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MANAGEMENT AND VALORIZATION OF WASTE GENERATED FROM AGRICULTURAL ACTIVITIES

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Abstract: The improper management of waste generated from agricultural activities can significantly affect enviromental quality through soil degradation, water contamination, atmospheric emissions, and the inefficient use of natural resources. Consequentely, identifying effective waste treatment and valorization strategies has become an essential component of sustainable agricultural development. The objective of this paper is to examine the environmental challenges associated with agricultural waste and evaluate the effectiveness of available management technologies in reducing their negative impacts. The research methodology involves a systematic examination of scientific studies, environmental assessments, and European legislative frameworks related to agriculture waste treatment and resource recovery. Particular emphasis is placed on the comparison of composting, anaerobic digestion, biological treatment, and biomass-based energy production. The degree of novelty is represented by the combined assessment of these technologies according to their environmental benefits, technological requirements, and potential contribuition to agricultural sustainability. Existing scientific evidence suggests that appropriate waste valorization methods can reduce uncontrolled decomposition limit cetain pollutant emissions, recover valuable nutrients, and support renewable energy generation. However, the environmental efficiency of these technologies varies depending on operational conditions, waste characteristics, and available infrastructure. The limitations of this research include the absence of experimental investigations and the dependence on previously published data. The findings highlight the importance of selecting appropriate treatment methods based on local environmental and agricultural conditions. The study contributes to a better understanding of sustainable agricultural waste management and emphasizes the relevance of technological innovation and integrated waste treatment approaches in minimizing agricultural pollution.
Keywords: Agricultural waste management; Waste valorization; Environmental impact; Waste treatment technologies; Resource recovery; Sustainable agriculture.

• Introduction

Agricultural activites generate crop residues (strow, husles and stalkes), livestock manuare, and organic by-products from processing. When these streams are burned, dumped or poorly stored, they may cause emissions, nutrient losses and contamination (1,2).
Circular- economy approaches treat these materials as resourcees: soil amendaments, bioenergy and carbon-rich products can partially replace virgin.

Objective: Compare four valorization routes by environmental performance, recovered valued and technical feasibility

• Material and method

A structured literature review and qualitative comparative analysis wew used. Peer-reviewed studies, environmental assessments and selected European institutional reports, mainly from 2020-2026, were identified trough Google Scholar, SienceDirect ans SpringerLink. Sources were selected for methodological clarity and relevance to residue treatment, resource recovery or environmental effects.

RESEARCH WORKFLOW

01 **Literature and EU evidance** → 02 **Three agricultural waste streams** → 03 **Four treatments technologies** → 04 **Qualitative comparison**

WASTE STREAMS

Crop residues | **Livestock manure** | **Processing by-products**

COMPARISTON CRITERIA

- **Feedstock suitability**
- **Pollution and emissions**
- **Nutrient / material value**
- **Resource / energy recovery**
- **Technological requirements**
- **Local implementation limits**

Study limitation
Secondary literature only; no laboratory trials, pooled effect-size estmates or site-specific life-cycle calculation were performed.

• Results and discussions

The literature identifies four complementary conversion routes, with benefits and limitations that depend on residue type and operating conditions (2-4).

Pathway	Feedstock / output	Potential value	Conditions / risk
COMPOSTING	Moist, biodegradable solids, compost	Returns organic matter and nutrients to soil	Aeration, moisture and process maturity
ANAEROBIC DIGESTION	Manure / wet organics;. biogas and digestate	Bioenergy plus possible nutrient recovery	Gas containment, feel quality and digestate use
PYROLYSIS	Relatively dry crop residues; biochar, oil and gas	Carbon-rich material and energy co-products	Heat input, biochart quality and emissions
GASIFICATION	Dry lignocellulosic residues; syngas	Fuel gas for useful heat or electricity	Drying, tar removal and plant complexity

INTERPRETATION Biological tratment generally suits wetter inputs; thermochimical routes usually favor drier biomass. No pathway is universally superior (1-4).

• Conclusions

- Agricultural residues can supply soil amendaments, recyclable nutrients and renewableenergy products.
- Feedstock properties, process controls and local infrastructure determine environmental performance.
- Site-specific life-cycle, economic and product-safety studies are needed before scaling up.