**Journal of Tropical Resources and Sustainable Science**
Website: http://journal.umk.edu.my/index.php/jtrss/
eISSN : 2462-2389
Vol: 13, Issue 2, 2025, 167-172
DOI: https://doi.org/10.47253/jtrss.v13i2.1933

RESEARCH ARTICLE

# Towards developing the circular economy framework in managing common agricultural waste: The case of Caraga Region, Philippines

Rowena P. Varela [1*] and Raquel M. Balanay [2]

[1] Department of Plant and Soil Sciences, College of Agriculture and Agri-industries, Caraga State University, Ampayon, Butuan City 8600 Philippines.
[2] Department of Agri-industries, College of Agriculture and Agri-industries, Caraga State University, Ampayon, Butuan City 8600 Philippines.

**ARTICLE HISTORY**
Received : 5 July 2025
Accepted : 30 July 2025
Online : 15 December 2025

**KEYWORDS**
Waste valorization
Reuse and recycling
Agricultural waste circularization
Circular economy framework
Sustainable waste management

☒ * **CORRESPONDING AUTHOR**
Rowena P. Varela
Department of Plant and Soil Sciences, College of Agriculture and Agri-industries
Caraga State University
Email: rpvarela@carsu.edu.ph

**ABSTRACT**

Agricultural waste management remains a critical aspect of sustainable agriculture in Caraga Region, Philippines. Agricultural waste is generally not reused or recycled for economic purposes and for reducing gas emissions due to lack of institutional and technical support. This study aims to develop a circular economy (CE) framework reflecting the local realities to guide the management of common agricultural waste. Using qualitative research design, data were gathered from 41 respondents through key informant interviews, 100 stakeholders in the focus group discussions, and documents from secondary sources. Using NVivo, the study revealed that common agricultural wastes come from rice farming, corn farming, coconut plantation, banana plantation and from livestock and poultry. These wastes are predominantly managed through informal and not environmentally friendly practices, including open burning and dumping. Key challenges include limited policy support, lack of appropriate technologies, and weak institutional coordination. Nevertheless, opportunities for waste valorization abound in Caraga Region, including reuse into mushroom beds, composting for organic agriculture, and biochar production. From the findings, the proposed CE framework will encompass waste characterization, stakeholder collaboration, policy and institutional support, technology and innovation, and capacity building for the key actors, the rural women. The framework supports a strategic approach to transition to sustainable agricultural waste management in Caraga Region through circularization, with potential applications in the entire Philippines.



## 1. INTRODUCTION

Agriculture is the key economic driver in the Philippines that provides livelihood in the countryside. In Caraga Region, socioeconomic development is largely anchored in agriculture. Caraga Region produces rice, coconut, banana, corn, and oil palm. Along with agricultural productivity, tons of waste are generated thus managing agricultural waste becomes a concern that poses significant environmental and socio-economic consequences. Waste disposal methods, such as open burning or indiscriminate dumping into water bodies, result in environmental concerns such as greenhouse gas emissions, soil contamination, and water pollution. These environmental concerns will, in turn, lead to health hazards for people. Agricultural waste management is an increasingly critical concern globally due to potential gas emissions and health hazards (Khan et al., 2024; Waqas et al., 2023; Raza et al., 2022). Several studies have shown innovative strategies in agricultural waste management to reconcile with environmental stewardship and economic productivity (Jamwal et al., 2024; Tanveer et al., 2022; El-Ramady et al., 2022).

The abundance of agricultural residues and the potential value of these wastes for composting, energy generation, and other sustainable uses lead to valorization. Reports on the reuse of agricultural waste for biofertilizer, bioenergy, and livestock feeds have been published in the past and recently. Studies on the conversion of agricultural waste into biostimulants and biofertilizers show great potential in optimizing resources and recycling the nutrients for agricultural production (Sarangi et al., 2023; Gupta et al., 2022; Puglia et al., 2021). The recycling of agricultural waste and biomass for bioenergy and biofuel has become a trend to reduce dependence on petroleum-based energy sources (Ufitikirezi et al., 2024; Kamar et al., 2023; Gupta et al., 2022). In the Philippines, reports from Nacua and Lacang (2024) and Reaño and Halog (2023) suggested the positive effects of agricultural waste biomass for bioenergy generation. The reuse and recycling of agricultural waste for economic purposes through green technology is an important element in circular economy

(CE). Closing-the-loop production methods to improve resource use efficiency is the primary goal of a CE. In closing the loop, reuse and recycling of by-products into economically usable goods are the main ideas and patterns as stated by the Ellen Macarthur Foundation (2012), where the role that green chemistry may play in the shift toward more sustainable models is critical. CE and green technology have job creation potential which might bring greater local employment, especially in entry-level and semi-skilled jobs, thereby addressing issues facing the economies of developed countries (Ellen Macarther Foundation, 2013). However, according to Ncube et al. (2023), international agreements should be reconsidered to provide an appropriate framework in advancing toward the circular economy and green chemistry. The framework must include the creation of incentives for businesses and individuals to adopt circular practices (Ncube et al., 2023). In addition, the establishment of education programs to promote circular practices is crucial, and the development of regulatory measures to support the transition to sustainable production and consumption patterns.

The management of agricultural waste to transition to circular economy has been deliberated in many symposia and scientific conferences in recent years. However, in the Philippines, the reuse of agricultural waste for circularization is still limited due largely to the lack of a mechanism to bring this agenda to a higher level. The RA 9003 (Ecological Solid Waste Management Act of 2000) stipulates to develop and prescribe procedures for the issuance of appropriate permits and clearances and review the incentives scheme for effective solid waste management, for purposes of ensuring relevance and efficiency in achieving the objectives. Even though the definition of solid waste includes agricultural waste, the economic aspects that include business permits and clearance along with the incentive system are not yet in place. CE from a local governance point of view has been implemented in a rather fragmented manner, although public policies remain a crucial driver for countries to transition towards more circular systems (Dagilienė et al., 2021). Partnerships and collaborative networks are crucial in overcoming the barriers (organizational inertia, financial constraints) and promoting the advancement of CE initiatives (Bourdin, S., & Jacquet, 2025). For Caraga Region, there is a critical need to develop a holistic and context-specific conceptual framework in managing the common agricultural wastes, which can be upscaled to the national level. This proposed framework integrates existing traditional knowledge, local waste management practices, institutional arrangements at the local level, potential market and industry as part of the supply chain, and policy and governance anchored on ecological waste management (RA 9003) to create a sustainable and inclusive waste management program. The law is comprehensive, however, having a holistic and contextualized agricultural waste management framework will open opportunities for circularization in agriculture that will lead to green job creation. Circularization will likewise improve farm productivity through employing regenerative agriculture approaches while addressing environmental issues and concerns. Non-traditional uses of agricultural waste can also be explored to broaden the entrepreneurial options in line with valorization. Biosorption using agricultural waste is emerging as a method that offers economical alternate biological materials to adsorb cadmium (Harshala & Wagh, 2022). Functional groups present in these agricultural waste-based biosorbents (AWB) make it possible for them to attach Cd2+ from waters (Kwikima et al., 2021). As the role of women in agriculture continues to expand with the global advocacy for gender equality, there is a growing recognition of women and their potential leadership in promoting sustainable waste management (Asteria & Herdiansyah, 2022). Women in rural communities are often at the forefront of agriculture-based development, particularly in waste recycling (Nwamaka et al., 2021; Yasmita & Rahmantari, 2025), since these come as a second skin to them because women have the natural tendencies to salvage waste to become something useful as mothers. Hence, they play a crucial role in handling organic waste from agriculture residues by promoting resource recycling.

This research describes the current state of agricultural waste management in Caraga Region as the basis to propose a conceptual framework tailored to the local context and realities by looking into the agro-ecological, socio-economic, and institutional landscape. The proposed framework will identify the challenges in managing agricultural waste in the region, gather and verify tested science-based interventions for ecological and sustainable waste management, policy and governance gaps as inputs in developing a community-driven model that empowers women to take leadership (Ameridyani et al., 2025; Reni & Prasetiyo, 2025; Dushkova & Ivlieva, 2024). This proposed CE framework will foster more inclusive and effective waste management practices that promote environmental sustainability and engage women, who are not working in the offices, to improve their livelihoods that will contribute to local economies. This waste management framework is essential in guiding future research, policymaking, and technology-based intervention for program implementation toward achieving a more sustainable agriculture in the region.

## 2. REVIEW OF RELATED LITERATURE

Agri-waste is abundant because it is directly proportional with the intensified agricultural production practices to cope with the increasing demand for food, which results in the overconsumption of resources and energy in agriculture (Rodríguez-Espinosa et al., 2023; Upadhyay et al., 2024).

  

Agriculture is estimated to occupy around 50% of the land used for human settlement, making agri-waste potentially substantial in amounts (Rodríguez-Espinosa et al., 2023; Upadhyay et al., 2024). Agri-waste takes various forms such as crop residues, animal wastes, and sludge waste (Upadhyay et al., 2024; Capanoglu et al., 2022), which are generated from various farm operations such as planting, farm care and maintenance, and harvesting (Chamorro et al., 2022). It has been observed to have an increasing volume over time in which the main contributor of this pattern is the increasing food loss and waste across the agri-supply chain (Capanoglu et al., 2022). As estimated, food loss and waste globally is around 1/3 of the food amount consumed by humans or approximately 1.3 billion tons annually (Capanoglu et al., 2022). Not paying attention to it is detrimental to productivity and sustainability (Kover et al., 2021).

Particularly, the environmental footprints of agri-waste due to food loss consist of 3.3 billion tons of $CO_2$ equivalent of greenhouse gases (GHG) equivalent to US$750 billion per year (Kover et al., 2021). Lončarić et al. (2021) viewed agri-waste as materials that can be used as inputs to production process in the mainstream. This waste can be valorized as fertilizers, biofuels and other useful biomaterials (Duque-Acevedo et al., 2020; Chamorro et al., 2022; Upadhyay et al., 2024). Circular economy (CE) is an umbrella paradigm that is viewed as a potential guide in closing the loop for agriculture and in ensuring that agricultural resources are used optimally or to the maximum extent, including the waste generated across the agri-supply chains (Rodríguez-Espinosa et al., 2023; Rekleitis et al., 2020). Duque-Acevedo et al. (2020) associated CE with sustainable production and consumption or balanced growth and development model. De Corato (2020) pointed out the mutual benefits from the circular economy model, in which agri-waste can contribute to cost-saving measures at the farm level with organic waste reused as soil amendments and biofertilizers for example. In taking advantage of the opportunities in implementing circular economy, waste materials must be understood particularly for end-of-pipe cases (Rekleitis et al., 2020; Khaksar et al., 2022).

Circular economy must be viewed as comprehensive as possible, such that the attention is not only to the waste materials to be reused but also to the conditions that can induce CE opportunities. This context emphasizes the necessary guidelines to promote and adopt CE technologies, frameworks and mechanisms (Perdana et al., 2023). Perdana et al. (2023) pointed out the importance of supply chain governance in the reduction of agri-waste across the agri-supply chain. Donner et al. (2021) reported that achieving circularity particularly across the agri-supply chains needs education about the critical factors including the risks to understand transition requirements. According to Donner et al. (2021), it is necessary to pay attention to the required “innovative conversion technologies, flexible in and out logistics, joint investments in R&D, price competitiveness for bio-based products, partnerships with research organizations, space availability, subsidies, agricultural waste management regulations, local stakeholder involvement and acceptance of bio-based production processes” in developing circular capabilities in the agri-supply chains. Here, models and frameworks are important to be defined to provide guidance in addressing the critical factors. This has been particularly stressed in the work of Batlles-dela Fuenta, which reviewed recent studies for new approaches to strengthen the circular economy framework for agriculture.

## 3. MATERIALS AND METHODS

### 3.1. Research site

The study focused on developing a framework for agricultural waste management in Caraga Region, specifically in the Provinces of Agusan del Sur and Surigao del Sur. The two (2) provinces within the Caraga Region have a predominantly agriculture economy. The dominant crops include rice, corn, coconut, banana, cacao, and oil palm. The production system for rice, corn and cacao is generally small-hold farming, while coconut and banana is a combination of small-hold and plantation-type system. Oil palm production system is plantation type and adopts an industry-level operation. In general, small hold farming of rice, corn and cacao does not adopt a specific waste management system as stipulated in RA 9003, although some farmers implement sustainable waste management. The plantation type production system, particularly the industry-level ones adopt the waste management system stipulated in RA 9003 because permits need to be secured as a requirement for the operation of the industry.

### 3.2. Ethics statement

Ethical review and approval were waived for this study because the Caraga State University (CSU) Research Ethics Guidelines is still underway. Nonetheless, based on the Philippine Data Privacy Act of 2012, the privacy of individuals involved in the project is ensured while allowing for the free flow of information for innovation and growth.

### 3.3. Research design

The study employed qualitative research design. It involved gathering comprehensive and thorough insights from stakeholders, analyzing existing data, and synthesizing relevant literature to ensure the framework's contextual significance and applicability to the locality. Key informant interviews (KIIs) and focus group discussions (FGDs) were conducted to gather primary data. The KII was done with 11 Municipal Agriculture Officers, 30 Agriculture Extension Workers, and 10 Farmer-

  

Leaders as respondents. The FGD was done once involving 100 stakeholders composed of farmers, rural women**,** local government officials, representatives from agricultural and environmental agencies, waste management practitioners, and academic researchers within the region. The data during the FGD were recorded and transcribed. The questions were in English while the answers are both in English and Bisaya (local dialect). The local dialect was then translated into English. The protocol in data privacy and the free and prior informed consent (FPIC) of the respondents were ensured as part of the observance of the ethical conduct of research. The primary data were validated with secondary data gathered through a review of relevant documents, including regional agricultural profiles, waste management reports, local ordinances, policy briefs, and published research findings. These sources provided background information which are important in identifying the issues and gaps in agricultural waste management.

### 3.4. Data analysis

Document analysis by thematic clusters was done to identify recurring patterns, issues and challenges, the opportunities and proposed innovative solutions from the qualitative data. In doing thematic analysis, NVivo was used (Tewari et al., 2025; Nguyen et al., 2023). Data from the interviews and FGDs were triangulated with secondary sources to ensure soundness and reliability of results. Based on the data gathered, an initial conceptual framework was crafted. The development of the framework is anchored on the scientific basis that CE models drive sustainable development and economic resilience, and that identification of policy barriers that hinder CE adoption are crucial (Ellen Macarthur Foundation, 2013). The proposed framework was validated through a consultative meeting and workshop with key stakeholders. The stakeholders' feedback and recommendations were integrated to refine the conceptual waste management model. The final framework was created which emphasized interconnected components such as waste characterization, stakeholder roles, enabling policies, sustainable technologies, and capacity-building mechanisms, particularly those addressing women empowerment to lead in waste management towards circular economy.

## 4. RESULT AND DISCUSSION

Table 1 shows a clustering of common waste generated from agricultural farms based on commodities that summarize the key themes and volumes of waste per season and the disposal methods that emerged from the KII and focus group data. This is a basic approach in qualitative research where thematic analysis is employed (Strang et al., 2022). Based on the data, the most common types of agricultural waste generated in the region include rice straw and rice hull, corn cobs and stalks, coconut husks and shells, banana trunks, and animal manure. In the rice-producing provinces such as Agusan del Sur and Surigao del Sur, high volumes of rice straw and husks during peak harvesting seasons have been reported. These are often disposed of through open burning or left in the fields to decompose (Table 1). Although some agricultural waste from rice farming has been utilized for animal feeds and for mushroom production, the most common practice is to just leave the waste in the field. When the time for land preparation comes and the residues have not decomposed yet, open burning is the option. For banana waste, the traditional practice is to use the banana pseudostem as raw feeds for livestock, particularly for cattle and swine. The extent of using agricultural waste for livestock feeds is very minimal, generally only at the household level. The key findings of the study have been crucial for the development of a context-responsive conceptual framework for sustainable agricultural waste management. The findings revealed critical information on the current practices, challenges, and opportunities related to agricultural waste management in the Caraga Region. These findings are relevant and necessary inputs in developing the conceptual framework that fits the local setting and realities.

**Table 1.** Common agricultural waste in Caraga Region by commodity, the volume generated and the disposal method.

| Commodity | Common Waste Types | Estimated Volume/Season | Typical Disposal Method |
|---|---|---|---|
| Rice | Straw, hull | High | Burning, decomposition, minimal amount reused for animal feed |
| Corn | Cobs, stalks, leaves | Medium | Burning, minimal amount used for animal feed |
| Coconut | Husk, shell, fronds | High | Left unused, some composting, minimal amount processed for the market |
| Banana | Trunks, leaves | Medium to High | Dumped or decomposed, minimal amount reused for animal feeds |
| Livestock | Manure | Varies | Fertilizer (limited processing) |

Source: DA-Caraga Profiles, KIIs and FGDs (2024)

This table illustrates the abundance of biodegradable materials that remain underutilized or are disposed of through open burning which emits gases into the atmosphere. The study found that agricultural waste management in the region is still largely informal and lacks integration into local development planning. Through clustering the FGD data, results reveal that farmers often manage waste based on traditional practices, such as burning or leaving the residues to decay and release gases into the atmosphere (Figure 1). In India, Deshpande et al.

  

(2023) reported an estimated increase of approximately 75% for CO and Greenhouse gasses (CO2, CH4 and N2O) in 2011-2020 attributed to agricultural residue burning. Crop residue burning in India poses a serious threat to the climate, soil fertility, human health and wellbeing, and air quality, increasing mortality rates and reducing agricultural productivity, hence, Singh et al. (2022) discussed some of the alternative crop residue management practices and policy interventions. In the Philippines, burning is still practiced for managing crop residues. The emission estimates of biomass burning rice straw have been observed to be high especially in the rice-producing provinces in Luzon (Perez et al., 2021). Thus, they suggested minimizing burning because of health impacts. These practices are traditional in the Philippines and have been implemented by farmers for decades particularly those with limited awareness of more sustainable options.

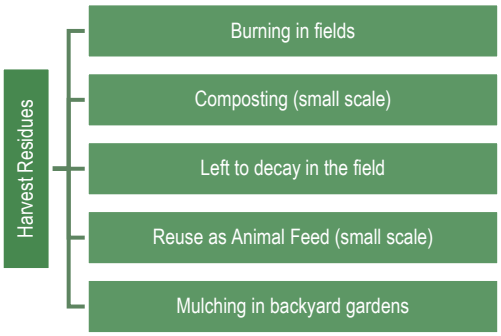


**Figure 1**. Current agricultural waste management practices in Caraga Region, Philippines

The challenges cited by the respondents related to the waste management practices they adopted include the lack of access to composting or recycling facilities, absence of incentives for sustainable practices, nominal technical guidance from extension services, and limited awareness of the potential of agri-waste as a resource. Markets and industry linkage that take up the products from recycled agricultural waste are rare, thereby limiting the monetary incentives for farmers and their households to recycle the waste. Composting and the use of waste as livestock feed or mulching materials were reported, but these practices remained localized and small-scale. There was minimal evidence of coordinated efforts or support mechanisms from local government units (LGUs) and agricultural institutions.

On the aspect of institutional and policy support, the stakeholders highlighted the absence of clear policies and guidelines specific to agricultural waste management (Table 2). While solid waste management programs existed under RA 9003 (Ecological Solid Waste Management Act), the local ordinances related to solid waste management, including penalties for non-compliance have been implemented, agricultural waste management is generally given little attention. The monitoring of waste generation in agricultural projects is limited. In terms of technical support, most of the training and workshops conducted are focused on household and industrial waste. Composting agricultural waste is considered an integral part in the advocacy of organic agriculture. Despite the promotion of organic agriculture, only farmers operating nurseries, ornamental gardens and vegetable gardens have been religiously using compost. For large-scale agricultural production such as rice farming or corn farming involving a hectare or bigger, farmers go for inorganic fertilization since they believe that the effect of organic fertilizer is slow. The solution to the problem of agricultural waste is complex requiring legislative, economic and technological components, hence, Agapkin et al. (2022) described the need to support cooperation between producers of organic fertilizers, and the producers and sellers of organic products. Rodríguez-Espinosa et al. (2023) investigated the nitrogen nutrition provided by organic wastes to agricultural systems, to demonstrate how common organic wastes can be utilized for sustainable agriculture. The combination of organic and inorganic fertilization to increase crop yield is recommended to deal with the massive agricultural residue generation in the context of circular economy.

**Table 2**. Institutional and policy gaps on agricultural waste management in Caraga Region, Philippines.

| Area | Institutional and policy gaps |
|---|---|
| Policy | No specific local ordinance on agricultural waste management |
| Institutional Roles | Overlapping mandates, limited inter-agency coordination |
| Technical Support | Infrequent extension activities on waste reuse or composting |
| Funding & Resources | Low budget allocation for agri-waste management programs |

Furthermore, weak enforcement of existing environmental policies, limited funding, and a lack of inter-agency collaboration were identified as major barriers to improving waste management. Incentivizing the proper management of waste is an option to encourage farmers and their households to recycle and reuse agricultural waste. In the Philippines, however, the market for organic products needs to be established to support the reuse of agricultural waste into organic fertilizer towards circularization.

Despite the challenges, stakeholders recognized opportunities for utilizing agricultural waste as valuable resources (Figure 2). Several informants suggested potential uses, including the production of organic fertilizers, biochar, mushroom cultivation, and biomass energy. In Agusan del Sur, village-level mushroom production has been a source of income for farming communities utilizing wastes from agriculture and tree farming. Moreover, another farming community in the same

  

province reuses corn production waste (corn cobs) for compost production and supplied to ornamental gardens. In villages near the mining industry in Surigao del Norte, biochar production is practiced by farmers and their households. This is in response to the demand for fertilizer used in mine rehabilitation among mining companies, which is a clear indication of the positive response to monetary incentives.

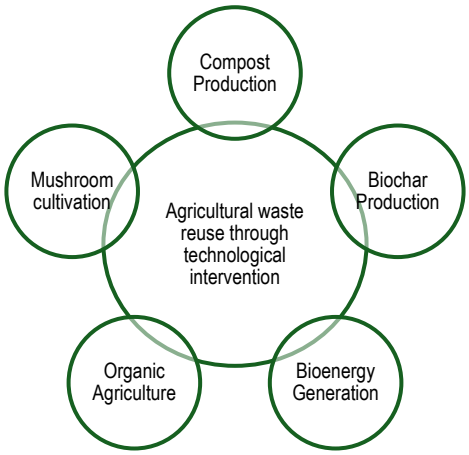


**Figure 2.** Advanced practices in the reuse of agricultural waste for resource recovery and circular economy in Caraga Region, Philippines

The presence of technical institutions and extension services in the region presents a promising avenue for promoting technology transfer and farmer education on resource recovery and value addition. Caraga's research institutions and universities can be tapped to promote awareness about agricultural waste reuse and create enterprises for circular economy (Figure 3). The emerging organic agriculture initiatives can be leveraged to create models of circular farming, turning waste into resources while boosting rural livelihoods.

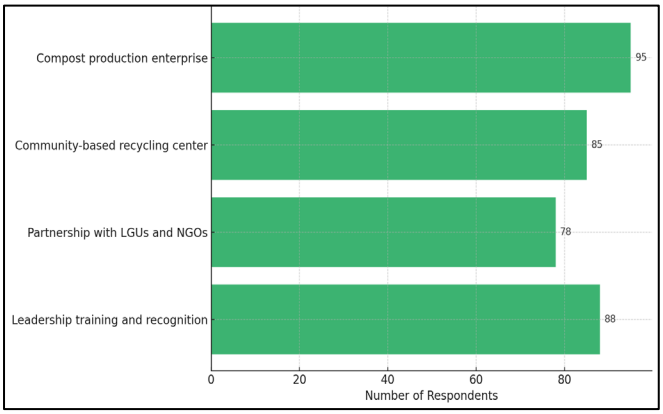


**Figure 3**. Opportunities for women-led agricultural waste management in Caraga Region, Philippines

The women-led initiatives align with SDG 5: Gender Equality by promoting women empowerment and leadership. It likewise addresses SDG 12: Responsible Consumption and Production as it encourages sustainable waste management, and SDG 13: Climate Action as this program reduces methane and GHGs from unmanaged organic waste. In the end, it aligns with SDG 8: Decent Work and Economic Growth as this opens enterprise opportunities like composting and recycling, SDG 11: Sustainable Cities and Communities, SDG 15: Life on Land, and SDG 17: Partnership for the Goal.

In response to the findings, a conceptual framework (Figure 4) was developed to guide agricultural waste management in Caraga Region. The framework consists of five interrelated components towards women-led agricultural waste circular economy. This is through the process of waste characterization and inventory by undertaking systematic identification and quantification of common agricultural wastes per commodity and locality. The five (5) key support systems for a holistic agricultural waste circular economy include:

a) Stakeholder Roles and Collaboration. There must be a clear delineation of responsibilities among farmers, LGUs, DA, DENR, NGOs, and academic institutions towards empowering women.

b) Policy and Institutional Support. The governance must be clear by developing enabling policies, incentives, and funding mechanisms specific to agricultural waste management.

c) Technology and Innovation. The academia and other support government agencies must promote locally appropriate technologies for composting, recycling, and energy conversion.

d) Capacity Building and Knowledge Sharing. There must be continuous education, training, and information dissemination for farmers and LGU personnel.

e) Market and Industry. Circular economy will not be running efficiently and effectively if there is no market and industry to receive the innovative products derived from agricultural waste.

The proposed framework emphasizes a multi-stakeholder, systems-based approach, aligning with sustainable development principles and circular agriculture practices. It also supports the integration of agricultural waste management into broader regional development plans and environmental governance structures. The promotion of organic agriculture has been a step forward in pursuing composting by recycling agricultural waste. However, a more focused program that encourages farmers and rural women to reuse and recycle agricultural waste into compost, animal feeds, or for bioenergy generation should be developed at the village or municipal level. In the concept of circular economy, incentivizing the efforts of the farmers and rural women is central in the agricultural waste management because this will add to their income and can be

  

regarded as green job creation. The proposed framework supports the region's development goals and serves as a roadmap for transitioning toward circular and climate resilient agri-food systems.

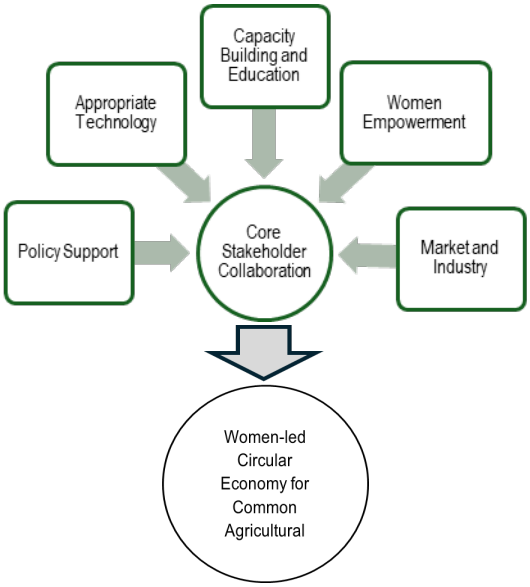


**Figure 4**. Proposed conceptual framework to guide agricultural waste management towards circular economy in Caraga Region

As a roadmap, the proposed framework serves as a guide to achieve sustainable agricultural waste management leading to countryside development. The framework is anchored on the principles of the circular economy (Ellen MacArthur Foundation, 2019; Geissdoerfer et al., 2017), sustainable rural livelihoods (Scoones, 1998), and feminist environmentalism (Clement et al, 2019; Agarwal, 1992), empowering women to lead in transforming agricultural waste into valuable resources within a closed-loop system.

The reuse of agricultural waste has been a regular work of rural women who are not working in the industry or offices. While working as housewives, these women have been busy in vegetable gardening, ornamental gardening and tending to backyard livestock production to assist their husbands in generating food for the table and to have extra cash to support their children. Thus, reuse and recycling of agricultural waste is already natural for rural women. Recognizing the important role of women to lead in agricultural waste management in rural villages is an essential foundation in transitioning to agriculture-based circular economy. In the Philippines, rural women have been involved in various agricultural post-harvest and waste-related tasks. However, their roles are often underrated and unsupported by institutional systems because they are not organized (Huyer, 2021). Women have inherent capabilities in nurturing organizations to success. By involving women in agricultural waste management, it contributes to the empowerment of rural women and the enhancement of their socioeconomic status (Clement et al., 2019). Data show that empowering women to lead in rural development initiatives often resulted to improved effectiveness and sustainability of community-based resource management (Leisher et al., 2016). In the context of Caraga Region, this framework highlights the recognition of the contribution of rural women to encourage genuine involvement resulting from the leadership roles given to them that boost their morale in designing and managing circular waste solutions.

The development of women's technical, entrepreneurial, and leadership capacities is important to be highlighted in the framework. Capacity building interventions that include training on circular economy principles, enterprise management, environmental policies and regulations, and sustainable technologies that involve both rural women and farmers should be incorporated in the framework. This component fosters institutional linkages with local government units (LGUs), agricultural extension services, academic institutions, and the agro-industrial sector in the locality. Findings from sociological studies reveal that when women are provided support and training, they are more likely to succeed in managing environmental enterprises and influencing community decision-making (World Bank, 2021). In the framework, collaboration with existing programs of the Department of Agriculture (DA), Agricultural Training Institute (ATI), Department of Science and Technology (DOST) and Department of Trade and Industry (DTI), including the research institutions and universities is necessary to institutionalize and operationalize the circularization of agricultural waste management.

Creation of value chains and access to markets and industry partners are essential in achieving effective circular waste management. Linking the products generated from agricultural waste management to the markets is a way to incentivize the participation of rural women and farmers in the reuse and recycling of agricultural waste. In Indonesia, most vegetable and dairy farmers (80% and 75% of respondents, respectively) do not manage their agricultural waste properly, thereby enhancing knowledge among farmers is essential (Perdana et al., 2023). This means that coordination and information-sharing among the supply chain actors to address food loss and agricultural waste problems are essential. The creation of value chains and access to markets support women-led groups in making the products such as compost, biofertilizers, or upcycled materials have access to markets. Facilitating their participation in local procurement, fairs, and online platforms helps bridge the gap between production and commercialization. According to Huyer (2021), building on

  

analysis of women's capacity and willingness to adopt CSA in the context of the gender productivity gap, CCAFS research generated a "gender-smart agriculture" (GSA) approach, that considers women's priorities and access to technology, resources, and information to support climate resilience.

The framework operates as a feedback-rich circular system wherein waste is continuously reintegrated into the production cycle, minimizing resource extraction and maximizing local benefits. The cyclical nature of the framework enhances environmental outcomes (e.g., reduction of landfill pressure and soil degradation), economic gains (e.g., job creation and income diversification), and social inclusion (e.g., empowerment of marginalized women). These are also reflected in the work of Figueroa et al. (2021) on "Circular Economy Strategies and Implementation in the Philippines". These dynamics are in line with the Ellen MacArthur Foundation's (2019) model of a circular economy that balances environmental regeneration with social equity and innovation.

The proposed agricultural waste circular economy framework is viewed to contribute to achieving national goals on climate change adaptation, gender equality, and sustainable agriculture, particularly under the Philippine Development Plan and the Gender and Development (GAD) agenda. The strategic direction of the agricultural waste management towards circularization is consistent with international frameworks such as the UN Sustainable Development Goals (SDGs), particularly SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 14 (Life on Land), and SDG 17 (Partnership for the Goal). Importantly, the participatory design of the agricultural waste management framework makes it suitable for replication in other regions having agriculture-based economies that experience similar waste management challenges and realities.

## 5. CONCLUSION

Managing agricultural waste in the Caraga Region is generally inefficient, resulting from the lack of institutional support, technical support and weak implementation of the policy. This is linked to inadequate infrastructure, limited policy support, and the proliferation of the traditional improper waste management practices. However, the findings of this study underscore the immense potential for turning agricultural waste into a valuable resource through improved management practices. Adopting a more structured approach in agricultural waste management can lead the Caraga Region to develop a sustainable waste management program to address critical environmental concerns while at the same time promoting sustainable agricultural practices and circularization of the rich resources in the farms. The proposed development framework for agricultural waste management in Caraga Region emphasizes a multi-stakeholder approach, that integrates waste characterization, policy support, technology innovation, and capacity building for the various groups, particularly the rural women. This framework provides a strategic pathway for enhancing the region's agricultural waste management practices, ensuring that both the environmental and socio-economic dimensions of sustainability are considered.

Developing enabling policies, enhancing inter-agency coordination, investing in education among rural women and farmers, and investing in research and development in the academia to ensure technical support are necessary inputs in the operationalization of the framework. Local governments play a fundamental role in ensuring the effective implementation of sustainable waste management practices through active enforcement of government policies and local ordinances. By engaging the research institutions, academia, and private sector, fostering innovation in agricultural waste management is facilitated which can significantly expand the opportunities for waste recycling, resource recovery, and value addition. Through a holistic and inclusive approach to agricultural waste management, Caraga Region can build a resilient, sustainable agricultural sector that benefits both farmers and the broader community towards good environmental health.

## ACKNOWLEDGEMENT

The researchers acknowledge the Department of Agriculture-Region 13 for funding the AMIA Project and Establishing Baseline Agriculture Performance and Rural Development Indicators Project and the Caraga Consortium for Agriculture, Aquatic and Resources Research and Development (CCAARRD) for support in this initiative.

## REFERENCES

Agapkin, A. M., Makhotina, I. A., Ibragimova, N. A., Goryunova, O. B., Izembayeva, A. K., & Kalachev, S. L. (2022, February). The problem of agricultural waste and ways to solve it. In *IOP Conference Series: Earth and Environmental Science* (Vol. 981, No. 2, p. 022009). IOP Publishing.

Agarwal, B. (1992). The gender and environment debate: Lessons from India. Feminist Studies, 18(1), 119–158. https://doi.org/10.2307/3178217

Ameridyani, A., Tokito, M., & Saizen, I. (2025). Towards community-driven rural development: Path of women group in empowering rural Women's capacities and role in rural development. *World Development Perspectives*, *39*, 100700.

Asteria, D., & Herdiansyah, H. (2022). The role of women in managing waste banks and supporting waste management in local communities. *Community Development Journal*, *57*(1), 74-92.

Batlles-delaFuente, A., Abad-Segura, E., González-Zamar, M. D., & Cortés-García, F. J. (2022). An evolutionary approach on the framework of circular economy applied to agriculture. *Agronomy*, *12*(3), 620.

Bourdin, S., & Jacquet, N. (2025). Closing the loop at the local scale: Investigating the drivers of and barriers to the implementation of the circular economy in cities and regions. *Ecological Economics*, *231*, 108542.

Capanoglu, E., Nemli, E., & Tomas-Barberan, F. (2022). Novel approaches in the valorization of agricultural wastes and their applications. *Journal of Agricultural and Food Chemistry*, *70*(23), 6787-6804.

Chamorro, F., Carpena, M., Fraga-Corral, M., Echave, J., Rajoka, M. S. R., Barba, F. J., ... & Simal-Gandara, J. (2022). Valorization of kiwi agricultural waste and

  

industry by-products by recovering bioactive compounds and applications as food additives: A circular economy model. *Food Chemistry*, *370*, 131315.

Clement, F., Buisson, M.C., Leder, S., Balasubramanya, S., Saikia, P., Bastakoti, R., Karki, E. and van Koppen, B., 2019. From women's empowerment to food security: Revisiting global discourses through a cross-country analysis. *Global Food Security*, *23*, pp.160-172.

Dagilienė, L., Varaniūtė, V., & Bruneckienė, J. (2021). Local governments' perspective on implementing the circular economy: A framework for future solutions. *Journal of Cleaner Production*, *310*, 127340.

Department of Agriculture (DA). (2020). Agricultural waste management in the Philippines: Policies and strategies. Department of Agriculture Report.

De Corato, U. (2020). Agricultural waste recycling in horticultural intensive farming systems by on-farm composting and compost-based tea application improves soil quality and plant health: A review under the perspective of a circular economy. *Science of the Total Environment*, *738*, 139840.

Deshpande, M. V., Kumar, N., Pillai, D., Krishna, V. V., & Jain, M. (2023). Greenhouse gas emissions from agricultural residue burning have increased by 75% since 2011 across India. *Science of the Total Environment*, *904*, 166944.

Donner, M., Verniquet, A., Broeze, J., Kayser, K., & De Vries, H. (2021). Critical success and risk factors for circular business models valorising agricultural waste and by-products. *Resources, Conservation and Recycling*, *165*, 105236.

Duque-Acevedo, M., Belmonte-Ureña, L. J., Plaza-Úbeda, J. A., & Camacho-Ferre, F. (2020). The management of agricultural waste biomass in the framework of circular economy and bioeconomy: An opportunity for greenhouse agriculture in Southeast Spain. *Agronomy*, *10*(4), 489.

Duque-Acevedo, M., Belmonte-Ureña, L. J., Yakovleva, N., & Camacho-Ferre, F. (2020). Analysis of the circular economic production models and their approach in agriculture and agricultural waste biomass management. *International Journal of Environmental Research and Public Health*, *17*(24), 9549.

Dushkova, D., & Ivlieva, O. (2024). Empowering communities to act for a change: A review of the community empowerment programs towards sustainability and resilience. *Sustainability*, *16*(19), 8700.

Ellen MacArthur Foundation. (2019). How the circular economy tackles climate change. https://ellenmacarthurfoundation.org

Ellen MacArthur Foundation. Ellen-MacArthur-Foundation-Towards-the-Circular-Economy—Vol. 1. Ellen MacArthur Foundation. 2013. https://www.ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an accelerated transition

Ellen MacArthur Foundation. Ellen-MacArthur-Foundation-Towards-the-Circular-Economy—Vol. 2. Ellen MacArthur Foundation. 2013. https://www.ellenmacarthurfoundation.org/towards-the-circular-economy-vol-2-opportunities-for-the-consumer-goods

El-Ramady, H., Brevik, E.C., Bayoumi, Y., Shalaby, T.A., El-Mahrouk, M.E., Taha, N., Elbasiouny, H., Elbehiry, F., Amer, M., Abdalla, N. and Prokisch, J. (2022). An overview of agro-waste management in light of the water-energy-waste nexus. *Sustainability*, *14*(23), p.15717.

Figueroa, A.M.I., Pintor, L.L., Sapuay, G.P., Ancheta, A.A., Atienza, V.A., Hintural, W.P., Abris, M.I.V. and Ghosh, S.K., 2021. Circular Economy Strategies and Implementation in the Philippines. Circular Economy: Recent Trends in Global Perspective, pp.219-257.

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy–A new sustainability paradigm? Journal of Cleaner Production, 143,

Gupta, N., Mahur, B. K., Izrayeel, A. M. D., Ahuja, A., & Rastogi, V. K. (2022). Biomass conversion of agricultural waste residues for different applications: a comprehensive review. Environmental Science and Pollution Research, 29(49), 73622-73647.757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Harshala, K., & Wagh, N. D. (2022). Use of Agricultural Waste-Based Biosorbents for the Removal of Heavy Metals from Aqueous Solution: A Review. *Nature Environment & Pollution Technology*, *21*(3).

Huyer S. 2021. Gender-smart agriculture: An agenda for gender and socially inclusive climate-resilient agriculture. CCAFS Working Paper no. 404. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Jamwal, V., Dhaundiyal, A., Mittal, A., Garg, S., Chidambaram, R., Junior, M. G., & Jeevitha, G. C. (2024). Agro-waste management and utilization. In *From Waste to Wealth* (pp. 111-123). Singapore: Springer Nature Singapore.

Khaksar, G., Sirijan, M., Suntichaikamolkul, N., & Sirikantaramas, S. (2022). Metabolomics for agricultural waste valorization: shifting toward a sustainable bioeconomy. *Frontiers in Plant Science*, *13*, 938480.

Khan, M. N., Sial, T. A., Ali, A., & Wahid, F. (2024). Impact of agricultural wastes on environment and possible management strategies. In *Frontier studies in soil science* (pp. 79-108). Cham: Springer International Publishing.

Kumar Sarangi, P., Subudhi, S., Bhatia, L., Saha, K., Mudgil, D., Prasad Shadangi, K., Srivastava, R.K., Pattnaik, B. and Arya, R.K., 2023. Utilization of agricultural waste biomass and recycling toward circular bioeconomy. *Environ Sci Pollut Res* **30**, 8526–8539 (2023). https://doi.org/10.1007/s11356-022-20669-1

Kwikima, M. M., Mateso, S., & Chebude, Y. (2021). Potentials of agricultural wastes as the ultimate alternative adsorbent for cadmium removal from wastewater. A review. *Scientific African*, *13*, e00934.

Loncric, R., Sudaric, T., & Milkovic, S. J. (2021, June). Circular economy and agricultural waste management in Croatia. In *Proceedings of the 10th International Scientific Symposium Region Entrepreneurship Development, Online* (pp. 787-1803).

Nacua, Z., & Lacang, G. (2024). Valorization of Agricultural Wastes to Offset Greenhouse Gases (GHGs) Emissions: An Insight in Southeast Asia. *Journal of Environmental & Earth Sciences| Volume*, *6*(02).

National Economic and Development Authority (NEDA). (2017). The Philippine Development Plan 2017-2022: Environmental sustainability and resource recovery. NEDA Publications.

Ncube, A., Mtetwa, S., Bukhari, M., Fiorentino, G. and Passaro, R., 2023. Circular economy and green chemistry: the need for radical innovative approaches in the design for new products. *Energies*, *16*(4), p.1752.

Nguyen, A. T., Nguyen, N., Phung, P., & Yến-Khanh, N. (2023). Residents' waste management practices in a developing country: a social practice theory analysis. *Environmental Challenges*, *13*, 100770.

Nwamaka, A. C., Sydney, A. U., Oyem, A., & Tina, A. (2021). The role of women in farm, household and environmental waste management. *International Journal of Research and Innovation in Social Sciences*, *5*(7), 9-14.

Oladejo, O. M., Mutereko, S., & Mavunda, N. A. (2024). Local Governments' Roles in Sustainable Waste Management for a Green Economy. In Waste Management and Life Cycle Assessment for Sustainable Business Practice (pp. 217-236). IGI Global.

Perdana, T., Kusnandar, K., Perdana, H. H., & Hermiatin, F. R. (2023). Circular supply chain governance for sustainable fresh agricultural products: Minimizing food loss and utilizing agricultural waste. *Sustainable Production and Consumption*, *41*, 391-403.

Perez, G. J., Comiso, J. C., & Cayetano, M. G. (2021). Swidden agriculture and biomass burning in the Philippines. In *Biomass burning in South and Southeast Asia* (pp. 183-198). CRC Press.

Philippine Statistics Authority (PSA). (2020). Caraga Region: A profile of agricultural production and waste generation. PSA Statistical Report.

Puglia, D., Pezzolla, D., Gigliotti, G., Torre, L., Bartucca, M.L. and Del Buono, D. (2021). The opportunity of valorizing agricultural waste, through its conversion into biostimulants, biofertilizers, and biopolymers. *Sustainability*, *13*(5), p.2710.

Raza, M.H., Abid, M., Faisal, M., Yan, T., Akhtar, S. and Adnan, K.M., (2022). Environmental and health impacts of crop residue burning: scope of sustainable crop residue management practices. *International Journal of Environmental Research and Public Health*, *19*(8), p.4753.

Reaño, R. L., & Halog, A. (2023). Analysis of carbon footprint and energy performance of biohydrogen production through gasification of different waste agricultural biomass from the Philippines. *Biomass Conversion and Biorefinery*, *13*(10), 8685-8699.

Rekleitis, G., Haralambous, K. J., Loizidou, M., & Aravossis, K. (2020). Utilization of agricultural and livestock waste in anaerobic digestion (AD): Applying the biorefinery concept in a circular economy. *Energies*, *13*(17), 4428.

Reni, D. S., & Prasetiyo, E. (2025). Community Empowerment through Waste Bank Program as an Eco-Centric Approach to Environmental Management in Jururejo Village, Ngawi Subdistrict. *Indonesia Journal for Community Service and Empowerment*, *1*(1), 31-37.

Rodríguez-Espinosa, T., Papamichael, I., Voukkali, I., Gimeno, A.P., Candel, M.B.A., Navarro-Pedreño, J., Zorpas, A.A. and Lucas, I.G., 2023. Nitrogen management in farming systems under the use of agricultural wastes and circular economy. *Science of The Total Environment*, *876*, p.162666.

Sarangi, P. K., Singh, A. K., Srivastava, R. K., & Gupta, V. K. (2023). Recent progress and future perspectives for zero agriculture waste technologies: Pineapple waste as a case study. *Sustainability*, *15*(4), 3575.

Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis. IDS Working Paper 72, Institute of Development Studies.

Singh, D., Dhiman, S.K., Kumar, V., Babu, R., Shree, K., Priyadarshani, A., Singh, A., Shakya, L., Nautiyal, A. and Saluja, S., 2022. Crop residue burning and its relationship between health, agriculture value addition, and regional finance. *Atmosphere*, *13*(9), p.1405.

Strang, K. D., Che, F., & Vajjhala, N. R. (2022). Thematic analysis of agricultural government policy and operational problems. *Agricultural Research*, *11*(3), 549-556.

Tanveer, M., Khan, S.A.R., Umar, M., Yu, Z., Sajid, M.J. and Haq, I.U. (2022). Waste management and green technology: future trends in circular economy leading towards environmental sustainability. *Environmental Science and Pollution Research*, *29*(53), pp.80161-80178.

Tewari, M., Chaturvedi, V., Vashisht, J.K. (2025). Exploring Implementation of Sustainable Development Goals Through Construction Demolition Waste Management for Environmental Sustenance Using NVivo. In: Shukla, B., Murthy, B.K., Hasteer, N., Gupta, S., Mahapatra, D. (eds) Digital Solutions for Environmental and Economic Development. ICEIL 2024. Lecture Notes in Electrical Engineering, vol 1385. Springer, Singapore. https://doi.org/10.1007/978-981-96-5066-8_14

Ufitikirezi, J.D.D.M., Filip, M., Ghorbani, M., Zoubek, T., Olšan, P., Bumbálek, R., Strob, M., Bartoš, P., Umurungi, S.N., Murindangabo, Y.T. and Heřmánek, A., 2024. Agricultural waste valorization: exploring environmentally friendly approaches to bioenergy conversion. *Sustainability*, *16*(9), p.3617.

  

UN Women. (2020). Women and sustainable agriculture in the Asia-Pacific region: Challenges and policy interventions. https://asiapacific.unwomen.org

Upadhyay, S. K., Singh, G., Rani, N., Rajput, V. D., Seth, C. S., Dwivedi, P., ... & Khoo, K. S. (2024). Transforming bio-waste into value-added products mediated microbes for enhancing soil health and crop production: Perspective views on circular economy. *Environmental Technology & Innovation*, *34*, 103573.

Waqas, M., Hashim, S., Humphries, U.W., Ahmad, S., Noor, R., Shoaib, M., Naseem, A., Hlaing, P.T. and Lin, H.A.,(2023). Composting processes for agricultural waste management: a comprehensive review. *Processes*, *11*(3), p.731.

World Bank. (2019). Agriculture and the environment: Managing agricultural residues and waste in developing countries. World Bank Group Report. https://www.worldbank.org/agriwaste

World Bank. (2021). Unlocking the potential of women-led enterprises in rural development. https://www.worldbank.org

Yasmita, I. G. A. L., & Rahmantari, N. L. L. (2025). Fostering Women's Welfare in Vegetable Farming: Sustainable Waste Management Strategies And Digital Financial Inclusion in Baturiti Villages. In Proceedings of the International Conference on Social Science, Environment and Technology Development (pp. 435-442).

  