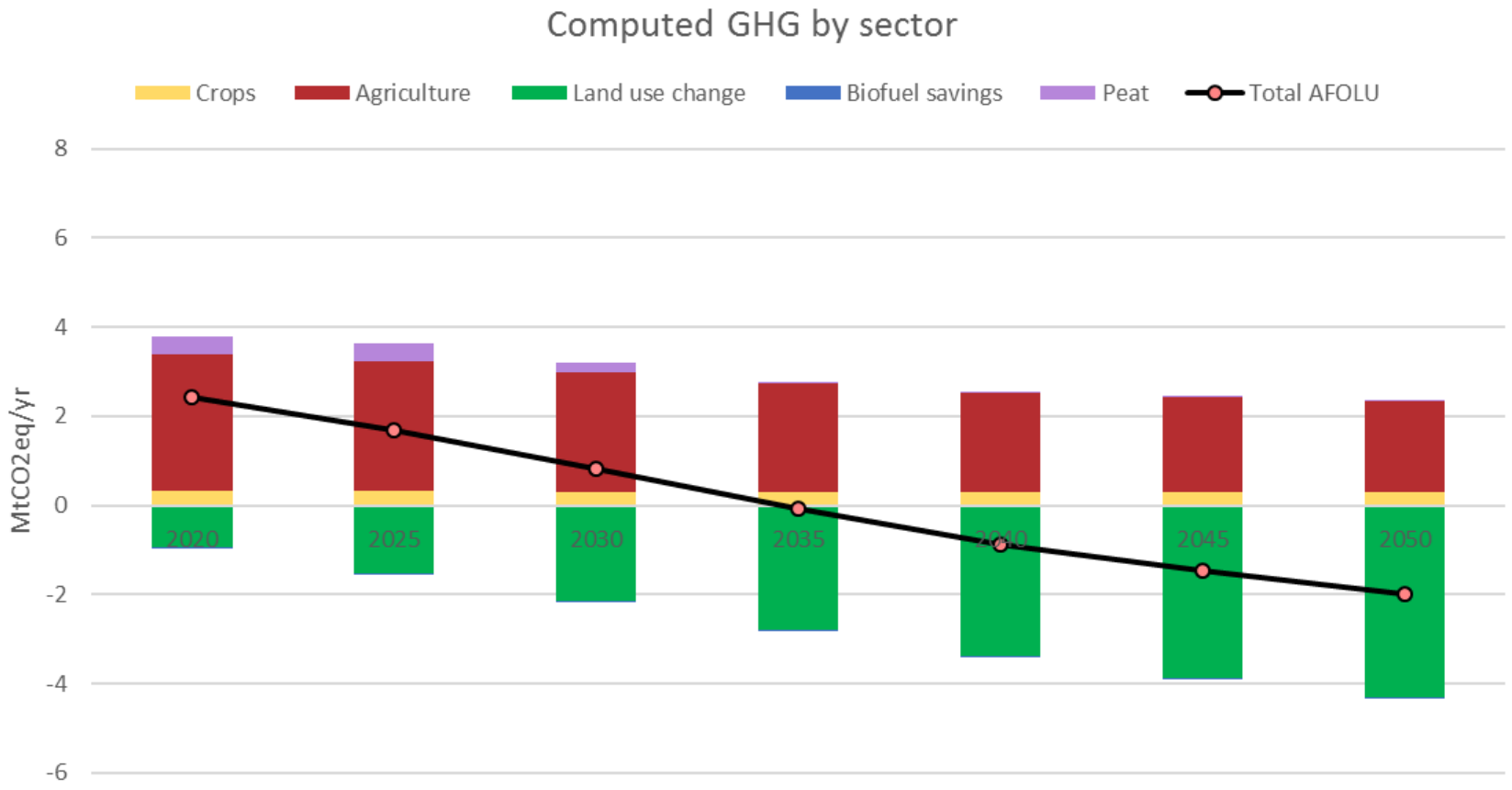
# GHGs – Land sparing




- Emissions from livestock and cropland decrease due to healthier diets
- Emissions from degraded peatland decrease to zero due to restoration
- Land use change emissions change to net sequestration due to conversion of pasture to natural land (due to diet change and productivity increases) and afforestation.
- BUT GHG impacts of increased livestock productivity (e.g. more fertiliser use on pasture) are not modelled

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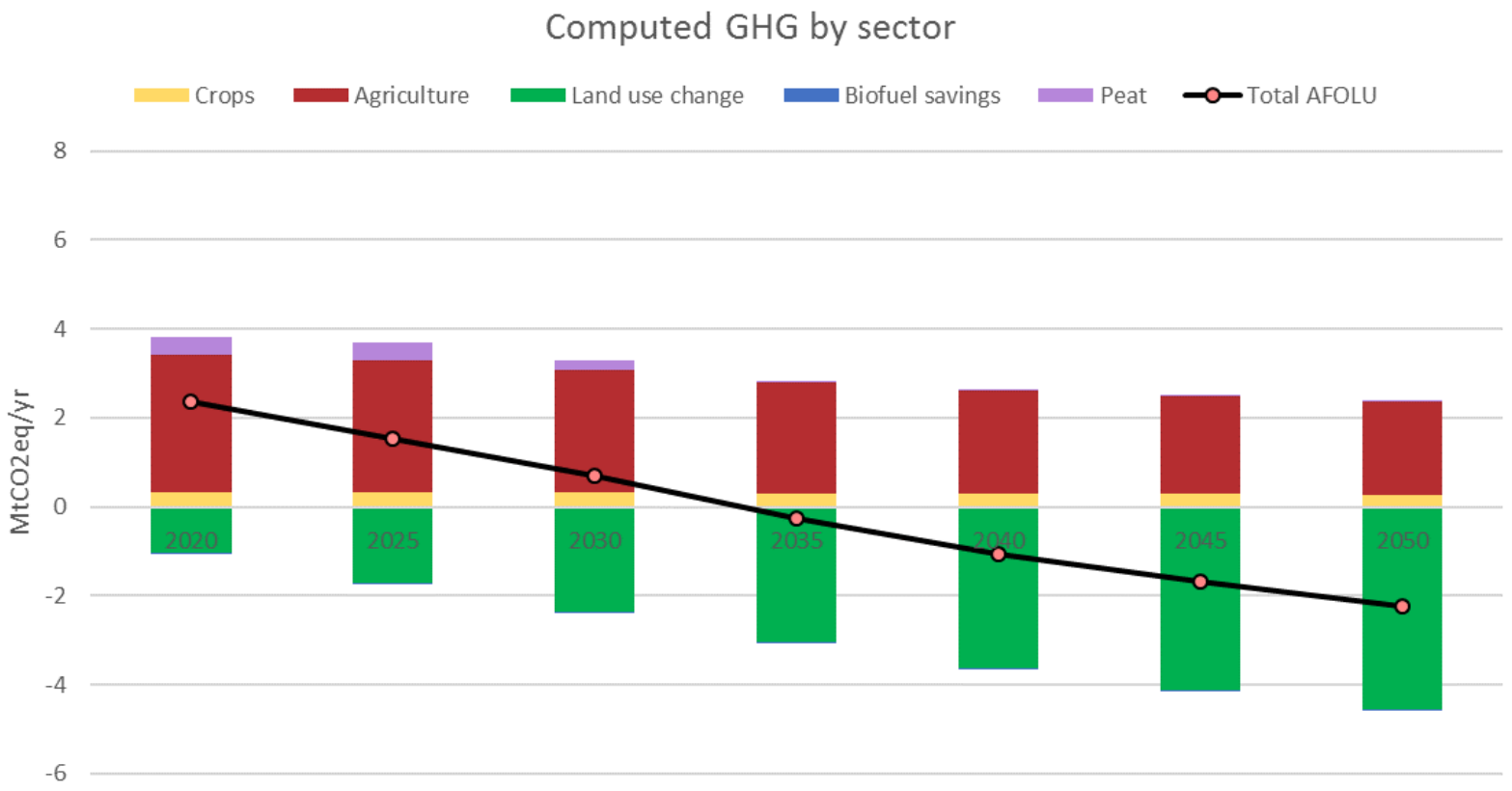
# GHGs – Land sharing




- Emissions from livestock and cropland decrease due to healthier diets
- Emissions from degraded peatland decrease to zero due to restoration
- Land use change emissions change to net sequestration due to conversion of pasture to extensive grassland (due to diet change and productivity increases) and afforestation
- Similar to Land Sparing but less reliance on increased use of fertilisers on grassland

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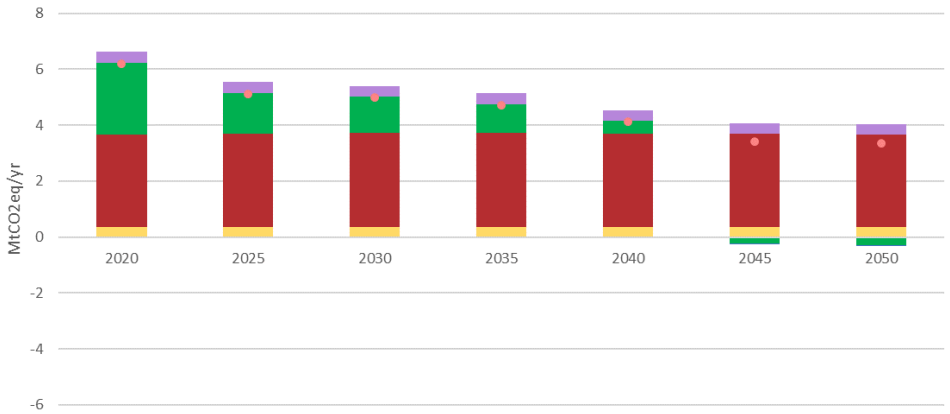
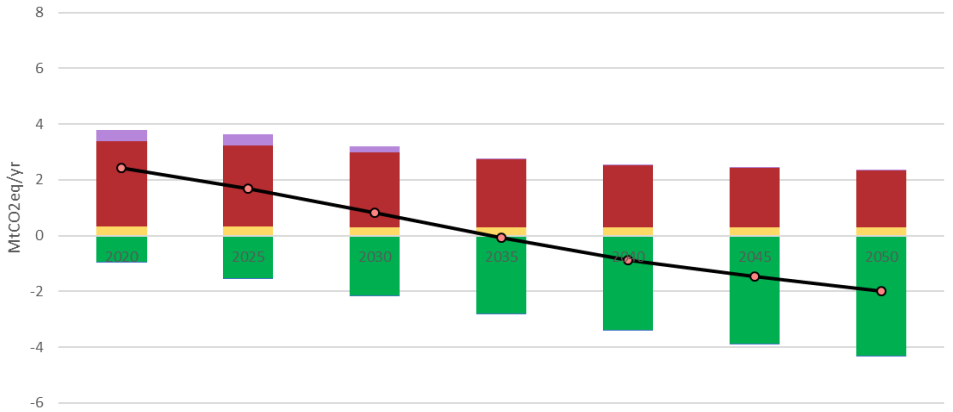
# GHGs – Comparison

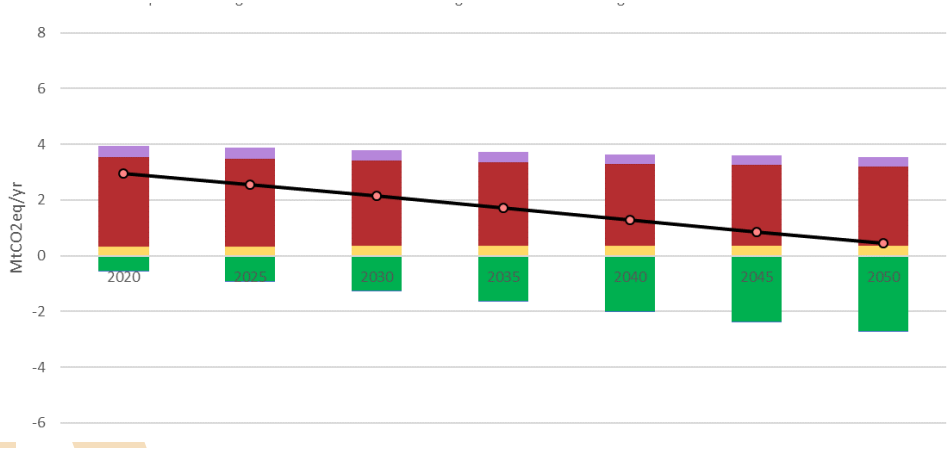
## Status Quo



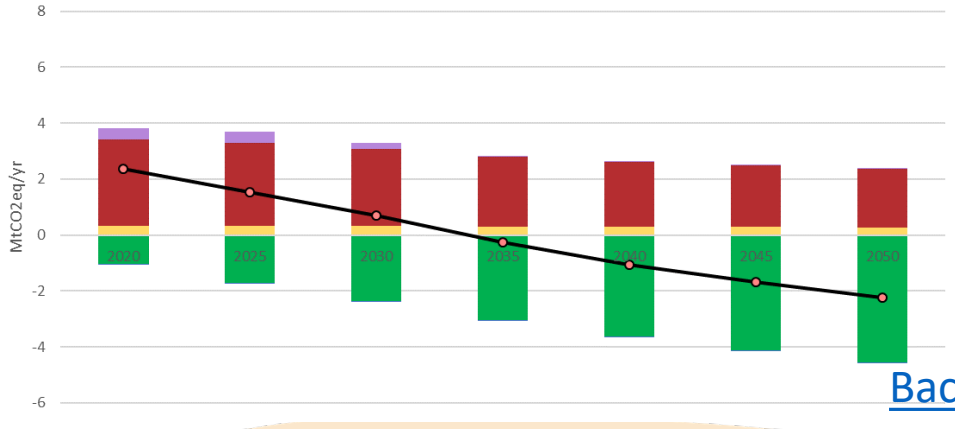

## Land Sparing




## Improvement on Current Trends




## Land Sharing

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Crops | Agriculture | Land use change | Biofuel savings | Peat | Total AFOLU

AFOLU = agriculture, forestry and other land use

# PART 3: Biodiversity

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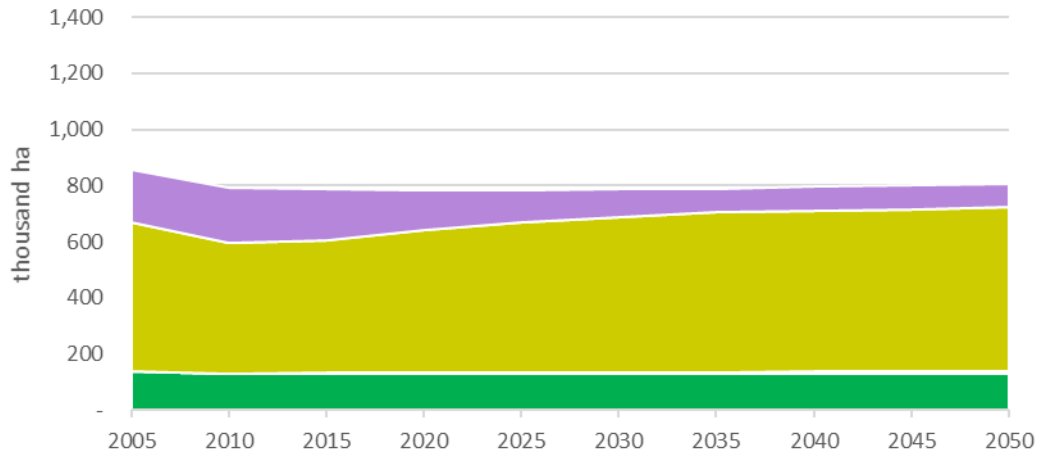
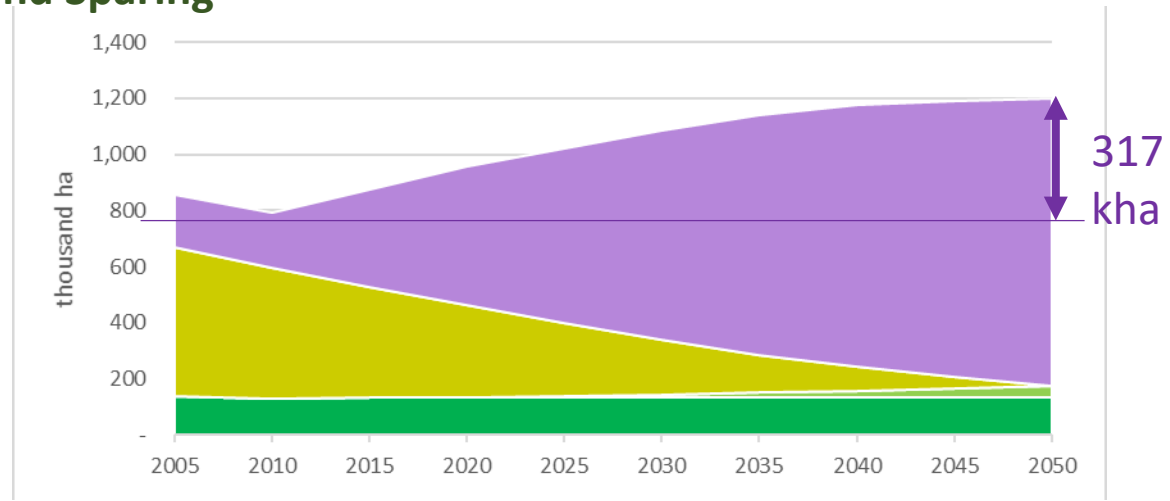
# Land that can support biodiversity conservation

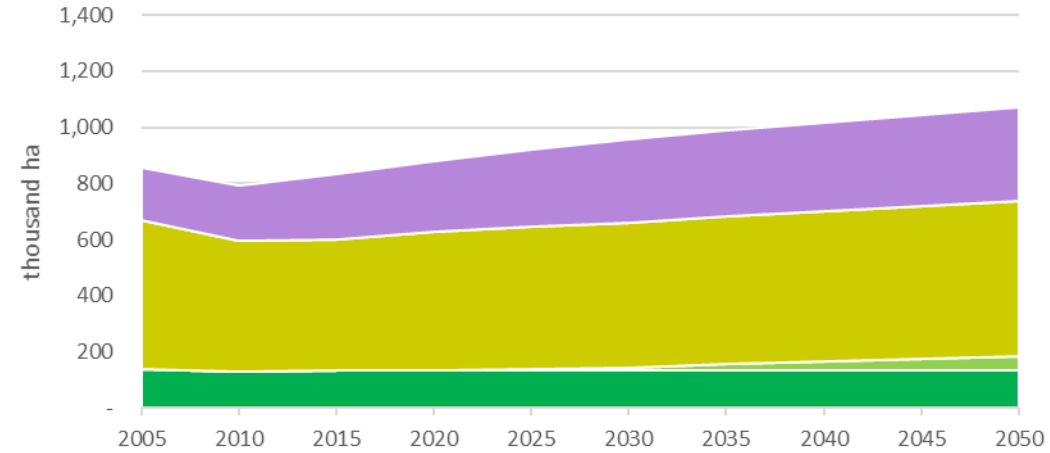
## Status Quo



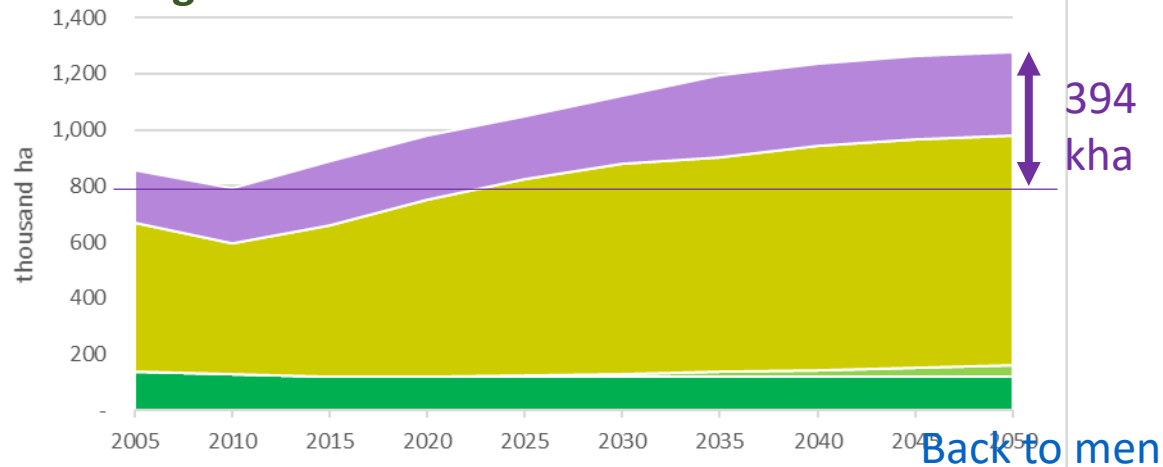

## Land Sparing




## Improvement on Current Trends




## Land Sharing

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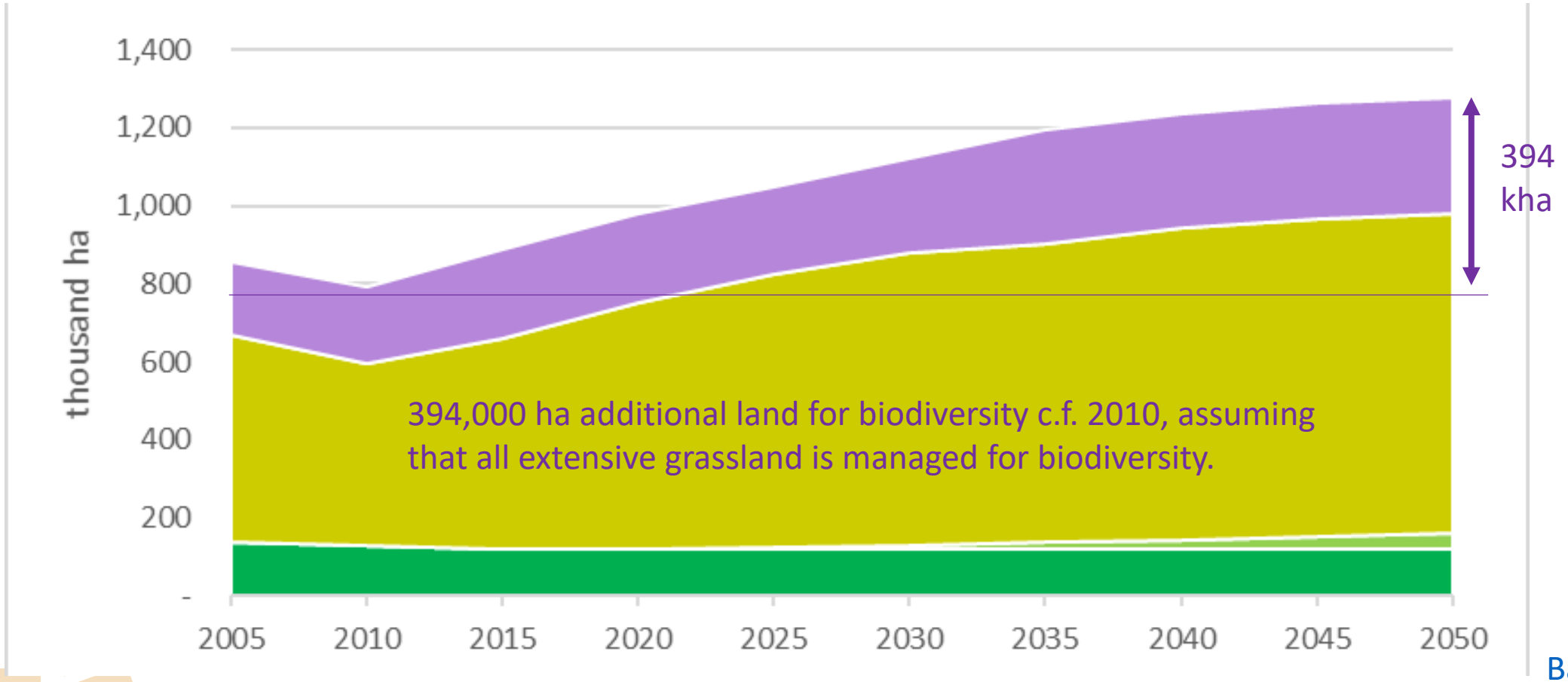
Existing forest | New forest | Extensive grassland | Other land

# Land that can support biodiversity conservation

## Land sharing: is the 500,000 ha new habitat target met?

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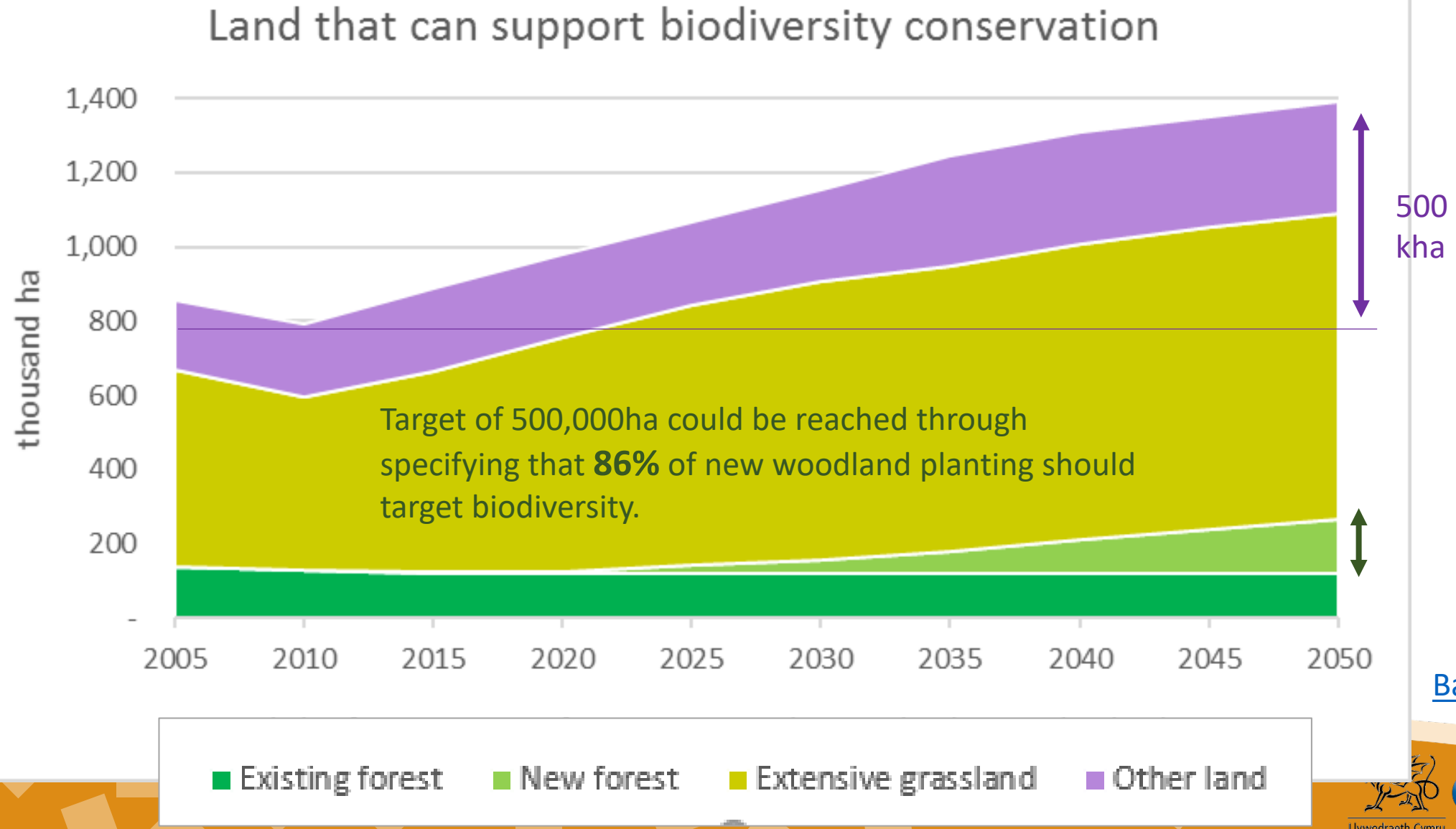
Llywodraeth Cymru
Welsh Government

Canolfan Ecoleg a Hydroleg y DU
UK Centre for Ecology & Hydrology

# Land that can support biodiversity conservation

## Land sharing: can the 500,000 ha new habitat target be achieved?

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# PART 4: Diets

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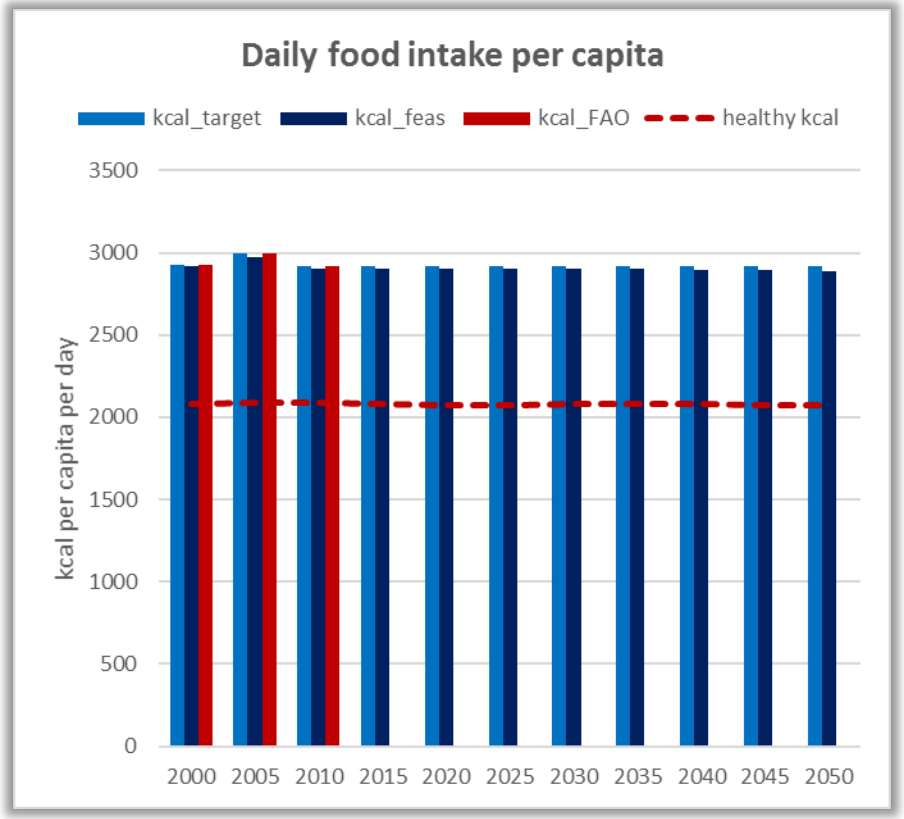
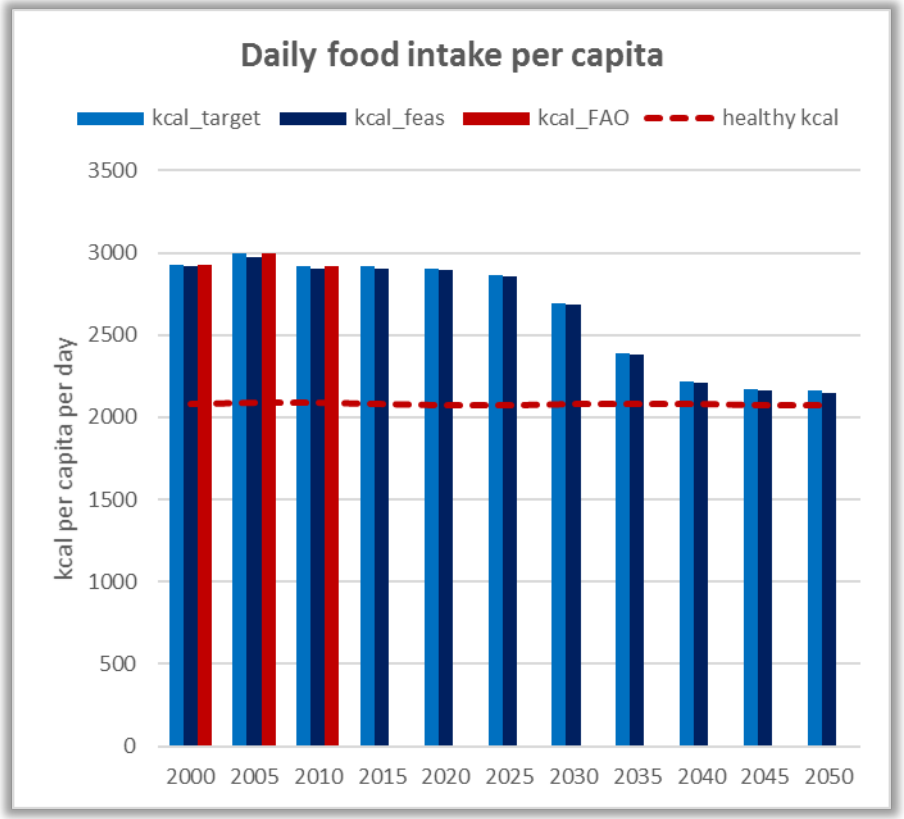
# Diet and Food – Daily food intake




Daily food intake per capita for Status Quo:

- Not much change up to 2050, as no changes to diet.
- Land area is insufficient to produce the required amount of food from 2030 onwards




Daily food intake per capita for Land Sharing and Land Sparing Scenarios:

- Decreases in kcal towards 2050, reflective of changes towards a more healthy diet (EatWell).

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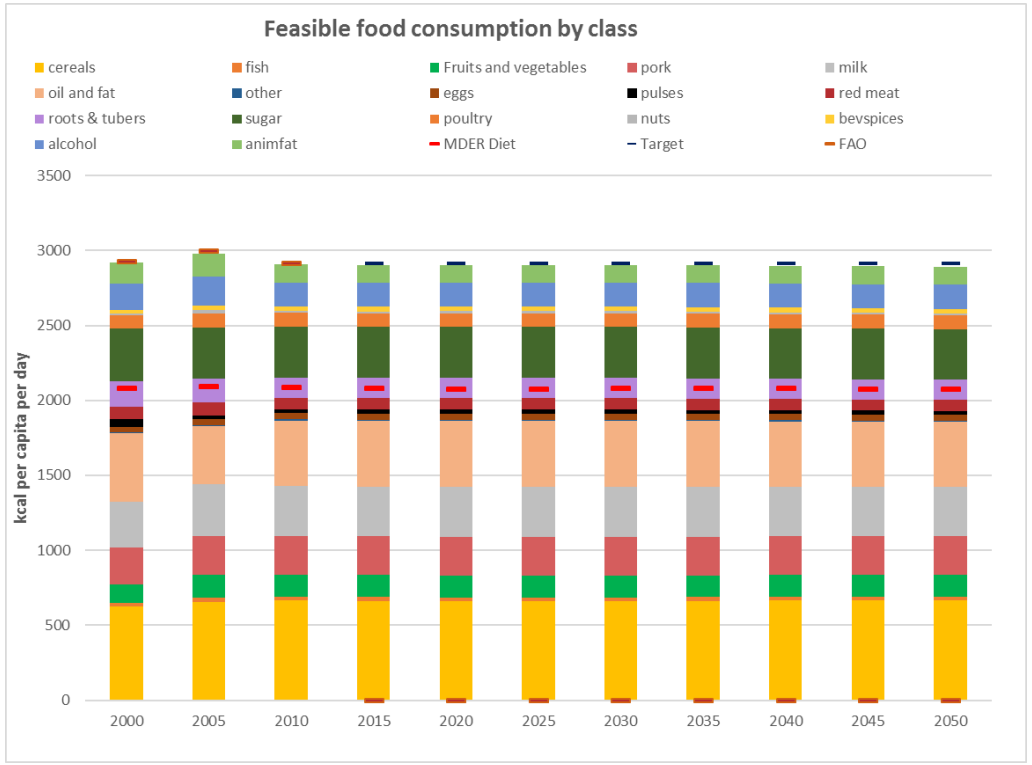
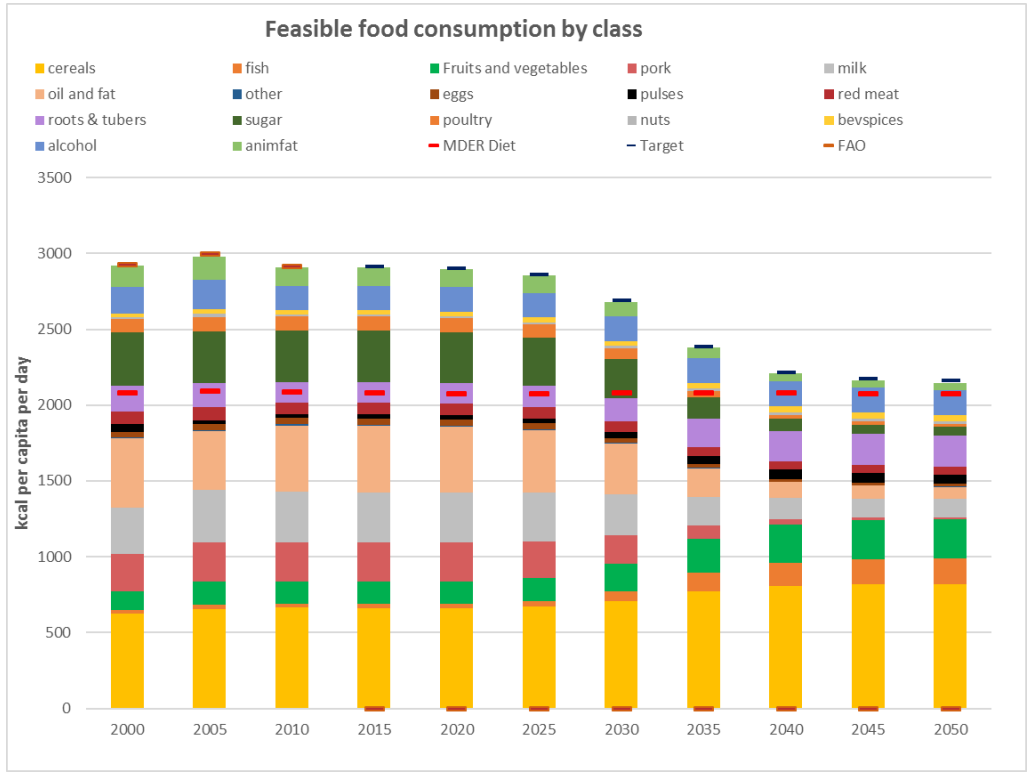
# Diet and Food – Feasible Food consumption




Composition of food for Status Quo:

- No changes to diet.

Composition of food for Land Sharing and land Sparing:

- Decreases in total calories reflective of healthier diet (EatWell).
- Increases in cereal, fruit and vegetable consumption, decreases in red meat, pork, poultry, sugar and fats

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# Annex 1 – Full list of underlying assumptions for the pathways

| **Population** Population projection – million inhabitants | | | |
|---|---|---|---|
| **Status Quo** | **Improving the Current System** | **Land Sparing** | **Land Sharing** |
| The Population is expected to reach 3.258 million by 2050- ONS predictions Principal projection - Wales population in age groups - Office for National Statistics (ons.gov.uk) | | | |
| **LAND** Constraints on agricultural expansion | | | |
| **Status Quo** | **Improving the Current System** | **Land Sparing** | **Land Sharing** |
| No constraints on agricultural expansion | Constraints on agricultural expansion within National Parks (but not on intensification) | Constraints on agricultural expansion within National Parks (but not on intensification) | No agricultural expansion on existing habitats. Scenario specified 500,000ha of habitat created on agricultural land but this cannot be modelled as it is an output not an input. Constraints on intensification captured in stocking levels. |
| **LAND** Afforestation or Reforestation Targets | | | |
| Total woodland creation in 2020/21 was around 280 hectares. Assume 300 ha/y to 2050. | The current Welsh Government target is to create 2,000 hectares of new woodland p.a., rising to 4,000 hectares as soon as possible. Planting 20,000 ha by 2030 and a further 80,000ha by 2050. This will lead to 106,000 ha created by 2050. | 43,000 ha planted by 2030 (average of 5,000 ha/yr from 2023), rising to 180,000 hectares by 2050 (7,500 ha/yr from 2035). | 40,000ha planted by 2030 rising to 180,000 ha by 2050 (7,500 ha / yr from 2035). |
| **LAND** Urban Expansion | | | |
| 5% increase in urbanisation, from 105,773ha to 110,000ha | | | |

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| **BIODIVERSITY** Protected areas (% of total land) | | | |
|---|---|---|---|
| **Status Quo** | **Improving the Current System** | **Land Sparing** | **Land Sharing** |
| Existing designated sites protected for nature are maintained (not including National Parks, AONBS and Heritage Coast), i.e. no agricultural expansion is allowed in these areas. | Existing designated sites protected for nature are maintained and so are National Parks, AONBS and Heritage Coast, i.e. no agricultural expansion is allowed in these areas. | Existing designated sites protected for nature are maintained and so are National Parks, AONBS and Heritage Coast, i.e. no agricultural expansion is allowed in these areas. | To reverse decline in biodiversity, all semi-natural habitat (excluding woodland) are protected. The scenario also specified creation of a further 500,000 ha of habitat on farmland but this cannot be modelled as it is an output not an input. However we identified the increase in the share of new woodland dedicated to biodiversity that will be needed to meet this target. |

| **TRADE Share of consumption which is imported for key imported products (%)** | | | |
|---|---|---|---|
| **Status Quo** | **Improving the Current System** | **Land Sparing** | **Land Sharing** |
| Exports and imports are estimated from the commodity balance after downscaling production and consumption from UK statistics (see Annexe 3) and then held constant after 2010. | | | |

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| **PRODUCTIVITY** crop productivity or the key crops in the country | | | |
|---|---|---|---|
| **Status Quo** | **Improving the Current System** | **Land Sparing** | **Land Sharing** |
| As for the UK, in 2050, crop productivity remains the same:<br>• 7.7 tons per ha for wheat (7.1 with climate change impacts).<br>• 5.7 tons per ha for barley.<br>• 43.9 tons per ha for potatoes.<br>Based on FAOSTAT historic yields for 2010. | Same as for Status Quo | As for the UK, by 2050, crop productivity reaches:<br>• 12.7 tons per ha for wheat (12.0 with climate change impacts).<br>• 9.4 tons per ha for barley.<br>• 72.4 tons per ha for potato.<br>Based on assumption that yields for all crops increase by 65% (from stakeholder discussions). | As for the UK, by 2050, crop productivity reaches:<br>• 10.7 tons per ha for wheat (10.1 with climate change impacts).<br>• 7.9 tons per ha for barley.<br>• 61 tons per ha for potatoes.<br>Based on assumption that yields for all crops increase by 39% from the 2010 value, in line with the revised CCC medium projection. |
| **PRODUCTIVITY** Livestock productivity for the key livestock products in the country | | | |
| Dairy Yield, Beef, Chicken to remain the same | Between 2015 and 2050, yields:<br>• Dairy: a 37% increase (from 7784 to 10,654 l/cow).<br>• Beef: Remain at 123.6 kg/head of population for cattle meat.<br>• Poultry: Remain at 1.37 kg/head of population for chicken meat.<br>• Lambing increases 17%. | Between 2015 and 2050, yields:<br>• Dairy: a 50% increase in milk yield (from 7784 to 11,676 l/cow).<br>• Remain at 123.6 kg/head of population for cattle meat<br>• Increase by 10% for chicken meat, from 1.37 to 1.51 kg/head of population .<br>• Lambing percentage increases 52% as sheep systems increases efficiency. | Same as Improved current system.<br>• Lambing increases 41% |
| **PRODUCTION** Pasture stocking rate | | | |
| No changes to stocking density | Change in livestock density compared to baseline: 132% | Change in livestock density compared to baseline: 202% | Change in livestock density compared to baseline: 136% |
| **PRODUCTION** Post Harvest Losses | | | |
| No changes to post harvest losses | No changes to post harvest losses | By 2050, the share of production and imports lost during storage and transportation reduces by 50% to reach 0.5%. This parallels the SDG 12.3 target to halve consumer and retail waste by 2030. | By 2050, the share of production and imports lost during storage and transportation reduces by 50% to reach 0.5%. This parallels the SDG 12.3 target to halve consumer and retail waste by 2030. |

| **FOOD** Average dietary consumption (daily kcal per commodity group) | | | |
|---|---|---|---|
| **Status Quo** | **Improving the Current System** | **Land Sparing** | **Land Sharing** |
| By 2030, the average target daily calorie consumption per capita is 2,983 kcal and is:<br>• 168 kcal for fruit and vegetables.<br>• 83 kcal for ruminant meat.<br>• 119 kcal for animal fats.<br>Based on assumption of no change in current diet as in FAOSTAT. | Same as Status Quo | Eatwell Diet - By 2030, the average target daily calorie consumption per capita is 2,739 kcal and is:<br>• 196 kcal for fruit and vegetables.<br>• 75 kcal for ruminant meat.<br>• 98 kcal for animal fats.<br>Based on meeting the Eatwell diet recommendations by 2050 (PHE, 2020; Scarborough et al., 2016). | Eatwell Diet - By 2030, the average target daily calorie consumption per capita is 2,739 kcal and is:<br>• 196 kcal for fruit and vegetables.<br>• 75 kcal for ruminant meat.<br>• 98 kcal for animal fats.<br>Based on meeting the Eatwell diet recommendations by 2050 (PHE, 2020; Scarborough et al., 2016). |
| **FOOD** Share of food consumption which is wasted (%) | | | |
| No change to food waste | Existing trends in food waste reduction - 50% reduction in food waste by 2050, 2% a year from 2015 | Wales aims to have zero avoidable food waste before 2050.<br>Key targets:<br>• By 2025, 50% reduction in avoidable food waste<br>• By 2030, 60% reduction in avoidable food waste<br>• By 2050, Zero avoidable food waste | Wales aims to have zero avoidable food waste before 2050.<br>Key targets:<br>• By 2025, 50% reduction in avoidable food waste<br>• By 2030, 60% reduction in avoidable food waste<br>• By 2050, Zero avoidable food waste |

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| **BIOFUELS** Targets on biofuel and /or other energy use | | | |
|---|---|---|---|
| **Status Quo** | **Improving the Current System** | **Land Sparing** | **Land Sharing** |
| | | | |
| **CLIMATE CHANGE** Crop model and climate change scenario | | | |
| **Status Quo** | **Improving the Current System** | **Land Sparing** | **Land Sharing** |
| As for UK, By 2100, global GHG concentration leads to a radiative forcing level of 6 W/m2 (RCP 6.0). Impacts of climate change on crop yields are computed by the crop model GEPIC using climate projections from the climate model HadGEM2-E without CO2 fertilization effect. | As for UK, By 2100, global GHG concentration leads to a radiative forcing level of 6 W/m2 (RCP 6.0). Impacts of climate change on crop yields are computed by the crop model GEPIC using climate projections from the climate model HadGEM2-E without CO2 fertilization effect. | As for UK, By 2100, global GHG concentration leads to a radiative forcing level of 2.6 W/m2 (RCP 2.6). Impacts of climate change on crop yields are computed by the crop model GEPIC using climate projections from the climate model HadGEM2-E without CO2 fertilization effect. | As for UK, By 2100, global GHG concentration leads to a radiative forcing level of 2.6 W/m2 (RCP 2.6). Impacts of climate change on crop yields are computed by the crop model GEPIC using climate projections from the climate model HadGEM2-E without CO2 fertilization effect. |

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# Annex 2 – Land use change assumptions

- Scaled LCM data to match the total desired for Wales (2,077,000 ha – Paul Guest).
- Interpolated figures from LCM 2000, 2007 and 2015 to obtain them for required years (2000, 2005, 2010, 2015).
- Arable land in LCM is greater than in the Wales Agricultural Statistics; this may be due to the inclusion of temporary grass in LCM. We will investigate this to see if we need to make an adjustment.
- We assumed historical stocking densities of 2.4 on Intensive grassland and 0.66 on Extensive grassland. These were derived by fitting to the historic livestock numbers and land areas.

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# Annex 3 – Downscaling from UK input data

**Parameters from FAOSTAT for the UK were downscaled for Wales as follows:**

- Consumption of food – scaled by population ratio.
- Consumption of animal feed – scaled by animal numbers requiring feed (pigs, poultry, some cattle).
- Production of crops, and consumption of seed – scaled by cropland area ratio.
- Production of animal products – scaled by animal numbers.
- Production of wood – scaled by forest area.
- Production of fish – scaled by data on landings in Welsh ports by UK vessels.
- FABLE assumed a high yield of beef from dairy cows; we set this to almost zero for Wales.

**Estimating imports and exports for Wales:**

- We estimated the production and consumption of each product as described above.
- We subtracted the consumption from the production to obtain exports or imports.
- We will then keep exports (in tonnes) and the share of consumption that is imported (%) constant after 2010, which is the default option in FABLE, unless asked to specifically model changing exports, e.g. to reflect a decrease in global and/or UK demand for meat.

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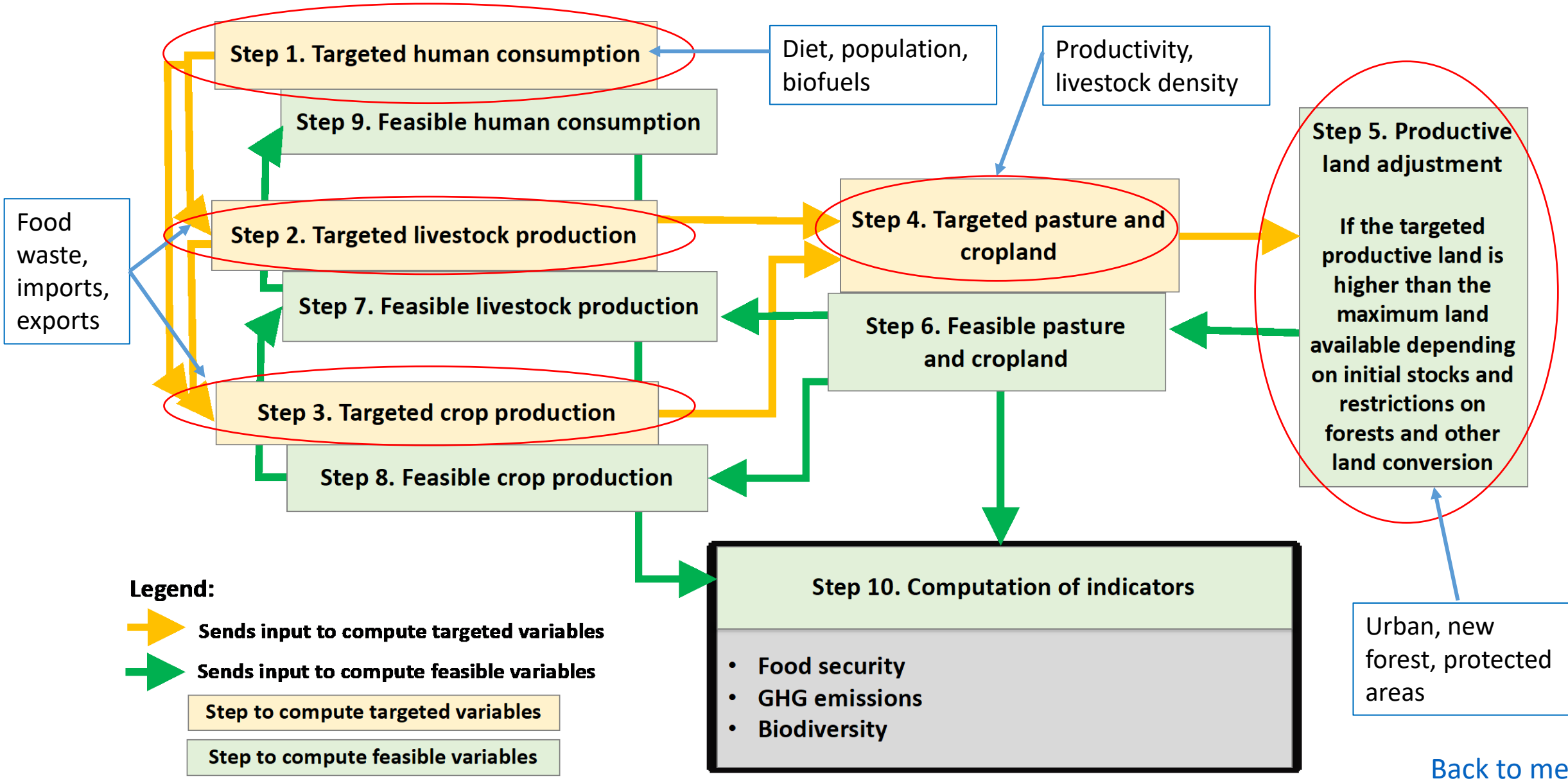
# Annex 4 – FABLE Calculator Schema

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ERAMMP Programme Office
UKCEH Bangor
Environment Centre Wales
Deiniol Road
Bangor, Gwynedd
LL57 2UW
+ 44 (0)1248 374500
erammp@ceh.ac.uk

www.erammp.cymru

www.erammp.wales