Assumptions for Farm Modelling

**Approach**

A computer-based model was used to assess the effects of increasing forage protein use at the farm level, comparing the ‘baseline’ and ‘optimal’ scenarios. For this to operate, a number of reliable data sources and assumptions were used (e.g. for livestock weight, feed requirements, crop inputs, etc.). The general assumptions applicable to all farms are listed below, along with assumptions for the operation of economic and carbon footprint calculations.

**General farm system assumptions for all farms**

- Total farm area (including ploughable area), and permanent pasture and rough grazing areas, remained the same for baseline and optimal scenarios.

- Basic enterprise data for each forage type, arable crop or livestock class was derived from the ABC 2012 handbook, though data has been adapted to be appropriate for the farm type: [http://www.abcbooks.me/](http://www.abcbooks.me/)

- Livestock numbers and production level remained the same for both scenarios (unless specifically noted in the individual farm assumptions).

- Livestock nutritional demands were calculated on an annual requirement basis using ‘Tried & tested – Feed planning for cattle and sheep’, though some data was adapted for each farm type: [http://www.nutrientmanagement.org/assets/1 2028](http://www.nutrientmanagement.org/assets/1 2028)

- Livestock requirements (with a small buffer) were identical for the baseline and optimal scenarios. Livestock feeding requirements were met through on-farm forage production and a simple two-component cereal and protein feed ration, as necessary. The optimal scenario resulted in a lower proportion of protein supplementation, though cereal feed often increased to ensure energy demands were still met.

- Forage yields were assumed to be similar between non-legume and legume-based forage crops but crop analysis was based on standard figures and data collected during the project.

- For the organic farms, mineral N fertiliser was always excluded, but for conventional farms mineral N fertiliser was assumed to be utilised. Even when legume crops were adopted in the optimal scenario, it was assumed that some mineral N fertiliser would continue to be used (e.g. 25% of baseline level). This reflects the potential for further savings in fertiliser use; as for most legume crops this would not be necessary.

**Assumptions for economic calculations**

- Economic values were applied to the physical quantities calculated through the farm model, such as feeds, fertilisers and crop inputs, livestock purchases, sales from cropping and livestock production.

- Fertiliser and feed costs were three-year averages, calculated from the AHDB website.

- Livestock output prices were sourced from project partners but may not reflect the current or future price achievable, whilst all other livestock data was taken from AHDB or ABC data sources.

- All internal transfers such as livestock, feed or straw are allocated and costed to enable calculation of enterprise costs for milk, beef and lamb.
All field operations for each activity were charged at standard contracting rates, as per the National Association of Agricultural Contractors and assumed to include fuel, labour and machinery costs: http://www.naac.co.uk/LatestContractorPricesGuide/

Other machinery and property costs, finance and land rental costs were not included as these would not vary between scenarios and can vary substantially between farm businesses.

**Assumptions for carbon footprint calculations**

- Emissions were calculated using standard international and UK reporting methods — the IPCC Tier 1 approach used in the UK National Inventory Report 1990-2012: https://www.gov.uk/government/statistics/uk-greenhousegas-inventory

- Emission Factors (EFs) (the 'carbon cost' of an item or activity) were applied to the physical quantities calculated through the farm model, such as feeds, fertilisers and crop inputs; livestock and crop production; and land use change. EFs were sourced from ISO 2050 compliant sources PAS: (http://shop.bsigroup.com/upload/shop/download/pas/pas2050.pdf)

- For more information on EFs, see the accompanying document “What is a carbon footprint”.

- Where available, separate EFs were applied to inputs on conventional and organic farms, reflecting differences in production under these systems.

- Physical quantities and costs were identical to the economic assessment data for the following: fertilisers; feed; bedding; livestock numbers (including economic values); crop types, areas and characteristics.

- All other physical quantities were taken from baseline data collected from the study farms: fuel and electricity use; agrochemicals and consumables; animal growth profiles (calculated monthly); housed livestock months; manure and waste bedding storage; and land-use change areas and types. These quantities remained constant between baseline and optimal scenarios.

- N2O emissions from ploughing-in of crop residues were calculated for any crops of < 20 year lifespan, on an annual basis according to crop cycle. Crops on a > 20 year cycle were considered to yield net zero emissions so were excluded.

- The final footprints include all externally inputted (embedded) and on-farm emissions, including land-use change resulting in emissions. Sequestration (carbon storage, e.g. in grassland or woodland) or land use change resulting in increased sequestration are excluded, as these would not vary between scenarios and can vary substantially between farm businesses.

- Product emissions (per kg liveweight lamb or beef; per L milk) were all calculated as farm gate values (i.e. before transport or processing). Emissions were allocated to final product footprints on an economic basis, using identical sales values to those used for the economic modelling.

- Emissions categories included in the charts group similar emissions together (see figure 1 in the accompanying document ‘What is a carbon footprint’), and include:
  1) **Concentrate feeds**: feed concentrates
  2) **Fertiliser & other inputs**: all farm inputs other than feed concentrates
  3) **Soils**: direct N2O emissions and indirect (associated with nitrate losses in leaching and runoff, and N deposition) N2O emissions, from soils, and CO2 emissions from lime application
  4) **Livestock**: CH4 emissions from livestock (enteric and manure management), and N2O emissions from manure management.

- Emissions savings car mileage equivalents were calculated using typical mid-point emissions from an efficiently run, tax band B, small family car (0.105 kg CO2e/km; sourced at http://carfueldata.dft.gov.uk/).