INTERNATIONAL JOURNAL OF TECHNOLOGY AND ACADEMIC RESEARCH

ISSN: 2224-6878 | Pakistan Volume 6, No. 10.

IF: 14.91 | 2026 http://waerasia.org/index.php/ijtar

RECYCLING AGRICULTURAL WASTE TO IMPROVE SOIL FERTILITY AND REDUCE NEGATIVE ENVIRONMENTAL IMPACTS

Savriddinov Ibratjon Ikrom o'g'li
Email: savriddinovibratjon@gmail.com
doi:**https://doi.org/10.5281/zenodo.23361115**

Abstract. This study provides a comparative theoretical analysis of agricultural waste conversion into soil amendments under the conditions of Uzbekistan. Crop residues, livestock manure and biodegradable farm by-products are evaluated as feedstocks for composting, vermicomposting, residue recycling and anaerobic digestion. Documentary analysis of local agronomic publications, Uzbek regulations and FAO materials identifies opportunities to replenish soil organic matter, recycle nutrients and avoid poorly managed waste disposal. The article develops an integrated implementation framework emphasizing source separation, process maturity, laboratory safety checks, nutrient planning and field monitoring. The findings represent evidence-based synthesis, not an original field trial; therefore, no unsupported yield or carbon-sequestration results are presented.
Keywords: agricultural waste, composting, vermicompost, soil organic matter, nutrient recycling, soil fertility, Uzbekistan, environmental protection.

QISHLOQ XO‘JALIGI CHIQINDILARINI QAYTA ISHLASH ORQALI TUPROQ UNUMDORLIGINI OSHIRISH VA ATROF-MUHITGA SALBIY TA’SIRNI KAMAYTIRISH

Annotatsiya. Maqolada qishloq xo‘jaligi chiqindilarini kompost, vermikompost va boshqa tuproq uchun foydali mahsulotlarga aylantirish usullari O‘zbekiston sharoitida tahlil qilinadi. Mahalliy tadqiqotlar va me’yoriy hujjatlar asosida organik modda muvozanati, oziqa elementlarini qaytarish va ekologik xavflarni kamaytirish imkoniyatlari baholanadi. Saralash, texnologik nazorat, laborator xavfsizlik va dala sinovlari zarurligi ko‘rsatib beriladi.
Kalit so‘zlar: qishloq xo‘jaligi chiqindilari, kompost, biogumus, tuproq unumdorligi, organik modda, ekologiya, O‘zbekiston.

ПЕРЕРАБОТКА СЕЛЬСКОХОЗЯЙСТВЕННЫХ ОТХОДОВ ДЛЯ ПОВЫШЕНИЯ ПЛОДОРОДИЯ ПОЧВ И СНИЖЕНИЯ НЕГАТИВНОГО ВОЗДЕЙСТВИЯ НА ОКРУЖАЮЩУЮ СРЕДУ

Аннотация. В статье рассматриваются способы превращения растительных остатков и животноводческих отходов в почвенные улучшители в условиях Узбекистана. На основе научных публикаций и нормативных документов сопоставляются компостирование, вермикомпостирование и другие методы переработки с учетом плодородия почв, круговорота питательных элементов и экологической безопасности. Обоснована необходимость лабораторного контроля готовых продуктов и проверки эффективности в полевых опытах.
Ключевые слова: сельскохозяйственные отходы, компост, биогумус, плодородие почв, органическое вещество, переработка, экология.

ISSN: 2224-6878 | Pakistan Volume 6, No. 10.

IF: 14.91 | 2026 http://waerasia.org/index.php/ijtar

INTRODUCTION

Agricultural development is accompanied by the accumulation of plant residues, cotton stalks, cereal straw, livestock manure and food-processing by-products. In the absence of an effective collection and processing system, recoverable nutrients may be lost through burning, dumping, runoff and uncontrolled degradation. Agricultural waste is therefore simultaneously an environmental management problem and a potential source of soil organic carbon and plant nutrients. The circular approach seeks to keep these materials within productive agricultural systems rather than treating them exclusively as waste.

In Uzbekistan, the relevance of residue recycling is heightened by arid climate, irrigation dependence, salinity and low organic matter in many cultivated soils. The Food and Agriculture Organization identifies organic matter additions, residue management and integrated nutrient management among the practices implemented in Uzbekistan's soil-carbon initiatives (1). The World Bank also emphasizes land degradation and the importance of protecting ecosystem functions, including soil retention and productive capacity (2). These conditions create an opportunity for science-based, locally adapted organic-input systems.

Historically, organic manure recovery in Uzbekistan has been incomplete, despite substantial potential for returning nutrients to cropland. FAO documentation notes that inadequate storage and handling can waste manure nutrients and contribute to environmental contamination (3). However, agricultural residues should not be applied indiscriminately: their safety and agronomic value depend on source, moisture, maturity, chemical composition and application rate. The objective of the present research is to synthesize the main processing routes, compare expected impacts and recommend an assessment methodology suitable for Uzbek agricultural systems.

LITERATURE REVIEW

Soil organic matter plays structural, biological and chemical roles. It contributes to aggregation, infiltration, moisture retention, nutrient supply and microbial activity. FAO technical guidance stresses that well-managed crop residues and compost can support these functions, whereas fresh carbon-rich residues may temporarily immobilize nitrogen during decomposition (4). Therefore, increasing biomass inputs is not equivalent to immediately increasing crop-available nutrients; timing and material stabilization are important.

Uzbekistan-oriented studies provide useful but heterogeneous evidence. Xoldorov and colleagues consider resource-saving, soil-protective agricultural practices and their implications for fertility and degradation control (5). Ismailov, Zinatdinov and Uzakova report the use of organo-mineral compost treatments for cotton grown on saline soils (6). Xalbayev investigates biohumus-containing substrates for rice germination (7). These studies illustrate promising uses but differ in scale, crops and indicators; consequently, results cannot be transferred directly from nursery substrates or individual plots to nationwide soil systems.

Legal and technical requirements establish a second dimension of the evidence base. The Law of Uzbekistan on Organic Products recognizes soil fertility preservation and the responsible utilization of renewable biological resources (8). National safety requirements for organic and organo-mineral fertilizers place importance on material origin and control of hazardous substances (9). Meanwhile, a spatial study of Uzbekistan by Khasanov and coauthors highlights salinity as a complex constraint that cannot be solved by adding organic fertilizer alone (10). Jointly, these sources call for a balanced agronomic and environmental evaluation.

ISSN: 2224-6878 | Pakistan Volume 6, No. 10.

IF: 14.91 | 2026 http://waerasia.org/index.php/ijtar

MATERIALS AND METHODS

The research was designed as a documentary review and comparative synthesis rather than an experiment with field plots. Ten publications and legal or technical documents were selected for direct relevance to soil fertility, Uzbekistan, agricultural organic inputs or environmental safeguards. The study compared waste streams and processing routes using four analytical dimensions: potential organic matter and nutrient recovery; expected soil functions; possible environmental benefits; and critical limitations or safety requirements.

Qualitative content analysis was applied to descriptions of composting, vermicomposting, residue retention and anaerobic treatment. Assertions about soil response were separated from recommended future measurements. The proposed monitoring protocol includes baseline and follow-up soil organic carbon, electrical conductivity, pH, bulk density, plant-available nutrients and crop yield. Amendment quality should additionally be assessed through moisture, C:N ratio, maturity, pathogen indicators and heavy-metal tests where relevant. A credible experimental design should include replicated controls and seasonal observations.

RESULTS

The synthesis identifies several practical waste-to-soil pathways with distinct suitability conditions. Composting of mixed crop residues and manure is a flexible approach for farms with access to water and space; maturity management reduces the risk of phytotoxicity. Vermicomposting can produce a fine-textured amendment from appropriate pre-stabilized inputs but is sensitive to temperature and feedstock composition. Residue retention protects soil surfaces and recycles biomass, yet may require adjusted nutrient management. Anaerobic digestion offers energy recovery alongside nutrient-rich digestate, which must still be safely stored and applied.

Table 1 summarizes the routes and illustrates the distinction between theoretical benefits and operating safeguards. The entries are based on documented mechanisms and regulatory considerations, not fabricated trial outcomes.

Table 1. Comparative assessment of agricultural waste recycling pathways

Input and method	Expected agronomic contribution	Main environmental consideration	Safeguard
Straw and residues: composting	Organic carbon return; improved aggregation	Can avoid open-field burning	Maturity, moisture and C:N control
Livestock manure: composting	Recycling of N, P, K and organic matter	Limits unmanaged manure runoff	Sanitation and salinity analysis
Sorted organics: vermicomposting	Biologically processed amendment	Local reuse of clean biodegradable waste	Pre-stabilize feedstock; screen pollutants
Residue retention / mulching	Soil cover and water conservation	Lower erosion and dust losses	Pest management; N balancing
Wet organics: anaerobic digestion	Digestate nutrients; recovered biogas	Potential energy and waste-management benefit	Digestate testing and enclosed storage

The most important common mechanism is the recovery of nutrients and organic carbon previously removed from productive fields. Stable organic inputs may improve aggregation and moisture buffering, while residue cover can mitigate wind and water erosion. In FAO's Uzbekistan RECSOIL framework, such practices are implemented together with crop diversification and careful nutrient management (1). This integrated approach is preferable to expecting any single compost product to fully restore a degraded soil.

ISSN: 2224-6878 | Pakistan Volume 6, No. 10.

IF: 14.91 | 2026 http://waerasia.org/index.php/ijtar

Environmental gains are not automatic. Aerobic treatment requires turning and moisture control; poorly managed heaps may generate odor and leachate. Raw manure may introduce microorganisms and soluble salts, while contaminated waste may pose chemical risks. Furthermore, environmental performance must be evaluated over the complete cycle from collection and transport to processing, storage and field application. Otherwise, the apparent benefit of diverting waste from burning may conceal pollution transferred to water or soil.

DISCUSSION

For Uzbekistan, an implementation model should begin with local waste inventories and source separation at farm, district or agro-cluster level. Feedstocks should be characterized by seasonal availability, cleanliness and transport distance. Next, the processing route should be matched to material properties and available technical capacity. Finished products require routine quality tests, followed by application rates based on actual nutrient composition and local soil analysis rather than uniform recommendations. On-farm demonstration plots can then evaluate agronomic and economic outcomes under realistic irrigation and rotation systems.

Soil salinity requires particular caution. Although organic amendments can improve certain physical and biological properties, they do not directly substitute for drainage, suitable irrigation or salt-management measures. Salty manure or immature compost can increase electrical conductivity in already vulnerable soils. Likewise, the presence of organic nutrients does not justify neglecting mineral nutrient budgets: over-application may increase nutrient runoff, phosphorus accumulation or nitrate leaching (9, 10).

The literature also suggests important research gaps. Available domestic studies are crop- and location-specific, and many reports do not use harmonized indicators of organic carbon change, waste-processing emissions or economic costs. Controlled experiments should compare equal nutrient inputs across compost, organo-mineral fertilizer and conventional treatments, and should record uncertainty as well as mean changes. Long-term measurements are needed because benefits for stable soil organic matter may emerge more slowly than short-term seedling or yield responses.

Cost-effectiveness may differ significantly across farm types. Smallholders can benefit from shared equipment and decentralized composting; large livestock farms may have sufficient manure volume for managed digestion. High-moisture materials are costly to transport, making local treatment preferable in many settings. Extension services, accessible laboratories and enforceable product-quality requirements are therefore essential if recycling is to become an economically viable component of sustainable agriculture.

CONCLUSION

Agricultural waste recycling can contribute to restoring soil functions and reducing certain forms of environmental pressure in Uzbekistan by recovering carbon and nutrients from livestock and crop residues. Composting, vermicomposting, residue retention and anaerobic digestion offer complementary rather than interchangeable pathways. Their effectiveness depends on suitable feedstocks, controlled processes, quality testing and site-specific soil management. The reviewed evidence supports adopting an integrated nutrient-recycling strategy while avoiding unsupported claims of guaranteed yield gains or salinity remediation.

Future priorities include source-separated collection, locally adapted treatment facilities, laboratory certification of organic amendments, scientifically justified application rates, and multi-season trials monitoring soil organic carbon, salinity, crop performance and pollution pathways. This approach can connect waste reduction with soil conservation and measurable environmental accountability.

ISSN: 2224-6878 | Pakistan Volume 6, No. 10.

IF: 14.91 | 2026 http://waerasia.org/index.php/ijtar

REFERENCES:

1. Food and Agriculture Organization of the United Nations. (n.d.). RECSOIL implementation in Uzbekistan. https://www.fao.org/global-soil-partnership/programmes/recsoil/implementation-sites/uzbekistan/en
2. World Bank. (2024). Uzbekistan country environmental analysis (Report P177108). https://documents1.worldbank.org/curated/en/099050324083529790/pdf/P17710818d91810e31a91f1da9f5387c0f4.pdf
3. Food and Agriculture Organization of the United Nations. (2003). Fertilizer use by crop in Uzbekistan. https://www.fao.org/4/Y4711E/Y4711E00.htm
4. Food and Agriculture Organization of the United Nations. (2005). The importance of soil organic matter. https://www.fao.org/3/a0100e/a0100e07.htm
5. Xoldorov, S. M., Temirov, J. J., Nurbekov, A. I., & Nizamov, S. S. (2026). Tuproqni himoya qiluvchi va resurs tejovchi qishloq xo‘jaligi amaliyotlarining tuproq unumdorligiga ta’siri. Agriculture and Water Management of Uzbekistan. https://qxjurnal.uz/index.php/qx/article/view/6
6. Ismailov, U., Zinatdinov, K., & Uzakova, A. (2026). Sho‘rlangan yerlarda organo-mineral kompostlarning g‘o‘zaning o‘sishi va rivojlanishiga ta’siri. Agro ilm, 128(7). https://qxjurnal.uz/index.php/ai/article/view/961
7. Xalbayev, A. (2026). Sholi urug‘larining unib chiqishiga turli substratlarning ta’siri. O‘zbekiston qishloq va suv xo‘jaligi, (8). https://doi.org/10.67048/qxju2026qxiss8m793
8. Republic of Uzbekistan. (2022). Law No. O‘RQ-766: On organic products. https://www.lex.uz/uz/acts/-5980334
9. Cabinet of Ministers of the Republic of Uzbekistan. (2020). Resolution No. 729 on safety requirements for organic and organo-mineral fertilizers. https://www.lex.uz/uz/acts/-5109078
10. Khasanov, S., Kulmatov, R., Li, F., van Amstel, A., Bartholomeus, H., Aslanov, I., Sultonov, K., Kholov, N., Liu, H., & Chen, G. (2023). Impact assessment of soil salinity on crop production in Uzbekistan and its global significance. Agriculture, Ecosystems & Environment, 342, 108262. https://doi.org/10.1016/j.agee.2022.108262