

Integrated regenerative practices for resource utilization of waste generated in the production and processing of products in agriculture and forestry

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Abstract : *The aim of this report is to demonstrate feasible regenerative practices in accordance with the requirements underlying the EC regulations and the package of measures introduced in December 2015 to implement the "circular economy". The reviewed regenerative practices achieve the principles of resource restoration, introduction of integrated production practices for soil regeneration and recarbonization. The ecological importance and control of soil microorganisms, the retention and restoration of soil moisture to ensure sustainable soil fertility is shown.*

KEYWORDS: CIRCULAR ECONOMY, INTEGRATED PRACTICES, SOIL QUALITY, COMPOST, BIOCHAR, GREEN BIOMASS.

1. Introduction.

One of the strategic directions enshrined in the plans developed at the national and EU levels for the next programming period until 2030 is ensuring the nutrition of the population and adapting to and overcoming the consequences of climate change, for which the so-called integrated practices and the circular economy are being developed and introduced into practice [6].

The main problem in our national practice stems from the lack of implementation of innovative and socially acceptable approaches for the utilization of generated biodegradable waste for the regeneration of basic elements of the environment, the annual quantities of which are estimated at over 9 million tons as resources, through integrated, decentralized and decarbonized practices for the retention and storage of organic carbon in soils (BioCCS practices), generation of alternative energy, analysis and evaluation of low-carbon innovative global practices for their feasibility in the conditions of Bulgaria and the construction of regional decentralized systems for the individual regions of Bulgaria.

The expected public benefits from the introduction of low-carbon practices for the recovery of biodegradable waste have multidirectional dimensions: management and resource recovery of biodegradable waste through decentralized systems, protection of public health and reduction of emissions polluting the atmosphere, sharp reduction of public costs in the waste collection, waste transportation and landfilling system and optimization of costs for the population, restoration of basic nutritional and structural elements in the soils and their recarbonization. The achieved results will be directly measurable by the reduced public costs, the saved funds of households, the restored and improved qualities of basic elements of the environment - soils, waters and air. Possible forms of integrated practices for decentralized resource recovery are:

The introduction of decentralized urban sites for resource utilization of biodegradable waste near the place of its creation through high-tech composting practices using mobile modern systems for activated composting will greatly help solve the tasks arising from the concepts adopted by the EC for the introduction of territorial circular economies at fair and acceptable prices for the population of the Republic of Bulgaria [1,2,3,5].

The implementation of decentralized settlement sites will provide the opportunity within settlements, on livestock farms or near enterprises for the production and processing of agricultural and forestry products to directly utilize biodegradable waste through a composting system and obtain a final compost product with guaranteed sanitary and hygienic qualities in accordance with the requirements of REG "CE" [4], as well as achieving a complex of integrated results such as: decentralized utilization of biodegradable waste, restoration of soil fertility, ensuring moisture retention in soils and overcoming droughts, limiting subsoil pollution and groundwater pollution, etc.

Considering the input streams for composting: biodegradable waste, including "green waste" from green municipal areas, the quality requirements and especially the sanitary requirements arising from the new EU rules for the processing of biological waste into raw materials that can be used for fertilization, in view of the principles of implementing circular economies and resource utilization of waste through the group of products with the "CE" marking with uniform qualities for all EU manufacturers, a combined composting scheme was chosen consisting of two closed reactors for accelerated thermophilic sanitation and an open site for compost stabilization.

One of the main priorities set out in the EU Framework for Rural Development Programmes [5] is to promote knowledge transfer and innovation in agriculture and forestry and in rural areas and to promote the efficient use of resources, supporting the transition to a low-carbon and climate-resilient economy in agriculture, forestry and the food sector.

In world practice, for decades, technical systems for the utilization of biodegradable agricultural waste (BAW) have been created, developed and found multi-purpose application through integrated decentralized systems based on thermal methods based on a pyrolysis process controllable within wide temperature limits.

One of the significant advantages of utilizing biodegradable agricultural waste (BAW) through gasification and controlled pyrolysis is the integrated resource utilization for obtaining energy and biological charcoal, for which both global and European standards exist and have been introduced as mandatory for their practical use.

Currently, there is no national regulatory framework for the disposal and processing of NPT in our country. In 2015, Regulation No. 20 of 10.02.2006 was repealed, adapting Regulation (EC) No. 1069/2009 of 21 October 2009 [4], which introduces strict requirements for animal by-products not intended for human consumption, into Bulgarian practice. Microbiological studies of soils from areas adjacent to poultry farms show the presence of: saprophytic bacterial microflora, mold fungi, E. coli, salmonella, etc.

A conceptual design of a plant for pyrolysis of NPT, generation of heat energy and production of biochar at the poultry farm level has been developed. The energy will be used for heating the farms themselves, and the biochar will be sold on the market as a soil improver. The technology used protects the environment to the maximum extent: it neutralizes dangerous biological waste. Biochar is an excellent means of improving the pH of acidic soils, improves soil aeration, contains trace elements and can serve as a biological soil improver. It can fix ammonia from the air up to 5%, thereby contributing to nitrogen fertilization of soils and reducing greenhouse gases. **Of course, the application of all composts and biochar must comply with the requirements for balanced soil fertilization to achieve maximum efficiency [5].**

2. Problem discussions.

The applied composting technology with the use of a developed series of composting activators allows to intensify the process, increase the efficiency of the installation and the resulting final product - compost to be used directly both as a soil improver and as a growth stimulator for fertilization, restoration of disturbed terrain, creation and development of green areas, reclamation and other municipal activities.

The principal spatial arrangement of the described composting site is shown in Fig. 1. The following Fig. 2 shows a schematic diagram for activated composting in a closed reactor for the implementation of technological schemes, methods and equipment in accordance with the requirements of REG "CE" [4].

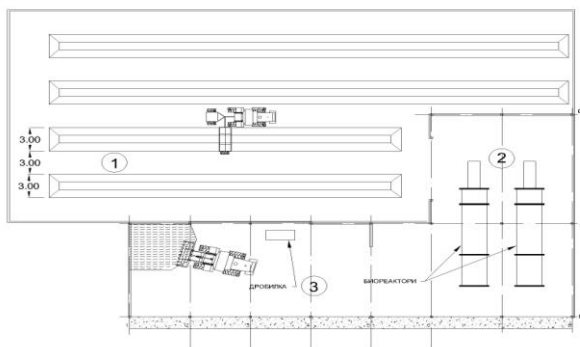


Fig.1. Activated composting site

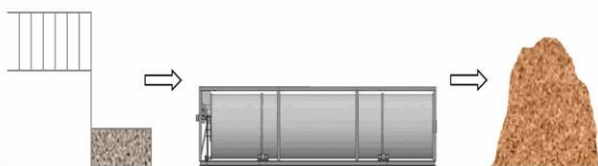


Fig. 2. Schematic diagram for activated composting in a closed reactor for the implementation of technological schemes, methods and equipment according to the requirements of REG "CE"

A series of composting activators have been developed and are being applied. The main eco and bio advantages of *Trichoderma harzianum* used as an inoculant - activator of the composting process are:

Increases the productivity of the microorganism-soil-plant system through eco-biologically acceptable methods;

Stimulates the natural increase of humus in the substrate-soil and kills soil pathogens;

Increases root and above-ground biomass, increases the number and intensity of flowers, increases the yield of green mass, etc.



Fig. 3. Produced activators for the activated composting process in a closed reactor [7],[8].

The action of the considered composting activators includes:

Mycoparasitism: produces enzymes such as chitinases, gluconases, peptidases, lytic enzymes, etc.;

Production of antifungal and antibacterial antibiotics, glitoxin, glioverin, trichocetene, cyclic peptides, isocyanides, T-2 toxin, trichodermin which suppress the development of fungal and bacterial pathogens;

Extremely competitive for space, nutrients and thus suppresses the growth of soil pathogens;

Stress tolerant;

Consistently dissolves inorganic nutrients;

Induces resistance;

Inactivates pathogenic enzymes;

It is active against the following diseases and pathogens: *Ganoderma spp.*, *Fusarium spp.*, *Rhizoctonia solani*, *Pitium spp.*, *Botritis cinerea*, *Sclerotium spp.*, *Sclerotia spp.*, *Rosellinia spp.*, *Phitophthora spp.*, *Macrominia spp.*, *Verticilium spp.*, *Erwinia spp.*, *Seeding rot*, *Roots rot*, etc.;

Utilization of biodegradable (BW) waste from agriculture and forestry by applying thermal methods includes integrated decentralized systems based on thermal methods based on a pyrolysis process controllable in wide temperature ranges. The pyrolysis process is carried out in a hermetically sealed reactor, in which the raw material is homogenized and decomposed. A characteristic feature of pyrolysis reactors is the high degree of hermeticity, with special attention paid to the charging device and the device for removing the pyrolysis residue. Fig. 4. shows a schematic diagram of a pyrolysis installation with a horizontal chamber.

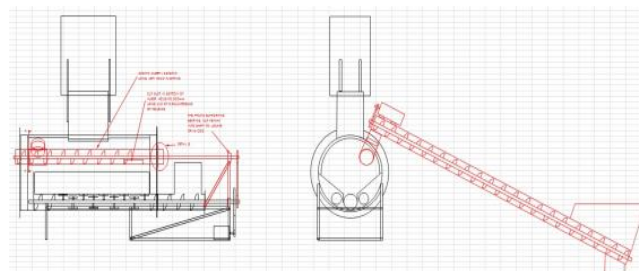


Fig.4. Schematic diagram of a pyrolysis installation with a horizontal chamber

Utilization of organic waste from poultry farming through a pyrolysis integrated project for the production of heat and biological charcoal.

The trend in the EU and in our country is to raise broilers, specially selected for rapid growth, in closed and strictly controlled systems of barns. They work with bedding on the floor, automated provision of water and food, and maintenance of temperature, humidity, etc. elements of the microclimate in the individual working rooms. In Bulgaria, more than 60,000 tons of organic waste are generated annually from broiler production. Below in the presentation, we will call this waste Unprocessed Chicken Manure - NPT. The technological scheme of the installation for combined production of heat energy and biological charcoal, through pyrolysis of NPT is shown in Fig.5[1]

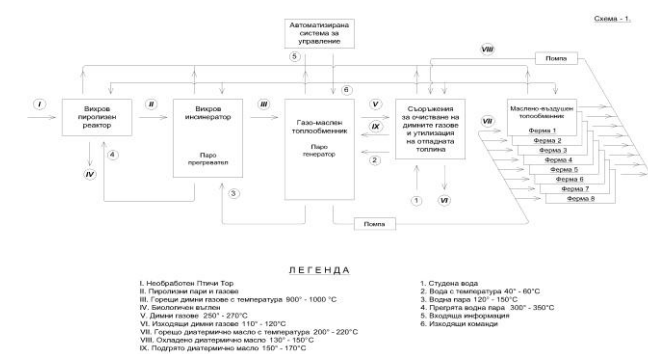


Fig.5 Principle technological scheme for combined heat and power generation and biochar.

3.Results and discussion.

The introduction of the considered **integrated practices for decentralized resource utilization of biodegradable waste will demonstrate:**

- On the one hand, the utilization of biodegradable waste through appropriately selected technological and technical solutions will meet the goals of limiting their quantities destined for landfill. The resulting products will be used in practices for the protection of basic components of the environment.
- On the other hand, through their carbonization and composting and subsequent application of the resulting products together with microbiological fertilizers in the soil, carbon capture and storage will be achieved for a significant period and a significant reduction in the emissions generated polluting the atmosphere from land use and biodegradable waste.
- Thirdly, the products used will improve a number of important elements of soil fertility: increasing the content and accessibility of nutrients, improving soil structure (this in turn contributes to reducing soil erosion and improving moisture retention), soil microflora, etc., which will guarantee soil fertility for a long period in conditions of climate change and possible drought in our country.
- Fourthly, but not least, with the introduction of a system of low-carbon practices, conditions will be created for the introduction of decentralized, decarbonized systems for the production of alternative energy using waste as resources.
- Fifthly, when implementing the application of different variants of compost and biochar, it is necessary to strictly comply with the requirements for balanced soil fertilization in order to achieve maximum efficiency [5].

5. Literature

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