

Muck Maps

Methodology

October 2024

Summary

Muck Maps reveals the areas of the UK that are most at risk of nutrient pollution from manure produced in factory farms. The darker areas of the map indicate where muck is spread at the highest quantities. Three additional maps present the volume of manure produced by factory farms per Local Planning Authority, Westminster Constituency, and main river catchment*.

Muck is excreted by poultry and pigs, removed when the animals are sent to slaughter, and is mostly exported to farmers to be used as fertiliser. While this adds nutrients to the soil, most soils in the UK are in a nutrient surplus and cannot absorb the volume of manure being spread (DEFRA 2022b). Manure runs off oversaturated soil into local rivers, either directly or slowly through soil. The nutrients from manure can cause algal growth in rivers, leading to algal blooms that starve plants of light and fish of oxygen, creating dead zones. Manure from factory farming also carries disease risks, and nutrient pollution from manure prevents housebuilding from taking place (Sustain et al. 2024). Research published earlier this year indicates where the dominant meat agribusinesses operate in relation to major rivers across the UK (Sustain, Friends of the Earth, and Materiality 2024).

Livestock farms that have more than 40,000 birds or 2,000 pigs are classed as intensive and require an environmental permit. These farms are recorded by DEFRA. Farms that require a permit are referred to as factory farms throughout the Muck Maps. The farm locations and livestock capacity data were used in combination with an authoritative map of farmland to indicate where factory farm muck could be spread. The probability of muck being spread was calculated from average distances that muck is exported to farmers, combined with the volume of muck produced by each factory farm. The darker brown areas are more likely to be spread with muck, and at higher volumes. The volume of manure produced by each factory farm and the overlap between export areas determines the muck spread colour gradient.

*The catchments used for this map are Hydrometric Areas from the National River Flow Archive. Hydrometric areas follow main rivers from source to sea and, unlike other catchment boundaries, are available as a single, consistent dataset file covering the UK.

Factory Farms:

The maps represent the spread of manure from factory farms that are large enough to require an environmental permit - i.e. any farm with over 40,000 birds or 2,000 pigs. There are many smaller factory farms that fall under the permit threshold that were not assessed in this research. For example, almost half of the poultry farms in the Wye catchment do not require permits (CPRW Brecon & Radnor 2021). These smaller farms can only be found through council planning portals, which are time consuming to survey thoroughly. As such, assessing the likely manure spread from smaller factory farms was beyond the scope of this project.

Livestock permits, farm locations and livestock numbers were sourced from the Environment Agency (Environment Agency 2024), Scottish Environmental Protection Agency* (SEPA 2018; 2024b; 2024a), Natural Resources Wales (Natural Resources Wales 2024a; 2024b), the Northern Irish Department of Environment, Agriculture and Rural Affairs (DAERA 2024). This information was provided by Compassion In World Farming (CIWF), which collated this data for its factory farming population density study (CIWF 2024).

CIWF data was cross-referenced with the Pollution Release and Transfer Registry (PRTR) from the Department for the Environment, Food and Rural Affairs (DEFRA 2024b), filtered to include only intensive pig and poultry farms. All CIWF-derived locations were matched with PRTR entries. Remaining PRTR entries were searched in the devolved permitting registries to assign population numbers. It was not possible to find permit documents for a small number of these farms, which were removed from the map, alongside farms marked as disused or surrendered in the PRTR spreadsheet.

Manure Production from Factory Farms:

The volume of manure produced by factory farms was estimated by multiplying the livestock capacity of each permitted farm by the amounts of muck produced by poultry and pigs. The quantities of manure by animal were derived from the DEFRA commissioned Manures-GIS study and calculated following a methodology developed by Sustain (ADAS and North Wyke Research 2008; Sustain 2023). The Local Planning Authority, Westminster Constituency, and River Catchments maps show the volume of manure produced in these areas, expressed as tonnes per day.

*SEPA was the target of a cyber-attack in 2020, which has restricted the availability of data on intensive livestock units. Their systems have been improved since the CIWF study, which excluded Scotland from its analysis. While we have included Scotland in our mapping and rankings, there are likely more farms than we have been able to find through online archives.

Not all manure is immediately spread on land, a proportion is stored and spread later or sent to anaerobic digesters and incinerators. Both are methods of energy generation that transform muck into digestate and ash byproducts, widely used as fertiliser. Muck Maps focuses on the largest pathway - manure sold for spreading on fields. We estimated volumes of muck destined for anaerobic digestion and incineration and removed these from the muck spread map.

The 2023 Farm Practices Survey (DEFRA 2023) estimates that 11% of livestock farms in England send their manure to anaerobic digesters. In the absence of information on which specific farms opt for anaerobic digestion, we allocated 11% of each farm's manure to this pathway. Incineration is specific to poultry manure, and the ash from incineration was not included, due to the large distance it can be transported (it has no water content), making mapping unfeasible. The proportion of poultry manure sent to incinerators (taken from Avara Foods' manure strategy) was excluded from spread and digestion pathways (Avara Foods 2023).

Manure Transportation from Factory Farms:

The areas of possible muck spread were premised on the economically feasible distances that manure can be transported from factory farms to fields as fertiliser for farmers. The consistency of livestock manure varies by the type of animal and the system of agriculture it stems from. The variable that was key to this study is the wetness, or dryness, of the waste. The weight of water, and its diluting effect on the nutritional value of manure, influences the distance it can be transported away from a factory farm. Water adds weight and decreases nutrient density, causing the manure to become less valuable as fertiliser and more expensive to transport.

The types of manure produced, and the usage of each type, were drawn from Manures-GIS, government farm practice surveys, policy reports and academic studies. The impact of water content on the maximum travel distance of manure was based on policy reports and academic studies from the UK and Ireland, following a review of academic and open sources (Fealy and Schröder 2008; Lalor 2010; Nolan et al. 2012; Freeman 2020; SAC Consulting and Earthcare Technical 2020). The water content was expressed in these studies as either a dry matter content percentage, or qualitatively as slurry, farmyard manure, or litter. The transport distances were matched to dry matter and qualitative categories of manure, per animal type, from the Manures-GIS study (ADAS and North Wyke Research 2008). Additional evidence for poultry litter transport distance was found in meetings and event recordings on manure management in the River

Wye catchment (Herefordshire Council 2021; Friends of the River Wye 2024), alongside discussions with residents and stakeholders.

Manure Consistency			Transport Distance (km)								
Wetness	Manure-GIS Category	Dry Matter (%)	Fealy (Energy)	Fealy (Cost)	Freeman	SAC for SEPA	Nolan (Cost)	Lalor	Wye Case Study	Mean	Mapped Distance
	Broiler litter	58			40	48			68	52	
	Layer manure	34			40	48				44	
Dry										54.66666	55
	Dairy FYM	22			25	48				36.5	
	Beef FYM	20			25	48				36.5	
	Pig FYM	17	75	25	25	32		22		35.8	
	Sheep FYM	17				32				32	
Wet										35.2	35
	Dairy slurry	7			10					10	
	Beef slurry	6			10					10	
	Pig slurry	4	40		10		15			21.66666	
Liquid										13.88888	14

For the purposes of mapping, muck was split into three categories according to water content - dry, wet, and liquid. Dry refers to poultry litter, while both wet and liquid are produced by pig factory farms. The estimated travel distance for dry muck was 55km, 30km for wet and 14km for liquid. The rounded average maximum distances (right-most column) were used to determine the radius of circles drawn around each farm.

Manure Spread Map Colours:

The transportation area surrounding each factory farm were assigned a colour fill determined by the volume of manure produced by each farm, from light brown to dark brown. The cumulative level of manure was represented using a multiply rendering process. Applying multiply increased the colour contrast between areas with many overlapping circles or high volumes of manure production and areas with low overlap or low manure production. The process multiplied colour values together for each overlapping circle, retaining information about the volume of manure produced while highlighting high density areas.

Fields Spread with Factory Farm Manure:

Muck spread is shown only on areas classified as farmland, with any other areas masked in green or grey. To achieve this, a 2021 map of land cover was overlaid (UKCEH 2021), with arable areas and improved grassland set as transparent, urban areas as grey in higher zoom levels, and all other areas in green.

While manure is spread to both arable fields and grassland as fertiliser, the amount spread may vary with the type of crop and if animals are grazing. Government statistics reported that in 2023 “81% of holdings [in England] spread manure or slurry on their grass and arable land” (DEFRA 2024a). Searches of The Farming Forum revealed that manure and slurry have been spread on both arable and grass fields. This study prioritised identifying areas of high muck spread for further research: detailed modelling of differences between arable and grassland spread was beyond the scope of Muck Maps.

Manures-GIS incorporated this variation into its modelling, using figures derived from the British Survey of Fertiliser Practice (BSFP). However, our concern was that this may underestimate the spread of manure. The BSFP authors noted that their manure spread figures are not wholly reliable: the survey was designed to gauge artificial fertiliser practice rather than organic manure spread (DEFRA 2022a). Further, national level figures may miss local variation in farm practice, which is likely affected by manure availability and price. High numbers of factory farms and available quantities of manure may affect the type of manure that farmers use, which types of fields or crops, and in what quantity.

Including spread on both arable fields and improved grassland minimised variation from changes in land use or inaccuracy in the process of land cover mapping. The 2021 Land Cover map used represents a snapshot of practice within a specific time period, and the algorithmic classification used on satellite imagery has a margin of accuracy/error. Including both arable and improved grassland is the most reliable way to identify areas that require more in-depth research and diligence in water pollution monitoring and enforcement. Our priority is highlighting the areas with the most manure production, and the highest likelihood of spread.

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