Opportunities to Drive a Transition Towards a Circular Economy in Viet Nam’s Agricultural Sector
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As of 2023, only 28 percent of NDCs explicitly mention circular economy (CE) as part of their mitigation measures. However, CE approaches can contribute to the reduction of greenhouse gases (GHGs) in several NDC sub-sectors, thereby raising climate ambition.

Building Circularity into NDCs: A Practical Toolbox (CE-NDC Toolbox) aims to support countries in identifying, prioritizing, implementing, and tracking CE interventions in their NDCs to raise ambition and accelerate implementation as part of a just and inclusive transition. The toolbox is organized in four stages to leverage a country’s policy cycle, from assessing the GHG emissions associated with material use and prioritising sectors/sub-sectors for the NDC to defining CE policy responses, identifying policy instruments, and tracking and reporting progress in national Biennial Transparency Reports (BTR) as part of the NDC process. Each stage includes a set of steps and key questions to consider, as well as tools, case studies, and checklists. Examples of how to use the toolbox in two high-impact sectors (construction and food waste) are also provided.

This issue brief is the first in a series exploring opportunities for integrating circular practices into Viet Nam’s agricultural sector, thereby contributing to enhancing the country’s climate commitment, and notably the new Nationally Determined Contribution (NDC) due in 2025. It is supported by Building Circularity into NDCs: A Practical Toolbox, of which Viet Nam is one of the four pilot countries, and incorporates inputs from the first consultation workshop entitled Boosting NDCs’ Ambitions Through Circularity in the Agricultural Sectors – Introducing the CE-NDC Toolbox, which was hosted by the Viet Nam Circular Economy Hub in January 2024.

The brief was prepared by Femke Gubbels, Dr. Dao The Anh, and Dr. Mai Van Trinh, with input from Morgane Rivoal. It was edited by Merran Eby.

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ABOUT THIS BRIEF

ABOUT BUILDING CIRCULARITY INTO NDCS: A PRACTICAL TOOLBOX

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KEY MESSAGES

1. Extractive, intensive, and unsustainable practices in the agriculture sector call for the transition towards a circular economy.

2. Viet Nam’s legislative framework is paving the way for the integration of circular practices into policies.

3. Circular practices already exist in various agricultural sectors in Viet Nam.

4. Resource recovery is a key entry point to scale up and expand circular agriculture.

5. CE practices hold huge potential to respond to agriculture and climate policy goals while delivering social and economic co-benefits.
As global demand for food has continued to increase rapidly in past decades, the pressure on agricultural production and natural resources has grown. However, the environmental and socio-economic costs of linear food production are significant. For every dollar spent on food, it is estimated that society spends double on environmental, health, and economic costs (Ellen MacArthur Foundation, 2016). Half of these costs – estimated at $5.7 trillion USD annually – are due to the linear nature of agriculture (Ellen MacArthur Foundation, 2016). Without changes to unsustainable production and consumption patterns, emissions could grow by 30 to 40% by 2050 (IPCC, 2019).

Agriculture is critical to Viet Nam’s economic development, food security, and livelihoods. In 2022, the value added to the economy of the agriculture, forestry, and fisheries sector grew by 3.36%, the highest growth in recent years (GSO, 2023). The agricultural sector increased by 2.88% and fisheries by 4.43% that year, and export turnover reached record levels of $53.53 billion USD. In addition, 13.9 million people were employed in the agriculture, forestry, and fisheries sector in 2022, equating to 27% of the country’s working population (ibid.).

However, the growth of Viet Nam’s agricultural sector has come at the expense of the environment. The intensive use of fertilizers and chemicals, coupled with land expansion, has led to deforestation, depleted fish stocks, water pollution, and overall land degradation. Agriculture is also the second-highest emitting sector, accounting for 19% of national GHG emissions. Rice production makes up almost half of GHG emissions in the agricultural sector and 75% of total national methane emissions (MONRE, 2020). High GHG emissions can be explained by inefficient irrigation, fertilizer application, and energy use, along with poor management of rice residue and livestock by-products.

1 Extractive, intensive, and unsustainable practices in the agriculture sector call for the transition towards a circular economy.
Not so long ago, Viet Nam’s farmers commonly used animal waste and agricultural by-products as fertilizer. Due to a push for commercialization of the agricultural industry, however, the use of chemical fertilizers was incentivized to increase yield. Between 2010-2015, survey data from 720 farmers in the Red River Delta showed that only 17% used manure as a crop fertilizer, while 83% exclusively used chemical fertilizer (Mai, 2018). From 2015 onwards, the Ministry of Agriculture and Rural Development (MARD) recommended farmers increase manure use in crop production, leading to an increase from 713 to 5,580 organic fertilizer products between 2017 and 2020, doubling organic fertilizer production from 1.07 million tons to 2.4 million tons (MARD, 2022). While use of organic fertilizer is increasing, supported by Decree 109/2018/ND-CP on organic agriculture, critical steps are still needed to leverage the full potential of by-products and waste generated during the production process.

The use of manure for crop fertilizers can be categorized as a CE practice. Indeed, a circular economy is a system that is “based on three principles, driven by design: eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature” (Ellen MacArthur Foundation, 2021). Viet Nam adopted its definition of CE in Article 142 of the Revised Law on Environmental Protection 2020, in which it is described as “an economic model which encompasses the design, production, consumption, and service activities aimed at reducing raw materials, extending product life, reducing waste generation, and minimizing adverse impacts on the environment” (National Assembly, 2022). Further criteria for CE integration were set out in Decree 08/2022/ND-CP, including (i) reducing the use of non-renewable resources and water while increasing the efficiency of materials and resources and saving energy; (ii) extending the life of products and materials; and (iii) reducing waste generation, minimizing environmental impacts, and increasing sustainable consumption.

Currently, Viet Nam’s agriculture sector is defining what circular economy means for agriculture in the country, and how a circular agriculture system can be developed based on both new techniques and existing practices.
Viet Nam’s legislative framework is paving the way for the integration of circular practices into policies.

In recent agricultural and climate policies, the government has stressed the importance of mainstreaming circular practices. While no formal definition of circular agriculture yet exists in Viet Nam, several decisions have been adopted to embed CE approaches in agriculture. Key legal documents and provisions related to CE and the agriculture sector that have been adopted in the last decade are presented in Table 1.

The Nationally Determined Contributions (NDC) 2022 encourages measures in the agriculture sector to reduce methane emissions by 30% from 2020 levels by 2030.

In June 2024, MARD promulgated the Scheme on Scientific Development, Application, and Technology Transfer to Promote CE in Agriculture by 2030 (540/QĐ-TTg). It aims to use science and innovation to create a circular and competitive agricultural market that includes increasing value in the production chain, improving resource efficiency, reducing waste, increasing the proportion of reused and recycled agricultural by-products, and creating low-emission agricultural products.
<table>
<thead>
<tr>
<th>LEGAL DOCUMENT</th>
<th>PROVISION RELATED TO CE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision No. 296/QD-BNN-KHCN adopted in 2023 approving the Strategy for Developing Science, Technology and Innovation in the Agricultural Industry and Rural Development to 2030 with a vision to 2050</td>
<td>Article 1 sets the objective of the strategy to use science and technology to promote circular models in the agriculture sector in order to increase competitiveness.</td>
</tr>
<tr>
<td>Decision No. 300/QD-TTg adopted in 2023 approving the National Action Plan to Transform a Transparent, Responsible and Sustainable Food System by 2030</td>
<td>Article 1 describes the promotion of sustainable food consumption practices and encourages the development of ecological and low-emission agriculture.</td>
</tr>
</tbody>
</table>
| Decision No. 1490/QD-TTg adopted in 2023 approving the Scheme for Sustainable Development of One Million Hectares of Low-emission, High Quality Rice Associated with Green Growth in the Mekong Delta by 2030 | The detailed objectives for 2030 include, among others:  
- Post-harvest loss rate is less than 8%  
- 100% of straw is collected from the fields and processed for reuse  
- GHGs are reduced by more than 10% compared to traditional rice farming  
- The amount of chemical fertilizers and pesticides of chemical origin is reduced by 30% and irrigation water is reduced by 20% compared to traditional farming |
| Decision No. 150/QD-CP adopted in 2022 approving the Sustainable Agricultural and Rural Development Strategy for the period 2021 – 2030 with a vision to 2050                                                                 | Article 1 states the objectives of developing environmentally friendly agricultural approaches and reducing sector emissions by 10% compared to 2010.  
Article 2 tasks the State Bank of Vietnam with providing credit policies to develop organic and circular agriculture.                                                                                                                                                                                                                                                                 |
| Decision No. 687/QD-TTg adopted in 2022 approving the Circular Economy Development project                                                                                                           | Article 1 outlines the objective of developing a CE that contributes to green growth.  
Article 2 describes responsibilities for MARD to formulate policies and develop programmes on CE for the agriculture sector and key value chains.                                                                                                                                                                                                                                                                 |
| Decision No. 1658/QD-TTg adopted in 2021 approving the National Strategy on Green Growth for the period 2021-2030 with a vision to 2050                                                                 | Article 1 sets out the overall objective of developing green economic sectors by applying the CE model. It also sets the strategic direction for developing sustainable organic agricultural models.  
Article 1 also tasks MARD with developing a sustainable agriculture sector using CE principles and promoting market development for organic agricultural products.                                                                                                                                                                         |
| Decision No. 889/QD-TTg adopted in 2020 approving the National Action Programme for Sustainable Production and Consumption for 2021-2030                                                                 | Article 1 promotes the sustainable use of resources and sets out activities to provide guidelines on CE models for waste, specifically from agriculture.                                                                                                                                                                                                     |
| Law No. 72/2020/Qh14 on Environmental Protection adopted in 2020                                                                                                                                                                     | Article 142 of the law stipulates the definition of a circular economy.                                                                                                                                                                                                                                                                                               |
| Decree 109/2018/ND-CP adopted in 2018 on Organic Agriculture                                                                                                                                                                                 | Article 3 sets out the definition of organic agriculture and Article 5 stipulates the development of national standards on organic agriculture.                                                                                                                                                                                                                       |
| Decree No. 38/2015 ND-CP adopted in 2015 on the Management of Waste and Discarded Materials                                                                                                                                                       | Article 51 encourages the improved management of waste from agricultural activities and the reduced use of chemicals.                                                                                                                                                                                                                                             |
3

Circular practices already exist in various agricultural sectors in Viet Nam.

Before the term ‘circular economy’ gained traction, existing agricultural models in Viet Nam already incorporated characteristics that aligned with CE principles, including waste reduction, recycling and reuse of by products, and zero-waste design (Trieu, 2023).

Approaches like the garden–pond–barn model (also known as VAC farming, based on the Vietnamese term vườn-ao-chuồng) were introduced in the 1980s, which integrated farming (garden), aquaculture (pond), and animal husbandry (barn) to create a closed-loop agricultural system where the outputs from one component serve as inputs for the others. Several variations of this model have been developed in response to differing regional contexts, such as garden–pond–barn–forest and garden–pond–barn–biogas. These models improved waste management by using agricultural by-products and contributed to reducing GHG emissions by reducing demand for fossil fuel-based electricity through the increased production of renewable energy from organic materials (Trieu, 2023; Nguyen, 2020).

In the Mekong Delta, the rice–shrimp and rice-fish models that became popular in the early 2000s focused on crop rotation practices and using manure from aquatic species as a natural fertilizer for rice crops. Post-harvest, fish and shrimp are shifted to the fields to consume the remaining rice stubble and grains as feed. This system efficiently uses organic matter to enrich the nutritional content of growing rice plants and minimizes the need for fertilizer and pesticides (Nguyen, 2018). In addition, such systems have been put forward as effective climate change adaptation strategies, since they not only support farmers to improve their livelihoods but also enhance food security and diversify income in the context of saline intrusion and land subsidence.
CE principles have also been applied for specific crops, such as sugar, rice, and coffee beans. For example, Lam Son Sugar JSC (Lasuco), one of Viet Nam’s leading sugar producers, is using dried bagasse – a by-product generated during sugarcane production – as an input for power generation supplying its sugar refineries. The unused electricity generated is sold back to the grid through the Viet Nam Electricity Group, earning Lasuco an additional income of 10 billion VND ($430,000 USD) annually (Dao and Mai, 2023). Other factories have also converted bagasse ash into biochar, which can be used to improve soil health (Nguyen, 2023).

Across Viet Nam, a common use of rice straw by-products is for cultivating mushrooms. The amount of straw from one hectare of rice cultivation can provide 250-300 kg of mushrooms after 25-30 days (Dao et al, 2023). With an average price of 25,000-27,000 VND per kg, farmers can earn an additional 6-8 million VND per hectare (ibid.). This model is popular in the Central Highlands, Mekong Delta, and coastal regions of Viet Nam.

Viet Nam’s largest diary company, TH True Milk, uses several strategies to increase efficient water use, waste management and treatment, and energy reuse. Automatic irrigation systems precisely control the water distribution per crop to avoid overuse. Biomass bedding is used to collect solid cow manure and is compacted to be sold to rubber and coffee plantations as organic fertilizer (Duteurte et al, 2015). Liquid waste is treated in an industrial plant by capturing and straining sediment followed by a chlorine treatment before the treated wastewater is released into nearby surface water (ibid.). Furthermore, solar power and bagasse energy are used to reduce carbon emissions (Trieu, 2023). Between 2018 and 2022, TH True Milk reduced its GHG emissions per product unit by 20% (Viet Nam Agriculture, 2023).

VinaMilk has adopted solar energy systems as well, and has introduced processes to convert waste into resources. Livestock waste is treated with a biogas system, followed by separation of waste into solid and liquid fertilizer used for pastures and crop cultivation (Trieu, 2023). In turn, the fertilizer improves soil quality. All of Vinamilk’s farms are certified with the Global Good Agricultural Practices portfolio of standards, using regenerative farming methods.

Technologically advanced models focused on zero waste have more recently emerged in industrial agriculture companies. Que Lam Group introduced the 4Fs model (farm–food–feed–fertilizer) and T&T159 Joint Stock Company uses a similar production model. Waste products from crop cultivation are used in feed production for livestock, probiotics are added to feed and water to reduce the risk of livestock diseases, and farms adhere to organic standards such as natural ventilation and biologically padded surfaces (Trieu, 2023). The fertilizer produced by the companies is organic and is both used for their own production and sold on the market.

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Similarly, industrial coffee producers reuse by-products from coffee production. For example, 10% of Nestlé Viet Nam’s coffee grounds are reused as biomass materials. Non-hazardous waste sludge generated through the production process is also treated to be used as fertilizer, and waste and sand from boilers is provided to local brick manufacturers (Nestlé Viet Nam, 2024). In the coffee production province of Son La, UNDP trained coffee farmers on how to transform coffee pulp into organic fertilizer while treating wastewater for use in irrigation (UNDP, 2024).

While the term ‘circular economy’ is now gaining momentum in Viet Nam’s agriculture sector, the above examples illustrate existing farming practices based on CE principles, including minimizing the use of non-renewable resources and reducing waste generation.
Resource recovery is a key entry point to scale up and expand circular agriculture.

The current agriculture sector in Viet Nam has several entry points to increase circularity. This issue brief focuses on opportunities for resource recovery and reuse of agro-waste, specifically for rice production and livestock farming. Agro-waste includes leftovers from agricultural activities, including stalks, husks, stems, pulp, effluents, and other residues and by-products.

In circular agriculture, each step in the system – from production and processing to distribution, consumption, and disposal – is designed with a view to use natural resources efficiently, recover resources, reuse by-products, and reduce GHG emissions. Furthermore, circular agriculture has the potential to enhance farmers’ resilience to climate impacts by regenerating soil and water, diversifying food production, and enhancing food quality and diversity.

Figure 1 shows the difference between linear and circular economy models along each step of the process:

- **Production**: optimizing production processes to reduce use of natural resources and harmful chemicals, while integrating the reuse of agricultural by-products.
- **Food processing**: using by-products and waste as inputs for subsequent production processes.
- **Distribution**: improving packaging and transportation processes.
- **Consumption**: encouraging sustainable lifestyles and food consumption.
- **End-of-life waste management**: recycling and recovery of agro-waste streams.
also contributed to a lack of straw reuse, as they generate a larger amount of straw in a shorter period, spreading the straw across the field (Nguyen et al., 2018). Furthermore, the decision whether or not to burn rice by-products in certain provinces depends on many regional factors, such as the development and enforcement of local policies, local customs (in some areas, mushroom cultivation using rice straw is more common than others), harvest timing (if the farmer is occupied with off-farm work, time to collect straw is limited; the spring rice harvest has a very short window with little time for drying and collecting straw), local weather conditions and seasonality (it is easier to burn in the dry season than the wet season), and the practicality of alternative options (ibid.). Awareness of ways to reuse rice straw and husks to produce straw bales, biochar, and pellets is relatively low, and farmers lack access to capital investment for the machinery and equipment needed to produce biofuels and fertilizers using rice straw (ibid.). These challenges are less of an issue among industrial producers. However, agricultural by-products contain key nutrients such as potassium, sulfate, urea, and phosphates that can be used as fertilizer and crop nutrients. Rice by-products (straw and husks) in Viet Nam can provide the equivalent of 28.73 million tons of soil organic matter, 0.95 million tons of urea, 1.33 million tons of single super phosphate, and 1.6 million tons of potassium sulfate. At present, most of this biomass is not recovered, leading to the loss of organic matter and potential crop nutrients while contributing to water and air pollution and soil degradation.

Resource recovery from rice production

The total amount of residue and agricultural by-products from staple and industrial crops in Viet Nam is estimated at 95 to 98 million tons per year, including a majority of 52 million tons of straw and husk from rice production (Do et al., 2019). Rice, which accounts for 77% of the total harvested land area, is the dominant staple crop in Viet Nam and is concentrated in the Red and Mekong River Deltas (Nguyen et al., 2017). Two-thirds of fertilizers sold are used for rice cultivation, and rice production is the primary contributor to sectoral GHG emissions (ibid.), with an estimated 49,693 ktCO2eq in 2016 (MONRE, 2020).

Currently, by-products from rice production are processed through open burning, re-incorporating them into the fields, burned as cooking fuel, or used as cattle feed, mulch, a substrate for composting, or for mushroom cultivation (Dao and Mai, 2023). In 2015, survey data that indicated open burning was the most commonly used method across most surveyed provinces (LCASP, 2015). Data from 2023 shows that in most surveyed provinces, rice crop residues are either left on the field or reused (Table 2). The increase in reuse may be due to incremental increases in the selling price of rice straw or the increased availability of equipment to collect and roll it (Do et al., 2019). Specifically for rice straw, reuse is more common in Viet Nam’s southeast agro-ecological zone and the highland plateau, with 81.7 and 70% of rice straw reused respectively (Table 3).

While extensively used in the past, nowadays rice straw is rarely considered a valuable resource. Burning by-products after the rice harvest is viewed as a convenient and cost-effective option to get rid of waste and reduce fallow time between rice cropping. The introduction of combine harvesters...
### Table 2: Approaches to management of rice by-products in 18 provinces in Viet Nam (Source: IAE, 2023)

<table>
<thead>
<tr>
<th>No.</th>
<th>Province</th>
<th>Open burning</th>
<th>Left on the field</th>
<th>Collected for processing</th>
<th>Landfill</th>
<th>Reuse</th>
<th>Other</th>
<th>Total</th>
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### Table 3: Rice straw management in agro-ecological zones in 2023 (Source: IAE, 2023)

<table>
<thead>
<tr>
<th>Agro-ecological zone</th>
<th>Open burning</th>
<th>Left on the field</th>
<th>Collected for processing</th>
<th>Landfill</th>
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<td>100.0</td>
</tr>
<tr>
<td>Mekong River Delta</td>
<td>43.6</td>
<td>5.5</td>
<td>16.3</td>
<td>4.8</td>
<td>23.9</td>
<td>5.7</td>
<td>100.0</td>
</tr>
<tr>
<td>National average</td>
<td>21.7</td>
<td>20.1</td>
<td>22.4</td>
<td>0.8</td>
<td>30.6</td>
<td>4.4</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Despite the above-mentioned barriers, the potential for resource recovery during the rice production process is substantial, generating value-added products such as biomass, biofuel development, and organic fertilizer:

- **Biomass development** uses rice by-products such as straw and husks to create biomass fuel pellets through primary processing for use by households, small-scale farms, and export. Using biomass pellets also generates biochar, which can be applied as organic fertilizer enhancing nutrient retention in water and soil (Trieu, 2023). Biomass pellet technologies are already being deployed in Vietnam, with further potential for upscaling.

- **Nutrient recycling**: About 40% of the nitrogen, 30-35% of the phosphorous, and 80-85% of the potassium used by rice plants during the growth cycle remain in the straw after harvest (Nguyen et al, 2018). A successful example of nutrient recycling can be found in Trieu Phong district, Quang Tri province, where the shift from burning rice straw in the fields to composting combined with microbiological inputs has yielded valuable products including rice, organic vegetables, and livestock with significant economic value (Trieu, 2023).

- **High-density rice straw compaction** from agro-waste can produce high-end market products such as dense bales, briquettes, and pellets, the use of which can decrease handling and transportation costs (Balingbing et al, 2020). IRRI and MARD’s Crop Production Department are working on mechanizing the collection of dry and wet straw as part of the recently approved Programme on the Sustainable Development of One Million Hectares of High Quality and Low-Emission Rice Associated with Green Growth in the Mekong River Delta By 2030 (also known as the ‘one million hectares of high-quality rice’ project), with the objective to remove 20 million tons of rice straw from the field and use it for mushroom cultivation, cattle feed, and composting (MARD, 2024). This aims to improve scalable technologies for the collection and treatment of rice stubble, which is currently costly (ibid.).

**Resource recovery from livestock farming**

In 2021, Vietnam’s livestock population included 524 million poultry, 23 million pigs, 6.3 million cows, and 2.3 million buffalo (GSO, 2022b). These are estimated to generate 71.9 million tons of solid waste and 76.4 million tons of liquid waste per year (MARD, 2021) which, when left untreated, has negative impacts on water and soil, in turn affecting crop quality (Parihar, 2019). Direct emissions from manure were 6,092 ktCO2eq in 2016 (MONRE, 2020).

Currently, livestock waste is primarily managed through composting for fertilizer, biogas digesters, and the use of unprocessed manure as fertilizer, depending on the location, livestock type, and farm size. Typically, poultry manure is often directly used as fertilizer, whereas the majority of waste from dairy farms is processed using biogas digesters (Trieu, 2023). Livestock waste can provide the equivalent of about 42 million tons of soil organic matter, 1.2 million tons of urea fertilizer, 3.1 million tons of phosphate, and 2.4 million tons of potassium sulfate fertilizer (Table 4). Combining by-products from crops with animal waste, approximately 85.4 million tons of soil organic matter, 3.06 million tons of urea fertilizer, 4.78 million tons of phosphate, and 4.63 million tons of potassium sulfate fertilizer can be generated per year, which exceeds the country’s total fertilizer demand of 10.23 million tons (Mai, 2023). This finding is particularly relevant, as it would contribute to reducing the country’s dependence on imported fertilizers whose price volatility directly influence farmers’ profits.

Using 2020 fertilizer prices of $0.50 USD/kg urea, $0.20 USD/kg phosphate and $0.45 USD/kg of potassium sulfate, the fertilizer from these sources (3.06 million tons of urea, 4.78 million tons of single super phosphate, and 4.63 million tons of potassium sulfate fertilizer) has the potential to save $4.5 billion USD each year, not including organic fertilizer (ibid.).

### Table 4: Nutrient content in livestock waste (Source: Mai, 2023)

<table>
<thead>
<tr>
<th>Livestock type</th>
<th>Nutrient concentration (%)</th>
<th>Nutrient mass (million tons)</th>
<th>Equivalent amount of fertilizer (million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry matter</td>
<td>N total</td>
<td>P2O5</td>
</tr>
<tr>
<td>Pigs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>33.8</td>
<td>0.669</td>
<td>0.546</td>
</tr>
<tr>
<td>Poultry</td>
<td>17.0</td>
<td>1.110</td>
<td>1.755</td>
</tr>
<tr>
<td>Cows</td>
<td>26.2</td>
<td>0.341</td>
<td>0.099</td>
</tr>
<tr>
<td>Buffalo</td>
<td>17.7</td>
<td>0.306</td>
<td>0.076</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24.30</strong></td>
<td><strong>0.56</strong></td>
<td><strong>0.52</strong></td>
</tr>
</tbody>
</table>

(MONRE, 2020).
Biogas is a source of renewable energy that can be generated through anaerobic digestion of waste from livestock, which is especially suitable for moist agro-industrial waste. Although the process is relatively straightforward, a 2021 survey in Ha Nam and Binh Phuoc province indicated that only 11% of the 102 agricultural models from households and cooperatives surveyed use biogas (Trieu, 2023). This is likely due to a lack of access to the required equipment (ibid.).

Using the wastewater generated in the process of biogas generation in a livestock farming context, several experiments involving the treatment of wastewater from biogas digesters with effective organisms have shown positive results in Viet Nam, although largely in experimental conditions to date. The approach reduced the concentration of key water quality parameters to acceptable levels. Experiments using water hyacinth to treat wastewater from biogas digesters showed similar results, although neither approach has been widely adopted by farmers due to the size required for the treatment area (Nguyen, 2017).

Another successful model that can be scaled up in livestock farming is black soldier fly farming. Black soldier flies are insects commonly found outdoors near livestock or close to areas with decomposing matter such as animal waste. Black soldier fly larvae are used to compost waste and convert it into animal feed in some provinces in Viet Nam, including Binh Phuoc, Ba Ria – Vung Tau, and Can Tho (Trieu, 2023). Black soldier fly larvae have a nutritional composition containing 43-51% protein, 15-18% fat, 2.8-6.2% calcium, and 1-1.2% phosphorus, so they form a rich source of nutrients for livestock (Nguyen et al, 2017). Aside from the protein production, fly larvae also produce another valuable resource called frass. Fly larval frass is a granulated and odorless residue that can be used as organic fertilizer directly or through conversion by earthworms (Cappellozza et al, 2019).

COMBINING BY-PRODUCTS FROM CROPS WITH ANIMAL WASTE, THE SOIL ORGANIC MATTER, UREA FERTILIZER, PHOSPHATE, AND POTASSIUM SULFATE FERTILIZER GENERATED PER YEAR CAN EXCEED THE COUNTRY’S TOTAL FERTILIZER DEMAND OF 10.23 MILLION TONS.

Mai, 2023
Circular economy practices hold huge potential to respond to agriculture and climate policy goals in Viet Nam.

Viet Nam’s agriculture sector already applies several practices that reflect characteristics of a circular economy, both in traditional approaches such as VAC models as well as in modern techniques supported by the rapid advancement of science and technology. Circular elements can be found in specific parts of the production process, especially regarding the resource recovery of waste and by-products, serving as a way to reduce production costs (Trieu, 2023). Production of organic fertilizers from animal waste and crop residue, incorporation of rice straw into soil, biomass development, use of biochar, and practices based on organic agriculture principles are applied to various degrees.

Due to the scale and importance of the agriculture sector, including its environmental impacts, contribution to GHG emissions, and vulnerability to climate impacts, it is strategic to further leverage the potential for a CE model for the agriculture sector. Accelerated resource recovery from agro-waste will contribute to the reuse and production of materials, proteins, energy, and nutrients while strengthening the resilience of food systems and smallholders to rapidly increasing climate impacts. Existing practices can be further scaled up with financial support and technological innovations, leveraging recently approved projects and policies (such as the ‘one million hectares of high-quality rice’ project) while also bringing circularity into processing, distribution, and consumption phases of the agriculture sector to fully close the loop.
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