**Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development**
**Vol. 21, Issue 3, 2021**
**PRINT ISSN 2284-7995, E-ISSN 2285-3952**

# WASTE MANAGEMENT IN AGRICULTURE

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***Abstract***

*Waste of any kind, resulting from many human activities, is a very topical issue, both due to the increase in quantities and types (which through degradation and infestation pose a danger to the natural environment and the health of the population) and significant amounts of materials, raw materials, reusable materials and energy that can be recovered and put into the economic circuit. Waste is not only an environmental problem, but also an economic loss. The types of waste resulting from agriculture and forestry are: vegetable waste and waste from preparation; waste from manure; waste from forest holdings; used motor oils; used tires; plastic waste, including plastic packaging waste; waste from batteries and accumulators. In Romania, of the total amount of waste generated, most is vegetable waste and waste from preparation (over 90%), according to the National Institute of Statistics. Waste management must be carried out in waste recovery or disposal facilities. Thus, waste from agriculture can be managed by: recovery of organic substances - biogas plants, composting, recycling of plastic waste; recycling of scrap metal; incineration - in the case of hazardous waste (agrochemical waste, used oils); storage - in the case of waste that cannot be recovered. The EU legislation, more exactly the Waste Framework Directive creates the framework in which waste management has to implemented regarding prevention, preparation for reuse, recycling, recovery and disposals. The Directive has the duty to prevent the greatest possible generation of waste, to utilize the waste generated as a resource and to diminish to a minimum the amount of waste that reaches landfills. In this way, environmental pollution can be significantly reduced. After all, waste can be a problem or a resource only depending on how it is managed.*

***Key words*:** *waste, environment, pollution, management*

## INTRODUCTION

Waste is represented by material residue resulting from a technological (or household) process of making a particular product, which can no longer be used directly in making that product. They can be substances, materials, objects, residues of raw materials from economic, household and consumer activities. Most human activities are also sources of waste production.

Waste is material considered worthless or useless. They should be eliminated as they endanger human health. Human contact with waste can occur either directly, through the accumulation of landfills near residential areas, or indirectly, through runoff into soil, groundwater or surface water and emission into the atmosphere.

With the end of the twentieth century, the population began to play an important role in the management of household waste by using recyclable materials, using methods of composting organic waste and by reducing the waste produced. Environmental laws have been implemented to protect the population and the environment from pollution generated by waste disposal. Due to the decrease in waste storage space and the controversy over the most appropriate method of disposal, the optimal solution seems to be the prevention of waste generation.

Europe generates very large amounts of waste: from agricultural activities, food and gardening waste, construction and demolition waste, mining waste, industrial waste, sludge, electrical and electronic equipment, old cars, batteries, plastic waste, paper, waste sanitary

ware, textiles, etc. [2, 19]. On average, the Europeans produce about 500 kilograms of municipal waste per year. A higher part of this amount is recycled or turned into compost, while a smaller part ends up in landfills. The amount of waste depends on the production and mainly to the society consumption habits. For example, this quantity depends on the a large range of products entering the market, as well as on demographic changes (increase of the number of single-person households).

Many of the generated waste can be recycled and transformed into new products. This can be an effective way of waste managing [9, 10].

A current method used in waste management is artificial intelligence. Thus, artificial intelligence algorithms can be used to optimize the plastic waste management [1].

One of the great problems of society is that many people are not aware that their lives can be suffocated, affected by tons of waste that are not properly managed.

2020 has brought a new source of pollution, along with the COVID pandemic. Certain wastes begin to accumulate, in huge quantities, in nature. These are masks, gloves, visors and other personal protective equipment used by people around the world to protect their health. This equipment's, used until now mainly in the medical field, have become products of common use. It is very important to know how to dispose of them responsibly so that we can take care of ourselves and environment too [13].

In principle, the measures of recovery of waste, as well as the measures to avoid their formation, must be estimated the degree of environmental pollution. The environmental impact assessment model includes the fields of collection, transport, processing and production of by-products, distribution logistics, marketing, use and sanitation.

In order to achieve the purpose of the evaluation, i.e., to estimate the degree of reduction of environmental pollution through production, with the help of waste recovery, it is possible to make various comparisons. A decisive influence on the evaluation result is the choice and establishment of the limits of the researched system [20].

The quality of the environment is a fundamental factor for the health, economy and well-being of the population of each country. However, it faces several major challenges, not least those related to climate change, unsustainable consumption and production, and various forms of pollution [3, 4].

Agricultural waste consists of organic waste and waste such as plastic, mechanical waste, fences, pesticide waste, herbicides, raticides, contaminated packaging related to them, used oils and veterinary medicines. Spreading waste on the ground under strict conditions, anaerobic digestion and composting can be considered ways of managing them.

One of the objectives of waste management in agriculture is to break the link between economic growth and the environmental impact associated with waste generation.

Agricultural waste management covers all stages of an agricultural product's life cycle, from obtaining raw materials on farms, processing, distribution and consumption, before waste is taken over by waste operators. Thus, the prevention of the generation of large quantities of agricultural waste is an important tool not only for environmental protection in the context of waste management but also for reducing the pressure on natural resources.

Environmental pollution, which has spread its threat to the entire planet generates, develops and propagates one of the worst dangers facing modern civilization. Lately, a term associated with environment is the pollution that manifests as a continual aggression against itself integrity.

## MATERIALS AND METHODS

The paper is a documentary study which intends to be a brief review of the issue of waste management in general and agricultural waste management in special, amid of the increasing public pressure on the environmental pollution crisis and the growing number of scientific evidence demonstrating the harmful impact on human health.

The responsibility for waste management in agriculture and animal husbandry lies with

those who generate this waste,, mainly agricultural and forestry holdings. However, in Romania there is no distinct information regarding the operators that capitalize on waste resulting from agriculture and from animal husbandry activities.

## RESULTS AND DISCUSSIONS

The concept of environment has the character of a complex but unitary system, consisting of a very large number of elements and links having a certain capacity for self-regulation and in which the factor the most active is represent by human communities. In recent decades, the global process of degradation of the environment factors of has had an increasingly worrying evolution, with the number of pollutants reaching figures that exceed any imagination.

Through their current activities, humans produce waste through their own existence. In addition, there are those from different industrial activities: clothing, furniture, detergents, cosmetics, household chemicals, etc. Most of wastes are not biodegradable and others are directly toxic. An additional source of pollution is outbreaks of coal, oil, gas, wood, which produce large quantities of smoke, ash, slag, gas. Another element pollutant consists of pathogenic bacteria that are circulated mainly in domestic waters.

From the point of view of nature and places of production, waste is classified as follows:

- *Waste from the mining industry* - are represented by fragments of rocks and poor ores. They are usually deposited at the mouth of the mine in undeveloped areas periodically exposed to erosion and washing by surface waters;
- *Waste from the energy and metallurgical industry* - can be slag, sludge, dust and ash. Waste from thermal power plants and non-ferrous metallurgy has a high content of heavy metals and a certain number of sulphates that can seriously pollute the environment;
- *Industrial waste* - generally comes from the manufacturing industry (textile, wood, food) and especially from metal processing;
- *Construction waste* - represents the materials from the demolition of constructions and from the remains of materials left from the civil and industrial construction sites;
- *Household waste* - are represented by paper, plastic, ceramic waste and bottles, rubble, food waste, vegetable waste, metals and dust, accumulated in the street areas from daily activities;
- *Radioactive waste* - are the result of industrial, medical and research activities. The largest quantities come from the activity of electricity production.
- *Agricultural waste* - consists of vegetable waste and waste from preparation; waste from manure; waste from forest holdings; used motor oils; used tires; plastic waste, including plastic packaging waste; waste from batteries and accumulators. Animal husbandry results in large amounts of manure.

Among the categories of pollutants, the chemically stable and highly toxic ones raise the biggest managerial problems. Heavy metals fall into this category. In order to substantiate the decisions regarding the management of areas contaminated with heavy metals, it is necessary to evaluate their effects, both on the components of natural capital and on the socio-ecological systems. The first step in this direction is to characterize their distribution in the compartments of these systems. In particular, if the effects of heavy metals on human populations in contaminated areas are to be assessed, their transfer routes from storage compartments to the human population must be characterized. One of the most important such transfer routes is through the consumption of plant and animal foods produced in the contaminated area.

The vast majority of waste can become hazardous in precarious storage or transport conditions. Thus, they can become explosive, oxidizing, flammable, irritating, toxic, carcinogenic, corrosive, infectious, mutagenic and radioactive and can emit toxic gases in contact with water, air or an acid.

Generally, due to the lack of facilities and poor operation, landfills are among the objectives recognized as generating impact and risk for the environment and public health.

The main forms of impact and risk determined by municipal landfills and industrial, in the order in which they are perceived by the population, are: landscape changes and visual discomfort; the air pollution; surface water pollution; changes in soil fertility and the composition of biocenoses on neighbouring lands.

Removing land for landfills from the natural or economic circuit is a process that can be considered temporary, but which in terms of the concept of sustainable development, extends over at least two generations if the summation periods are summed (1-3 years), exploitation (15-30 years), ecological restoration and post-monitoring (15-20 years). In terms of biodiversity, a landfill means the removal of 30-300 species/ha from the affected area, without considering the microbiological population of the soil. In addition, the biocenoses in the vicinity of the deposit are changing, in plant associations species from polluted areas become dominant and some mammals, birds, insects leave the area, to the advantage of those who find their food in garbage, like rats.

Although the effects on flora and fauna are theoretically limited in time during the exploitation of the deposit, the ecological reconstruction achieved after the release of the area of technological tasks will not be able to restore the initial biological balance, the evolution of the bio system being irreversibly modified.

Waste, especially industrial waste, is a source of health risk due to its content in toxic substances such as heavy metals (lead, cadmium), pesticides, solvents, used oils, etc. The most difficult problem is hazardous materials (including toxic sludge, petroleum products, paint residues, metallurgical slag) that are stored in common with municipal solid waste. This situation can lead to flammable, explosive or corrosive mixtures and combinations; on the other hand, the presence of easily degradable household waste can facilitate the decomposition of complex hazardous components and reduce environmental pollution.

One downside is that many recyclable and useful materials are stored along with non-recyclable ones; being mixed and contaminated from a chemical and biological point of view, their recovery is difficult.

Agriculture is an important source of environmental pollution by: triggering and favouring soil degradation processes following the processes of erosion, salting, compaction; use of pesticides; excessive use of chemical fertilizers, etc. [15, 16, 17, 21].

The European Union is one of the largest food producers in the world. It uses modern agricultural production systems and has land suitable for agriculture. Productivity per hectare has increased considerably, due to the development of monocultures and irrigation systems, more efficient equipment and the use of a larger amount of chemicals, such as pesticides and fertilizers. At the same time, however, these modes of production have generated a greater amount of agricultural waste and higher environmental costs. The intensification of agricultural waste generation puts more pressure on the environment, resulting in higher nitrogen pollution and more CO2 emissions, greater loss of biodiversity on agricultural land and greater contamination of soil, rivers and lakes. In addition, increasing the use of external factors to achieve higher yields in food production usually decreases the overall energy efficiency of the process.

Establishing the plant nutrition regime is a prerogative from the perspective of evaluating fertilizer doses to ensure the optimal plant nutrition and development [5, 14, 16].

In the organization of modern agriculture, a role very important is the arrangement works of land and, in particular, water management. But dams and irrigation canals do not change only the hydrological regime in that area, but and local ecological systems, through change edaphic factors. Both positive effects can occur (territorial extension of cultivated areas and uplift productivity) and negative (salting).

The amount of agricultural waste depends on the importance given to agriculture in each country and the type of agriculture. Most are organic residues, so they are biodegradable and can be converted by biological, physical or chemical processes into feed or fertilizer. Globally, their production is estimated at

about 2 billion tons/year, the growth rate being about 6-7 times higher than that of urban and industrial waste combined.

In Romania, for the period 2014-2020, the objectives and targets regarding waste management in agriculture and animal husbandry activities provided in the legislation and in the National Strategy and the National Waste Management Plan were the following:

- Streamlining control over the storage of untreated waste from agriculture and animal husbandry (vegetable waste and animal manure);
- Encourage the recovery by aerobic and anaerobic processes of waste from agriculture, animal husbandry and forestry (vegetable waste and animal manure) [12].

When looking forward, global waste is expected to grow to 3.40 billion tonnes by 2050 (Figure 1), more than double population growth over the same period. Overall, there is a positive correlation between waste generation and income level [22].

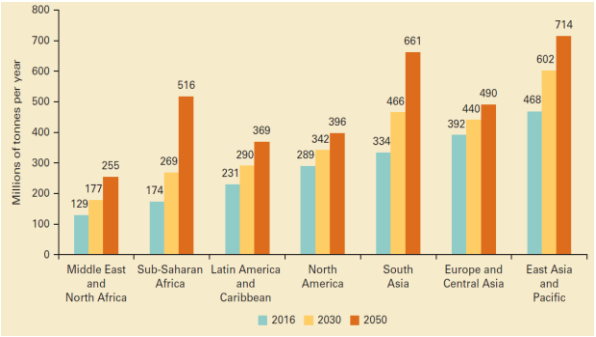


Fig. 1. Worldwide waste generation, by region (millions of tonnes/year)
Source: [22].

Figure 2 presents the weight of different economic activities and households waste generation in 2018. In the EU, from the total amount in 2018, constructions have a share of 35.9%, followed by mining and quarrying (26.6%), manufacturing (10.6%), waste and water services (9.8%) and households (8.2%); the rest of 9.1% waste is generated by other economic activities, especially by services (4.2%) and energy (3.4%).

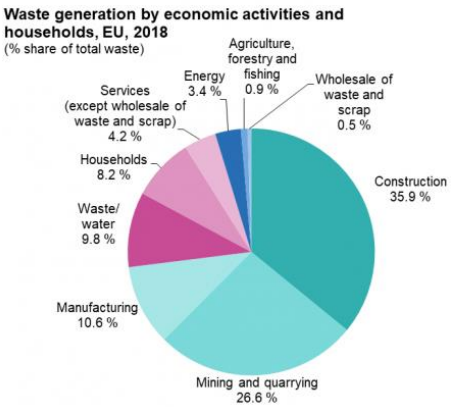


Fig. 2. Waste generation in Europe
Source: [7].

In order to get out of the vicious circle of a still linear economy, limit resource depletion and reduce waste generated, the concept of circular economy was launched at EU level, i.e., extending the life cycle of a product by reusing, repairing and recycling components, to achieve the ideal of "zero waste." This initiative is represented by the Waste Management Framework Directive, which requires of the Member States to meet certain waste recycling targets, namely 55% by 2025, 60% by 2030 and 65% by 2035 [8].

The problem must be solved, first of all, at the source. Manufacturers and traders must gradually reduce and then give up the production of disposable plastic packaging and invest primarily in reusable systems, in the joint effort to have a consumer experience that does not harm our health and the environment; at the same time, it must review the policies established by the associations with which it collaborates and ensure that they operate in accordance with their social and environmental values.

Waste recycling ensures the preservation of natural resources and the reduction of pollution. Waste contains materials or energy that can be reused. Only a tiny part of the waste can be reused as such, most of it being sorted and reintroduced into the processing industry. Thus, the following can be recycled: scrap metal, which currently accounts for 10% of world steel production; lead, by recovering from the 80 million batteries discharged annually from use, and from water / sewerage networks; precious metals from electronic equipment, by using advanced technologies;

plastics that can be melted and reused industrially; household waste, by collection by categories, in containers with precise destination. The most important markets for secondary materials resulting from waste are: paper; plastic; glass; metal; textiles; wood.

In Central and Western Europe are recycled between 30-40% of municipal waste: paper between 22-58% (in the first places being the Netherlands Germany and Norway), and glass between 22-70% (Switzerland, Holland, Germany, Austria, Belgium and Italy).

Bioconversion of organic waste is a process by which organic waste is transformed by aerobic or anaerobic bacteriological processes into products that can be used as agricultural fertilizers.

In Romania, the National Waste Management Strategy is developed by the Ministry of Environment and Water Management. Of all the European countries, Romania recycles only 1% of the entire volume of produced waste, the rest being thrown in the landfill. At the opposite pole is Belgium, which recycles 94%.

The options for sustainable waste management are: prevention of occurrence - by applying the "clean technologies" in activities that generate waste; reducing quantities - by applying the best practices in each field of waste generating activity; recovery - through reuse, material recycling and energy recovery; disposal - by incineration and storage.

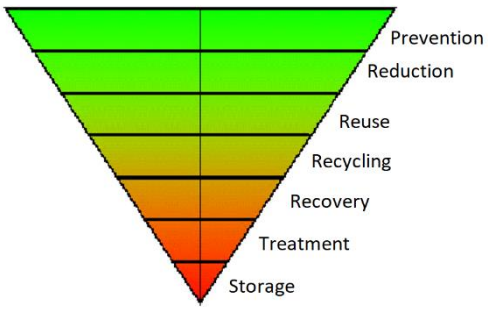


Fig. 3. Preferred waste management options
Source: [23].

Preferred waste management options are prevention, reduction, reuse, recycling, treatment and storage (Figure 3).

Integrated waste management requires: reducing the amount of waste produced; recycling (recovery) of waste in conditions of economic efficiency; composting of organic waste; waste incineration in conditions of minimal impact on the environment; controlled storage of waste.

Starting from the specific hierarchy of waste management, the waste whose formation cannot be avoided must be capitalized according to the possibilities. Waste recovery measures should be implemented where those to prevent the formation are not possible or were, for ecological or economic reasons, they would no longer be rational. With regard to waste disposal, the superiority of the recovery must be recognized, as long as this is technically possible and with some modest representation costs for the recovered materials, a sales market is available, respectively this market can be created.

Agricultural users and public decision-makers need to be aware of the risk associated with contamination with various chemicals in order to be able to estimate and subsequently prevent adverse effects and to set standards for their use.

Within the National Program of Waste Management, the statistics of agricultural waste can be found at Environmental Statistics section. The statistical research is carried out by survey, by the National Institute of Statistics, once every two years. The object of statistical research includes agricultural holdings with legal personality (about 1,000), and aims the collection of data and the realization of the estimation procedure regarding the generation, treatment and outsourcing of agricultural waste [12].

Efficient management of agricultural waste consists of minimizing waste production, recovery, recycling and reuse, including biodegradable waste, and promoting modern agricultural technologies. Undoubtedly, agricultural waste is a source of pollution, but well-managed waste can generate additional benefits, such as reduced consumption of natural resources, saving energy and financial resources. Transforming of the agricultural waste into reusable resources (raw material) is

one of the main objectives of the green economy.

The recycling of agricultural waste is the process by which it is transformed into a secondary raw material for the manufacture of new products. The benefits of recycling are multiple, beneficial to communities, the environment, but also with a positive effect on the economy. In this regards, various agricultural wastes can be used in classical structures of lignocellulosic composites [6]: maize and cotton stalks, as agricultural waste, are used to manufacture agglomerated panels of medium density fibers; sunflower stalks have been used successfully to replace wood flour as a reinforcing element for polypropylene in the case of thermoplastic composites, as a potential raw material for replacing wood chips in the structure of PAL panels. The cereal straws (especially wheat and rice) can also be used for alternative panels of PAL and PFL, etc.

By reusing agricultural waste, financial savings can be achieved. For example, a company that dries fruit and produces plum jam, also produces agricultural waste as cherries and plums kernels pip. The average annual quantity of this type of agricultural waste is about 36 tons. However, these seeds contain a considerable amount of energy, so that the company can reuse them to produce the heat needed to dry the fruit. Thus, the company can save half of the natural gas used, which means about 17,000 m³ / year, and the financial savings are around 120,000 lei / year [18].

The management of agricultural waste must be carried out without endangering human health and without harming the environment, in particular without creating a risk to air, water, soil, fauna or flora; without creating discomfort due to noise or odours and without adversely affecting the landscape or areas of special interest. From this point of view, the producers of agricultural waste and the owners of agricultural waste have the obligation to subject the waste that has not been recovered to a safe disposal operation, by observing the following measures: ensuring complete disposal of waste; use of the most sustainable techniques available and which do not involve excessive costs for waste disposal; locate and arrange the waste disposal facility in a space and under conditions established by the territorial authorities for environmental protection; disposal of agricultural waste only in authorized spaces for this purpose; etc.

Substances that persist in the environment and tend to accumulate at different levels structures related to a high potential for toxicity are of particular interest in the management of contaminated areas.

In accordance with Law no. 211/2011 (updated), "the agricultural waste producer or any waste holder has the obligation to carry out the treatment operations or to transfer these operations to an authorized economic operator carrying out waste treatment activities or to a public operator or private waste collection in accordance with legal provisions. Also, the economic operators that carry out waste collection and transport operations have the obligation to deliver and transport the waste only to installations authorized for carrying out the sorting, treatment, recycling and storage operations" [11].

An example of a company that deals with the provision of ecological services in Oltenia Region is ECO TOTAL SRL, established in 2008. The company aims to reduce the effects of pollution, supporting economic agents with integrated and flexible solutions for agricultural waste management and decontamination. It has a modern car fleet, properly equipped, according to the legislative norms in force, for the activities of collection, transport and storage of agricultural waste: authorized vans, equipment for their loading and unloading; capacities of over 100,000 litres of liquid waste storage. The company proposes integrated solutions with multiple advantages that lead to the reduction of time and internal resources allocated to environmental actions. It also has its own authorized storage spaces, with a storage area of over 1,000 square meters [18].

ECO TOTAL obtained the certification of the quality management system, environment and occupational health and safety: ISO 9001: 2008 - SR EN ISO 9001: 2008; ISO 14001:

2004 - SR EN ISO 14001: 2005; OHSAS 18001: 2007 - SR OHSAS 18001: 2008 [18].
The development of socio-economic systems and industrialization has a significant negative impact on components of ecological systems. In order to predict the effects of these pressures, the use of models is necessary as a decision support tool.

## CONCLUSIONS

The best way to reduce the impact of waste on the environment is to prevent its occurrence.
The attitude towards waste production and management differs from country to country or even within the same state. In some countries, a hierarchy of preferential waste management options has been developed and adopted at four distinct levels: the prevention of waste production is preferable to recycling; recycling is preferable to incineration; incineration is preferable to storage; storage and control of the evolution of deposits is preferable to uncontrolled emissions.
Some measures to prevent the generation of agricultural waste is the following: efficient use of agricultural resources; promoting research and development in order to achieve agricultural raw materials and products through sustainable technologies and the distribution of research and development results; promoting the eco-design by systematically integrating environmental aspects into the projection of agricultural products, etc.
Integrated management of waste in the economic and social process, according to the concept of sustainable development is the effective support of material and energetic capitalization of the waste. Efficient waste management starts from the awareness of each person to respect the environment, by proceeding to a separate collection of waste, to its recycling and finally, to improve their own living conditions.

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