Teagasc National Farm Survey

A Report on Bovine Manure Management, Application and Storage Practices in Ireland 2017 to 2021

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ISBN: 978-1-84170-683-2

February 2023

Teagasc
Agriculture and Food Development Authority

ACKNOWLEDGEMENTS

The authors wish to thank all who contributed to the National Farm Survey over the 2017 to 2021 period, including the farmers who participate voluntarily and the Central Statistics Office who select the sample and provide the population weights. The authors gratefully acknowledgement is due to the Teagasc research staff involved in the collection and validation of the farm data: J. Brennan, J. Colgan, A. Curley, L. Deane, L. Delaney , T. Doyle, P. Harnett, P. Healy, S. Hegarty, G. Kenny, P. Madden, J. Maughan, J. McConnon, E. McGrath, K. McNamara, M. Murphy, M. Nicholson, J. Robinson, D. Schilder, J. Teehan and to Muriel Clarke for administration of the survey.

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The specifics of manure management on Irish farms is important for a number of reasons. Details relating to the volume, storage and application of manure are required to calculate the national emission inventories for greenhouse gases and ammonia. Similarly, such data is required in the context of the Nitrates' Directive. The Teagasc National Farm Survey has been adapted over the last number of years to collect a wider suite of management data in this area (Buckley et al., 2019). This report presents data relating to bovine animal housing periods, slurry and farm yard manure (FYM) storage, manure generated by different animal types, season of manure application, manure application methods and manures stored by different type of storage method. Aggregated results are presented on a national, nitrate zone and farm system basis over the 2017 to 2021 period. **No data is available on sheep housing periods, so data presented in this report relates exclusively to bovine generated animal manure.** It should be noted that bovine manure represent the vast bulk of the manure generated in Irish agriculture.

Summary Results relating to Manure Management at National Level (2017-2021)

- **Housing of dairy cows and bulls:** Dairy cows and bulls were housed for 124 days on average over the 2017-2021 period. Other bovine livestock categories tend to be housed for between 144 to 148 days over the period 2017-2021 (see Table 3).
- **Storage of manure:** The proportions of manure stored as slurry and FYM remained unchanged at 82% and 18% respectively over the period 2017-2021 (see Table 4). Slurry / FYM storage ratios ranged from 94%/6% for dairy cows to 55%/45% for cattle 0 to 1 year respectively (see Table 5).
- **Source of total slurry:** Averaged over the period 2017-2021, 34% of aggregate slurry generated (and stored) nationally was derived from dairy cows, 23% from suckler cows and 11 to 13% from each of the cattle 0 to 1 year and cattle 1 to 2 year age categories. Cattle categories over 2 years of age accounted for between 1 to 3% of aggregate slurry. Overall, the proportion derived from dairy cows is observed to be on the increase over the study period (see Table 6).
- **Source of total FYM:** Averaged over the period 2017-2021, 47% of aggregate FYM generated came from the cattle 0 to 1 year age category. Suckler cows were responsible for a further 20%, with the remaining bovine animal categories accounting for between 1 to 10% of the remaining aggregate FYM (see Table 7).
- **Timing of slurry application:** Averaged over the period 2017-2021, 43% of slurry was applied to land during both the January to April and May to July periods. Just 11% and 2% was applied in August and September and October to December, respectively (see Table 8).
- **Timing of FYM application:** On average over the period 2017-2021, 41% of average aggregate FYM was applied during October to December, with a further 40% applied during August and September (see Table 9).
- **Method of slurry application:** In 2021, the final year of the study period, low emission slurry spreading (LESS) methods accounted for 48% of aggregate slurry applied. Trailing shoe, followed by trailing hose are the two most commonly used low emission slurry spreading technologies. The use of LESS has increased significantly since the start of the study period (see Table 10).
- **Type of slurry storage:** In 2021, 90% of aggregate slurry on average was stored under a roofed slatted tank, a further 4% was stored in either an unroofed underground tank or an uncovered over

ground tank, with 3% stored in a covered over ground tank. Lined lagoons accounted for less than 1% of aggregate slurry stored over the study period on average (see Table 11).

Summary Results relating to Manure Management by Geographic Nitrate Zone (2017-2021)

Under nitrates based regulations, Ireland is divided into three geographic zones. Southern and eastern counties are in zone A, south-western and western counties are in zone B and some of the counties bordering Northern Ireland make up zone C. The summary results outlined below relate to these three zones. Given that differences with respect to land use class, amount of rainfall and length of growing season are the basis for the definitions on these zones, differences with respect to some aspects of manure management across the zones are to be expected, as nitrates regulations across the three zones are not uniform.

- **Duration of slurry storage period:** In the period 2017-2021, farms in nitrate zone A tended to have the shortest animal housing period on average (see Table 12).
- **Storage of Slurry:** In the period 2017-2021, 75%, 89% and 91% of aggregate animal manure was stored as slurry in nitrate zone A, B, and C respectively (see Table 13).
- **Storage of FYM:** In the period 2017-2021, 25%, 11% and 9% of animal manure was stored as FYM in nitrate zone A, B, and C respectively. A higher ratio of FYM storage (versus slurry) were associated with cattle 0 to 1 year (see Table 14).
- **Source of Slurry:** In the period 2017-2021, 44% of slurry generated and stored in nitrate zone A was derived from dairy cows. While a total of 29% and 34% of slurry generated in nitrate zones B and C was derived from suckler cows (see Table 17).
- **Source of FYM:** In the period 2017-2021, between 46% to 58% of FYM generated and stored across all 3 nitrate zones was associated with the cattle 0 to 1 year category (see Table 18).
- **Timing of slurry application:** Across the four application periods, the largest amount of slurry in nitrate zone A was applied in the January to April period at 46%. Whereas in zones B and C, 46% and 48% of slurry was applied in the May to July period (see Table 19).
- **Timing of FYM application:** Across the four application periods, the largest amount of FYM that was applied in Zone A and Zone C was in the August to September period at 42% and 41% respectively. Whereas, the largest amount of FYM in Zone B (46%) was applied in the October to December period (see Table 20).
- **Method of slurry application:** In 2021, the final year of the study period, 63%, 59% and 47% of total slurry was applied by LESS methods (trailing shoe, trailing hose and injection) in Zones A, B and C respectively (see Table 21).
- **Type of bovine slurry storage:** In the period 2017-2021, between 87% to 94% of slurry was stored under a roofed slatted tank across all nitrate zones on average (see Table 22).

Summary Results relating to Manure Management by Farm System (2017-2021)

No data is available on sheep housing periods, pig and poultry manure are not covered in this report. Hence, data presented in this report relate exclusively to bovine generated animal manure. However, sheep and tillage farms are included in this analysis, as many have bovine animals as part of a secondary enterprise. Summary result below hence relate to bovine slurry across various farm systems.

- **Storage of manure:** In the period 2017 to 2021, 82 to 84% of bovine based animal manure was stored in slurry form on dairy, cattle and sheep farms. Except for the cattle 0 to 1 year category, the majority of manure generated by bovine animal categories was stored as slurry on dairy, cattle and sheep farms (see Table 23).
- **Source of slurry:** In the period 2017 to 2021, 80% of total bovine slurry on dairy farms was generated by dairy cows. The majority of bovine slurry (41 to 45%) on cattle and sheep farms (with cattle) was generated by suckler cows (see Table 28).
- **Source of FYM:** In the period 2017 to 2021, 64% of FYM generated on dairy farms was associated with cattle 0 to 1 year with a further 28% generated by dairy cows. On cattle and sheep farms (with cattle), cattle 0 to 1 year and the suckler cow categories generally accounted for the majority of FYM (see Table 29).
- **Timing of slurry application:** In 2021, Tillage farms with bovine slurry tended to apply the most proportionately in the January to April period at 52% of total slurry. This was followed by dairy (47%), sheep farms with cattle (42%) and cattle farms (44%). Cattle and sheep farms tended to apply greater proportions in the May and June period (45% on average) compared to dairy (37%) and tillage farms (23%) (see Table 30).
- **Timing of FYM application:** In 2021, the majority of FYM tended to be applied in or after August (greater than 75%) across all farm systems (see Table 31).
- **Method of slurry application:** In 2021, the final year of the study period, over 75% of the slurry on dairy farms and 55% on tillage farms was applied using a LESS method. The corresponding figures were considerably lower on sheep and cattle farms at 20% and 28% respectively (see Table 32).
- **Type of slurry storage:** Over 95% of bovine manure that is stored as slurry is stored under a roofed slatted tank across cattle, sheep and tillage farm systems. However, the figure for roofed slatted tanks was lower for dairy farms (80% on average) as underground and overground tanks can be found to a greater extent on dairy farms compared to other farm types (see Table 33).

1 INTRODUCTION

Manure management is responsible for 12% of the greenhouse gas emissions from Irish agriculture (Duffy et al., 2022). Methane is emitted due to the anaerobic decomposition of organic matter during manure storage, especially in liquid manure (slurry), while nitrous oxide (N_2O) is emitted via the nitrification of NH_4^+ and partial denitrification of NO_3 during storage of solid manure and soil application of both solid and liquid manures (Kavanagh et al., 2019). Additionally, ammonia (NH_3) volatilisation is a major loss pathway for nitrogen. Agriculture accounts for approximately 99.4% of national ammonia emissions in Ireland, of which 90% are associated with the management of livestock manure (EPA, 2022). The majority of ammonia emissions originate from livestock manure streams associated with housing, storage and land spreading of manures (Burchill et al., 2017).

National inventory based estimates of greenhouse gases and air pollutants are established from activity data multiplied by an emission factor. This report increases the detail available for national level activity data in the areas of animal housing days, proportions of manure stored as slurry and farm yard manure (FYM), manure generated by different animal types, manure applications during different seasons and by various application methods as well as proportion of manure stored by type of storage method. All of the data presented are critical for the more accurate estimation of national level GHG and air pollutant inventories associated with agriculture.

In addition to gaseous emissions, the activity data contained in this report is relevant for policymakers with respect to water quality. The EU Nitrates Directive (91/676/EEC) was introduced in 1991, with the objective of reducing water pollution caused or induced by nitrates from agriculture and preventing further such pollution, with the primary emphasis being on the management of livestock manures and other fertilisers. In Ireland the Nitrates Directive has been implemented through the Good Agricultural Practice regulations (Government of Ireland, 2006; 2009; 2010; 2014; 2017; 2018; 2020; 2022). Indeed, the 2020 regulations (Government of Ireland, 2020) require farmers who are farming under a Nitrates Derogation to use Low Emission Slurry Spreading (LESS) equipment for all slurry applied after 15th April in 2020 and all slurry spread post 12th January in 2021.

Given the importance of manure management in the context of gaseous emissions and water quality, the Teagasc National Farm Survey (NFS) has been adapted over the last number of years to collect a wider suite of environmental/sustainability data. This report follows on from previous reports using Teagasc NFS data (Buckley et al., 2020). However, it is important to note that the results from the previous reports (2017 onwards) have been updated on the back of recent methodological revisions, as outlined in section 2.2 following.

2 MATERIALS AND METHODS

2.1 DATA

The data used for this analysis has been extracted from the Teagasc NFS. The NFS has been produced annually since 1972 and fulfils Ireland's statutory obligation to provide data on farm output, costs and income to the European Commission through the Farm Accountancy Data Network (FADN) of the European Union. Over time, there has been an increased appreciation that data relating to the environmental aspects and sustainability of agriculture are of growing importance. In Ireland the response to this has been the collection, through the NFS, of a suite of data that go beyond current FADN requirements. This includes, animal housing dates, the proportion of manure stored as slurry and farm yard manure (FYM), the proportion of manure generated by animal type, proportion of manure applied during different seasons, proportion of manure applied by different application methods, proportion of manure stored by type of storage method. **No data is available of sheep housing periods, so data presented in this report relate exclusively to bovine generated animal manure. However, sheep and tillage farms are included in this analysis as many have bovine activity as a secondary farm enterprise**. Results are at the aggregate level presented across national, nitrate zone and farm system dimensions over the 2017 to 2021 period.

2.2 METHODOLOGICAL UPDATE – NFS SAMPLE REWEIGHTING FOR 2017 TO 2020

The Teagasc NFS is a survey of approximately 840 farms which are representative of approximately 85,000 farms in Ireland. In order to ensure that the sample is representative of this population, farms in the sample are selected at random from strata (categories) in the farm population. These strata ensure that the sample contains an appropriate mix of farm types and that the economic size (measured in farm output) of the farms selected is also representative of the farm population.

The nationally representative results that are produced are not a simple aggregation of the results for each individual farm. Each farm in the sample is assigned a weighting factor, hence each farm in the sample is representative of a specific number of farms in the population. The total number of farms represented and the numbers in each size class in the sample can change over time, in response to changes in the distribution of the total farm population.

The population of farms and its composition is determined by the Central Statistics Office (CSO). Each decade the CSO conducts a Census of Agriculture which provides details on, amongst other things, the number of farms and their economic size. In the period between each Census, the CSO conducts Farm Structure Surveys, which also provide information on farm numbers and farm size. Information from the Census of Agriculture and Farm Structure Surveys provide the weighting factors for the NFS farms. The weighting factors used in the NFS will relate to either of these two CSO data sources and will depend on which of these CSO enumerations is more recent.

The CSO conducted a Census of Agriculture in 2020 and initial results became available in 2022 (CSO, 2022). These census results allowed us to update the weighting factors that had been used in the NFS for the period 2017 to 2020 (which had previously been based on the Farm Structure Survey 2016). This updating of farm weights in the NFS takes place periodically to reflect the availability of more up-to-date data. Normally this reweighting results in minor and generally unremarkable changes to the NFS results for the preceding years, reflecting relatively small changes in weighting factors applied.

The application of new weighting factors based on the Census of Agriculture in 2020, has resulted in some minor changes to NFS results for the period 2017 to 2020 for cattle, sheep and tillage farms. However, following the removal of the EU milk quota system, there has been a period of considerable structural change in the dairy sector in Ireland and this is reflected in the newest weighting factors from the Census of Agriculture 2020.

Compared to the Farm Structure Survey of 2016, the Census of Agriculture 2020 indicates that there are now fewer dairy farms than in 2016, but that a greater proportion of these farms fall into larger size classes.

When applied to the NFS sample, these new weights increase the average absolute output, income and emissions of dairy farms compared to previously reported estimates for the period 2017 to 2020 (per hectare estimates have remained stable). The basis for this increase is that dairy farms in these years were typically larger in area and had a larger herd size than previously estimated. As well as containing detailed sustainability results for 2021, this report also contains updated estimates for the years 2017 to 2020 to reflect this updated set of population weights. Hence, results for 2017 and 2018 will be different to those publish in the previous report by Buckley et al., (2020).

2.3 SAMPLE PROFILE AND POPULATION REPRESENTATION

Table 1 provides a detailed breakdown of the sample and population represented on a national, nitrate zone and farm system basis. It should be noted that when aggregate results are reported (843 farms aggregated in one result), the population represented is reflective of farms that have the relevant category of animal (e.g. suckler cows) and/or activity (e.g. slurry storage). Hence, for example, any suckler cows held on dairy farms are included in the aggregate suckler cow category. Farms in the Teagasc NFS with no bovines are excluded from this analysis as are very small farms, defined as farms below the €8,000 standard output threshold, since these very small farms fall outside of the NFS annual survey sampling frame. Standard output measures are applied to each animal and crop output on the farm. A standard output of €8,000 or more is equivalent to 4 dairy cows, 5 hectares of wheat or 11 suckler cows. The Teagasc NFS sample is representative of 85% of the utilizable agricultural area, 97% of the standard land based (grassland and tillage) agricultural output and 96% of livestock units in Ireland. Therefore, the exclusion of very small farms has minimal impact on these results.

Table 1: Population of farms represented on a national, nitrate zone and farm system basis

National	2017	2018	2019	2020	2021
Sample number (farms)	843	853	832	795	787
Population represented	84,820	82,970	81,509	79,928	78,826

Nitrate Zone	2017	2018	2019	2020	2021
Zone A*					
Sample Number (farms)	437	434	421	392	384
Population represented	32,131	30,723	30,574	29,763	29,510
Zone B*					
Sample Number (farms)	297	301	293	286	286
Population represented	40,318	39,662	38,312	37,706	37,871
Zone C*					
Sample Number (farms)	109	118	118	117	117
Population represented	12,065	11,885	11,470	11,289	11,232

*** The population represented by zone differs from that of the national population due to the regional concentration of some farm system type**

Farm System	2017	2018	2019	2020	2021
Dairy					
Sample Number (farms)	309	313	318	301	288
Population represented	15,956	15,768	15,547	15,319	15,319
Cattle					
Sample Number (farms)	370	381	365	348	357
Population represented	52,589	51,088	49,696	48,227	48,227
Sheep					
Sample Number (farms)	100	100	94	90	85
Population represented	10,970	10,671	11,435	10,572	10,272
Tillage					
Sample Number (farms)	45	43	43	40	41
Population represented	3,929	3,977	3,673	4,013	3,851
Mixed Livestock Farms**					
Sample Number (farms)	19	16	12	16	16
Population represented	1,375	1,466	1,158	1,797	1,158

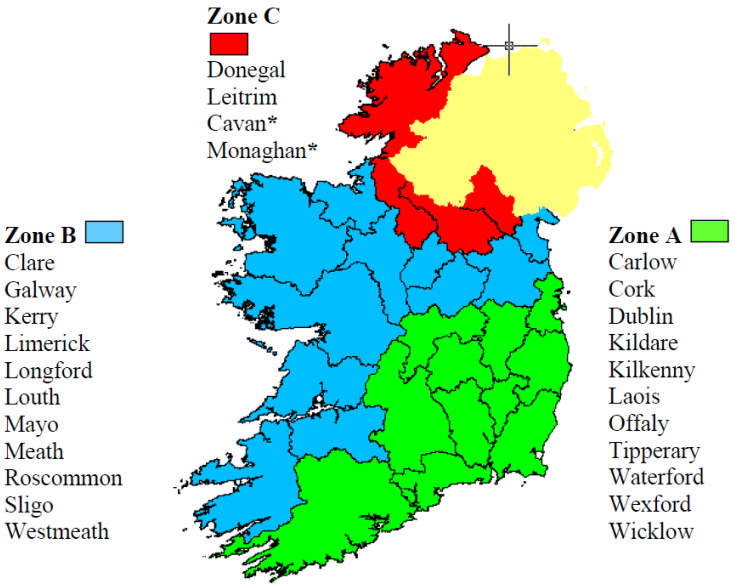
**** Due to small sample size results for the Mixed Livestock Farms are not reported in the farm system section**

DEFINITION OF KEY VARIABLES

Aggregate Result: All results presented in this report are on an aggregated basis. All individual farm results are aggregated to produce aggregate results at a national, nitrate zone or farm system level average results, as opposed to an average calculated from individual farm level results.

Nitrate Zones: The EU Nitrates Directive National Action Programme was implemented on a whole territory basis in Ireland and the national territory was subdivided into three management zones (based on groups of counties) by reference mainly to land use class, amount of rainfall and length of growing season. Regulations relating to nutrient management differ across these zones. These nitrate zones are displayed in Figure 1 below.

Figure 1: Nitrate Zone designation in Ireland under the EU Nitrates Directive



Source: Department of Agriculture, Food and the Marine (2014)

The most recent regulations that give effect to the National Action Programme in this area were enacted through statutory instrument (SI) No. 113 of 2022 Good Agricultural Practice for Protection of Waters (GAP) Regulations (Government of Ireland, 2022). The GAP Regulations encompass rules on slurry storage capacity, application of inorganic and organic fertilisers, livestock stocking densities and farm facilities. Under the GAP Regulations, storage capacity on farm holdings across all zones must be sufficient for the full housing period and should also provide an adequate level of storage to allow for circumstances where application might be hindered due to periods of adverse weather.

The following minimum storage capacity for bovine livestock manure are set down:

- 16 weeks in Zones A
- 18 weeks in Zone B, and
- 20 or 22*[1] weeks in Zone C.

[1] Recognising the high water quality in counties Donegal and Leitrim and the lower intensity of agricultural production, the required minimum storage period was set at 20 weeks. The minimum storage period for counties Cavan and Monaghan was designated at 22 weeks

The periods during which the application of organic fertiliser are prohibited (both dates inclusive) are outlined in Table 2 below.

Table 2: Prohibition periods for spreading organic fertilisers

Zone	All Organic Fertilisers Excluding Farmyard Manure	Farmyard Manure
A	8 Oct. to 12 Jan.	1 Nov. to 12 Jan.
B	8 Oct. to 15 Jan	1 Nov. to 15 Jan.
C	8 Oct. to 31 Jan.	1 Nov. to 31 Jan.

Source: Government of Ireland, 2022

Farm system: Within the Teagasc NFS, farms are classified into major farming systems according to the standardised EU typology used by FADN (a more detailed explanation can be found in Dillon et al., 2018). This report displays results for the four dominant farm systems namely, dairy, cattle, sheep and tillage.

Slurry: In this report slurry relates to animal manure stored in a liquid format. Sheep, pigs and poultry are not covered in this report. Hence, results presented exclusively relate to bovine slurry. Quantities of slurry generated are estimated from animal numbers housed, the duration of housing and slurry coefficients per bovine animal category as per the Nitrates Regulations (S.I. No. 113 of 2022).

Farm Yard Manure (FYM): In this report, FYM relates to animal manure stored in a more solid form (slurry mixed with straw). Again, as no data is available on sheep housing dates, the results presented exclusively relate to bovine FYM. Quantities of FYM generated are estimated from animal numbers housed, the duration of housing and FYM coefficients per bovine animal category, as per the Nitrates Regulations (S.I. No. 113 of 2022).

Days Housed: The housing period was based on reported cattle turn out and turn in dates. A half day was assumed when animals were out by day and housed by night. Animal numbers housed were based on animal inventories held on December 31st each year over the study period. Only farms with the relevant animal category (e.g. dairy cows) were included in the analysis for that animal category.

Slurry applied by Season: Slurry applied by season was based on the total volume of slurry generated (based on the number and type of animal housed as well as number of days housed) and the percentage of slurry reported spread by farmers during the periods January to April, May to July, August and September and October to December.

FYM applied by Season: FYM applied by season was based on the total volume of FYM generated (based on the number and type of animal housed as well as number of days housed) and the percentage of FYM reported spread by farmers during the periods January to April, May to July, August and September and October to December. All FYM is assumed to be broadcast spread using either side discharge or rear discharge spreaders.

Slurry applied by different application methods: Slurry applied by season was based on the total volume of slurry generated (based on the number and type of animal housed as well as number of days housed) and the percentage of slurry reported spread using different methods (e.g. splash plate) either by the farmer or a contractor.

Slurry stored by type of storage method: Slurry stored by type of storage method was based on the total volume of slurry generated (based on the number and type of animal housed as well as number of days housed) and the percentage of slurry reported stored in different ways (e.g. underground tank under roofed slatted shed).

5 years average basis: Due to potential impact of weather shocks (positive and negative) results are presented on an individual and 5-year average basis.

Low emissions slurry spreading (LESS): This covers slurry application by either injection, trailing shoe or trailing hose.

3 RESULTS

Results are presented on a national, nitrate zone and farm system aggregate basis.

3.1 AGGREGATE RESULT – NATIONAL

Table 3 reports on the number of days housed by livestock category on a national aggregate basis. On average dairy cows are housed for the shortest period, at 124 days based on the 5 year average. Other livestock categories tended to be housed for between 144 to 148 days on average over the period examined.

Table 3: Number of days housed by bovine category on a national aggregate basis

	Annual Average					
All Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	120	124	128	128	121	124
Suckler Cows	153	149	150	145	139	147
Cattle 0 to 1 year	150	148	148	146	139	146
Cattle 1 to 2 years Female	152	151	146	149	143	148
Cattle 1 to 2 years Male	148	147	145	147	139	145
Cattle 2 to 3 years Female	151	145	154	148	139	148
Cattle 2 to 3 years Male	148	152	145	147	141	146
Bulls	151	145	142	142	140	144

Source: Teagasc National Farm Survey

On average over the 2017 to 2021 period, 82% of manure was stored as slurry and 18% was stored as FYM on an aggregate basis. The percentage stored as slurry tended to increase over the study period and conversely the percentage of manure stored as FYM declined, as seen in Table 4.

Table 4: Percentage of bovine manure stored as slurry & FYM on a national aggregate basis

	Annual Average					
All Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
% Stored as slurry	81%	82%	82%	82%	82%	82%
% Stored as FYM	19%	18%	18%	18%	18%	18%

Source: Teagasc National Farm Survey

On average 94% of manure generated by dairy cows was stored as slurry. The next highest in relative terms was male and female cattle 1 to 2 years and female cattle 2 to 3 years, where 86% of manure was stored as slurry. For manure generated by suckler cows, on average 84% was stored as slurry, as illustrated by Table 5. The lowest proportion stored as slurry was among the cattle 0 to 1 year at 55%.

Table 5: Breakdown of bovine manure stored as slurry & FYM by animal type on an aggregate basis

	Annual % Average Slurry & FYM					
	2017	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows						
% Stored as slurry	94%	94%	94%	94%	94%	94%
% Stored as FYM	6%	6%	6%	6%	6%	6%
Suckler Cows						
% Stored as slurry	83%	84%	83%	84%	85%	84%
% Stored as FYM	17%	16%	17%	16%	15%	16%
Cattle 0 to 1 year						
% Stored as slurry	56%	56%	53%	55%	56%	55%
% Stored as FYM	44%	44%	47%	45%	44%	45%
Cattle 1 to 2 years Male						
% Stored as slurry	85%	87%	86%	86%	86%	86%
% Stored as FYM	15%	13%	14%	14%	14%	14%
Cattle 1 to 2 years Female						
% Stored as slurry	84%	86%	85%	86%	88%	86%
% Stored as FYM	16%	14%	15%	14%	12%	14%
Cattle 2 to 3 years Male						
% Stored as slurry	86%	91%	82%	85%	87%	83%
% Stored as FYM	14%	9%	18%	15%	13%	17%
Cattle 2 to 3 years Female						
% Stored as slurry	81%	83%	81%	86%	84%	86%
% Stored as FYM	19%	17%	19%	14%	16%	14%
Bulls						
% Stored as slurry	77%	79%	77%	78%	80%	78%
% Stored as FYM	23%	21%	23%	22%	20%	22%

On average 34% of aggregate slurry generated (and stored) nationally was derived from dairy cows over the 5 year study period. This figure has been seen to increase between 2017 to 2021. Conversely, the figure for suckler cows has declined over the same period from 25% to 22%. On average between 10 to 14% of aggregate slurry was derived from each of the cattle 0 to 1 year and cattle 1 to 2 year categories as presented in Table 6.

Table 6: Percentage of total bovine slurry generated by animal type on an aggregate basis

	Annual % Average Slurry					
All Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	31%	32%	35%	37%	36%	34%
Suckler Cows	25%	24%	24%	22%	22%	23%
Cattle 0 to 1 year	14%	13%	12%	13%	14%	13%
Cattle 1 to 2 years Female	14%	14%	13%	13%	14%	13%
Cattle 1 to 2 years Male	10%	12%	11%	11%	10%	11%
Cattle 2 to 3 years Female	3%	3%	3%	2%	1%	3%
Cattle 2 to 3 years Male	2%	2%	2%	2%	2%	2%
Bulls	1%	1%	1%	1%	1%	1%

Source: Teagasc National Farm Survey

The majority of aggregated FYM generated (and stored) came from the cattle 0 to 1 year age category (47% on average over the 5 year study period). The suckler cow category was responsible for a further 20% on average nationally as can be observed in Table 7.

Table 7: Percentage of bovine FYM generated by animal type on a national aggregate basis

	Annual % Average FYM					
All Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	9%	10%	9%	11%	11%	10%
Suckler Cows	22%	21%	21%	19%	18%	20%
Cattle 0 to 1 year	45%	46%	46%	48%	51%	47%
Cattle 1 to 2 years Female	11%	10%	10%	10%	9%	10%
Cattle 1 to 2 years Male	7%	8%	8%	8%	8%	8%
Cattle 2 to 3 years Female	3%	3%	3%	2%	1%	2%
Cattle 2 to 3 years Male	1%	1%	2%	1%	1%	1%
Bulls	1%	1%	1%	1%	1%	1%

Source: Teagasc National Farm Survey

Table 8 indicates that 43% of slurry was applied to land between January and April on an average aggregate basis, a further 43% and 11% was applied in May to July and August and September respectively. On average 2% of total slurry was applied in October ahead of the closed period.

Table 8: Percentage of bovine slurry applied by season on a national aggregate basis

	Annual Average					
All Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	45%	41%	42%	43%	45%	43%
May-July	40%	43%	44%	45%	43%	43%
August-September	11%	12%	12%	10%	10%	11%
October-December	3%	3%	2%	2%	2%	2%

Source: Teagasc National Farm Survey

The largest proportion (41% on a 5-year average basis) of aggregate FYM was applied in August-September period, with a further 40% applied in October before the end of the closed period as outlined in Table 9.

Table 9: Percentage of bovine FYM applied by season on a national aggregate basis

	Annual Average					
All Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	12%	10%	10%	9%	8%	10%
May-July	8%	8%	8%	11%	11%	9%
August-September	44%	43%	43%	38%	33%	40%
October-December	36%	39%	39%	42%	49%	41%

Source: Teagasc National Farm Survey

There has been a significant transition in the way slurry is applied to land, with a move away from the splash plate method towards various LESS methods (injection, trailing shoe & trailing hose) over the study period. In 2017, 94% of slurry was applied via splash plate, but this decreased to 52% by 2021. Conversely, the use of LESS increased from 4% to 48% between 2017 and 2021, with trailing shoe and trailing hose accounting for the largest portion of these applications as seen in Table 10.

Table 10: Percentage of bovine slurry applied by different application methods on a national aggregate basis

	Annual Average					
Method of application (All Farms)	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Splash plate	94%	94%	78%	62%	52%	76%
Injection	1%	1%	1%	4%	4%	2%
Trailing Shoe	2%	2%	11%	24%	28%	14%
Trailing Hose	1%	2%	10%	11%	16%	8%
Side End	2%	1%	0%	0%	0%	1%
Other	0%	0%	0%	0%	0%	0%

Source: Teagasc National Farm Survey

The vast majority of slurry was stored under a roofed slatted tank (90% on average over the 5 years) on average over the study period as seen by Table 11. A further 4% of slurry was stored in an unroofed underground tank, 3% of slurry was stored in both uncovered over ground tanks and covered over ground tanks on average. The use of lined lagoons was seen to diminish over the study period.

Table 11: Percentage of bovine slurry stored by storage method on a national aggregate basis

	Annual Average					
Slurry Storage Method (All Farms)	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Under roofed slatted tank	89%	90%	90%	90%	89%	90%
Unroofed underground tank	4%	4%	4%	3%	4%	4%
Uncovered over ground tank	3%	3%	4%	4%	4%	4%
Covered over ground tank	3%	2%	2%	3%	3%	3%
Unlined lagoon	0%	0%	0%	0%	0%	0%
Lined lagoon	1%	1%	0%	0%	0%	0%

Source: Teagasc National Farm Survey * No data was available on type of umbilical system used

3.2 AGGREGATE RESULT – NITRATE ZONE

Table 12 outlines the number of days that various bovine animal categories are housed on an aggregate basis by nitrate zone. Farms in Zone A tended to have the shortest housing period on average over the study period. Dairy cows in Zone A for example were housed for 10% fewer days than dairy cows in Zone B and 23% fewer days than dairy cows in Zone C. Dairy cows tended to be the category of animal housed for the shortest period across the zones.

Table 12: Number of days housed by livestock category on an aggregate basis by Nitrate Zone

	Annual Average Days Housed					
Zone A	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	114	122	121	122	115	119
Suckler Cows	141	143	142	139	129	139
Cattle 0 to 1 year	146	146	144	142	133	142
Cattle 1 to 2 years Male	148	154	145	145	139	146
Cattle 1 to 2 years Female	146	148	143	144	135	143
Cattle 2 to 3 years Male	155	149	152	147	129	147
Cattle 2 to 3 years Female	152	154	146	146	137	147
Bulls	144	140	141	139	131	139

	Annual Average Days Housed					
Zone B	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	130	124	135	135	132	131
Suckler Cows	162	152	154	148	143	152
Cattle 0 to 1 year	152	150	150	149	143	149
Cattle 1 to 2 years Male	157	146	148	154	147	150
Cattle 1 to 2 years Female	150	148	149	151	144	148
Cattle 2 to 3 years Male	146	145	158	150	144	149
Cattle 2 to 3 years Female	145	150	150	152	148	149
Bulls	156	150	145	145	145	148

Annual Average Days Housed						
Zone C	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	150	142	171	159	150	155
Suckler Cows	170	162	164	154	153	161
Cattle 0 to 1 year	164	159	156	157	154	158
Cattle 1 to 2 years Male	159	146	147	155	154	152
Cattle 1 to 2 years Female	152	150	147	145	148	148
Cattle 2 to 3 years Male*	154	-	-	-	-	-
Cattle 2 to 3 years Female**	-	161	122	-	-	140
Bulls	162	151	145	154	159	154

Source: Teagasc National Farm Survey
* No result reported due to small sample size
** Result is based on a 2 year average

Over the five-year study period, the highest proportion of bovine manure stored in slurry form was in Zone C at 91%, followed by Zone B at 89%, with the Zone A at 75%. Conversely, 25% of aggregate manure in Zone A was stored as FYM on a three-year average basis, this declined to 11% in Zone B and 9% in Zone C, as outlined in Table 13.

Table 13: Percentage of aggregate bovine manure stored as slurry & FYM by nitrate zone

	Annual Average					
	2017	**2018**	**2019**	**2020**	**2021**	**Average**
Zone A						
% Stored as slurry	74%	76%	75%	75%	76%	75%
% Stored as FYM	26%	24%	25%	25%	24%	25%
Zone B						
% Stored as slurry	88%	89%	89%	89%	88%	89%
% Stored as FYM	12%	11%	11%	11%	12%	11%
Zone C						
% Stored as slurry	90%	93%	92%	92%	89%	91%
% Stored as FYM	10%	7%	8%	8%	11%	9%

Source: Teagasc National Farm Survey

Over the study period on average 93% of manure generated by dairy cows was stored in slurry form in Zone A. Excluding suckler cows and cattle 0 to 1 year, 82% to 90% of aggregate manure was stored in slurry form across the other categories. The majority of manure (56%) for cattle age 0 to 1 year was stored as FYM, as shown in Table 14.

Table 14: Proportion of aggregate bovine manure stored as slurry & FYM by animal type in Zone A

	Annual % Average Slurry & FYM					
Zone A	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows						
% Stored as slurry	92%	92%	93%	93%	93%	93%
% Stored as FYM	8%	8%	7%	7%	7%	7%
Suckler Cows						
% Stored as slurry	82%	83%	83%	81%	82%	82%
% Stored as FYM	18%	17%	17%	19%	18%	18%
Cattle 0 to 1 year						
% Stored as slurry	45%	45%	43%	44%	45%	44%
% Stored as FYM	55%	55%	57%	56%	55%	56%
Cattle 1 to 2 years Male						
% Stored as slurry	87%	89%	88%	90%	88%	88%
% Stored as FYM	13%	11%	12%	10%	12%	12%
Cattle 1 to 2 years Female						
% Stored as slurry	90%	90%	90%	91%	89%	90%
% Stored as FYM	10%	10%	10%	9%	11%	10%
Cattle 2 to 3 years Male						
% Stored as slurry	84%	85%	83%	86%	85%	84%
% Stored as FYM	16%	15%	17%	14%	15%	16%
Cattle 2 to 3 years Female						
% Stored as slurry	90%	94%	82%	85%	83%	87%
% Stored as FYM	10%	6%	18%	15%	17%	13%
Bulls						
% Stored as slurry	82%	84%	81%	80%	81%	82%
% Stored as FYM	18%	16%	19%	20%	19%	18%

Nearly all (99%) of the manure generated by dairy cows was stored in slurry form in Zone B, as illustrated in Table 15. Excluding bulls (83%) and cattle 0 to 1 year (73%), over 90% of aggregate manure was stored as slurry for the other livestock categories.

Table 15: Proportion of aggregate bovine manure stored as slurry & FYM by animal type in Zone B

	Annual % Average Slurry & FYM					
Zone B	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows						
% Stored as slurry	100%	100%	99%	99%	99%	99%
% Stored as FYM	0%	0%	1%	1%	1%	1%
Suckler Cows						
% Stored as slurry	95%	96%	97%	97%	95%	96%
% Stored as FYM	5%	4%	3%	3%	5%	4%
Cattle 0 to 1 year						
% Stored as slurry	73%	76%	73%	72%	72%	73%
% Stored as FYM	27%	24%	27%	28%	28%	27%
Cattle 1 to 2 years Male						
% Stored as slurry	92%	97%	97%	96%	96%	96%
% Stored as FYM	8%	3%	3%	4%	4%	4%
Cattle 1 to 2 years Female						
% Stored as slurry	94%	95%	92%	95%	96%	94%
% Stored as FYM	6%	5%	8%	5%	4%	6%
Cattle 2 to 3 years Male						
% Stored as slurry	94%	95%	93%	95%	94%	94%
% Stored as FYM	6%	5%	7%	5%	6%	6%
Cattle 2 to 3 years Female						
% Stored as slurry	97%	96%	98%	98%	96%	97%
% Stored as FYM	3%	4%	2%	2%	4%	3%
Bulls						
% Stored as slurry	83%	83%	84%	81%	83%	83%
% Stored as FYM	17%	17%	16%	19%	17%	17%

Zone C was similar to Zone B where 99% of manure generated by dairy cows was stored as slurry, as illustrated in Table 16. Again, excluding bulls (82%), male cattle 2 to 3 years (89%) and cattle 0 to 1 year (78%), the remaining categories indicated over 90% of aggregate manure was stored as slurry.

Table 16: Proportion of aggregate bovine manure stored as slurry & FYM by animal type in Zone C

	Annual % Average Slurry & FYM					
Zone C	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows						
% Stored as slurry	99%	99%	99%	99%	98%	99%
% Stored as FYM	1%	1%	1%	1%	2%	1%
Suckler Cows						
% Stored as slurry	95%	96%	96%	95%	91%	95%
% Stored as FYM	5%	4%	4%	5%	9%	5%
Cattle 0 to 1 year						
% Stored as slurry	78%	81%	77%	80%	73%	78%
% Stored as FYM	22%	19%	23%	20%	27%	22%
Cattle 1 to 2 years Male						
% Stored as slurry	91%	91%	92%	92%	89%	91%
% Stored as FYM	9%	9%	8%	8%	11%	9%
Cattle 1 to 2 years Female:						
% Stored as slurry	94%	99%	98%	98%	97%	97%
% Stored as FYM	6%	1%	2%	2%	3%	3%
Cattle 2 to 3 years Male						
% Stored as slurry	89%	89%	89%	90%	91%	89%
% Stored as FYM	11%	11%	11%	10%	9%	11%
Cattle 2 to 3 years Female						
% Stored as slurry	94%	99%	94%	97%	97%	96%
% Stored as FYM	6%	1%	6%	3%	3%	4%
Bulls						
% Stored as slurry	82%	80%	81%	82%	82%	82%
% Stored as FYM	18%	20%	19%	18%	18%	18%

The percentage of total aggregate slurry generated by animal type differs significantly across the zones, as seen in Table 17. The largest share of total slurry generated and stored in Zone A was derived from dairy cows at 44% on average over the study period. This reflects the greater concentration of dairy farms in this zone. In contrast, the largest share of slurry generated in Zone B and Zone C were derived from suckler cows, at 29% and 34% respectively, again reflecting the greater density of cattle rearing activities in these zones.

Table 17: Percentage of bovine slurry stored by animal type on an aggregate basis by nitrate zone

	Annual % Average Slurry					
Zone A	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	40%	41%	45%	48%	48%	44%
Suckler Cows	17%	16%	16%	14%	14%	15%
Cattle 0 to 1 year	11%	10%	9%	10%	11%	10%
Cattle 1 to 2 years Male	16%	16%	14%	14%	14%	15%
Cattle 1 to 2 years Female	11%	11%	10%	10%	10%	10%
Cattle 2 to 3 years Male	3%	3%	3%	2%	1%	3%
Cattle 2 to 3 years Female	2%	2%	1%	1%	1%	1%
Bulls	1%	1%	1%	1%	1%	1%
Zone B	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	26%	25%	28%	30%	28%	27%
Suckler Cows	31%	30%	30%	28%	26%	29%
Cattle 0 to 1 year	14%	15%	13%	14%	17%	15%
Cattle 1 to 2 years Male	13%	13%	12%	11%	13%	12%
Cattle 1 to 2 years Female	10%	11%	10%	11%	10%	10%
Cattle 2 to 3 years Female	3%	3%	3%	2%	2%	3%
Cattle 2 to 3 years Male	2%	2%	3%	2%	2%	2%
Bulls	1%	1%	1%	1%	1%	1%
Zone C	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	22%	22%	26%	27%	27%	25%
Suckler Cows	35%	34%	33%	32%	33%	34%
Cattle 0 to 1 year	20%	20%	17%	19%	20%	19%
Cattle 1 to 2 years Male	9%	6%	7%	6%	8%	7%
Cattle 1 to 2 years Female	10%	14%	14%	13%	8%	12%
Cattle 2 to 3 years Male	1%	1%	1%	1%	1%	1%
Cattle 2 to 3 years Female	2%	3%	2%	1%	2%	2%
Bulls	1%	1%	1%	1%	1%	1%

Source: Teagasc National Farm Survey

The largest share of FYM generated and stored across all 3 zones was associated with the cattle 0 to 1 year category (46% to 58%) on a 5 year average aggregate basis (Table 18). Straw bedding is associated with calf rearing activity that corresponds to this age category.

Table 18: Percentage of bovine FYM generated and stored by animal type on an aggregate basis by nitrate zone

	Annual % Average FYM					
Zone A	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	11%	12%	11%	13%	14%	12%
Suckler Cows	20%	19%	20%	19%	17%	19%
Cattle 0 to 1 year	44%	45%	43%	46%	50%	46%
Cattle 1 to 2 years Male	13%	12%	12%	11%	9%	11%
Cattle 1 to 2 years Female	7%	7%	7%	7%	7%	7%
Cattle 2 to 3 years Male	3%	3%	3%	1%	1%	2%
Cattle 2 to 3 years Female	1%	1%	2%	1%	1%	1%
Bulls	1%	1%	1%	1%	1%	1%
Zone B	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	3%	3%	4%	4%	2%	3%
Suckler Cows	24%	26%	25%	20%	21%	23%
Cattle 0 to 1 year	46%	45%	48%	53%	57%	50%
Cattle 1 to 2 years Male	10%	7%	5%	6%	6%	7%
Cattle 1 to 2 years Female	11%	12%	11%	12%	10%	11%
Cattle 2 to 3 years Male	3%	3%	3%	2%	1%	2%
Cattle 2 to 3 years Female	1%	2%	3%	1%	1%	2%
Bulls	2%	2%	2%	2%	2%	2%
Zone C	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	3%	2%	3%	3%	4%	3%
Suckler Cows	22%	22%	21%	24%	27%	23%
Cattle 0 to 1 year	54%	60%	60%	60%	56%	58%
Cattle 1 to 2 years Male	9%	7%	6%	7%	7%	7%
Cattle 1 to 2 years Female	6%	3%	4%	3%	2%	4%
Cattle 2 to 3 years Male	2%	1%	1%	1%	0%	1%
Cattle 2 to 3 years Female	1%	0%	1%	0%	1%	1%
Bulls	3%	3%	3%	3%	2%	3%

Source: Teagasc National Farm Survey

Taking a five year average, across the four application periods, the largest share of slurry in Zone A was applied in the January to April period at 46%, with a further 37% applied in the May to July period. These shares were reversed for Zone B, where 46% was applied in May to July period and 42% in January to April. This pattern was repeated for Zone C, with 48% applied in May to July and 40% in the January to April period, as shown in Table 19.

Table 19: Percentage of bovine slurry applied by season on an aggregate basis by nitrate zone

	Annual Average					
Zone A	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	47%	44%	45%	48%	47%	46%
May - July	35%	37%	37%	37%	36%	37%
August - September	13%	14%	13%	13%	12%	13%
October-December	4%	4%	4%	3%	4%	4%
Zone B	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	43%	39%	40%	41%	45%	42%
May - July	44%	46%	47%	49%	46%	46%
August - September	11%	13%	12%	9%	8%	11%
October-December	2%	2%	1%	1%	1%	1%
Zone C	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	45%	39%	40%	38%	39%	40%
May - July	40%	50%	49%	50%	48%	48%
August - September	13%	10%	11%	11%	12%	11%
October-December	1%	1%	0%	1%	0%	1%

Source: Teagasc National Farm Survey

Taking a five year average, across the four application periods, the largest share of FYM was applied in August and September in Zone A (42%) and Zone C (41%), as illustrated in Table 20. By contrast, the largest share of FYM in Zone B was applied from October to the end of the closed period for spreading (46%).

Table 20: Percentage of bovine FYM applied by season on an aggregate basis by nitrate zone

	Annual Average					
Zone A	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	12%	11%	11%	9%	8%	10%
May - July	8%	7%	7%	10%	9%	8%
August - September	47%	47%	45%	40%	30%	42%
October-December	34%	35%	37%	40%	53%	40%
Zone B	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	15%	6%	6%	9%	8%	9%
May - July	12%	17%	17%	16%	16%	16%
August - September	26%	26%	32%	31%	35%	30%
October-December	47%	51%	44%	44%	41%	46%
Zone C	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	21%	8%	12%	9%	5%	11%
May - July	8%	6%	7%	11%	11%	9%
August - September	48%	48%	41%	39%	31%	41%
October-December	23%	37%	40%	41%	54%	39%

Source: Teagasc National Farm Survey

As discussed previously, there has been a transition away from slurry application by splash plate to LESS methods. This is evident from the results across all nitrate zones, as illustrated from Table 21.

Table 21: Percentage of bovine slurry applied by different methods on an aggregate basis by nitrate zone

Method of application	Annual Average					
Zone A	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Splash plate	94%	93%	81%	58%	37%	72%
Injection	0%	0%	1%	1%	4%	1%
Trailing Shoe	3%	4%	7%	24%	34%	14%
Trailing Hose	1%	2%	11%	17%	25%	11%
Side End	2%	2%	0%	0%	0%	1%
Other methods	0%	0%	0%	0%	0%	0%
Zone B	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Splash plate	88%	88%	41%	25%	39%	56%
Injection	0%	1%	1%	4%	2%	2%
Trailing Shoe	5%	5%	29%	58%	41%	28%
Trailing Hose	3%	3%	27%	13%	16%	12%
Side End	5%	3%	1%	0%	0%	2%
Other methods	0%	0%	0%	0%	2%	0%
Zone C	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Splash plate	83%	84%	66%	50%	52%	67%
Injection	0%	1%	0%	11%	2%	3%
Trailing Shoe	3%	6%	19%	29%	36%	19%
Trailing Hose	1%	3%	16%	10%	9%	8%
Side End	9%	6%	0%	0%	0%	3%
Other methods	4%	0%	0%	0%	0%	1%

Source: Teagasc National Farm Survey

The majority of slurry was stored under a roofed slatted tank across all zones (87% to 94%), on a 5 year average aggregate basis, as outlined in Table 22.

Table 22: Percentage of bovine slurry stored by building structure on an aggregate basis by nitrate zone

	Method of application					
Zone A % Slurry Stored in:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Under roofed slatted tank	86%	87%	88%	88%	86%	87%
Unroofed underground tank	6%	6%	6%	6%	7%	6%
Uncovered over ground tank	4%	5%	4%	4%	4%	4%
Covered over ground tank	2%	2%	1%	2%	2%	2%
Unlined lagoon	0%	0%	0%	0%	0%	0%
Lined lagoon	1%	1%	1%	1%	1%	1%
Zone B Slurry Stored in:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Under roofed slatted tank	89%	91%	89%	89%	89%	89%
Unroofed underground tank	2%	2%	2%	1%	1%	2%
Uncovered over ground tank	3%	3%	4%	4%	5%	3%
Covered over ground tank	6%	5%	5%	5%	5%	6%
Unlined lagoon	0%	0%	0%	0%	0%	0%
Lined lagoon	0%	0%	0%	0%	0%	0%
Zone C Slurry Stored in:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Under roofed slatted tank	93%	95%	95%	95%	95%	94%
Unroofed underground tank	3%	2%	2%	1%	2%	2%
Uncovered over ground tank	3%	2%	2%	2%	2%	3%
Covered over ground tank	1%	1%	0%	1%	0%	1%
Unlined lagoon	0%	0%	0%	0%	0%	0%
Lined lagoon	0%	0%	0%	0%	0%	0%

Source: Teagasc National Farm Survey

3.3 AGGREGATE RESULT – FARM SYSTEM

The majority of bovine based animal manure was stored in slurry form on dairy, cattle and sheep farms (82% to 84%) over the study period. On tillage farms, farmyard manure storage was more prevalent accounting for 46% of aggregate cattle manure. Results for slurry and FYM storage proportions by farm type are shown in Table 23.

Table 23: Percentage of bovine manure stored as slurry & FYM on an aggregate basis by farm system

	Annual Average					
Dairy Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Stored as slurry	83%	84%	85%	85%	85%	84%
Stored as FYM	17%	16%	15%	15%	15%	16%
Cattle Farms						
Stored as slurry	81%	82%	83%	82%	82%	82%
Stored as FYM	19%	18%	17%	18%	18%	18%
Sheep Farms						
Stored as slurry	81%	84%	82%	83%	82%	83%
Stored as FYM	19%	16%	18%	17%	18%	17%
Tillage Farms						
Stored as slurry	57%	59%	43%	54%	57%	54%
Stored as FYM	43%	41%	57%	46%	43%	46%

Source: Teagasc National Farm Survey

Slurry was the pre-dominant manure storage method on dairy farms across the animal categories, except for cattle 0 to 1 year, where 61% of manure was stored as FYM, as presented in

Table 24.

Table 24: Percentage of bovine manure stored as slurry and FYM by animal type on dairy farms

Dairy Farms	Annual % Average Slurry & FYM					
	2017	2018	2019	2020	2021	Average
Dairy Cows						
% Stored as slurry	95%	94%	95%	95%	95%	95%
% Stored as FYM	5%	6%	5%	5%	5%	5%
Suckler Cows						
% Stored as slurry	89%	87%	89%	92%	89%	89%
% Stored as FYM	11%	13%	11%	8%	11%	11%
Cattle 0 to 1 year						
% Stored as slurry	38%	38%	39%	39%	42%	39%
% Stored as FYM	62%	62%	61%	61%	58%	61%
Cattle 1 to 2 years Male						
% Stored as slurry	85%	88%	88%	89%	87%	88%
% Stored as FYM	15%	12%	12%	11%	13%	12%
Cattle 1 to 2 years Female						
% Stored as slurry	91%	93%	94%	96%	97%	94%
% Stored as FYM	9%	7%	6%	4%	3%	6%
Cattle 2 to 3 years Male						
% Stored as slurry	92%	98%	82%	98%	100%	94%
% Stored as FYM	8%	2%	18%	2%	0%	6%
Cattle 2 to 3 years Female						
% Stored as slurry	98%	100%	100%	100%	100%	100%
% Stored as FYM	2%	0%	0%	0%	0%	0%
Bulls						
% Stored as slurry	84%	82%	82%	81%	85%	83%
% Stored as FYM	16%	18%	18%	19%	15%	17%

Between 71% and 92% of manure on cattle farms was stored as slurry across all animal categories, as illustrated by Table 25. The cattle 0 to 1 year category had the greatest proportion of FYM at 29% on a 5 year average basis.

Table 25: Percentage of bovine manure stored as slurry and FYM by animal type on cattle farms

Cattle Farms	Annual % Average Slurry & FYM					
	2017	2018	2019	2020	2021	Average
Dairy Cows						
% Stored as slurry	0%	0%	0%	0%	0%	0%
% Stored as FYM	0%	0%	0%	0%	0%	0%
Suckler Cows						
% Stored as slurry	90%	91%	93%	92%	92%	92%
% Stored as FYM	10%	9%	7%	8%	8%	8%
Cattle 0 to 1 year						
% Stored as slurry	73%	73%	72%	71%	68%	71%
% Stored as FYM	27%	27%	28%	29%	32%	29%
Cattle 1 to 2 years Male						
% Stored as slurry	90%	92%	94%	92%	93%	92%
% Stored as FYM	10%	8%	6%	8%	7%	8%
Cattle 1 to 2 years Female						
% Stored as slurry	91%	93%	91%	93%	92%	92%
% Stored as FYM	9%	7%	9%	7%	8%	8%
Cattle 2 to 3 years Male						
% Stored as slurry	88%	90%	92%	89%	90%	90%
% Stored as FYM	12%	10%	8%	11%	10%	10%
Cattle 2 to 3 years Female						
% Stored as slurry	91%	94%	89%	91%	89%	91%
% Stored as FYM	9%	6%	11%	9%	11%	9%
Bulls						
% Stored as slurry	83%	84%	83%	81%	83%	83%
% Stored as FYM	17%	16%	17%	19%	17%	17%

Slurry was again the dominant method of bovine manure storage on sheep farms with a secondary bovine enterprise. Between 76% and 97% of bovine manure on sheep farms was stored as slurry across all the bovine animal categories as seen in Table 26. The cattle 0 to 1 year category again had the greatest proportion of FYM at 24% on an average 5 year basis.

Table 26: Percentage of bovine manure stored as slurry and FYM by animal type on sheep farms (with cattle)

Sheep Farms (with Cattle)	Annual % Average Slurry & FYM					
	2017	2018	2019	2020	2021	Average
Dairy Cows						
% Stored as slurry	0%	0%	0%	0%	0%	0%
% Stored as FYM	0%	0%	0%	0%	0%	0%
Suckler Cows						
% Stored as slurry	90%	94%	95%	94%	97%	94%
% Stored as FYM	10%	6%	5%	6%	3%	6%
Cattle 0 to 1 year						
% Stored as slurry	70%	72%	75%	79%	82%	76%
% Stored as FYM	30%	28%	25%	21%	18%	24%
Cattle 1 to 2 years Male						
% Stored as slurry	93%	95%	83%	85%	78%	87%
% Stored as FYM	7%	5%	17%	15%	22%	13%
Cattle 1 to 2 years Female						
% Stored as slurry	88%	90%	92%	88%	93%	90%
% Stored as FYM	12%	10%	8%	12%	7%	10%
Cattle 2 to 3 years Male:						
% Stored as slurry	97%	97%	96%	99%	99%	97%
% Stored as FYM	3%	3%	4%	1%	1%	3%
Cattle 2 to 3 years Female						
% Stored as slurry	97%	97%	96%	98%	99%	97%
% Stored as FYM	3%	3%	4%	2%	1%	3%
Bulls						
% Stored as slurry	80%	78%	91%	86%	90%	85%
% Stored as FYM	20%	22%	9%	14%	10%	15%

On tillage farms (with bovines) the majority of manure generated by suckler cows (51%) was stored as FYM. This contrasted with storage practices for the other bovine categories, where slurry was the pre-dominant storage method as seen by Table 27.

Table 27: Percentage of bovine manure stored as slurry and FYM by animal type on tillage farms (with cattle)

Tillage Farms (with Cattle)	Annual % Average Slurry & FYM					
	2017	2018	2019	2020	2021	Average
Dairy Cows						
% Stored as slurry	0%	0%	0%	0%	0%	0%
% Stored as FYM	0%	0%	0%	0%	0%	0%
Suckler Cows						
% Stored as slurry	50%	46%	45%	52%	52%	49%
% Stored as FYM	50%	54%	55%	48%	48%	51%
Cattle 0 to 1 year						
% Stored as slurry	63%	78%	64%	62%	50%	63%
% Stored as FYM	37%	22%	36%	38%	50%	37%
Cattle 1 to 2 years Male						
% Stored as slurry	87%	87%	72%	93%	89%	86%
% Stored as FYM	13%	13%	28%	7%	11%	14%
Cattle 1 to 2 years Female						
% Stored as slurry	94%	88%	86%	90%	80%	88%
% Stored as FYM	6%	12%	14%	10%	20%	12%
Cattle 2 to 3 years Male						
% Stored as slurry	67%	73%	58%	73%	71%	68%
% Stored as FYM	33%	27%	42%	27%	29%	32%
Cattle 2 to 3 years Female						
% Stored as slurry	88%	95%	93%	92%	84%	90%
% Stored as FYM	12%	5%	7%	8%	16%	10%
Bulls						
% Stored as slurry	66%	80%	66%	65%	50%	65%
% Stored as FYM	34%	20%	34%	35%	50%	35%

Farm system type dictates the proportion of aggregate bovine slurry generated by different bovine animal categories, as can be observed in Table 28. On dairy farms, dairy cows generated 80% of total aggregate bovine slurry on average over the study period. This contrasted with cattle and sheep farms, where greater proportions of bovine slurry were generated by suckler cows (41% to 45%) on a 5 year average aggregate basis. On tillage farms, the majority of slurry was associated with cattle 1 to 2 years of age (58%) on average.

Table 28: Percentage of bovine slurry generated by Animal Type on an aggregate basis by Farm System

	Annual Average % Slurry					
Dairy	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	78%	78%	80%	82%	82%	80%
Suckler Cows	2%	2%	1%	1%	1%	1%
Cattle 0 to 1 year	8%	7%	7%	7%	8%	8%
Cattle 1 to 2 years Male	5%	4%	4%	3%	3%	4%
Cattle 1 to 2 years Female	6%	7%	5%	5%	5%	6%
Cattle 2 to 3 years Male	0%	0%	0%	0%	0%	0%
Cattle 2 to 3 years Female	0%	0%	0%	0%	1%	0%
Bulls	1%	1%	1%	1%	1%	1%
Cattle	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	0%	0%	0%	0%	0%	0%
Suckler Cows	41%	40%	42%	41%	39%	41%
Cattle 0 to 1 year	18%	17%	15%	17%	20%	18%
Cattle 1 to 2 years Male	19%	20%	19%	19%	22%	20%
Cattle 1 to 2 years Female	12%	15%	15%	15%	14%	14%
Cattle 2 to 3 years Male	5%	5%	4%	4%	2%	4%
Cattle 2 to 3 years Female	3%	3%	3%	3%	2%	3%
Bulls	1%	1%	1%	1%	1%	1%
Sheep	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	0%	0%	0%	0%	0%	0%
Suckler Cows	48%	45%	45%	45%	44%	45%
Cattle 0 to 1 year	17%	17%	17%	19%	21%	18%
Cattle 1 to 2 years Male	15%	14%	17%	14%	12%	14%
Cattle 1 to 2 years Female	12%	12%	13%	14%	14%	13%
Cattle 2 to 3 years Male	4%	5%	3%	4%	3%	4%
Cattle 2 to 3 years Female	3%	4%	2%	2%	5%	3%
Bulls	1%	1%	1%	1%	1%	1%
Tillage	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	0%	0%	0%	0%	0%	0%
Suckler Cows	8%	7%	15%	13%	20%	13%
Cattle 0 to 1 year	9%	11%	16%	13%	14%	13%
Cattle 1 to 2 years Female	44%	37%	31%	35%	42%	38%
Cattle 1 to 2 years Male	22%	23%	19%	22%	13%	20%
Cattle 2 to 3 years Female	10%	14%	11%	8%	7%	10%
Cattle 2 to 3 years Male	7%	7%	8%	9%	4%	7%
Bulls	0%	0%	1%	0%	1%	0%

Source: Teagasc National Farm Survey

The majority of bovine based FYM generated on dairy farms was associated with cattle 0-1 year (64%), with a further 28% generated by dairy cows on an average aggregate basis, as illustrated in Table 29. For the cattle and sheep farms (with a secondary cattle enterprise) the cattle 0 to 1 year and the suckler cow categories accounted for the majority of FYM (ranging from 32% to 42% depending on the category). For tillage farms with cattle, the FYM distribution was spread more broadly across the bovine animal categories.

Table 29: Percentage of bovine FYM generated by Animal Type on an aggregate basis by Farm System

	Annual Average % FYM					
Dairy	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	26%	29%	27%	30%	30%	28%
Suckler Cows	1%	1%	1%	1%	1%	1%
Cattle 0 to 1 year	64%	63%	65%	65%	64%	64%
Cattle 1 to 2 years Male	4%	3%	3%	3%	2%	3%
Cattle 1 to 2 years Female	3%	2%	2%	1%	2%	2%
Cattle 2 to 3 years Male	0%	0%	0%	0%	0%	0%
Cattle 2 to 3 years Female	0%	0%	0%	0%	0%	0%
Bulls	1%	1%	1%	1%	1%	1%
Cattle	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	0%	0%	0%	0%	0%	0%
Suckler Cows	35%	34%	35%	32%	25%	32%
Cattle 0 to 1 year	38%	39%	38%	42%	50%	42%
Cattle 1 to 2 years Male	12%	12%	8%	10%	11%	11%
Cattle 1 to 2 years Female	8%	9%	12%	10%	9%	10%
Cattle 2 to 3 years Male	4%	4%	3%	3%	2%	3%
Cattle 2 to 3 years Female	2%	1%	3%	2%	2%	2%
Bulls	1%	1%	2%	2%	1%	1%
Sheep	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	0%	0%	0%	0%	0%	0%
Suckler Cows	38%	35%	30%	31%	30%	33%
Cattle 0 to 1 year	39%	45%	36%	34%	36%	38%
Cattle 1 to 2 years Male	6%	6%	19%	14%	17%	12%
Cattle 1 to 2 years Female	15%	11%	10%	17%	14%	13%
Cattle 2 to 3 years Male	1%	1%	2%	0%	0%	1%
Cattle 2 to 3 years Female	1%	1%	2%	2%	1%	1%
Bulls	2%	2%	1%	2%	1%	2%
Tillage	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Dairy Cows	0%	0%	0%	0%	0%	0%
Suckler Cows	19%	21%	22%	26%	35%	25%
Cattle 0 to 1 year	19%	15%	17%	23%	24%	19%
Cattle 1 to 2 years Female	35%	32%	33%	27%	18%	29%
Cattle 1 to 2 years Male	12%	17%	12%	17%	15%	14%
Cattle 2 to 3 years Female	11%	13%	11%	5%	5%	9%
Cattle 2 to 3 years Male	4%	2%	3%	3%	2%	3%
Bulls	0%	0%	0%	1%	1%	1%

Source: Teagasc National Farm Survey

Tillage farms with a cattle enterprise tended to apply more slurry proportionately in the January to April period at 55% on an average 5 year aggregate basis, as illustrated in Table 30. This was followed by dairy (46%), sheep farms with cattle (44%) and cattle farms (41%). Cattle and sheep farms tended to apply greater proportions of bovine slurry in the May to June period (45% to 46% on average) compared to dairy (37%) and tillage farms (23%).

Table 30: Percentage of bovine slurry applied by season on an aggregate basis by Farm System

	Annual Average					
Dairy Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	47%	45%	47%	47%	47%	46%
May - July	36%	37%	38%	38%	37%	37%
August - September	14%	14%	13%	13%	13%	13%
October-December	3%	4%	2%	2%	3%	3%
Cattle Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	44%	40%	40%	42%	45%	42%
May - July	42%	46%	47%	48%	46%	46%
August - September	11%	11%	10%	10%	8%	10%
October-December	3%	3%	3%	2%	2%	3%
Sheep Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	48%	39%	42%	44%	49%	44%
May - July	42%	46%	46%	48%	44%	45%
August - September	8%	14%	10%	8%	6%	9%
October-December	2%	1%	1%	0%	0%	1%
Tillage Farms	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	61%	58%	48%	55%	52%	55%
May - July	21%	21%	24%	22%	29%	23%
August - September	18%	21%	24%	22%	18%	20%
October-December	1%	0%	5%	2%	2%	2%

Source: Teagasc National Farm Survey

The majority of FYM tended to be applied in or after August (greater than 70%) across all farm systems, as seen by Table 31.

Table 31: Percentage of bovine FYM applied by season on an aggregate basis by Farm System

	Annual Average					
Dairy	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	6%	6%	5%	4%	4%	5%
May - July	6%	8%	4%	11%	10%	8%
August - September	42%	36%	42%	30%	30%	36%
October-December	46%	49%	49%	55%	56%	51%
Cattle	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	15%	10%	10%	9%	9%	11%
May - July	11%	11%	14%	14%	16%	13%
August - September	35%	38%	38%	37%	29%	35%
October-December	39%	40%	39%	39%	46%	41%
Sheep	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	20%	10%	10%	12%	14%	13%
May - July	2%	1%	2%	5%	3%	3%
August - September	67%	66%	67%	60%	66%	65%
October-December	10%	22%	21%	22%	17%	19%
Tillage	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
January-April	16%	15%	16%	16%	9%	14%
May - July	6%	2%	6%	7%	0%	4%
August - September	66%	70%	57%	55%	43%	58%
October-December	13%	13%	21%	23%	48%	23%

Source: Teagasc National Farm Survey

As already indicated, there has been a transition away from slurry application by splash plate to LESS methods across all farm systems. As expected, due to the prevalence of dairy farms having to adhere to conditions of their Nitrates Derogation, this transition to LESS has been largest on dairy farms, where 75% of slurry is applied via LESS methods (injection, trailing shoes and trailing hose) in 2021. The majority of slurry generated on tillage farms was also applied via LESS methods in 2021 (65%). The splash plate was still the dominant method of application in 2021 on cattle and sheep farms (72% to 80%), however there has been an increased uptake of LESS methods also in these drystock systems towards the end of the study period, as can be observed in Table 32.

Table 32: Percentage of bovine slurry applied by different methods on an aggregate basis by farm system

	Annual Average					
Dairy Farm % applied by:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Splash plate	93%	93%	65%	40%	25%	63%
Injection	1%	1%	1%	6%	5%	3%
Trailing Shoe	3%	3%	17%	36%	45%	22%
Trailing Hose	2%	2%	16%	18%	25%	12%
Side End	2%	1%	0%	0%	0%	1%
Other methods	0%	0%	0%	0%	0%	0%
Cattle Farm % applied by:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Splash plate	95%	96%	87%	80%	72%	86%
Injection	0%	0%	0%	3%	4%	1%
Trailing Shoe	1%	1%	6%	11%	15%	7%
Trailing Hose	0%	1%	6%	6%	9%	4%
Side End	3%	1%	1%	0%	0%	1%
Other methods	0%	0%	0%	0%	1%	0%
Sheep Farm % applied by:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Splash plate	96%	95%	89%	85%	80%	89%
Injection	0%	0%	0%	2%	1%	0%
Trailing Shoe	1%	2%	6%	11%	14%	7%
Trailing Hose	1%	1%	4%	2%	5%	2%
Side End	1%	2%	0%	0%	0%	1%
Other methods	1%	0%	0%	0%	0%	0%
Tillage Farm % applied by:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Splash plate	99%	99%	71%	49%	45%	73%
Injection	0%	1%	0%	0%	0%	0%
Trailing Shoe	0%	0%	10%	46%	24%	16%
Trailing Hose	0%	0%	19%	5%	31%	11%
Side End	1%	1%	0%	0%	0%	0%
Other methods	0%	0%	0%	0%	0%	0%

Source: Teagasc National Farm Survey

Between 96% and 99% of cattle manure in the form of slurry was stored under a roofed slatted tank across cattle, sheep and tillage farms on average over the study period, as illustrated in Table 33. The figure was 80% on dairy farms on average over the 5-year period, with unroofed underground tanks, covered over ground tanks and uncovered over ground tanks accounting for 7%, 6% and 5% respectively.

Table 33: Percentage of bovine slurry stored by building structure on an aggregate basis by farm system

	Annual Average					
Dairy Farm Slurry % Stored in:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Under roofed slatted tank	78%	79%	81%	82%	80%	80%
Unroofed underground tank	8%	8%	7%	6%	7%	7%
Uncovered over ground tank	5%	6%	6%	6%	7%	6%
Covered over ground tank	7%	6%	5%	5%	5%	5%
Unlined lagoon	0%	1%	0%	0%	0%	0%
Lined lagoon	1%	1%	1%	1%	1%	1%
Cattle Farm Slurry % Stored in:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Under roofed slatted tank	95%	97%	96%	96%	96%	96%
Unroofed underground tank	2%	1%	1%	1%	2%	2%
Uncovered over ground tank	2%	2%	1%	1%	1%	2%
Covered over ground tank	1%	0%	1%	1%	1%	1%
Unlined lagoon	0%	0%	0%	0%	0%	0%
Lined lagoon	0%	0%	0%	0%	0%	0%
Sheep Farm Slurry % Stored in:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Under roofed slatted tank	93%	96%	97%	98%	98%	96%
Unroofed underground tank	2%	1%	1%	0%	0%	1%
Uncovered over ground tank	4%	2%	2%	1%	1%	2%
Covered over ground tank	1%	1%	1%	0%	1%	1%
Unlined lagoon	0%	0%	0%	0%	0%	0%
Lined lagoon	0%	0%	0%	0%	0%	0%
Tillage Farm Slurry % Stored in:	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
Under roofed slatted tank	96%	99%	99%	100%	100%	99%
Unroofed underground tank	2%	0%	0%	0%	0%	1%
Uncovered over ground tank	1%	0%	0%	0%	0%	0%
Covered over ground tank	1%	0%	0%	0%	0%	0%
Unlined lagoon	0%	0%	0%	0%	0%	0%
Lined lagoon	0%	0%	0%	0%	0%	0%

Source: Teagasc National Farm Survey

4 SUMMARY CONCLUSION

This reports provides data on national level activity associated with manure management practices, to assist policymakers in the context of the Nitrates Directive, GHG and air pollutant inventory development. Results relate to bovine generated animal manure are presented at an aggregate level, on a national, nitrate zone, and farm system basis over the 2017 to 2021 period, as well as an average for this period.

National Aggregate Level: On average over the study period, dairy cows and bulls were housed for 124 days, while other livestock categories tend to be housed for 144 to 148 days. In all, 82% of manure was stored as slurry and 18% as FYM. Slurry / FYM storage ratios ranged from 94%/6% for dairy cows to 55%/45% for cattle 0 to 1 year respectively. In aggregate terms, 34% of slurry was derived from dairy cows, 23% from suckler cows and 11% to 13% from each of the cattle 0 to 1 year and cattle 1 to 2 year age categories. Conversely, 47% of aggregate FYM was derived from the cattle 0 to 1 year age category, with suckler cows responsible for a further 20%.

A total of 43% of slurry was applied to land in the periods January to April and May to July, with a further 11% and 2% applied August-September and October to December respectively. The application of FYM was on the other hand concentrated at the back end of the year, with 40% to 41% of average aggregate FYM applied in the August-September and October to December periods respectively. The majority of slurry (76%) on a national basis was applied via the splash plate method on average over the period 2017 to 2021. However, continuing adoption of LESS methods over these five years means that slurry application via LESS methods had risen to 48% by 2021. The majority of aggregate slurry (90%) was stored under a roofed slatted tank.

Nitrate Zone Aggregate Level: On average, farms in Zone A had the shortest livestock housing periods, as would be expected. A total of 75%, 89% and 91% of bovine manure was stored as slurry in Zone A, B, and C respectively, with the remainder stored as FYM on an average aggregate basis. A higher ratio of FYM storage (versus slurry) were associated with cattle 0 to 1 year across the zones compared to the other animal categories. In terms of slurry production, 44% of aggregate slurry in Zone A was derived from dairy cows, whereas 29% and 34% of slurry generated in Zone B and Zone C was derived from suckler cows. Aggregate FYM generation across the 3 zones ranged from 46% to 58% for the cattle 0 to 1 year category.

Timing of slurry application across the four application periods differed across the zones, with the largest proportion of slurry (46%) in Zone A applied in the January to April period, whereas 46% and 48% was applied between May and July in Zone B and Zone C respectively. Conversely, the majority of FYM was applied after July. The splash plate method accounted for 72%, 56% and 67% of slurry applications across zones A, B and C respectively. However, in 2021, 63%, 59% and 48% of slurry was applied by LESS methods across zones A, B and C respectively. Slurry storage under a roofed slatted shed was the dominant structure for slurry storage, ranging from 87% to 94% across the three zones.

Farm System Aggregate Level: A total of 82% to 84% of bovine based animal manure was stored in slurry form on dairy, cattle and sheep farms. Farm type dictated the source of slurry and FYM generation. For example, 80% of slurry on dairy farms was generated by dairy cows, whereas 41% to 45% of slurry on cattle and sheep farms was generated by suckler cows. Additionally, 64% of FYM generated on dairy farms was associated with cattle 0 to 1 year, whereas on cattle and sheep farms, the cattle 0 to 1 year old and the suckler cow categories both were significant sources of FYM. Tillage farms with bovine slurry tended to apply more proportionately in the January to April period when 55% of total slurry was applied, followed by dairy (46%), sheep farms with cattle (44%) and cattle farms (42%). Cattle and sheep farms tended to apply greater proportions of slurry in the May to June period (45% to 46% on average) compared to dairy farms (37%) and tillage farms (23%). Conversely, the majority of FYM tended to be applied in or after August (greater than 75%) across all farm systems. Results indicated that in 2021 the majority of slurry on dairy and tillage was applied via LESS methods at 75% and 55% respectively. In 2021, the majority of slurry on cattle and sheep farms was still applied via splash plate, but there is a transition

towards the use of LESS methods. Over 97% of cattle manure that is stored as slurry is stored under a roofed slatted tank across cattle, sheep and tillage farms. On average, the slurry volume in roofed slatted tanks on dairy farms was lower at 80%.

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