Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 15, Issue 1, 2015
PRINT ISSN 2284-7995, E-ISSN 2285-3952

PROSPECTS OF USING THE LOCAL ORGANIC WASTE IN THE AGRICULTURE OF THE REPUBLIC OF MOLDOVA

Tamara LEAH

Institute of Soil Science, Agrochemistry and Soil Protection "Nicolae Dimo", 100 Ialoveni Street., 2070, Chisinau, Republic of Moldova, Phone: +37322/284861, Fax: +37322/284859, Mobile:+373/69384142, Email: tamaraleah09@gmail.com

Corresponding author: tamaraleah09@gmail.com

Abstract

Land use in agriculture of Moldova led to the acceleration of decomposition of accumulated organic matter, and therefore to the loss of carbon. High carbon losses from agricultural soils become a problem with appropriately sized, as this phenomenon affects not only agriculture, but accelerates the degradation of the environment. In the last 20 years, the amount of organic fertilizers decreased 60 times and consists 0.01 t/ha, the area of alfalfa has decreased 4-5 times, on the large areas the crop residues are burned. As a source of remediation the soil organic matter can serve local organic waste: manure of rural households, sewage sludge, wine lees, vinasse, cereal waste, fermented straw etc. Application of organic waste in agricultural practice for soil fertilization contributes to the maintenance a balanced circuit of carbon and nutrients. Each tone of organic waste applied as fertilizer supplements humus reserve with 85-100 kg/ha, with nitrogen 8-9 kg/ha, stimulates increasing production potential and improves the soil fertility. The effect of organogenic waste application is expected for a period of 4-5 years. Along with increasing the soil fertility and reducing the negative impact on the environment, applied waste can provide, depending on the production schedule and application specific, income from 1 tone of fertilizer: 89-928 MDL, with a recovery period of expenses - 1-3 years.

Key words**:** *degradation, humus, Moldova, soil, organic waste*

INTRODUCTION

The current state of arable soils fertility of the Republic of Moldova caused to the long period of their use in agriculture. Humus content reached the level of 3% on average of the whole plowing area. The mean values of soil organic matter losses were about 0.5 t/ha per year. As a result of soil use in the intensive agriculture during 140 years the original natural soil fertility remains around 50-60% [1]. At the bases of soil conservation, humus stability of agriculture soils are crop rotation, which should return a large part of the mineralized soil humus. The use of organic fertilizer, favoring the accumulation of humus in the soil ensures the preservation and improvement of soil fertility. Currently, the amount of applied organic fertilizers in agriculture decreased to 0.01 t/ha [2].

To create a good basis for restoration of soil fertility is very important source of accumulation of organic matter are local organic fertilizers. In the context of a balanced rotation, in terms of the regeneration of soil fertility, they own the compensatory role of humus deficit.

MATERIALS AND METHODS

The research aimed to highlight the local sources of organic matter in order to use them for the remediation of the degraded soils properties.

In this study were used: mixed manure of rural population households, dehydrated sewage sludge, straw, wine lees, etc.

The research was conducted in field experiments at the experimental stations of the Institute "N. Dimo".

For chemical analysis, the traditional methods were used.

In the solid waste samples were appreciated the following indicators: moisture, ash, carbon, total forms of NPK, N-NO_3, N-NH_4.

RESULTS AND DISCUSSIONS

In conditions of the Republic of Moldova, a significant proportion of organic waste belongs to the livestock sector, processing enterprises and agricultural industries. Livestock complexes are the most common supplier of organic fertilizers. Another important source of organic waste are crop residues (straw, leaves, green manure, etc.), waste of sugar and wine factories, urban waste.

Waste livestock sector consist of cattle, swine, sheep, goats and horses manure. Livestock manure accounts over 80 percent of total organic fertilizers currently available to Moldovan agriculture. According to the Statistical Yearbook (2013) now in Moldova about 90 percent of livestock rural households support themselves. The quantity of waste in the years 1985-1990 was about 12 million tons per year. The amount of organic fertilizers decreased from 9.7 million tons in 1990 to 7.5 million tons in 2000 [2]. During 2002-2014 the livestock, including cows, decreased by 52%, decrease rate constituted in average about 4% annually (Fig.1.).

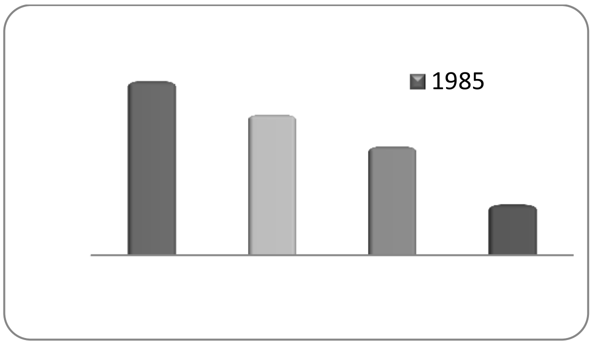

Fig. 1.Dynamic of accumulated organic waste

In the last five years at country level is produced 3.3-3.7 million tones of manure, on average 3.5 million tons (Table 1).

Table 1. Quantity of manure accumulated annually in the country

Indicators	2009	2010	2011	2012	2013	Average
All categories of households, thousand tons	3,374	3,638	3,732	3,544	3,342	3,526
Population households, thousand tons	3,104	3,347	3,433	3,196	2,982	3,213
The share of the total amount, %	92.0	92.0	92.0	90.2	89.3	91.1

In recent years, on average by 1 hectare of arable land the application of organic fertilizers amounts 0.02 tons. For establishing non-deficit balance of humus in the soil it is necessary at least to double the volume of organic waste. Cattle manure consists 62% of the total amount of animal waste, pigs - 14%; sheep - 15%, horses - 8%, poultry - 1%. The annual total amount of organic waste contains 630 tons of humus, 27 tons of nitrogen, 14 tons of phosphorus and 34 tons of potassium [6]. This potential of organic fertilizer being introduced per 1 hectare of arable land will provide in the soil - 0.4 tons of humus, 16 kg nitrogen, 8 kg phosphorus, 20 kg potassium [1]. The quantity and quality of livestock waste accumulated at the level of districts are various and depends on the species, origin of litter and feed quality. Currently, the vast numbers of animals are in the private sector, that's why the solid manure prevails over other forms of organic fertilizers.

The *litter cattle manure* contains an average: 53% of water, 0.56% of nitrogen, 0.33 of phosphorus, 0.65% of potassium. Organic matter content is 17.3%. Nitrogen mobile form does not exceed 10% of the total, the ratio of carbon to total nitrogen is 17.9 [6]. One ton of litter cattle manure contains 5.6 kg of nitrogen, 3.3 kg phosphorus, 6.5 kg potassium (Table 2). The *semiliquid cattle manure* (without litter) comprises 82% of water, 0.39% nitrogen, 0.27% phosphorus, 0.46% potassium. Organic matter - 11.2%. In 1 ton of manure consist: 3.9 kg nitrogen, 2.7 kg phosphorus, 4.6 kg potassium [4].

Decomposed cattle manure in dose of 40-60 t/ha is very effective for row crops. It is recommended to use it for growing crops (wheat, barley) at a dose of 20-30 t/ha [1].

Table 2. Content of NPK in the organic waste

Type of waste	NPK, kg
Cattle manure (litter)	15.4
Cattle manure (semiliquid)	11.2
Pig manure (litter)	22.7
Pig manure (semiliquid)	11.0
Sheep manure (litter)	31.7
Sheep manure (semiliquid)	23.5
Poultry manure (litter)	43.9
Poultry manure (semiliquid)	32.5

Pig manure. *Litter swine manure* contains: 57% of water, 0.82% nitrogen. 0.71 phosphorous, 0.74 potassium and 24.4% ash. Organic matter content is 18.3%. The ratio of carbon to total nitrogen is 12.9. One ton of

litter pig manure contains 8.2 kg of nitrogen, 7.4 kg phosphorus,7.4 kg potassium [7].
The *semiliquid swine manure* contains 84% of water, 0.5% nitrogen, 0.29% phosphorus and 0.24% potassium. Organic matter content - 11.7% [4].One tone of manure contains 5.7 kg of nitrogen, 2.9 kg phosphorus, 2.4 kg potassium (Table 2).
Sheep manure. According to the content of nutrients it is close to pig manure. Litter and semiliquid sheep manure contains relatively little water (from 40% in the litter to 53% without litter) and a large amount of nitrogen (0.45% - litter and 0.92% - without litter), phosphorus (0.45 and 0.36%, respectively), and potassium (1.77 and 1.07%), [7].
Poultry manure. Litter poultry manure is the most valuable organic fertilizer on the content of therein nutrients and organic matter. It is characterized by increasing the availability of nutritive substances needed for plant nutrition. Litter poultry manure contains more potassium and phosphorus, and less nitrogen compared with semi liquid (without letter manure). It is characterized by a higher content of dry substances and organic matter, respectively, but poorer in minerals. One ton of poultry manure with litter contains 16.3 kg of nitrogen, 14.5 kg of phosphorus, and 13.0 kg of potassium (43,9 NPK). One ton of poultry manure without litter contains 22.2 kg of nitrogen, 7.4 kg phosphorus, and 9.9 kg of potassium (32.5 kg NPK). Mineral nitrogen is 35.5% of the total content [2,6,7].
This type of fertilizer can be applied at different periods, at various cultures in a dose of 7-12 t/ha. To reduce the loss of nutrients and to increase the efficiency of this fertilizer should be used in chicken houses a bed of straw and sand in a ratio of 20-30% of the litter. It may also be used for bedding the ash or superphosphate (5-6% by volume).
Crop residues, which are not alienated from the cultivated land (stubble, roots, straw, sunflower stems, corn cobs) return only half of mineralized soil humus to produce a crop and partly nutrients used by plants. The biggest part of the nutrients from the soil alienated by main products [1].
Straw, irrespective of the type of use (as forage or as bedding for animals, for the production of compost, or directly as a fertilizer) must get into the soil and serve to restore its fertility. Countrywide, are collected annually 1.1 million tons of straw. From this quantity, about 400 thousand ton have not some vital destination, stronger than the restoration of soil fertility. About 25% of this mass is maintained as stock of fodder, which after 1-2 years is losing its quality. Old straw can be used as livestock bedding, for production of compost, or directly as a soil fertilization. One ton of straw can synthesize 200 kg of humus, the amount secured by 2-3 tons of manure [7].
Direct use of old straw as fertilizers involves primarily shredding and distributing it on the field in dose of 3-4 t/ha. With straw spreader entered 30-40 kg/ha of nitrogen in order to optimize the ratio between carbon and nitrogen. Under the current circumstances created in agriculture using straw as organic fertilizer is appropriate, accessible and provides a process that does not require large cash expenditures to increase soil fertility and crop yields. According to the organic matter content 1 ton of straw is equivalent to 3.5-4.0 tons of manure. Through a household management of plant residues can make up to 52 percent of annual loss of humus [4].
Sediments of urban wastewater. The chemical composition of urban sediments varies and depending on the structure of the economic sector, technology of producing and purifying of wastewater. Due to the high content of organic matter and variety of nutrients the waste is considered an organic fertilizer and is used in many countries for crop production. But due to the high content of heavy metals its application is limited and requires special preparation. Every year at all stations for wastewater treatment accumulates about 350-400 thousand tons of sludge with humidity 35-55%. About 20 years ago, the annual amount of sewage sludge (sediments) was about 700 thousand tons with a moisture content of 65-75% [8].
Urban wastewater sludge contain the same amount of organic matter (15-18%) as the litter manure and 2 times more the total nitrogen (0.85%), 3.0-4.5 times phosphorus (1.2%), 2-3 times less potassium.

Municipal sediments, compared to other organogenic wastes contain high available phosphorus and mineral nitrogen. Applying the sediments in relatively small doses (15 t/ha) would provide plants 30-60 kg of mobile phosphorus in the first year of application.

The widespread use of urban sediments in agriculture may be limited in their high content of the composition of some heavy metals and the presence of pathogenic agents. The maximum permissible concentration in the urban sediments (Pb, Cr, Ni) does not exceed the allowable limits, and therefore, it does not preclude their use as organic fertilizer. Municipal sediments in comparison with other organic waste richer in micronutrients (Zn - 700 mg, Mn - 410 mg, Cu - 319 mg, B - 140 mg, Co - 16 mg, Mo - 11 mg/kg of dry mass) required for plant nutrition, especially on eroded and weakly productivity soils [2, 4].

Sediments obtained at stations for wastewater treatment weakly expressed in pathogenic agents, with a strong as their infestation (dangerous), this limiting factor can be easily overcome by composting with other organogenic material. Using sediments of municipal wastewater as organic fertilizers contributes to obtaining high yields and at the same time, improve the environmental situation in the cities of the country.

Sewage sludge are rich in organic matter and elements that necessary for plant nutrition, especially phosphorus. In most cases they can be applied to perennial and annual crops without special training. Application rates are determined by the content of phosphorus, which quantitatively dominates and balancing the ratio between nitrogen and phosphorus is achieved by the use of nitrogen fertilizers.

In the case than heavy metals exceed the tolerance limits is recommended to compost these sediments with manure, sludge from ponds or soils with rich content of humus. The ratio between the components should ensure reduction in the concentration of heavy metals in compost to acceptable values.

Taking into account the restrictive factors that must be followed when using sewage sludge, in each case requires their complex testing before they can be used to fertilize the soil.

Waste of sugar factories. Every year in the country accumulates over 250-300 thousand tons of sugar factories waste. Chemical composition of these waste largely depends on the technology used in processing of sugar beets. Obtained by special technology, waste at the local factories is poor in organic matter and nutrients, but contains a lot of calcium. This waste is most suitable for calcium amelioration of saline soils.

Waste, resulting in a mixed technology, characterized by a more favorable agrochemical parameters. It contains 3,66-4,70% of organic matter, 0,56-0,90% of nitrogen, 0,42-0,90% of phosphorus, 0,12-0,38% of potassium. Mobile forms of phosphorus constitute 20-43 mg/100 g, exchangeable potassium - 40-70 mg/100 g [5].

Using the waste from sugar factories for soil fertilization leads to the enrichment of the arable layer of the most important nutritive elements, a full mobilization of potential fertility, increase crop yield. The sugar waste is used on the gray and podzolic soils, leached chernozem, under cereals crops (corn, winter wheat). It is advisable to use these waste in neighboring with sugar factories farms.

This waste is an extremely good material to make compost by mixing with sewage sludge, manure and other organogenic waste with high humidity. Direct use of sugar waste as fertilizer or after composting, effectively as agronomic and economic point of view, giving the opportunity to resolve environmental problems in its storage.

Sludge accumulated in the ponds. The country has more than 3500 watersheds, including 1200 severely silted or destroyed. In ponds deposited a large quantities of silt brought from the neighboring slopes. Lake silts are mainly represented by the fertile layer of soil exposed to erosion. Compared with eroded soils, they have a higher fertility and are interest as a material for restoring the fertility of eroded soil by earth-covering. Lacustrine silts in most cases have a thickness of 2.5-3.5 m, contain 2.5-5.5% of humus, much richer in mobile forms of phosphorus than soils prone to erosion, exceeding in this regard full-profile soil [1]. A significant part of silt are rich in potassium available to plants

The main limiting factor that should be taken into account when using lacustrine silts in earth-covering the eroded soils, is high salt content, which is most often found in sediments in the south of country. Comprehensive testing of lake silt involves identification of factors that may limit their use in earth-covering of eroded soils, such as physic-chemical properties, sanitary, content of pesticides.

The most effective way to use ponds silts is composting with organogenic waste rich in organic matter. Composts of lake silts with manure contribute to a radical restoration of fertility of heavily eroded soils.

Data on the current state of humus of arable soils showed that the annual loss of mineralization organic matter exceed 1500 thousand tones. Crop residues remaining in the soil, make up only 800 thousand tons of humus, accounting deficit of 700 thousand tons of humus per year [2].

Involving the local sources of organic matter in agricultural purposes, available in stock, would cover the deficit of humus and maintain the soil fertility, which, as already mentioned unsatisfactory. Available resources are currently used in very small quantities. Hence, improving soil fertility, even in the case of full utilization of these resources is impossible without optimum crop rotation in order to increase the amount of organic matter accumulated in the soil.

Humus loss from erosion cannot be compensated by organic fertilizers. This problem can be solved by the application of measures to combat this phenomenon.

Liquid waste. Cattle effluents contain significant quantities of nutrients in a readily available form for plants, in particular potassium and nitrogen.

Liquid wastewater from pig complexes contain 0.3-6.1 g/l of organic substances. One cubic meter of wastewater contains an average 0.79 kg of nitrogen, 0.1 kg of phosphorus and 0.80 kg of potassium [5].

The amount of organic matter in the wastewater facilities for breeding and fattening of cattle is 0.7-9.8 g/l. In 1 m^3 its contain 3.9 kg of organic matter, 0.78 kg nitrogen, 0.23 kg of phosphorus, 1.18 kg of potassium [7].

Wastewater of poultry farms are characterized by a high content of organic matter and mineral substances and nutritive elements. In 1 m^3 contained an average 5 kg of organic matter, 0.9 kg of nitrogen, 0.1 kg of phosphorus and 1.4 kg of total potassium. It should be noted that poultry waste are rich in micronutrients, mg/kg: B-20, Mn-200, Co-1, Cu-16, Zn-96, Mo-2 mg/kg of dry matter.

Waste water from the manufacture of alcohol from molasses contains high amounts of mineral and organic substances. In 1 m^3 contained 4.0-7.3 kg of organic matter, 0.5-1.3 kg of total nitrogen, 0.3-0.9 kg of ammonia nitrogen, 0.023-0.043 kg of total phosphorus, 0.3-0.9 kg of sodium and 2.5-3.4 kg of total potassium [5].

Waste water from the manufacture of sugar have a lower concentration of organic matter and mineral substances. In 1 m^3 of wastewater contain 0.5 kg of organic matter, 0.2-0.3 kg of nitrogen, 0.01 kg of phosphorus, 0.5-0.7 kg of potassium [4].

Irrigation quality of wastewater does not meet the requirements for their use of soil irrigation, so they can be used to a limited extent to crops fertilization.

Using the wastewater as crops fertilizer requires a comprehensive study of the chemical composition in the prevention of contamination of soils and agricultural products with harmful substances.

Currently at the wineries and sections for obtaining alcohol from grain accumulates as waste material about 40-80 thousand tons of wine lees, 50 thousand cubic meters of vinasse and 50-60 thousand cubic meters of cereal grains molasses. The total waste of the wine industry is impressive and ever growing. Mineral residue constitutes 2.0-2.7 g/dm^3 that characterizes them as liquids with high mineralization index. Cereal vinasse is characterized by higher salinity potential. But the greatest danger of saline and alkaline contamination of soils can cause the abusive incorporation and uncontrolled discharge of wine lees [2, 5].

Simultaneously, these wastes contain the primary elements necessary for plant nutrition and soil fertility, which are required recovered strongly. In 100 cubic meters of wine yeast contains about 190 kg of total nitrogen, as much phosphorus and approximately 550 kg of total potassium. Less concentrated in nutrients, but not negligible, are dreys and vinasse. In 1000 cubic meters of vinasse contained up to 120 kg nitrogen, 190 kg phosphorus, 100 kg of potassium. It is appreciated more in line with the needs of plant the primary elements of dreys concentration, where in 1000 cubic meters containing up to 230 kg nitrogen, 110 kg phosphorus and approximately 80 kg of potassium. These wastes no one way is not used, there is no liquidation regulations.

Wine industry waste (vinasse and wine yeast) have a minor negative impact on the physical properties of leached chernozem. Their application leads to soil compaction which attenuates to doubling the dose of amendment. Not found a further increase in bulk density from repeated application of waste. Negative trends were in both the structural-aggregate composition and hydrostability. But they are not dangerous and values fall within the class of "good" quality of soil structure in accordance with the percentage of aggregates diameter from 0.25 to 10 mm.

Application the dose of 47 m^3/ha of cereal waste improved structural indices of 0-20 cm layer of leached chernozem. Dose of 94 m^3/ha had a negative impact on these indices, increasing small content of hydrostabile aggregates. In order to improve agrophysical indices of cambic chernozem recommended dose is 47 m^3/ha [7].

Rational use of organic fertilizers. Each farm (or peasant association), regardless to land surface or number of lots must be constantly concerned about the problem of conservation of humus in the soil, using all local organic waste. Each producer has to keep in mind that annual losses of humus in the field rotations, currently used, reaches 1-1.2 t/ha, excluding erosion loss, with consist an average of 0.6-0.7 tons/ha. Crop residues cover only half of the humus deficit in soils. In orchards and vineyards the humus loss account 2.5-3 t/ha. For full compensation of humus loss in crop rotations, it is necessary to use an average 10 t/ha of organic fertilizer. This is only possible in farms that having at least one cow per 1 hectare [3]. Organic fertilizers are applied under the row and perennial crops during plowing. The rest of the succeeding crops use of organic fertilizers aftereffect. It is essential that in each commune, on the basis of contracts, foresaw to economic conditions for farms - provide with fodder, and peasant farms - with manure.

CONCLUSIONS

To stabilize the humus content in arable soils and soils under permanent crops, it is necessary to applied annually 20-22 million tons of organic fertilizers. Existing sources of organic matter can provide 12 million tons of organic fertilizers.

The deficit of organic fertilizers, equal to 10 million tons, could be neutralized by changing the structure of sown areas, categories of land use, crop rotation optimization, full use of all sources of local organic wastes.

REFERENCES

[1] Andries, S., Banaru, A., Filipciuc, M., Tiganoc, V., 2004, Complex program to recovery of degraded lands and increase soil fertility. Part. II. Improving soil fertility. Pontos, Chisinau, 30-57 (rom).

[2]Andriesh, S., Banaru, A., Cerbari, V. et.al., 2001, Complex national program to enhancement soil fertility in 2001-2020, Chișinău, Pontos, 84-87 (rom).

[3]http://agora.md/analize/71/republica-moldova-a-ramas-cu-mai-putin-de-jumatate-din-efectivul-de-bovine-de-acum-12-ani

[4]Plămădeală, V., Banari, A., 2010, Wastewater impact on the quality (pollution) soils. In: Soil Quality Monitoring of the Republic of Moldova (data base, conclusion, prognoses, recommendations), Ch., Pontos, 420-459 (rom).

[5]Plămădeală, V., 2013. Agroameliorative indices of liquid wastes from processing grapes, producing the divine and ethyl alcohol. Lucrări Șt. ale Univ. de Științe Agricole și Medicină Veterinară ”Ion Ionescu de la Brad”, Ser. Agronomie, Iași, 56 (2): 33-38

[6]Rusu, A., Plămădeală, V., 2011, Research of Quantitative Fluctuations in livestock waste accumulated and exploitated in the country. Agricultural Science, Ch., UASM, nr.1, 7-11, (rom.).

[7]Rusu, A., Plamadeala, V., Siuris, A. et.al., 2012. User guide of organic fertilizers. Ch., Pontos, 7-29

[8]Siuris, A., 2011, Properties of sewage sludge resulted from urban waste water treatment in the Republic of Moldova. Scientific papers. Agronomy. Univ. de Științe Agronomice și de Medicină Veterinară București, Vol. 54: 103-108.