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Field storage of solid farmyard manure on unprepared surfaces

In Germany around 25 % of cattle and 10 % of pigs are kept in straw-bedded housing with resultant annual production of some 32 million tonnes of solid manure. Apart from that produced in deep litter housing systems, this manure is normally continually removed to solid-based storage near the respective livestock buildings. In exceptional cases it may be necessary to deposit manure on an intermediate basis out in the fields on unprepared surfaces. Currently there are no uniform recommendations from the specific authorities in Germany regarding such intermediate storage of solid manure. This paper describes the existing requirements in this respect from the aspects of soil and water protection.

Keywords

Solid manure, storage of solid manure on field surfaces, manure production quantities, animal production

Abstract

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■ Solid manure is a mix of animal excrement, litter materials and feed leftovers. The amounts and composition of the solid manure produced (Table 1) [1] fluctuates markedly, depending on the animals responsible, their respective production targets, composition of their respective feeds, housing involved and type and amount of litter applied, as well as the manure storage conditions.

Reasons for intermediate storage of solid manure

As long as the protection of soil and ground and surface water is respected, temporary storage of solid manure on an unpaved surface is permitted:

- To help ensure precise fertilising according to requirements in terms of time of application and amount.
- Where farmyard capacity and storage in the immediate vicinity is limited.
- Where weather conditions limit drivability of field surfaces.
- When crop growth stage is unsuitable for immediate application of manure.
- During labour peak periods.

Storage area requirement

For the storage of sufficient manure for spreading on 1 ha farmland (approx. 20 t fresh material) with a trapezoidal clamp (height 1.3–1.5 m, Ø density of manure 0.8 t/m³) around 20 m²

ground area is required. If clamps of the same base area are built higher it can then be assumed that the liquid leaking from the pile, the leachate, would increase only under-proportionately to the amount of manure stored, thus limiting the danger of nutrient leaching through the percolation of precipitation.

Leachate production and nutrient losses

With the produced leachate plant nutrients leak from the manure into the soil. The rate of leachate flow and the nutrients included is usually markedly higher at the beginning of storage than after a longer storage period. The total N amounts that leach into the soil from around 100 t manure are from 3–30 kg N/100 m². This is less than 5 % of the N contained in the manure clamp whereby over 90 % of the leached N, mostly in the form of ammonia N, is to be found in the top soil layer (0–30 cm deep) (Table 2).

The increased amounts of N in the topsoil under manure clamp sites can be found accumulated deeper in the soil profile in the form of nitrate converted from ammonia. Such a conversion process is strongly inhibited within the manure clamp so that even on sorption-weak soils such as sand the resultant amount of transported nitrogen is limited.

Leachate from fresh manure has the characteristic of blocking the soil pore system and this leads to a binding in the topsoil of the nutrients contained in the solid manure. This soil pore blocking effect is reduced where manure has already been stored because then the leachate production is reduced and, with this, the amount of organic substances in solution percolating out of the manure and into the soil. In absolute terms this means less nutrients are leached, but also that the nutrients that are leached are bound less strongly in the topsoil.

Following the removal of a solid manure clamp in autumn it is advantageous either to drill a winter crop or catch crop on

Table 1

Quantities of solid and liquid manure in cattle and pig husbandry in the Federal States of Germany (2009) [1]

Bundesland/ <i>Federal state</i>	Festmist/ <i>Solid manure</i>			Jauche/ <i>Liquid manure</i>		
	Rinder <i>Cattle</i>	Schweine <i>Pigs</i>	Gesamt <i>Total</i>	Rinder <i>Cattle</i>	Schweine <i>Pigs</i>	Gesamt <i>Total</i>
Mio t FM/a bei mittlerer Einstreumenge (4,5 kg/GV) <i>Solid manure (Mio t FM/a) and mean litter quantity (4.5 kg/LU)</i>						
Baden-Württemberg/ <i>Baden-Württemberg</i>	3,7	0,8	4,5	1,0	0,3	1,3
Bayern/ <i>Bavaria</i>	6,7	1,6	8,4	1,8	0,7	2,5
Berlin/ <i>Berlin</i>	0,0	0,0	0,0	0,0	0,0	0,0
Brandenburg/ <i>Brandenburg</i>	2,0	0,4	2,4	0,5	0,2	0,7
Bremen/ <i>Bremen</i>	0,0	0,0	0,0	0,0	0,0	0,0
Hamburg/ <i>Hamburg</i>	0,0	0,0	0,0	0,0	0,0	0,0
Hessen/ <i>Hesse</i>	0,9	0,3	1,2	0,2	0,1	0,4
Mecklenburg-Vorpommern/ <i>Mecklenburg-Vorpommern</i>	0,5	0,2	0,7	0,1	0,1	0,2
Niedersachsen/ <i>Lower Saxony</i>	1,3	1,0	2,3	0,3	0,4	0,8
Nordrhein-Westfalen/ <i>North Rhine Westphalia</i>	2,0	1,6	3,6	0,5	0,7	1,2
Rheinland-Pfalz/ <i>Rhineland-Palatinate</i>	0,8	0,1	1,0	0,2	0,1	0,3
Saarland/ <i>Saarland</i>	0,2	0,0	0,2	0,0	0,0	0,1
Sachsen/ <i>Saxony</i>	1,4	0,2	1,6	0,4	0,1	0,5
Sachsen-Anhalt/ <i>Saxony-Anhalt</i>	2,1	0,6	2,7	0,6	0,2	0,8
Schleswig-Holstein/ <i>Schleswig-Holstein</i>	1,5	0,3	1,8	0,4	0,1	0,5
Thüringen/ <i>Thuringia</i>	1,1	0,3	1,4	0,3	0,1	0,4
Deutschland 2009/ <i>Germany 2009</i>	24,2	7,6	31,8	6,5	3,1	9,6

the site in question as soon as possible after cultivation, or to leave the site uncultivated so that any mineralisation boost is avoided. Such actions should work against leaching of nitrogen into deeper soil layers.

Covering manure clamps and protection of the field surface underneath

Manure clamp covers of waterproof, but gas-permeable, material are used although there are insufficient results available regarding their practicality. Such a covering, or a straw layer at least 10 cm thick, can be recommended for dry poultry manure or poultry manure with limited litter in the mix.

Protection from leaching into the soil under the clamp serves to halt the flow of nutrients so that it remains in the topsoil surface. Very suitable for this is a layer of clay because of this soil type's high sorption capacity.

Legal requirements at federal and state levels

The following has to be observed when storing solid manure on outdoor sites: In each case applicable federal and state water protection requirements must be respected including further regulations in water protection and spa water areas. Also applicable is criminal legislation controlling water and soil pollution as well as environment-endangering waste disposal.

According to the Water Resources Act (2009) [3]: "It is the duty of everybody to apply all necessary care under the given circumstances to avoid any damage through altering existing characteristics of bodies of water (§ 5 WHG). Substances may only be stored or deposited in ways that prevent damaging changes within surface or ground water (§ 32 WHG). Working with water-endangering substances within licenced water facilities is forbidden, especially on the margins alongside bodies of water – as a rule a 5 m wide strip on both sides (§ 38 WHG)." Furthermore, there exist bans on the storage of solid manure in water protection and spa water areas. The length of time for the existence of a clamp in the open is also subject to legal control. Too long a storage period may be regarded as an offence under the laws applying to storage of water-endangering substances. Interpretation of § 78 par. 1, nr. 4 and 5 WHG indicates that storage of solid manure is not permitted over a period of six months.

Conclusions

The requirements for legally acceptable storage of solid manure outdoors concern [2]:

- The amount: Including the nutrients contained therein and planned mineral N fertilising according to crop requirement.
- Pre-treatment of the manure: Where the dry matter content is less than 25 % a pre-rotting period of at least three

Table 2

N_{min} content (NH_4-N , NO_3-N) in soil underneath solid manure storage heaps directly following removal of manure and 5 months later (Averages from 3 manure heaps; Hanover Chamber of Agriculture, unpublished, [2])

Bodentiefe/Soil depth	N_{min} -Gehalte in kg/100 m ² Mistplatzfläche/ N_{min} content in kg/100 m ² manure storage area			
	Direkt nach dem Räumen der Miete/Directly following removal of manure		5 Monate später/5 months later	
	NH_4-N	NO_3-N	NH_4-N	NO_3-N
0–30 cm	26,4	0,5	3,0	7,6
30–60 cm	0,7	0,4	2,8	6,0
60–90 cm	0,3	0,2	0,3	1,5
0–90 cm	27,4	1,1	6,1	15,1
N_{min}	28,5		21,2	

weeks is required, during which the manure is stored on a solid-floored area.

- Storage site: The manure clamp site should be on farmland only – changed every year – and when sited on the margins of bodies of water or where there is danger of flooding, clamps should be only temporary and not established during periods when flooding is a potential danger.

- Types of soil: Soils containing clay are preferable. When on drained areas the manure should not be stored in the immediate vicinity of a drain line.

- Groundwater depth: The distance from soil surface to groundwater table should be at least 1.5 m.

- Distance from reservoirs/water collection facilities: A minimum 100 m; there are special regulations for water and spa protection areas!

- Distance from bodies of surface water: These should be far enough away from clamps so that there is no danger of substances leaching into them, nor of a hindrance of water flow or maintenance of the body of water (rule: at least 20 m distance).

- Planning of manure clamps: The base ground area should be as small as possible. The site surface should be flat and even; on slopes measures to prevent seepage out of the bottom of clamps, and run off from the surface of clamps, must be undertaken.

- Covering the clamps: This is not a fundamental requirement. When a clamp is to be covered then this should take place after the completion of the thermophile decomposition phase (4–6 weeks after depositing the manure). Covering should be only with material such as straw, or with sheeting that is gas-permeable.

- Protection of soil and water below the field surface: This is recommended on level areas and where soil types are light and where the stored manure has a low dry matter content. Suitably protective are soils with clay that has a high binding capacity (the amount applied depends on the cation exchange capacity: 5–8 mol/m²). With soils where leachate binding capacity is not so high, a layer of straw (thickness at least 20 cm) is recommended. Where the base area soil surface is sealed

with clay, the upper 5 – 10 cm of the topsoil should be removed when the manure is being applied.

- Storage period: Should be until the next opportunity for manure application but in any case not longer than 6 months.

- Treatment for the site surface afterwards: Cultivation of the site is only then required when a crop is to be established.

References

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