AGROCYCLE FACTSHEET

Livestock manure production and value chains

This information is taken from an in-depth study; “Agricultural production systems and sustainable value chains”, written by the NNFCC as part of the Agrocycle project.

Manure Production

Livestock manure is the most abundant food supply chain waste generated in Europe, as a by-product of all animal growth produced daily; including beef cattle, dairy cattle, pigs, and poultry.

- Between 2010 and 2014, 1.56 billion tonnes/year of manure were produced on average.
- France and Germany produced the most manure between the same period, followed by the UK, Poland, Spain, and Italy
- Beef cattle produce the largest volumes of manure in the EU, followed by dairy cows, and pigs, while chickens produce the smallest amount of manure per year on average.

1. Production and Management

Storage of slurry in lagoon (left) and steel tower (right)

Typical Management

Manure is generally collected to improve hygiene on farm and to minimise health and safety concerns. As such, the cost of collection adds no an additional cost when valorising manure.

Manure is produced year-round, but is stored and used seasonally, unlike crop residues which are generally only available seasonally. The spreading of manures is constrained due to season, weather conditions, pollution legislation, and biosecurity reasons (to avoid spreading of disease) and must be stored suitably until use. Therefore, the vast majority of livestock farms already have storage facilities in place for manure, ready for use, such as lagoons, steel towers and heaps with an impermeable base.

Legislation

Legislation is an important consideration for managing and spreading slurry, as slurry has high nutrient availability and can cause water pollution. Particular attention should be paid to the Water Framework Directive (WFD) and national legislation such as Nitrate Vulnerable Zone (NVZ) regulations in the UK. The WFD is an EU directive which provides measures against chemical pollution of surface and ground water for environmental protection of rivers. NVZs are areas of land at risk of agricultural nitrate pollution of water bodies. In these zones there are strict regulations to limit the amount of fertiliser that can be applied, the timing of fertiliser application, and the storage of manures in tanks while it cannot be applied. These regulations are in place to protect river ecology and drinking water. NVZ’s include around 58% of land in England so are a concern for a large proportion of farmers.

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Different types of manure

Manure from different animals varies significantly, from different feed and housing regimes or different age groups of animals, both in terms of the composition, and also the quantity.

*'**Farmyard Manure** (FYM)'* signifies a mixture of bedding material and animal excreta in solid form arising from the housing of livestock.

*'**Slurry**'* means (a) excreta produced by livestock whilst in a yard or building or (b) a mixture consisting wholly or mainly of such excreta, bedding, rainwater and washings from a building or yard used by livestock or any combination of these, of a consistency that allows it to be pumped or discharged by gravity at any stage in the handling process; it excludes dirty water.

2. Processing systems resulting in manure

Farmyard manure (left) and slurry (right)

Pig Slurry Manure Production

Manure from housed systems can be collected in either solid or liquid form. Manure from outdoor pigs, which is a mix of liquids and solids is difficult to recover efficiently, and is generally left on the ground. Rotational grazing can be used to ensure a more uniform distribution and avoid overloading areas around feed and watering points. Pigs in intensive indoor units produce mostly liquid manure, a mix of faeces, urine, waste water and feed, although some may be gathered in more solid form if bedding is used.

Dairy Cattle Manure Production

The main dairy production systems in the EU are high input/output (intensive) systems and low input/output (extensive) systems. In extensive systems, manure deposited during grazing, is spread over the land and is therefore not collected. However, manure produced during milking can be collected. In intensive systems, manure can be collected both during the housed periods (either over winter or all year round in zero-grazing systems) and during milking.

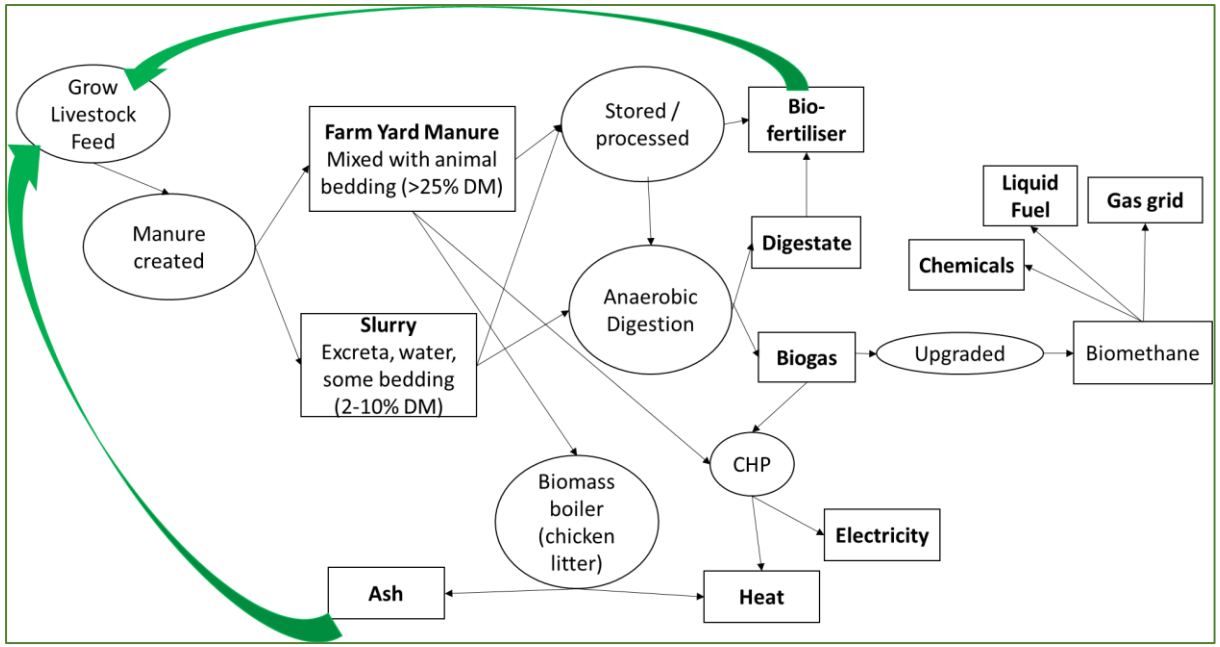
	Cattle FYM	Cattle slurry	Pigs FYM	Pig slurry	Poultry FYM
Dry Matter (%)	25	6	25	4	35
Total nitrogen (kg N/t)	6.0	2.6	7.0	3.6	19
Available nitrogen (kg N/t)	1.2	1.2	1.8	2.5	9.5
Total phosphate (kg P_2O_5/t)	3.2	1.2	6.0	1.8	14
Available phosphate (kg P_2O_5/t)	1.9	0.6	3.6	0.9	8.4
Total potash (kg K_2O/t)	8.0	3.2	8.0	2.4	9.5
Available potash (kg K_2O/t)	7.2	2.9	7.2	2.2	8.6
Sulphur (kg SO_3/t)	2.4	0.7	3.4	1.0	4.0
Magnesium (kg MgO/t)	1.8	0.6	1.8	0.7	2.6

Beef Cattle Manure Production

Beef cattle are typically housed in closed or semi-open barns that allow good ventilation and avoid the build-up of moisture. In housing with concrete floors manure is typically removed periodically along with the bedding. In housing with slatted floors manure and urine can pass into underfloor storage tanks, which may be emptied either periodically (deep pits) or at regular intervals using scrapers (shallow store).

Production of Poultry litter

In indoor rearing systems, all manure is collected in the form of chicken litter, a mixture of chicken manure and bedding (The floor, clay or concrete is covered evenly with bedding at the start of the growing period to absorb excreta). In free-range systems, only manure produced inside the broiler house is collected; manure deposited in the outdoor areas is left on the ground.



3. Typical value chains

Anaerobic Digestion facility

Biofertilizer

The vast majority of manures are currently utilised as a biofertilizer, with little or no processing.

- Manures are resources rich in nutrients vital for plant growth, including Nitrogen (N), Phosphorous (P) and Potassium (potash) (K) Sulphur (S) and Magnesium (Mg).
- Application of manure must be timed to have maximum benefit to crop nutrition, while avoiding run off, which can cause eutrophication, river pollution and nutrient depletion. They are recommended to be spread in spring, and not around the time of rainfall.

Anaerobic Digestion

In recent years, a small but increasing amount of manures are being processed via anaerobic digestion (AD) to increase their value by making energy, reducing volume and emissions, and by increasing their fertiliser potential.

- The main output of AD is biogas which can be burned in a combined heat and power (CHP) engine to produce heat and power, or be upgraded to biomethane and be injected to the gas grid or used as vehicle fuel.
- The other main output of AD is digestate, which is mostly used as a fertiliser and consists of nutrients, dead microbes, and undigested material.

Chicken Litter Combustion

Chicken litter consists of chicken manure with bedding and is drier than pig and cow manures, which makes it more suitable for burning.

- There is evidence that the use of chicken litter for energy has lower impact on the environment than its use as a fertiliser.
- The energy created can make the poultry farm more self-sufficient for energy and heating needs, displacing other fuels including gas, wood fuel, and national grid electricity.
- Compared to spreading fresh manure, the ash is lighter to transport, can be used as a PK fertiliser, and causes less air and water pollution.

Constraints to maximise utilisation of manure

There is great potential in this plentiful, nutrient-rich resource, but improvements need to be made to maximise the value captured from the exploitation of manure. Common issues include:

- Lack of finance to invest in new equipment.
- Low value and high moisture content of manure, which make it uneconomical to transport and process.
- Low confidence of farmers and entrepreneurs to start value chains when other valorisation pathways are established at lower risk.
- With regard to slurry AD, it only produces a small yield of biogas compared to other feedstocks such as crop and food waste.

4. Constraints and actions for further exploitation

Chicken litter AD plant (left) and advanced Manure application equipment (right)

Indicative actions for more sustainable exploitation

There is great potential in this plentiful resource, but there are also improvements to achieve a more sustainable manure management.

- Making technologies small scale and flexible can increase the utilisation of processing technologies on farm, like AD.
- Introduction of advanced manure application machinery that can reduce the emissions and improve nutrient use efficiency and accuracy with precision farming.
- Policy could be reviewed to make regulations even tighter, to ensure higher value uses are encouraged and not restrictive in any way.

Chicken Litter – An aggressive feedstock

- Chicken manure is too strong to be used raw on flowers or vegetables as it can damage the roots and even burn the plants.
- Composting is an easy way to dispose chicken litter as it inactivates pathogens and reduces the risk of contamination. However, compositing is a net energy consumer and results in high ammonia emissions, odours and leachate production.
- Chicken litter combustion is another alternative that can result in lower environmental impacts but still results in high emission levels, which can pose risks to human health.
- Anaerobic Digestion appears to be the most preferable treatment method, but chicken litter is a problematic substrate due to its high ammonia content. Several strategies have been developed to process 100% chicken litter via AD, including water dilution with, or ammonia stripping from the feedstock, prior to addition to the digester.

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