

Methods for ensuring the processing and disposal of agricultural waste

Dmitry Rudoy^{1,2}, *Mary Odabashyan*¹, *Anastasiya Olshevskaya*¹, *Alexander Rybak*¹, *Daniil Kovalchuk*¹, *Natalya Kulikova*¹, *Alexey Prutskov*¹, and *Dzhuletta Sarkisian*¹

¹ Don State Technical University, Gagarin sq. 1, Rostov-on-Don, 344003, Russia

² Agricultural Research Centre “Donskoy”, Lenin Str., 14, Zernograd, Rostov Region, 347740, Russia

Abstract. Nowadays, the issue of processing and disposal of agricultural waste is becoming increasingly relevant. Agriculture has a serious impact on the environment, and pollution from waste from poultry and livestock farms is often associated with imperfect technologies and equipment used, as well as non-compliance with environmental standards. The purpose of this article is to explore effective ways to process and dispose of agricultural waste. We will look at different methods of recycling and recycling agricultural waste, and also offer recommendations for optimizing this process. Keywords. Agricultural waste, recycling technologies, waste processing, livestock waste, crop waste, pesticide disposal.

1 Introduction

Agriculture creates a greater impact on the natural environment than any other branch of the national economy. Environmental pollution by poultry and livestock enterprises most often occurs due to imperfections in the technologies and technical means used, non-compliance with established environmental requirements.

One of the main problems is that if agricultural waste (be it animal corpses or something else) is not disposed of properly, it can have a negative impact on the environment, as is the case with other types of waste. Chemicals such as pesticides that are used in agriculture, if they end up in the wrong place, can also cause significant environmental damage. They pollute not only the soil, but also the air and groundwater.

Agricultural waste can be dealt with by implementing a waste management system that includes waste reduction, reuse, recycling and safe disposal. Compliance with relevant laws and regulations is also key to ensuring responsible waste management. The decomposition time of agricultural waste varies depending on the type of waste and environmental conditions. For example, the decomposition of plant residues in a compost heap can take from several weeks to several months, while the decomposition of some types of plastic used in agriculture in the environment can take hundreds of years.

Agricultural waste is by-products generated as a result of agricultural activities. They may include waste from crop production, animal husbandry and the processing industry.

Waste from crop production:

leaves and stems of plants;

waste from harvesting (e.g. husk or peel);

Straw and other crop residues.

Animal husbandry waste:

manure and manure;

leftover feed and litter;

products obtained from the processing of animal waste (for example, meat and bone meal).

Waste from the processing industry:

pulp and bard in the sugar industry;

beer pellet in brewing;

waste products from the production of vegetable oils and others.

Agricultural waste can pose a danger to the environment if it is not disposed of properly. Therefore, it is important to recycle or destroy them correctly in order to prevent contamination of soil, water and air.

The growing population growth requires an increase in agricultural production. It is believed that agricultural production has more than tripled over the past five decades.

Agricultural waste can pose a danger to the environment. Improper disposal of such waste can lead to contamination of soil, water and air.

Animal waste, such as manure and manure, contains organic compounds, pathogens and salts. If handled incorrectly, they can become a source of pollution of reservoirs and groundwater, as well as contribute to the spread of infectious diseases.

Crop waste, such as leaves and plant stems, may contain pesticides and other chemicals that have been used to protect plants from pests and diseases. If improperly disposed of, they can lead to the accumulation of these substances in the soil and water.

Waste from the processing industry, such as pulp and bard in the sugar industry, can also be a source of environmental pollution if they are improperly disposed of.

Therefore, it is important to properly recycle or destroy agricultural waste in order to prevent environmental pollution and preserve natural resources.

The easiest way to reduce the negative impact on nature is the modernization and updating of technological equipment in departments, making changes to the organization of economic activities that comply with modern environmental standards. The agro-industrial sector of the economy has a greater impact on the environmental situation than other sectors. Today, the environment suffers from residues of fertilizers, pesticides and undecomposed agricultural waste. Untimely processing of this waste leads to negative consequences for the environment and leads to a detrimental effect not only on the environment, but also on the industry itself. Every year, according to the Federal Service for Supervision of Natural Resources, the generation of production and consumption waste from agriculture and fisheries averages 46,096.7 thousand tons. On the one hand, this creates serious sanitary and environmental problems, since almost half of all waste is manure and droppings from farm animals, but they are also an important raw material for the production of organic fertilizers. This makes it possible to create a new industry for the production of organic fertilizers based on these resources.

2 Materials and methods

Cutting-edge methods for managing and treating poultry and livestock waste now incorporate VacuumEcoDry technology, which operates through a three-stage process. This innovative technology produces dry organic fertilizer, low-moisture content feed and fuel suitable for direct use as a fertilizer, protein feed supplement for animals, or fuel source. It also yields reusable water and environmentally-friendly exhaust. Vacuum drying takes place in a controlled environment with specific temperature and pressure parameters, utilizing various energy sources such as electricity, natural gas, or waste heat. The system efficiently processes

the initial waste material by drying it in a vacuum chamber, separating it into distinct components, and producing a high-quality final product that can be further processed for various applications. By employing these advanced technological solutions, a sustainable and emission-free process is established for treating different types of animal waste, such as pig and cattle manure with high moisture content [1-9].

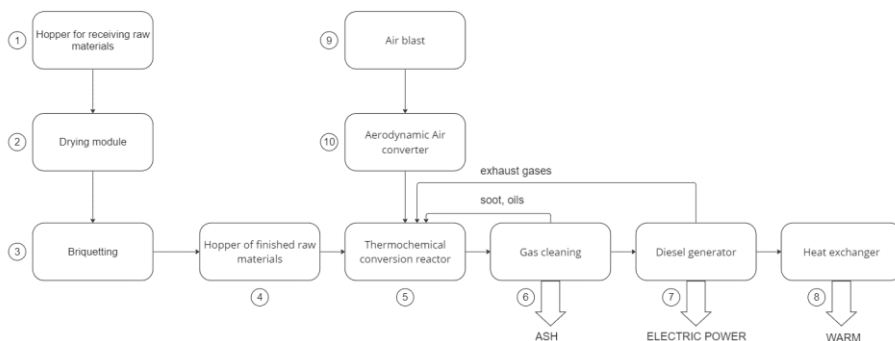


Fig.1. Plant concept for poultry and livestock waste treatment

The manure processing process is as follows: automatic weighing of manure on a weighing platform in front of the receiving hatch. The waste is then fed by a sluice feeder into the drying module, where a vacuum heater and a liquid ring pump remove moisture (18%). The heated and dried manure is pumped by a screw pump into a high-temperature heater, where it is heated to 2240 °C. The manure then enters the tank through the throttle valve, where the remaining moisture evaporates as the pressure decreases (23%). The released saturated steam is utilized in a vacuum heater, where it condenses and cools to 600 °C. The dried manure is unloaded by a sluice feeder into the flow of the drying agent (flue gases) and sent by pneumatic transport to the roller dryer.

Upon completion of the drying process, the manure undergoes briquetting and is then directed into a designated storage bunker with a capacity of 75 m³. The briquetted raw materials are subsequently transported to specialized thermochemical conversion reactors for the production of combustible gas. The resulting steam-gas mixture is channeled into a vortex gas purification apparatus, where it undergoes thorough cleansing to remove vapors, ash, and oils. Subsequently, the purified gas is cooled to 40 °C in a heat exchanger before being fed into diesel generators to generate electricity. The ash residue produced during the conversion process is automatically extracted at a temperature range of 100–120 °C and is processed in an electromagnetic activation device to separate any metal impurities. The segregated ash and metals are then directed to storage containers with a capacity of 1 m³.

Diagram 2 illustrates a reactor designed for rapid, high-temperature conversion featuring air supply and reverse gas extraction mechanisms: 1 - Hydraulic press for raw material provision; 2 - Detachable reactor cover; 3 - Air blowing tuyeres; 4 - Hydraulic press for efficient operation.

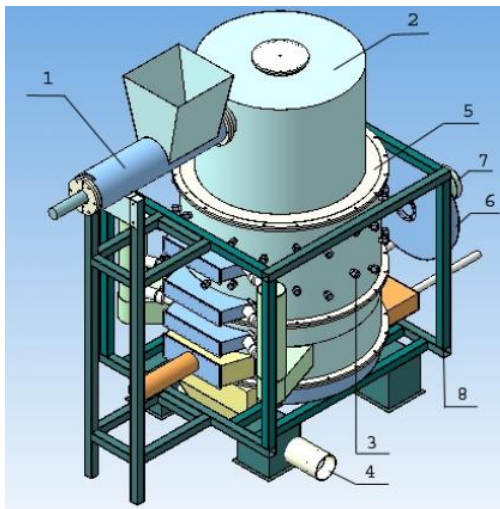


Fig.2. Reactor for high-speed and high-temperature conversion with air supply and reverse gas extraction: 1 - Hydraulic press for raw material supply; 2 - Removable reactor cover; 3 - Blowing tuyeres; 4 - Hydraulic press for ash selection; 5 - Reactor vessel; 6 - Flow fan; 7 - Aerodynamic converter; 8 - Frame.

Modern systems being developed for the disposal of crop waste must be highly efficient and mobile to meet the requirements of various agricultural enterprises. These systems vary in thermal efficiency, raw material and air supply methods, method of unloading processed products, waste gas composition, degree of automation, cost of production and energy generation [6].

Table 1. Main characteristics of recovery furnaces currently in use.

Type of oven	With inclined grate and cylindrical combustion chamber	Constantly fed with cyclonic combustion chamber	IRRI oven without grate
Application options	Small size dryers (4-20 tons per cycle)	High performance suspended bed dryer	High performance suspended bed dryer
Cost of investment	4 – 6	14	4 – 7
Pros of installation	Easy to use, low maintenance cost	Automatic and continuous operation	Automatic and continuous operation
Installation Cons	Requires large labor resources	Low efficiency and high maintenance costs	Low efficiency

The main difficulties in recycling crop waste are associated with harmful emissions, the high cost of waste gas purification and the need to ensure efficient and reliable operation of equipment. Innovative recycling methods make it possible to obtain gaseous or liquid fuel, as well as a valuable ash product containing amorphous carbon and amorphous silica. There are several types of moving bed gasifiers, presented in a conceptual diagram, that are currently in use [6] (Fig. 3).

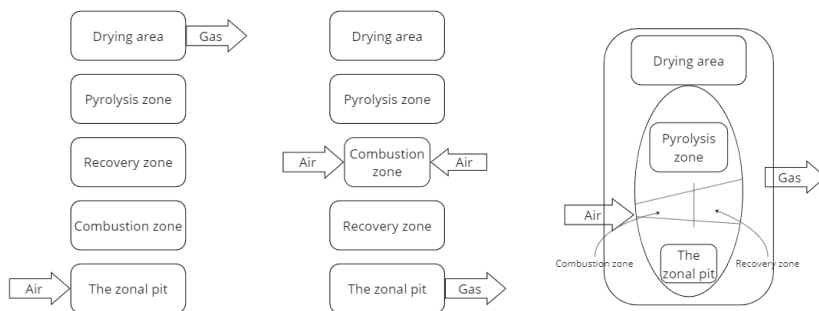


Fig.3. Conceptual model of different types of moving bed gas generators.

Gasification progresses in a two-step process: first, pyrolysis at temperatures between 400-600°C leads to the creation of pyrolysis gas, tar, liquid fuel, and carbonized rice husks, followed by gas synthesis at temperatures of 800-1000°C. The properties of the resulting products are determined by reactor conditions (temperature, pressure, duration), the design of the gas generator, the presence of activators, and quality requirements.

Utilizing the generated gases for energy production has environmental implications. A purification facility can cost up to \$400 per kilowatt of power generated and consumes approximately 2 liters of water per kilowatt-hour. The resin produced during pyrolysis is deemed carcinogenic, impacting the functioning of the facility.

In Russia, the Ustyuzhensky Carbon Plant has devised a basic furnace setup utilizing a cyclone-vortex combustion chamber for livestock waste and municipal solid waste disposal. However, this retort furnace system is not designed for crop waste disposal. Mobility and compact versions are unavailable from manufacturers, and the existence of a chimney suggests potential emissions of harmful substances into the air.



Fig.4. External view of the installation of the Ustyuzhensky carbon plant

In contrast to screw or retort pyrolysis technologies, the New Technologies company in Yaroslavl uses an innovative method based on a thermal destruction turbojet reactor using a microwave plasmatron. As a result, a high-calorie synthetic gas is formed, which is 2-3 times higher than conventional pyrolysis gas, for example, produced by the installation of the PirolizEko company in Kolomna. The developed system for purifying synthetic gas allows it to be used in a gas piston engine to produce electricity, ensuring the autonomy of the installation in container and mobile versions [6].

Reducing emissions of harmful substances into the atmosphere, such as CO, NOx and unburned hydrocarbons, is achieved through the use of efficient vortex counterflow combustion chambers capable of burning emissions after the drying unit and pyrolysis gas, providing energy recovery [6].

The KUPO-2 recycling plant, created by the PyrolizEko company, is designed for processing and disposal of crop waste using the method of low-temperature fast pyrolysis. It has such advantages as an optimal price-performance ratio, mobility, autonomous operation without external energy sources, obtaining energy from waste, environmental safety, high profitability and quick payback, as well as simplicity of design [6].

Technical features and characteristics of some Russian installations presented for comparison are listed in Table 2.

Table 2. Comparison of characteristics of Russian installations for recycling crop waste.

Technical characteristics of installations	Installation "PirolizEco"	Installation of UUS	Installation "New technologies"	Installation "RHAT100"
Raw material consumption (t/hour)	2	0,5	2	0,1
Reactor type	Screw with fast pyrolysis	Furnace with distributed blast zones	Turbojet with plasmatron	Screw, low temperature with activator
Dimensions (LxWxH mm)	8000x2000x3000 (two containers)	12000x5000x5000	6000x3000x3000	8000x3000x3000
Power consumption (kW)	15	15	До 55	< 6
Production volume (t/hour)	0,35 (16% in terms of 50/50 SiO ₂ and C)	-	0,5	0,02 (80-90% SiO ₂) – 0,04 (50/50 SiO ₂ and C)
Amount of pyrolysis or synthetic gas at the outlet (% by weight of raw materials)	25-35	Up to 30	Up to 70	30-50
Environmental safety	Low emissions	Insufficient	Low emissions, environmentally certified	Sufficient, there is a unique gas afterburning system
Specifics of the structure of the structure	Mobile, providing your own heat energy needs	Stationary, combustion of pyrolysis product in a cyclone burner	Electricity generation, additional biogas and biofuel storage units	Adjustable performance, different products on one equipment, autonomy and mobility

An important problem is the disposal and decontamination of pesticides, since improper disposal results in contamination that causes serious harm to the soil, water and humans as well. In addition to the pesticides themselves, an equally important issue is the disposal of pesticide containers; due to the residues of pesticides, it poses no less a threat than the toxic substances themselves.

Disposal of pesticides occurs by organizing large containers in the ground with thick concrete walls to place poisons there, but this method has shown little effectiveness, since due to violations of technology, destruction under the influence of time and vandalism,

sarcophagi began to become unusable. They began to seep into the soil and enter groundwater, which began to lead to the formation of new chemical compounds that are even more toxic and cause enormous damage to the health of aquatic organisms, cattle and people. This began to cause various skin and pulmonary diseases, causing severe allergies. Burials cannot completely solve the problem; only proper disposal and disinfection of pesticides and agrochemicals can save nature and people.

There are some ways to effectively dispose of pesticides:

- Biological: Biological decomposition – involves the use of special types of bacteria.
- Chemical: Decontamination through the use of chlorine
- Thermal: By combustion

Let's look at each method in more detail.

Bacteria, actinomycetes, fungi and higher plants decompose the active ingredients of pesticides. The decomposition time of pesticides by microorganisms can vary from several years to tens of years and depends on the characteristics of the active substance, types of microorganisms and soil characteristics. However, there is insufficient information on how soil microorganisms degrade modern groups of pesticides.

The process of decontaminating pesticides with chlorine includes the following steps:

1. Mixing pesticides with water to obtain a solution of the desired concentration.
2. Addition of chlorine or other oxidizing agent to activate the decontamination process.
3. Stirring the mixture to evenly distribute the reagents and ensure contact between the pesticides and the oxidizing agent.
4. Keeping the mixture for a certain time necessary for the chemical reaction to occur and the pesticides to be decontaminated.
5. Separation of treated water from solid residues of pesticides and other pollutants.
6. Purification and filtration of water to remove residual reaction products and achieve the required quality standards.

After the decontamination process is completed, the purified water can be returned to the environment or used for technical needs.

Food waste is an important source of solid agricultural waste. Therefore, preventing food waste at all levels before it is generated will save some of this waste and prevent unnecessary deterioration of health and the environment, as well as huge economic losses. This can be achieved through proper education and awareness of those involved in agricultural activities at all levels, as well as by being a little more generous and feeding the hungry with fresh food, instead of storing them until they spoil.

The treatment and disposal of agricultural waste is crucial for environmental sustainability and resource management. Here are some methods that are commonly used:

1. Composting: Agricultural waste such as crop residues, manure and leftover plant material can be composted to create nutrient-rich amendments to the soil. This process involves decomposition by microorganisms under controlled conditions, creating compost that can be used to enrich soil fertility.

2. Anaerobic digestion: This process involves the destruction of organic materials in the absence of oxygen, producing biogas (a mixture of methane and carbon dioxide) and rich in nutrients. Biogas can be used as a source of renewable energy, while digestate can be used as a fertilizer.

3. Biomass conversion: Agricultural waste can be converted into biofuels or bioenergy through processes such as pyrolysis, gasification or fermentation. These technologies can produce renewable energy sources such as bioethanol, biodiesel or biogas, reducing dependence on fossil fuels.

4. Animal feed: Some agricultural waste, such as crop residues and by-products, can be used as animal feed after proper processing. This reduces the demand for traditional feed sources and provides a sustainable way to manage waste.

5. Incineration: Although it is less environmentally friendly due to air pollution problems, incineration can be used to recycle agricultural waste when expressing energy. Advanced combustion technologies can help minimize emissions and maximize energy recovery.

6. Landfill: This is often considered the least desirable option due to its potential for environmental pollution and lack of resource recovery. However, in some cases where other methods are not feasible, agricultural waste can be sent to landfill sites that are properly managed to minimize environmental impacts.

7. Biochar production: Agricultural waste can be converted into biochar through a process called pyrolysis. BioChar is a stable form of carbon that can improve soil quality and sequester carbon by mitigating climate change, providing valuable soil correction.

8. Integrated Pest Management (IPM): Implementing IPM practices can help reduce agricultural waste by minimizing the need for chemical pesticides and fertilizers. This approach focuses on preventing outbreaks of pests and diseases through cultural, biological and mechanical methods, thereby reducing waste associated with chemical inputs.

9. Government policies and regulations: Governments can play an important role in promoting sustainable waste management practices through regulations, incentives and subsidies. Encouraging waste reduction, recycling and the adoption of cleaner technologies can help mitigate the environmental impact of agricultural waste.

In general, the recycling of agricultural production waste offers environmental benefits by reducing greenhouse gas emissions, minimizing pollution and increasing resource efficiency in the agricultural sector.

3 Conclusion

In conclusion, we can say that the processing and disposal of agricultural waste are important tasks for preserving the environment and rational use of natural resources. The introduction of low-waste and non-waste technologies, as well as modern methods of waste processing, makes it possible to reduce the negative impact on the environment, reduce the consumption of primary raw materials and reduce air, water and soil pollution.

Effective management of agricultural waste requires a combination of strategies tailored to the specific types of waste generated, local environmental regulations and available resources. In addition, raising awareness among farmers about the importance of waste management and supporting the implementation of sustainable practices is an important step to reduce the ecological presence of agriculture.

By using these methods in combination with sustainable agricultural practices, we can effectively manage and minimize the environmental impact of agricultural waste.

Various methods of processing and disposal of agricultural waste provide huge opportunities to improve the quality of products, as well as to prevent irreparable harm to the environment. At the moment, all areas of production have put human health and life at risk, and their further uncontrolled activities can lead to irreversible consequences in the biosphere as a whole. The development of science and technology can prevent further harmful effects on the biosphere. The use of low-waste and waste-free production has a positive impact on the entire sphere of agriculture and not only. The creation of closed production cycles is the highest priority area of development. Recycling of agricultural waste is a more productive method of disposal.

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