Scientific Bulletin
of the Politehnica University of Timisoara, Romania

TRANSACTIONS on ENGINEERING AND MANAGEMENT

Volume 4, Number 1, 2018

Possibility of Using Sewage Sludge in Agriculture

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Abstract – The use of sewage sludge through its use in agriculture is considered to be a good practical option for the environment, being promoted and encouraged by the European and national legislation in force.
The use of sewage sludge in agriculture has created some concerns about their possible harmful effect. Studies have shown that these fears are unjustified. Although the results obtained so far are more than encouraging, the actual interest in using sludge in agriculture is still quite low. The involvement of public administration in this process could favor this activity.

Keywords: Sewage, Sludge, Agriculture, Administration

I. INTRODUCTION

The use of sludge from sewage sludge in agriculture is one way of capitalizing on their content of organic matter and nutrients [1, 3, 4]. Sewage sludge can be used in agriculture for: sustainable development of the environment benefiting both the sludge producer and the farmer [2, 7, 8].
Sewage sludge, a common by-product of the municipal wastewater treatments, contains macronutrients and micronutrients essential for plant growth and is a potentially valuable source of organic matter for most agricultural soils. The application of sewage sludge to agricultural land is of importance about metropolitan areas, where soils have been intensively cultivated for centuries and have typically low fertility and organic matter content. Although several studies on reuse of municipal sewage sludge in agriculture have been reported, the adoption of a plan for applying organic amendments to agricultural soils requires information regarding the effect of such amendments on any crop or environment. However, in the literature is a large debate on European regulations concerning the management of sewage sludge. Thus, it is becoming an issue of growing importance. In all countries of the European Union, directives are introduced based on which each member state has to create relevant. According to European regulations management methods involving storage are now being replaced by methods leading to waste stabilization and safe recycling. legislation, programs and developmental strategies. Their aim is, amongst other things, to promote pro-ecological management of sewage sludge. Management methods involving storage are now being replaced by methods leading to its stabilization and safe recycling. These methods may consequently lead to the recovery of valuable raw materials from potentially dangerous materials, processing them in order to enable their use in agriculture, various branches of industry or heat and energy recovery [1, 2, 3, 4, 7, 8]. At each stage of sewage sludge processing, its characteristics change.
During the disinfection process, the microflora of sludge is changed; the methane fermentation process leads to a decrease in overall carbon content, while thermal processing, depending on the temperature, may result in densification of sludge or even transformation of all organic matter into inorganic compounds. Therefore, many various kinds of processed sewage sludge are generated and each of them have a different chemical composition. They may also vary in the physical properties, consistency or even parameters such as toxicity or stability of pollutants. All those factors may decide whether the material will be classified as safe or unsafe. Determined values of parameters, mentioned above, may influence on changes in processing technology in order to develop other methods of management.
Therefore, it is important that at every stage of processing of this type of waste, the resulting material should be subjected to a comprehensive chemical analysis. Due to their diversity, other methods and analytical techniques will be useful in each case. Therefore, the choice of a suitable analytical method depends on the planned method of sewage sludge management, which to some extent determines the technology used for processing them.

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The purpose of this study was to investigate and debate the use of sewage sludge through its use in agriculture. The main topics that are discusses are related to the following statements:

- The use of sewage sludge in agriculture has created some concerns about their possible harmful effect. Studies have shown that these fears are unjustified.
- Although the results obtained so far are more than encouraging, the actual interest in using sludge in agriculture is still quite low. The involvement of public administration in this process could favor this activity.

II. MATERIALS AND METHODS

From a technological point of view sludge is considered as the final stage of water purification, which includes products of metabolic activity and / or raw materials, intermediate products and finished products of industrial activity [9, 17].

The amount of sludge generated by the treatment plants currently depends on: the population connected to the sewage system; the input of industrial waters collected through the sewerage system; technology applied to the treatment of wastewater (primary or secondary treatment) and the yields obtained in operation; Accurate quantification of the amount of sludge produced is difficult because one part is lost in sewer networks or transport operations. The main options for sewage sludge recovery are as follows: use in agriculture; composting; anaerobic fermentation; incineration [5, 6].

The condition of promoting sludge as a fertilizer in agriculture is that the soil is not adversely affected by its components. Often due to the content of heavy metals, nitrogen compounds, etc. no sludge recovery in agriculture is made. The sludge can be used in agriculture only if the legal provisions of the Joint Order of the Ministry of Environment and Waters and the Ministry of Agriculture no. 344/2004 for the approval of technical norms regarding the protection of the environment and especially the soil when the sludge is used in agriculture [11].

According to this order, for sewage sludge to be used in agriculture, the maximum admissible values for: heavy metal concentrations in sludge soils, heavy metal sludge concentrations, the maximum annual quantities of heavy metals that can be introduced into agricultural land [12, 13, 14].

The limits allowed for sludge to be used in agriculture are shown in the Table 1.

From a technological point of view sludge is considered as the final stage of water purification, which includes products of metabolic activity and / or raw materials, intermediate products and finished products of industrial activity [15, 16].

Table 1. Allowed limits for sludge to be used in agriculture

Elements	Limit	Unit
Pb	900	mg/kg DS
Cd	10	mg/kg DS
Cr	100	mg/kg DS
Cu	800	mg/kg DS
Ni	200	mg/kg DS
Hg	8	mg/kg DS
Zn	2500	mg/kg DS
PCB	0.2	ng/kg DS
PCDD	100	ng/kg DS

III. RESULTS AND DISCUSSIONS

Sewage sludge has 97% water content. By centrifugation or filtration, the water content can be reduced to 70 - 80%, for this reason the dehydration process is a prerequisite for economical transport and possible storage / disposal [18]. Reusability requirements in agriculture require a drying level of more than 90% to ensure that sludge is not fermentable and can be stored in silos until reuse [17].

Currently sludge from sewage treatment plants are most often removed / transported to existing waste landfills, so we cannot talk about a treatment / recovery, not even using it as a fertilizer in agriculture, except in a limited number of cases of exceptionally nature, such as except the sludge from the Sewage Treatment Plant - Sfantu Gheorghe, Galati or Arad.

The case study was conducted in Arad. The average daily quantity of sludge from Arad is 20 tons. If the sludge is not used for fertilization, the operator moves it to landfill or by incineration. After the conclusion of a collaboration agreement with the Water Company, Arad farmers can benefit from free sludge; Water Company is the one who transports and spreads sludge on farmland.

The experimental study was done in the experimental block:

(1) three experimental variants of inert slag and fly ash topsoil fertilized with slaughterhouse sludge type in quantity of 3.0, 6.0 and 9.0 t ha–1, variants referred to as: VA 1, VA 2, and VA 3, respectively;

(2) three experimental variants of inert slag and fly ash topsoil fertilized with sewage sludge type in quantity of 3.0, 6.0, and 9.0 t ha–1, variants referred to as: VS 1, VS 2, and VS 3, respectively.

The experiment was carried out in pots with 6.0 kg of soil. In the pots, 5 g per pot of seeds from the Lolium perenne plant species were planted. Each experimental variant was done in three replicates [10].

The use of biodegradable waste, sewage sludge and slaughterhouse sludge, led to the settling of a stable and healthy vegetation cover over a long period of time (2 successive years of culture with Lolium perenne species). The amount of harvested biomass increased by 35,6% in the 2nd year of culture compared to the amount harvested in the first year. To obtain a vegetative cover with a decisive role in the ecological restoration/phytoremediation of the landscape destroyed by this ash and slag dumps and a maximum amount of seeds, a minimum amount of 3 t ha–1 of fertilization agent (slaughterhouse sludge or sewage sludge) was enough. Biomass and/ or harvested seeds for optimum ecological restoration/phytoremediation variant of slag and fly ash dump will be directed to different sectors after an assessment on metal accumulation in tissues, according to national regulations.

Being a good source of macro and micronutrients, sludge from sewage treatment can be used in agriculture as it reduces production costs and improves soil quality; It brings a nutrient and organic matter input to organic farming, while improving humanity's ability to survive.

IV. CONCLUSIONS

The use of sludge from sewage sludge in agriculture is one way of capitalizing on their content of organic matter and nutrients. Sewage sludge can be used in agriculture for: sustainable development of the environment benefiting both the sludge producer and the farmer; increasing crop yields; reducing the use of agricultural fertilizers; improving the physical and organic soil properties through the intake of nutrients, trace elements, organic compounds; water retention in soil; improving microbial activity in soil; rehabilitation of degraded lands by improving soil texture; low cost; simple technology.

The use of sewage sludge in agriculture has created some concerns about their possible harmful effect. Studies have shown that these fears are unjustified. Although the results obtained so far are more than encouraging, the actual interest in using sludge in agriculture is still quite low; An involvement of public administration in this process could favor this activity.

REFERENCES

[1] Alvarenga, P., Mourinha, C., Farto, M., Santos, T., Palma, P., Sengo, J., ... & Cunha-Queda, C. (2015). Sewage sludge, compost and other representative organic wastes as agricultural soil amendments: Benefits versus limiting factors. *Waste management*, *40*, 44-52.

[2] Alvarenga, P., Mourinha, C., Farto, M., Palma, P., Sengo, J., Morais, M. C., & Cunha-Queda, C. (2016). Ecotoxicological assessment of the potential impact on soil porewater, surface and groundwater from the use of organic wastes as soil amendments. *Ecotoxicology and environmental safety*, *126*, 102-110.

[3] Alvarenga, P., Palma, P., Mourinha, C., Farto, M., Dôres, J., Patanita, M., ... & Sousa, J. P. (2017). Recycling organic wastes to agricultural land as a way to improve its quality: A field study to evaluate benefits and risks. *Waste Management*, *61*, 582-592.

[4] Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture. Available at: https://eurlex.europa.eu/legalcontent/EN/TXT/?uri=celex%3A31986L0278

[5] Choong, Y. Y., Norli, I., Abdullah, A. Z., & Yhaya, M. F. (2016). Impacts of trace element supplementation on the performance of anaerobic digestion process: A critical review. *Bioresource technology*, *209*, 369-379.

[6] Demirel, B., Scherer, P. (2011). Trace element requirements of agricultural biogas digesters during biological conversion of renewable biomass to methane. *Biomass and Bioenergy. 35(3),* 992-998.

[7] Divya, D., Gopinath, L.R., Merlin Christy, P.(2015). A review on current aspects and diverse prospects for enhancing biogas production in sustainable means. *Renewable and Sustainable Energy Reviews, 42(2),*690-699

[8] Dong. B., Liu, X., Dai, L., Dai, X. (2013) Changes of heavy metal speciation during high-solid anaerobic digestion of sewage sludge. *Bioresource Technology, 131(3),*152-158

[9] Fang, W., Wei, Y., Liu, J.(2016), Comparative characterization of sewage sludge compost and soil: Heavy metal leaching characteristics. *Journal of Hazardous Materials,310(6),*1-10

[10] Masu, S., Nicorescu, V. & Popa, M. (2015). Slag and fly ash dump treatment with biodegradable waste herbaceous vegetation purpose. *Journal of Environmental Protection and Ecology, 16(3),*968-971

[11] Order no.344 / 2004 of the Ministry of Environment for the approval of the Technical Norms on environmental protection and especially of soils when using sewage sludge in agriculture, http://www.legex.ro/Ordin-344-2004-43800.aspx

[12] ISO 11047:1999 - Soil quality. Determination of cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc of soil extracts in royal water. Methods by atomic flame absorption spectrometry and electrothermal atomization

[13] ISO 11466:1999 - Soil quality. Extraction of microelements soluble in aqua regia water.

[14] SR 13315:1996/SR 13315:1996/C91:2008 - Water quality. Determination of iron content. Spectrometric method of atomic absorption (in Romanian)

[15] EN ISO 6869:2002 - Feeds. Determination of calcium,copper, iron, magnesium, manganese, potassium, sodium and zinc content. Spectrometric method of atomic absorption

[16] ISO 11047:1999 - Soil quality. Determination of cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc of soil extracts in royal water. Methods by atomic flame absorption spectrometry and electrothermal atomization

[17] Thanh, P.M., Ketheesan, B., Yan, Z., Stuckey, D. (2016). Trace metal speciation and bioavailability in anaerobic digestion: A review. *Biotechnology Advances,34(2),*122-136

[18] Yang, K., Zhu, Y., Shan, R., Shao, Y., Tian, C. (2017). Heavy metals in sludge during anaerobic sanitary landfill: Speciation transformation and phytotoxicity. *Journal of Environmental Management*, *189(3),*58-66