Reflections on Decanted Waste Water Application in the Timis County (Romania)

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Abstract. Livestock rearing in an enormous number on zootechnical piggery complexes is accompanied by a great quantity production of waste water, which needs a good management in order to turn to account and pollution control. At Timiș county, level worked at the 1st January 2018 – 32 zootechnical piggery complexes, located in the plain zone, with a daily effective of 530,882 pigs. At an medium discharge of 30 l/head/day, results a daily volume of 15,926 m³ waste water which needs to be transported and stocked in a decanting pond. The positive aspect of this problem is the content of nutrients – about 2.3 g/l N_{total}, 0.07 g/l P_{total} and 0.7 g/l K_{total}, what means for all quantities of waste water a total quantity of nutrients of 36.6 tones N, 1.11 tones P and 11.15 tones K. Because to waste water contains also 62-72% C (relate to dry substance) through the biochemical decomposition at the soil surface, will be release 6370 m³ of carbon dioxide in the atmosphere, emission which contributes to the climate change. For this reason, there is absolutely necessary to application the decantated waste water by placement. Owing to the great diversity of the soils cover and the present the ground water layer at 1.0-1.5 m depth on a large area, it is necessary a permanent monitoring so as to avoid water and soil pollution with Na’, heavy metals or pathogens. The analytical data have been made for the Parța territory from Timiș county, in the years 2015 -2016 -2017 and were compared with a soil survey achieved in the year 2010.

1. Introduction

In the same time with the development of large piggery and stations for purification of sewage water, turned up the necessity for turning to account the sewage water as fertilizer in the agriculture.

The agricultural technologies have as the first aim to create optimal conditions in the soil for plants nourishment with active substances and water in order to assimilate in the photosynthesis process more atmospheric CO₂. For this reason, the soil is undergoes of tillage for loosening for storing water and air necessary for vital processes but also for exposes the soil organic matter to mineralization and biological humification [1]. In agricultural systems significant amounts of nutrients are removed each year in produce and yields decline over time unless the nutrients are replaced using fertilizer.

The capacity of soils to feed to world’s current population is heavily dependent on fertilizer [2].

The 16 essential nutrients are H, O, C, N, P, K, Ca, Mg, Si, Cl, Fe, b, Mn, Zn, Cu and Mo. The first nine are called macronutrients while the rest are called micronutrients for plants [3]. Among the
essential macronutrients, N and P are the most studied because they are often in limited supply for plant production and both cause environmental problems.

For a correctly establish the necessary of macronutrients and micronutrients of the various soil types, it imposes an agrochemical survey, which has three phases: field phase, laboratory phase and study phase [4]. This evaluation allows to establish the insurance level with nutrients and the fertilization level for the optimum economic fertilizer rates.

In accordance with Ionescu A. (1985) [5] the sewage water from the industrial piggery complexes contains on the average $N_{\text{total}}$ 2.3 g/l, $P_{\text{total}}$ 0.07 g/l and $K_{\text{total}}$ 0.7 g/l and can be regarded as liquid fertilizer. From the experimental results accumulated in Romania until the present, can be formulated the conclusion that the sewage water application by placement determine considerable increments of yield due to the contribution of nutrients and water.

The origin of the environmental problems caused by nitrogen and phosphorous in the soil are the result of the large amount of reactive N and P added anthropogenically in the last century to attend the demand for food by the increasing population and little attention has been given to the probable impacts on biodiversity, global warming, water quality and human health [6].

2. **Material and methods**
The scientific research bases on a monitoring study made in the years 2015-2018 of OSPA – Timis (Office of Pedological and Agrochemical Studies) for 32 zootechnical piggery complexes from Timis county, relative to the use of sewage water as liquid fertilizer. The monitoring study was associated with agrochemical and pedological report.

The present paper deals only with the Parța farm from the Smithfield Ferme S.R.L. in which were studied in the year 2015th -156 plots from 568.08 ha, in the year 2016th – 30 plots from 350.13 ha and in the year 2017th – 67 plots from 145.76 ha.

The main chemical analysis were pH, Pppm, Kppm, C%, NO$_3$ppm, NH$_4$ppm, w% from 113 soil samples in the year 2015, from 84 soil samples in 2016th and from 32 soil samples in the year 2017.

In every year were analyzed, also, the sewage water.

3. **Results and discussions**
The soil cover on Parța cadastral territory is composed of Chernozems, Phaeozems, Eutric Cambisols, Vertisols and Fluvisols.

In the table 1 we present the analytical data from one of the main soil type from Parța, that is a Gleyic Chernozems.

| Horizon   | Ap  | Amt | Amg$_2$ | ABGox | BvGr | BCGr |
|-----------|-----|-----|---------|-------|------|------|
| Depth, cm |     |     |         |       |      |      |
| Coarse sand, % | 1.0 | 1.0 | 22-40   | 40-52 | 52-117 | 117-152 |
| Fine sand, %   | 33.8| 33.3| 28.8    | 26.9  | 25.5  | 31.0 |
| Silt, %      | 22.2| 22.5| 24.2    | 23.7  | 23.5  | 21.9 |
| Clay, %     | 43.0| 43.2| 46.0    | 49.2  | 49.0  | 43.4 |
| pH$_{H_2O}$ | 6.54| 6.79| 6.95    | 7.12  | 7.58  | 7.92 |
| OC, %       | 1.58| 1.54| 1.47    | 1.15  | -     | -    |
| Pppm    | 10.2| 4.45|         |       |       |      |
| Kppm   | 97.1| 88.0|         |       |       |      |
To make a comparison between the physical and chemical properties of so a great diversity of soil types is a heavy task and because of that we are going to present the contribution with C, N, P, K and other nutrients of the sewage water into the plots.

For the sewage water were made some chemical analyses in the years 2015, 2016, and 2017.

**Table 2. Analytical data – liquid fertilizer**

| Property                        | Year  | 2015  | 2016  | 2017  | Mean  |
|---------------------------------|-------|-------|-------|-------|-------|
| PHO                           |       | 7.73  | 7.63  | 7.69  | 7.68  |
| Nitrogen, %                    |       | 0.15  | 0.15  | 0.16  | 0.153 |
| P2O5, %                        |       | 0.0087| 0.0379| 0.046 | 0.0309|
| K2O, %                         |       | 0.281 | 0.147 | 0.110 | 0.179 |
| Soil Organic Matter (500°C)    |       | 62.50 | 61.25 | 72.05 | 65.27 |
| Moisture content, w, % (105°C) |       | 99.29 | 99.18 | 98.07 | 98.85 |

Within the piggery of Parța, with 37,225 pigs, results daily about 740 m³ sewage water transported in the storage basins for decanting. The sewage water has been applied as organic fertilizer by introduction in the soil amount 15.03 and 31.10 of the year through a unit formed by cistern + scarifier in the first 20 cm of the soil profile.

If we relate to the year 2017, for a fertilizer application by placement with 70-100 m³/ha sewage water will be resulted 14.19 t N, 3.96 t P2O5, 9.69 t K2O for a total area of 145.76 ha cultivated with wheat (98.47 ha), maize (12.4 ha), sunflower (4.86 ha), rape (12.77 ha) and alfalfa (17.26 ha).

The quantity of sewage water was calculated for an yield of 6,000 kg/ha wheat, 10,000 kg/ha maize, 4,000 kg/ha sunflower, 3,000 kg/ha rape and 12,000 kg/ha alfalfa, and for that production the nutrients released from sewage water were of 19.26 t N, 11.48 t P2O5, 5.84 t K2O, plus mineral fertilizers.

For the purpose of a high standard of yield it is useful to increase the fertilizer dozes of sewage water to 400 – 500 m³/ha and the dozes of mineral fertilizers, function of the soil content in C, N, P, K.

The level of yields can be increase for wheat to 8,000 - 10,000 kg/ha, maize to 15,000 kg/ha, sunflower 4,500 kg/ha, rape 4,000 kg/ha and alfalfa 14,000 kg/ha.

In this case, the mineral fertilizer doses will be for wheat – 184 kg/ha N, 174 kg/ha Pmobil, and 148 kg/ha Kmobil, for maize – 275 kg/ha N, 167 kg/ha Pmobil, and 228 kg/ha Kmobil.

This evaluation is correctly when the soil content in N, P, K is low. From the agrochemical survey, for the year 2017, the content in C, N, P and K in the first 20 cm of the soil profile in the 67 plots fertilized with sewage water are in the table 3, for the total area of 145.76 ha [7]

**Table 3. Nutrients insurance of the soils – Parța (% from total area)**

| Insurance                  | low    | medium | high | very high |
|----------------------------|--------|--------|------|-----------|
| Nitrogen index             | 62.28  | 37.72  | -    | -         |
| Mobile phosphorus ppm      | 24.01  | 42.60  | 13.25| 18.40     |
| Mobile potassium ppm       | -      | -      | 34.82| 65.18     |
| Carbon, %                  |        | 100    |      |           |

\[
\text{Nitrogen index} = \frac{H \cdot SB}{SB + SH} \quad (1)
\]
where:

\[ H = \text{content of humus, } \% \]

\[ SB = \text{sum of exchangeable bases, me/100 g soil} \]

\[ SH = \text{total exchangeable hydrogen, me/100 g soil} \]

From the pedological and agrochemical report have been achieved the analytical data for every plot (67 in total). These data point out that the pH is weak acid (6.14), the content of organic carbon is medium, the nitrogen index is 2.01% (medium), with great differences between plots.

The supply with mobile phosphorus is usually good, and also with mobile potassium.

Since the sewage water application has been monitored starting with the year 2015, but every year another plot, it is necessary a two – three year period to find out the results of fertilizers.

There is certainly a contribution with carbon, nitrogen, phosphorus and potassium through sewage water application, but is necessary to repeat the fertilization with greater quantities of sewage water two-three years running on every plot.

4. Conclusions

The soil and agrochemical survey made in the year 2010 for a surface of 9000 ha has identified 7 soil types with 33 subtypes in the cadastral territory from Parța.

At the first of January 2017 in the zootechnical complex were 37225 pigs, with a production of 1300 m$^3$ sewage water.

After a period for decantation in the basins, the sewage water, with 70 % water, was used for fertilizer application by placement in 67 plots with a total area of 145.76 ha.

The chemical analytical data indicated the increase of the content for carbon, nitrogen, phosphorus and potassium relative to the soil profiles without sewage water treaty.

In order to present the soil and ground water pollution it is necessary that the sewage water use to be permanently monitored.

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