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MANAGEMENT OF MANURE

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Abstract

In this paper, we aimed to achieve the management of the manure taken from five localities near the county of Iași, Romania. For this, two manure storage platforms with an area of 500 square metres will be built for its temporary storage. The platforms will serve the small farmers in this area, consisting of the platform itself and a collection basin located next to the platform, where the water from precipitation, animal urine and water for sanitising the platform reaches. Thus, this paper describes the constructive elements of the platforms, calculates the volumes of water collected from its surface and sizes the collection basin. The collection basin will have a volume of 120 m^3 and has been sized to ensure a storage capacity for a period of 30 days of precipitation and all liquid fractions resulting from the composting process.

Key words: *collection basin, manure, management, storage platform.*

INTRODUCTION

Manure is not only an agricultural waste but also anorganic fertiliser resource. Applying organic fertilisers is a feasible practice for mitigating soil degradation caused by excessive use of chemical fertilisers, which can affect bacterial diversity and soil composition (Zhang S. et al., 2020).

It is used on unstructured land, consisting of humus-poor soils, improves water retention, stimulates soil microbial activity, adds genetic and functional diversity to soils, and improves soil chemical and physical properties (Das et al., 2019; Wang J. et al., 2019; Yost J.L. et al., 2023; Köninger J. et al., 2021).

An important amount of the micro and macro elements taken from the plants used in fodder is returned to the soil through manure.

Applying manure and other organic fertilisers is important both for the nutrients that are embedded into the soil and for improving the conditions for the growth and development of plants (Wang J. et al. 2023). Since manure results gradually, applying it is not done as such. It is collected in platforms and composted.

Manure composting can be done by several methods. Commonly used methods are aerobic composting, anaerobic composting, and mixed composting.

Applying manure before a minimum rainfall period and applying manure by embedding reduces the risks associated with nutrient loss through surface runoff (Saha A. et al., 2023).

Manure can also cause pollution by introducing toxic elements, for example, heavy metals, antibiotics, pathogens and contributes to nutrient losses.

Another additional risk of pollution from manure results from the massive use of food supplements for animals (for example, copper and zinc supplements in raising pigs and poultry) for the purpose of their intensive breeding, supplements that end up in manure (Moral et al., 2008; Provolo et al., 2018).

Soil organisms play an essential role in the transformation of manure into soil and in the degradation of any potentially toxic constituents (Köninger J. et al., 2021).

Thus, manure is stored as far as possible from households and water sources, at least 50 metres, to avoid air and water pollution. It is recommended to place a platform specially arranged for this purpose, on a higher ground, so that rainwater does not collect at the base of the material.

Through the controlled storage of manure, nutrient losses resulting there from are mitigated and the product obtained can support soil fertility and increase crop productivity (Basit A. et al., 2019).
The purpose of this paper is to organise the management of manure collected from an area belonging to Iași county and to size the constructive elements of the platforms necessary for its controlled storage.

MATERIALS AND METHODS

The temporary storage of manure will be done on two storage platforms. The first platform will serve three localities, whereas the second one will serve two localities.
The platforms will have the same surface and will be located at least 500 m from the first household in the locality.
The sizing of the collection basin located next to the storage platform will be done considering the types of water collected from the surface of the platform. Thus, water from precipitation, animal urine produced, drinking water wasted by animals and/or people and water for sanitation will be captured.
This volume is determined by the formula 1.

$$V_t = V_u + V_p, \text{ (year)} \quad (1)$$

where:
V_u is the volume given by animal urine, drinking water wasted by animals and/or humans and water for sanitation; according to the provisions of the Code of Good Agricultural Practices, 4-5 m^3 for every 100 tons of fresh manure (Integrated Nutrient Pollution Control Project, 2016) and the amount of 81 tons/year of manure produced by the 5 UVM held by the owner result:

$$Vu = 5 \cdot \frac{81}{100} \text{ (m}^3\text{/year)} \quad (2)$$

where: $Vu = 4.05$ (m^3/year)
V_p is the volume of water originating from precipitation during the period of one year.
The volume of water from precipitation (V_p) to be captured during a year, from the surface of the manure platform, will be calculated by the following calculation equation (Cojocaru et al., 2021):

$$V_p = 10000 \cdot \sum_{i=1}^{Ts} (P_i - E_i) \cdot (1-\delta) \cdot \sigma \cdot S_p \ (1) \quad (3)$$

where:
Pi is the height of precipitation dropped in month i of the storage period, in an average climatic year, (mm/month i);
i - the month in the manure storages pan;
Ei - the value of evaporation from month i of the storage period, in an average year;
σ - the coefficient of leachate drainage from the storage facility; we propose $\sigma = 0.95$;
δ - the coefficient of precipitation retention in manure; we propose $\delta = 0.7$;
S_p - the area of the manure platform (ha).
Considering a degree of filling of 90% for the drainable basin, the total volume of the drainable basin is calculated by the equation:

$$\text{Vbv} = \frac{\text{Vp}}{0.9} \text{ (m}^3\text{)} \quad (4)$$

where:
Vp is the volume of water from precipitation.

RESULTS AND DISCUSSIONS

Considering the amounts of manure obtained for the studied area, it is necessary to place two manure storage platforms, each with an area of 500 square metres.
These platforms will be located on the public sector and the distances from the last households can be seen in the Figures 1 and 2.
The main elements that make up the two manure platforms are: the concrete storage platform, the semi-buried collection basin and the water drainage system with gutters.

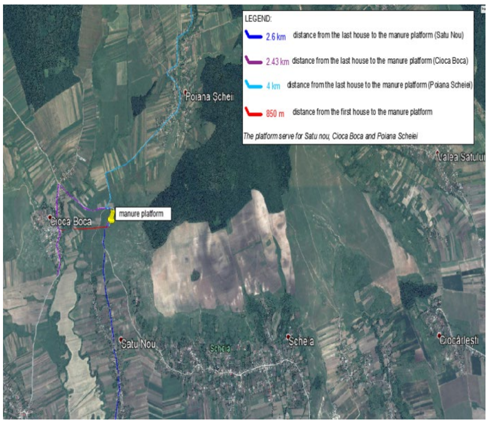


Figure 1. Location area of platform 1

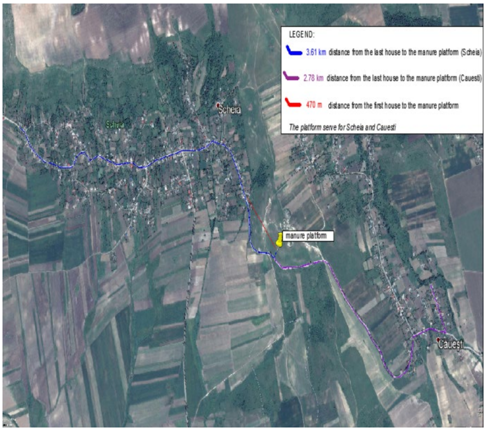


Figure 2. Location area of platform 2

The platform will be made of road concrete and the walls of reinforced concrete. All elements of the construction will be sized in such a way as to withstand the specific load exerted by the volumes of stored manure, machinery, external forces as well as the accidental touching of the walls by the machinery.
The platform will not have internal dividing walls in order not to disturb the handling of the machines and to allow the free disposal of the manure piles.
The characteristics of the platform are rectangular shape, walls on 3 sides (no front side), top view dimensions: L x W x h = 20 x 25 x 2 m.
In Figures 4-5, the main elements of the two manure platforms can be seen.
When checking the sizing of the platform, the maximum amount of stored manure must be considered.
In Figure 3, a frontal view of the future platform can be seen.
At the front of the platform, a concrete scraper will be provided, necessary to ensure an area for the movement and handling of machinery and for the unloading/loading of manure from the means of transport.
Along the entire length of the front plate between the platform and the scraper, there is an effluent collection channel covered with a metal or reinforced concrete grate that discharges into the basin.

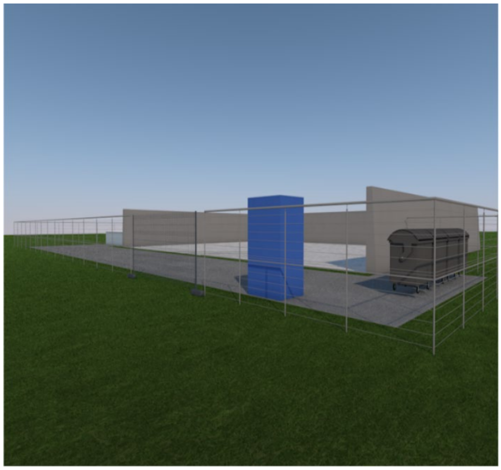
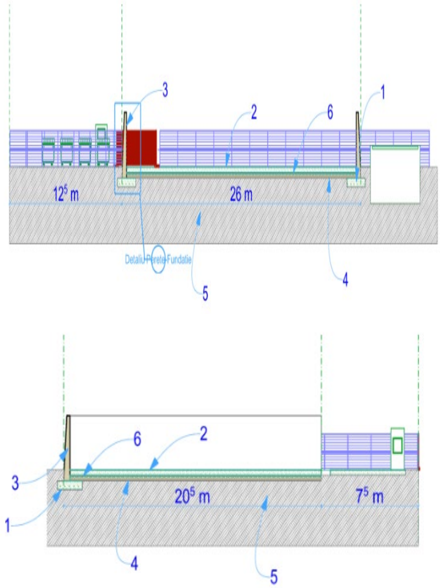


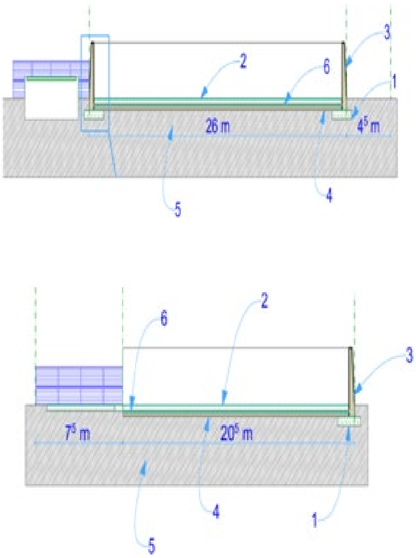
Figure 3. Manure storage platform

Sections through the two platforms are shown below.



1 - Reinforced concrete foundation
2 - Manure platform
3 - Reinforced concrete wall
4 - Ballast layer
5 - Natural land
6 - Membrane for waterproofing.

Figure 4. Sections through concrete storage platform 1



1 - Reinforced concrete foundation
2 - Manure platform
3 - Reinforced concrete wall
4 - Ballast layer
5 - Natural land
6 - Membrane for waterproofing.

Figure 5. Sections through concrete storage platform 2

A semi-buried basin of reinforced concrete with a volume of 120 useful cubic metres will be built, located in the immediate vicinity of the platform with the role of collecting effluents and rainwater. It has been sized to ensure a storage capacity for a period of 30 days. The collection basin will be waterproofed to prevent any possible infiltration of the liquid fraction from the manure into the soil. For the drainage of rainwater from the road surface inside the composting platform, a unique slope of 2% towards the sewer was provided.
There will be an empty tank trailer that serves to handle the liquid fraction that accumulates in the storage basin by turning it over the rows of manure on the platform to maintain the moisture required in the composting process.

A view of the collecting basin is shown in Figure 6.

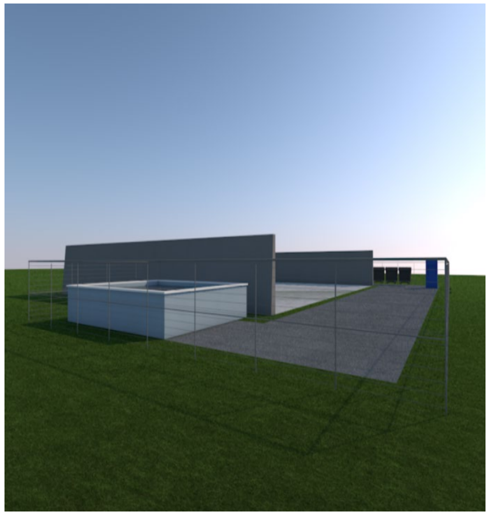


Figure 6. View of the collecting basin

In order to prevent pollution and to constantly monitor the quality of the underground water, the inner surfaces of the walls and floor of the platform as well as the collecting channel will be waterproofed. Also, a waterproofing membrane will be placed on the layer of earth on which the platform is built to prevent the infiltration of effluents from the manure storage into the ground and into the groundwater in case of damage to the platform.
In order to periodically monitor the quality of underground water, two piezometers will be installed both downstream and upstream of the storage platform to be built.
The volume of water from precipitation during a year that reaches the surface of the platform was calculated by means of equation (3) and the results obtained are presented in Table 1.
By then substituting in equation (4), it follows that the drainable basin must have a minimum volume Vbv=79.28 m^3.

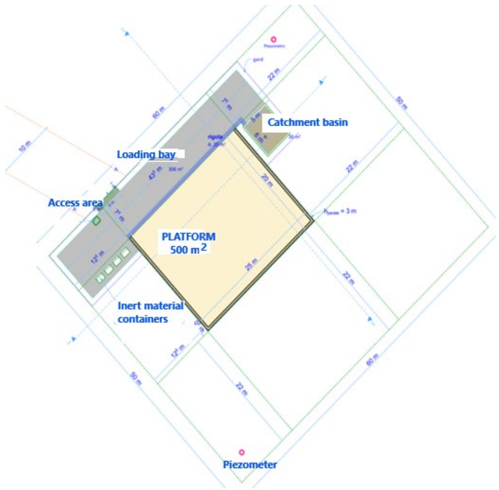


Figure 7. Elements of manure platform 1

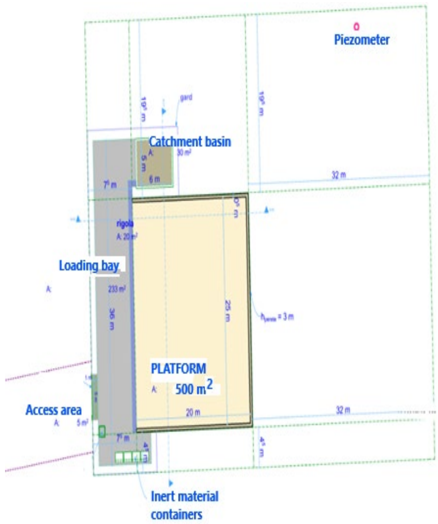


Figure 8. Elements of manure platform 2

Table 1. Calculation of the volume of water from precipitation (Vp)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
P (mm)	32	31	31	53	63	101	83	56	48	25	35	31
E (mm)	0	0	13.66	57.44	90.09	96.81	95.5	79.61	58.94	35.55	13.5	0
Pi-Ei	32	31	17.34	-4.44	-27.09	4.19	-12.5	-23.61	-10.94	-10.55	21.5	31
σ	0.95	0.95	0.95	0	0	0.95	0	0	0	0	0.95	0.95
δ	0.7	0.7	0.7	0	0	0.7	0	0	0	0	0.7	0.7
Sp (ha)	0.0783	0.0783	0.0783	0.0783	0.0783	0.0783	0.0783	0.0783	0.0783	0.0783	0.0783	0.0783
Vi (mc)	16.66	16.14	9.03	0	0	2.18	0	0	0	0	11.19	16.14
Vu (mc/year)	**71.35 mc/year**											

Considering the volume obtained, a standard drainable basin with a volume of 120 m^3 will be chosen, a sufficient volume if the platform is expanded in the future.

CONCLUSIONS

Through the management of the manure in the five localities, the quality of life will be improved, the risk of affecting the citizens' health will be reduced and the air hygiene will be maintained in a suitable state of comfort. Also, the soil will not be affected by pollution, because the storage platform will be waterproofed with a waterproofing membrane to prevent the infiltration of effluents from the manure storage.
And by collecting effluents and rainwater in the collection basin located next to the platform, possible infiltration into the soil is thus prevented.

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