AGRICULTURAL USE OF SEWAGE SLUDGE PROS AND CONS

UTILIZAREA NAMOLULUI ORĂŞENESC ÎN AGRICULTURĂ PRO ŞI CONTRA

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***Abstract**: Sewage sludge, also referred as biosolids, is a byproduct of sewage treatment process. Land application of sewage sludge is one of the important disposal alternatives. Characteristics of sewage sludge depend upon the quality of sewage and type of treatment process followed. Being rich in organic and inorganic plant nutrients, sewage sludge may substitute for fertilizer, but available of potential toxic metals often restricts its uses. Sludge amendment to the soil modifies its physico-chemical and biological properties. Bioavailability of metals increases in sludge amended soils at excessive rates of application for many years. Plants differ in their abilities to absorb heavy metals from sludge applied on the soil. The aim of the paper is to review the available information on various aspects of sewage sludge application on soil fertility and consequence effects on plant production to explore the possibilities of exploiting this byproduct in agriculture.*

***Rezumat:** Namolul orăşenesc reprezintă un subprodus rezultat în urma tehnologiilor de epurare a apelor reziduale. Una dintre cele mai importante alternativ de depozitare o reprezintă utilizarea acestuia în agricultură, ca resursă fertilizantă. Caracteristicile namolului depind de compoziţia chimică a apelor reziduale şi de tehnologia de epurare. Având o compoziţie bogată în substanţe cu caracter nutritiv pentru plante, namolul orăşenesc poate fi folosit ca îngrăşământ. De cele mai multe ori însă, utilizarea acesteia este restricţionată de potenţialul toxic al metaleor grele. Aplicarea namolului orăşenesc modifică proprietăţile fizice, chimice şi biologice ale solului tratat. Bioaccesibilitatea metalelor grele creşte odată cu aplicarea unor doze excesive şi repetate de namol. Scopul lucrării este de a face o succintă trecere în revistă a datelor referitoare la variatele aspecte ale aplicării namolului pe terenurile agricole metalelor grele.*

***Key words**: sewage sludge, disposal alternatives, heavy metals bioavailability*
***Cuvinte cheie**: namol orăşenesc, alternative de depozitare, bioac-cesibilitatea*

INTODUCTION

Yearly, in the world, are generated hudges quantities of sewage sludge as a result of wastewaters treatment. So, for many years, wastewater sludge has posed disposal problems.

The safe disposal of the sewage sludge is one of the major environmental concerns throughout the world. Disposal alternatives that have been tried include soil application, dumping in waters, landfilling and incineration. Landfilling and land application of the sewage sludge are suggested to be the most economical sludge disposal method.

In table 1 are presented the quantities of sewage sludge generated yearly and disposal methods, in few states from Europa and United States.

According to the European Commision, a general increase in the sludge quantity is foreseen in the future, but this increase does not reflect the situation in each country.

France, UK, Luxembourg, Germany and the Netherlands plan to further develop incineration. Agricultural use of sewage sludge will also increase in Ireland, Finland, UK and Portugal. It should concern about 55% of sludge produced in the European Union, whereas landfilling should concern about 19% and incineration 23%.

Table 1

Amounts and disposal methods of sewage sludge

Country	Amount	Disposal method (%)			
	Mil t dry solids/year	Application to land	Land filling	Incineration	Other
Austria	320	13	56	31	0
Belgium	75	31	56	9	4
Denmark	130	37	33	28	2
France	700	50	50	0	0
Germany	2500	25	63	12	0
Greece	15	3	97	0	0
Ireland	24	28	18	0	54
Italy	800	34	55	11	0
Luxembourg	15	81	18	0	1
Holland	282	44	53	3	0
Portugal	200	80	13	0	7
Spain	280	10	50	10	30
Sweden	180	45	55	0	0
Switzerland	215	50	30	20	0
United Kingdom	1107	55	8	7	30
United States	6900	41	17	22	20

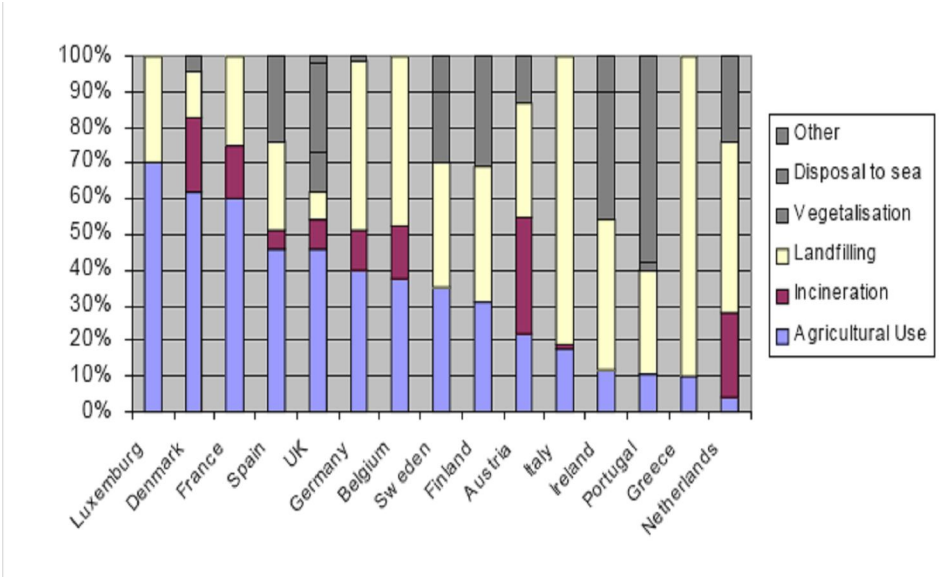

Figure 1 Disposal routes for sewage sludge in E.U. member states during 1996-1998

Table 2

Evolution in sewage sludge production in EU countries, between 1997 – 2005

Country	1997	2005	Evolution (%)
Austria	200	195	-3
Belgium	85	159	87
Denmark	151	160	6
Germany	2227	2787	25
Greece	59	99	68
Spain	685	1088	59
France	820	1172	43
Ireland	38	113	197
Luxembourg	8	14	75
Netherlands	209	401	92
Portugal	245	359	47
Finland	136	160	18
United Kingdom	1195	1583	32

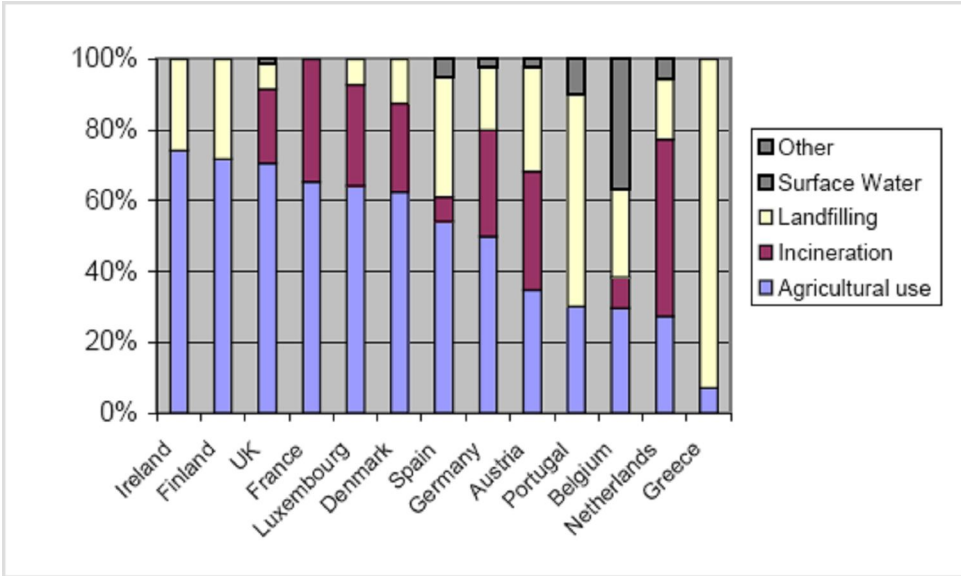

Fig.2 Destination of sewage sludge in the member states of EU in 2005 (Renner 2000)

Stricter regulations on discharge of sewage sludge into waters, higher costs of alternative disposal methods and higher prices of chemical fertilizers, have increased interest in the use of sewage sludge in agriculture.

Application of sewage sludge to cropland could result in soil contamination, phytotoxicity and accumulation of trace elements in food supply. The magnitude of the problem depends on the interrelationship of a number of factors, such as: sludge composition the rate and frequency of applications, soil characteristics and plant species. Sludge type and sludge-soil interrelation influence the chemical forms of a metal, which determine its availability for plant uptake. However, additional plant and soil factors further modify the uptake and the concentration of elements in crops.

RESULTS AND DISCUSSION

Sewage sludge contains organic contaminants, heavy metals and pathogens. non hazardous treatments of sewage sludge can degrade parts of organic pollutants, destroy some pathogens, but heavy metals can not be removed by common treatments such as: composting, aerobic or anaerobic digestion. So, the sludge disposal may represent an environmental pollution source if treated improperly. Among the different ways of sewage sludge disposal, land application is low costs and high effective and has been used widely [1]. However land application may result in heavy metals accumulation in cultivated soils. This fact has received more and more concern in recent years.

In countries where sludge land application have been carried out for a long time, considerable heavy metal accumulations have been reported and in some cases in crops [2].

Following a worldwide trend, a large share of the resulting sludges will probably applied to the soil. Some studies have shown that the available fraction of heavy metals mainly decided the mobility, bioavailability or phytotoxicity of heavy metals in soils. So, are necessary detailed informations on heavy metals present in sewage, before their land application. To this end, a series of rules have been prepared in order to set the requirements concerning sanitary quality, heavy metal content and specific rates of application for treated and stabilized sludges.

In table 3 are presented maximum permitted concentration of heavy metal in sludges used in land application, in Romania [3]:

Table 3

Maximum allowed content of heavy metal in sludges used in land application, in Romania

Parameter	Maximum allowed content (ppm)
Cd	10
Cu	500
Ni	100
Pb	300
Zn	2500
Hg	5
Cr	500
Co	50
As	10

In table 4 are presented maximum allowed values for heavy metals concentration in soils cu pH greater than 6,5, which could be treated with sewage sludge.

The source of heavy metal in wastewater, whether domestic or industrial, also has important effects on the total content as well as chemical fractions of heavy metals in sludge. For example industrial effluents are the predominant source of Cd, Cr, Hg and Ni, while Cu and Zn are mainly of domestic origin and the major source of Pb may be both surface runoff and domestic wastewater.

Table 4

Maximum allowed values for heavy metals concentration in soils cu pH greater than 6,5, which could be treated with sewage sludge

Parameter	Maximum allowed content (ppm)
Cd	3
Cu	100
Ni	50
Pb	50
Zn	300
Hg	1
Cr	100

The heterogeneous nature of sewage sludge produced at different treatment plants and the variation between seasons needs knowledge of the chemical composition of sewage sludge prior to the land application.

Soil-plant system posed three protective mechanisms that can limit the toxic potential of heavy metals in plants and can reduce the problems that might cause to the living creatures. Soil-plant barrier includes:

- elements that are non soluble in soil and aren't accumulated by plant: Pb, Hg, F, Cr, Ag, Au, Ti, Sn, Si, Zr;
- elements that are adsorbed at the root level but are non soluble and they are find in limited quantities in stem : Fe, Al, occasional Hg and Pb;
- elements that in excess determine phytotoxicity and plants are not consumed by human or animals: Zn, Cu, Ni, Co, Mn, As, B (Singh, 2008).

Not all the heavy metals present in sludge are in this three categories. The exceptions are Cd, Se and Mo that can produce intoxications. Mo and Se are present in sludge in low concentrations, so they can't limit the application dose on soil. Cd determines major health problems to living creatures that eat plants cultivated on soils contaminate with this metal in high concentrations.

In sewage sludge metals exists in different forms, depending of chemical properties of sludge and the chemistry of the metal.

The literature data present that less than 17 % from the total quantity of Cu, Zn, Pb, Cd and almost 22 % from the quantity of Ni, are find in adsorbed and changeable form, accessible to the plants. The remain quantities are present in forms that must be convert in soluble in water form, changeable or adsorbed, before they can be taken by the plants (Renner, 2000).

The comparative data between the cultivated species indicates large variations in their capacity to adsorb toxic heavy metals from the system sewage sludge-soil. Cereals and vegetables accumulate less Cd in stem comparing with leaf vegetables such as celery and spinach. The tomatoes accumulate more Mo from soils treated with sludge, more than barley and bean.

There were been made many experiments during the time, but remain more asking marks regarding the effects of sewage sludge application on land. The unique composition of sludge, the many factors that influence the plant-soil system, the accumulation of those metals in plant, complex the problem of sludge application on land.

CONCLUSIONS:

1. Sewage sludge application on agricultural lands can have the next benefits effects:
   - supplying the nutritive elements (N, P, K, secondary macro elements, microelements)
   - improvement of physical properties of soil
   - the rising of the humus content in soil.
2. On the other hand exists a serial of inconvenient, such as:
   - contaminant potential of nitrates and phosphates;
   - destructive potential on the health of the heavy metals;
   - pathogens potential transfer.

3. This disadvantage depends on the inter relations between a few factors: sludge composition, the dose and the frequency of application on soil, soil characteristics and the plant.

4. Sludge composition, and the relation between the soil and this, influences the chemical form of metals and the accessibility for the plant.

5. A method to estimate the accessibility of metals regarding the soil needs must be tested in field conditions, on different soil types, and with sludge having a different composition. It must be taken in considerate any chemical modification of metals from sludge.

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