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Circular Economy in Vietnam's agriculture, the Potential Substitute of Chemical Fertilizers by Animal Wastes and Crop Residues

[1]Mai Van Trinh
[1]Institute for Agricultural Environment, Vietnam Academy of Agricultural Sciences
Address: Sa Doi street, Phu Do ward, Nam Tu Liem district, Ha Noi city, Viet Nam
Corresponding email: maivantrinh@gmail.com

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ABSTRACT

The objectives of this study is to calculate the potential of plant nutrients from animal wastes and crop residues. Animal population data was collected from the reports of the Ministry of Agriculture and Rural Development and crop residue data were collected by the Institute for Agricultural Environment project in its current use of crop residues. Annual amount of equivalent fertilizers can be calculated from massive wastes and residues from the current agricultural production. Crop residues contain the equivalent of 43.40 million tons of organic matter, 1.86 million tons of urea, 1.68 million tons of single super phosphate and 2.23 million tons of potassium sulfate, while animal wastes contain the equivalent of 42 million tons of organic matter, 1.20 million tons of urea, 3.10 million tons of single super phosphate and 2.40 million tons of potassium sulfate. In total, wastes and residues from both sub-sectors contain an equivalent of 85.40 million tons of organic matter, 3.06 million tons of urea, 4.78 million tons of single super phosphate and 4.63 million tons of sulfate potassium. However, the current used wastes and residues are very low, not taking advantage of resources, causing greenhouse gas (GHG) emissions, and polluting the environment. The circulation of these wastes and residues needs to have a combination of both crops, livestock sides and aquaculture as well as other kinds of agricultural production. Some current practices of circular systems are the production of organic fertilizers from animal wastes and crop residues, incorporation of rice straw into the soil, stove gasification and carbonization for renewable energy and biochar, organic agriculture and circulated farms. These practices showing many advantages of effectively using animal wastes and crop residues for agricultural production to reduce environmental pollution, enhancing soil fertility, generating clean energy and reducing the use of synthetic fertilizers as well as reducing GHG emissions.

Keywords: Animal wastes, crop residues, fertilizers, sustainable farming

INTRODUCTION

McCarthy *et al.* (2019) concluded that agricultural wastes can be turned into bio-products such as fertilizers, energy, materials and compounds. FAO (2021) defined that circularizing agriculture is based on the principles of minimizing demands on external inputs, closing nutrient loops, and reducing the environmental impact from discharges and runoff. Landini (2020) wrote that organic wastes from farming has long been used as a source of fertilizer for agriculture. Biological wastes such as crop stalks, leaves and pods, and animal wastes can be converted into fertilizers which are rich in nitrogen, phosphorous, potassium and other nutrients and can reduce the cost and resource demand for external inputs of synthetic fertilizers. That biomass from plant and animal wastes can also be used directly or modified to produce biofuels that can be used for heat, electricity, or transportation fuel production (Landini, 2020).

In Thailand, the collaboration between the Netherlands and Thailand on circular agriculture (The Netherlands Embassy in Bangkok, 2020) for rice and sugarcane, in which the traditional, vital economic crops of Thailand were used, reported that by-products from rice production are used for rice bran oil, organic fertilizer, and biomass for silage. Sugarcane also presents opportunities for the utilization of by-products to produce food, feed, and other products for the agro-industry in the form of food ingredients, bio-energy, and household products. However, while the awareness is rising, the country is still in an early stage of its transition towards circular economy (CE). In this stage, policy frameworks are being adjusted, and the industry is gradually transforming.

In Europe, it is estimated that a circular approach to food systems could reduce the use of chemical fertilizers by 80% (Ellen MacArthur Foundation, 2016).

In Uganda, a small-scale mixed farming system, where a range of livestock and plants are grown on the farm has been developed, so waste products can be shared and reused within the system to provide fertilizers, pesticides and energy (AfricaFoodPrize, 2023).

Also in Uganda, livestock waste is fed to maggots which can be used as feed for fish and other animals, with the insects' waste and nutrient-rich wastewater from the aquaculture system used to fertilize and irrigate crops. An anaerobic digester is also used to process livestock wastes to make biogas for cooking (The Ellen MacArthur Foundation, 2023).

Singapore developed a Singapore Green Plan 2030 (Government of Singapore, 2022) with following key targets of planting 1 million more trees, quadrupling the deployment of solar energy by 2025, reducing wastes sent to landfill by 30% by 2030, at least 20% of schools are targeted to be carbon neutral by 2030, and all newly registered cars are to become cleaner-energy models from 2030

After a long period of implementing advanced and intensive farming measures, the crop cultivation is facing many environmental problems and sustainable development issues such as: (i) excessive fertilizers and chemical pesticides than recommended which causes waste and environmental pollution (Nguyen, 2017); (ii) the use of compost is severely reduced to less than 15% in both quantity and volume (Mai Van Trinh and cs, 2018); burning 35-70% of agricultural residues in the field lead to the loss of both organic matter and plant nutrients, smog and air pollution, and increasing climate change (Do Thu Ha and cs, 2019).

Growing livestock is always accompanied with a load of wastes. Nguyen The Hinh (2017) has calculated the annual volume of wastes released from livestock to the environment with 70-80 million tons/year. The high-speed development and the obsolete infrastructure systems and environmental treatment lead to a series of environmental problems such as soil, water and air pollution from solid and liquid wastes and wash water from cattle barn discharged into the environment without treatment; air pollution and public health issue from foul odors from barns accompanied by toxic gases H_2S, NH_3; and wastes from slaughterhouses (feces, washing water, fur, nails, secretions, excess body parts).

Some circular systems developed in Vietnam from the past showed some prospects for stimulation in the future, for example, the system of Garden-Pond-Barn (VAC) has been widely adopted in Vietnam since the 1980s and is considered the simplest form of circular agriculture (Nguyen Xuan Hong, 2020). In particular, the farm is for planting crops, ponds are for aquaculture and barn is for livestock and poultry in households and farms. The close system of Garden - Pond - Barn (VAC) has created a system of integrated agricultural production, linking crops with livestock, limiting wastes, following natural form and fully conforming to the principles of circular economy. Some other close systems of Garden - Pond - Barn - Biogas (VACB), Garden- Pond - Barn - Forest (VACR) usually practiced in mountainous provinces and the system ofimplementing these agricultural systems is both highly economical and helps reduce greenhouse gas (GHG) emissions. Other examples are the "rice, shrimp" and "rice, fish" systems (Vu Rain, 2020). The "rice and shrimp" system has been applied since the early 2000s in the Mekong Delta provinces, while the "rice and fish" system is implemented in low-lying and frequently flooded province in the Red River Delta. In these systems, when raising shrimps or fishes in rice fields, the waste of shrimps, fishes and leftover foods (of shrimps, fishes) will serve as fertilizers to supplement nutrition for rice growth. Another example is the system of rice - mushroom - organic fertilizer - fruit tree cultivation (Vu Ba Quan, 2020), which is popular in most provinces and cities throughout the country. In this system, farmers have taken advantage of rice straw residues from rice fields to grow mushrooms and use straw yards after harvesting mushrooms to produce fertilizer for crops (fruit trees, vegetables).

Crop residues were completely collected in the 1980s and 1990s for many purposes of making house’s roof, cooking and more effectively, to put into the pig’s stable to mix with animal wastes (both solid and liquid) to become Farm Yard Manure (FYM) with very high quality. This FYM is taken out and apply to the crop every season of 6 months. That resulted in the collection of all crop residues and animal wastes to be used and there was no pollution in the environment where most of the fields were applied FYM. However, according to recent surveys, the baseline of organic manure application in Red River Delta for low emission rice cultivation project by Mai Van Trinh *et al*., (2016) showed that only 17% of farmers applied manure with less dose compared with the recommendations and most of the farmers applied chemical fertilizers only, while a lot of animal wastes and rice straws directly emitted to the environment which causes more pollution. Moreover, the open burning of rice straw in the period of 2010 was up to 70% of total rice straw. This huge resources of carbon and plant nutrients is being used ineffectively and can be returned to the soil for mitigating environment pollution and improve agricultural production economic.

Therefore, the objective of the study is to present the potential of circular economy (CE) for agriculture by reusing crops and livestock wastes circulated material flows to replace chemical fertilizers, increasing the development of sustainable agriculture through organic agricultural practices and circular-oriented agriculture.

METHODOLOGY

Method of data collection

Data on crop residues was collected by the Institute for Agricultural Environment through a project on the current use of crop residues in Vietnam’s agro-ecological zones (IAE, 2019). Data on livestock was collected from the report of the Ministry of Agriculture and Rural Development for the period 2016-2020 (MARD, 2021). Emissions figures from cattle, poultry and farming systems are collected from different sources such as: General Statistics and plans of the Ministry of Agriculture and Rural Development, journals, scientific reports and experts. Data on biochar come from field experiment in Soc Son district, Ha Noi, Vietnam during 2011-2012 with different treatment of organic material and chemical fertilizers on degraded soil to evaluate effects of biochar on improving soil fertilities. Energy from crop stove also come from gasification experiment with 3 different gasifiers to evaluate the energy yield and by-product from each in 2017.

Methods of synthesis, calculation and formulation of proposals

Data on livestock wastes, crop residues and their nutritional composition were collected and compiled from variety of sources. The collected data was standardized and processed to come up with a representation.

Nutrient content from each type of crop residues and animal wastes were adopted from previous published studies. The potential nutrients from crop residues (in 2015) and animal wastes (average 2016-2020) were calculated. By then, the potential replacement of organic fertilizers and chemical fertilizers were also calculated. Effect of biochar on soil fertilities were analyzed and compared with soil analysis results between biochar applied and control treatments in biochar field experiment. The barriers of waste circulation were identified, thereby developing proposals to make use of most of valuable resources for sustainable agricultural production through farming activities such as organic agriculture, circulation.

RESULTS AND DISCUSSION

Crop residues

Agricultural production land in the country occupies over 11 million hectares with many crops, the largest of which is about 4 million hectares of rice land or over 7.4 million hectares of cultivated rice and approximately 1 million hectares of maize land. Other plants, such as annual vegetable crops, short-term, long-term industrial plants, fruit trees account for smaller area. Each plant has a certain percentage of residues after harvesting. Some crops with large amounts of agricultural residues are shown in Table 1.

Table 1. Main cultivation biomass in 2015

Sources of agricultural biomass	Potential (million tons)
Rice straw	45.22
Rice husk	8.73
Corn stalks	6.33
Cassava	3.50
Sugarcane	20.00
Coffee pods	0.77
Vegetable of all kinds*	10.50
Sum	95.05

Source: Institute for Agricultural Environment (2019)

Table 1 shows that rice straw, the largest volume of residues, has over 45 million tons of straws and over 8 million tons of husks per year, followed by sugarcane with the volume of kelp and old leaves also over 20 million tons / year, followed by corn leaf stems, cassava, vegetables of all kinds and coffee peels. Although the volume of residues from vegetable plants are large, the dry matter and nutrient content are low, so it is not taken as seriously as other crops. Straw is used for many purposes. However, in the context of industrialization and urbanization, straw is much redundant, leading to higher rate of burning, ranging from 35-70% (Do Thu Ha and cs, 2019). The issue which most people are concerned are sugarcane inguinal and leaves, which are often burned 100% after harvesting on the grounds because of their difficulty in tilling and soft transmission of diseases. Most crop residues have not been used effectively and could have high percentage of open burning and free releasing in the environment causing GHG emissions and environmental pollution.

Animal wastes

According to the statistics of the Ministry of Agriculture and Rural Development (MARD, 2021), on average from 2016 to 2019, the total herd of cattle and poultry in the country reached 27.28 million pigs, 420.34 million poultry, 6.02 million cows and 2.48 million buffaloes (Table 2).

Table 2. Estimated daily waste volume of cattle and poultry

Livestock	Solid wastes, kg/head/day	Liquid wastes, kg/head/day	Total wastes (million tons)

	(1)	(2)	(3)	(2)	(3)	Annual average (2016-2020) 1,000 (2016)*	solid	Liquid
Pig	2.5	1.2-3.0	2.3	4-6	3.5	27,283	24.90	49.79
Poultry	0.02	0.02-0.05		-		420,336	3.07	-
Cow	10.0	15-20		6-10		6,024	26.20	17.59
Buffalo	15.0	18-25		8-12		2,481	17.70	9.06
Goats, sheep	1.5	1.5-2.5		0.6-1.0		-	-	-
Sum							71.87	76.44

(1): Tong Xuan Chinh, 2015; (2): Vu Chi Cuong (2013); (3) Elena Forbes; * Ministry of Agriculture and Rural Development (2021).

With the emission coefficient reported by Tong Xuan Chinh (2015), Vu Chi Cuong (2013) and Elena Forrbes (2015), the total amount of wastes from livestock in the year (average 2016-2020) of our country comprised 71.87 million tons of solid wastes and 76.44 million tons of liquid wastes per year, of which the herds of pigs and buffalo contribute the most amounts of solid wastes and pigs contribute the largest amount of liquid wastes.

Potential for crop nutrients through organic fertilizers for agricultural production

From the total crop residues as shown in Table 1 and the characteristics of each crop residues with the content of main nutrients such as organic matter, protein, phosphorus, potassium, we can calculate the potential that these residues can provide for agricultural production (Table 3).

Table 3. Nutrient content in some major crop residues

Crop residues	Nutrient content (%)				Amount of nutrients (million tons)				The amount of equivalent fertilization (million tons)			
	Dry matter	N	$P_2O_{5\ total}$	K_2O_{total}	C	N	P_2O_5	K_2O	Organic matter	Urea	Super phosphate	Potassium Sulfate
Rice straw	31	0.80	0.20	1.50	14.02	0.36	0.09	0.68	24.21	0.80	0.54	1.36
Rice husk	30	0.80	1.50	1.35	2.62	0.07	0.13	0.12	4.52	0.15	0.79	0.24
Corn stalks	30	1.29	0.26	0.12	1.90	0.08	0.02	0.01	3.28	0.18	0.10	0.02
Sugarcane	31	0.77	0.20	1.40	6.20	0.15	0.04	0.28	10.71	0.34	0.24	0.56
Vegetables of all kinds	3.7	1.70	0.014	0.30	0.39	0.18	0.00	0.03	0.67	0.39	0.01	0.06
Sum					25.12	0.85	0.28	1.12	43.40	1.86	1.68	2.23

Source: calculated by author

The residues of major crops such as rice, corn, sugarcane, vegetables of all kinds with the critical content of nutrients can provide the equivalent of about 43.4 million tons of organic matter, 1.86 million tons of urea, 1.68 million tons of single super phosphate and 2.23 million tons of potassium sulfate. This biomass is being used inefficiently with 35-70% being burned (especially 100% of sugarcane leaves and the majority of corn leaf stems burned after harvest) causing loss of huge amounts of organic matter and crop nutrients, water and air pollution, lack of organic matter in soil and severe soil degradation.

Table 4. Nutrient content in livestock wastes

Animal	Nutrient concentration (%)				Nutrient mass (million tons)				The amount of equivalent fertilization (million tons)			
	Dry matter	N total	P_2O_5	K_2O	C	N	P_2O_5	K_2O	Organic matter	Urea	Super phosphate	Potassium Sulfate
Pig	33.8	0.669	0.546	0.991	11.42	0.23	0.18	0.33	19.73	0.50	1.11	0.67
Poultry	17.0	1.110	1.755	2.585	2.89	0.19	0.30	0.44	4.99	0.42	1.79	0.88
Cow	26.2	0.341	0.099	0.795	6.86	0.09	0.03	0.21	11.86	0.20	0.16	0.42
Buffalo	17.7	0.306	0.076	1.129	3.13	0.05	0.01	0.20	5.41	0.12	0.08	0.40
Sum					**24.30**	**0.56**	**0.52**	**1.18**	**41.99**	**1.24**	**3.14**	**2.37**

Source: authors calculated

Based on the volume and characteristics of each type of solid wastes, the results show that annually, the amount of livestock wastes can provide the equivalent of about 42 million tons of organic matter, 1.2 million tons of urea fertilizer, 3.1 million tons of single super phosphate and 2.4 million tons of potassium sulfate fertilizer.

Thus, both crop residues and animal wastes can contribute about 85.4 million tons of organic matter, 3.06 million tons of urea, 4.78 million tons of single super phosphate and 4.63 million tons of potassium sulfate fertilizer per year, that is more than the total amount of fertilizers that the country demands in a year. Taking fertilizer price in 2020 with US$0.5 /kg urea, US$0.2 /kg single super phosphate and US$0.45 /kg of potassium sulfate. The chemical fertilizer from these sources can save US$4.5 billion each year, not including organic fertilizers.

The current state of circular agriculture in Vietnam

Production of organic fertilizers from animal wastes and crop residues

Animal wastes and crop residues were completely used for agriculture as manure in the past before the year 2000 in kind of farm yard manure. Due to urbanization and industrialization, household livestock production reduces very rapidly, together with no area for household livestock production and storing wastes. The use of animal wastes and crop residues dropped down to a very low level in the years of 2010-2015. Our survey from 720 farmers in Red River Delta (Mai Van Trinh, 2018) showed that less than 17% of farmers apply manure for crops and 83% of farmers used chemical fertilizers only. The quantity of manure they used was also very low, less than 5 tons/ha/season compare with 10 tons/ha/season in the past. From 2015 onwards, under the movement and pressure of different programs of organic farming, the MARD recommended to use more manure in crop production and planned to have the production of manure of about 3 million tons/year. Because of that, production of organic materials increased very fast from 713 organic fertilizer products and the production of 1.07 million tons in 2017 to 5,580 organic fertilizer products and the production of 2.4 million tons in 2020 (PPD, 2022)

Straw incorporation

As stated above, rice straw was well collected in the past for many purposes, but became redundant nowadays, especially when the number of farmers increased using the combined harvester to collect rice straw and left the remaining rice stubble on the fields. This trend increased year by year and rice stubble is plowed and incorporated into the soil as green manure for soil fertility. This practice helps to return a big amount of organic material (carbon content is about 46% of rice straw) that adding a big amount of carbon and nutrient to the soil as analyzed above). However, the practice also left behind many disadvantages of releasing CH_4 and H_2S during decomposition processes that can poison the young rice plants, releasing acid to make the soil more acidic and competing in plant nutrients by microbial means. So that many research questions need to be answered to have better use of rice straw.

Stove gasification and carbonization for renewable energy and biochar

Rice straw and rice husk were carbonized by a farm household heater in a very low oxygen or sometimes no concentration to become biochar (Mai Van Trinh *et al*. 2012). The heater can be operated very easily without adding any energy but making the biochar quantity and quality stable. The heater then was re-designed with some improvement in size and construction material that can be used for a group of farmers on a village scale. Biochar then continued to be produced from many other crop residues like corn cobs, corn stems and leaves, bamboo and coconut residues. Biochar was used not only for soil improvement, but also for treatment of polluted water, making pot soil, tooth path and other forms of medicines (Tran Viet Cuong, 2012). The char process was then optimized by using gasification system to gasify crop residues (rice straw, rice husk, saw dust) for cooking. The residues from that process are biochars remained in the gasifier for soil improvement material. The benefit of residue gasification is presented in Table 5.

Table 5. Stove gasification results by different gasifiers

Performance metrics	MHH-003 stove	DK-T5 stove	Husk industrial stove
Materials	Husk, sawdust, husk firewood …	Husk, sawdust, husk firewood …	Husk, sawdust, husk firewood …
Max. Temp.	1,250^{o} C	950^{o} C	1,100^{o} C
Calorie at peak (KJ/m^3)	12,000	8,700	11,500
Max. material (kg)	Husk (10-12kg), sawdust (14-15 kg), husk firewood (15-17kg)	2 kg husk firewood, 1 kg husk	4 kg husk, 6 kg husk firewood
Burning period/kg material	30-35 minutes	25-30 minutes	30-35 minutes
The rate of biochar/fuel (%)	28-33	16-20	18-20
CH_4 pollution reduction potential (%)	100	35-50	40-60
Price (US$)	150.00	72.25	99.00

Note: MHH-003 stove: the close gasifier from Institute for Agricultural Environment; DK-T5 stove: open gasifier from Dang Khoi company; and gasified by industrial tool.

Table 5 shows stove gasification by three gasifiers, the first one made by the Institute for Agricultural Environment that is close gasifier to have the highest GAS and biochar yield, the second one made by Dang Khoi company shows that open gasifier has lower gasifier and biochar yield. The MHH-003 stove gasifier has higher gas and biochar yield than both DK-T5 and industrial gasifiers.

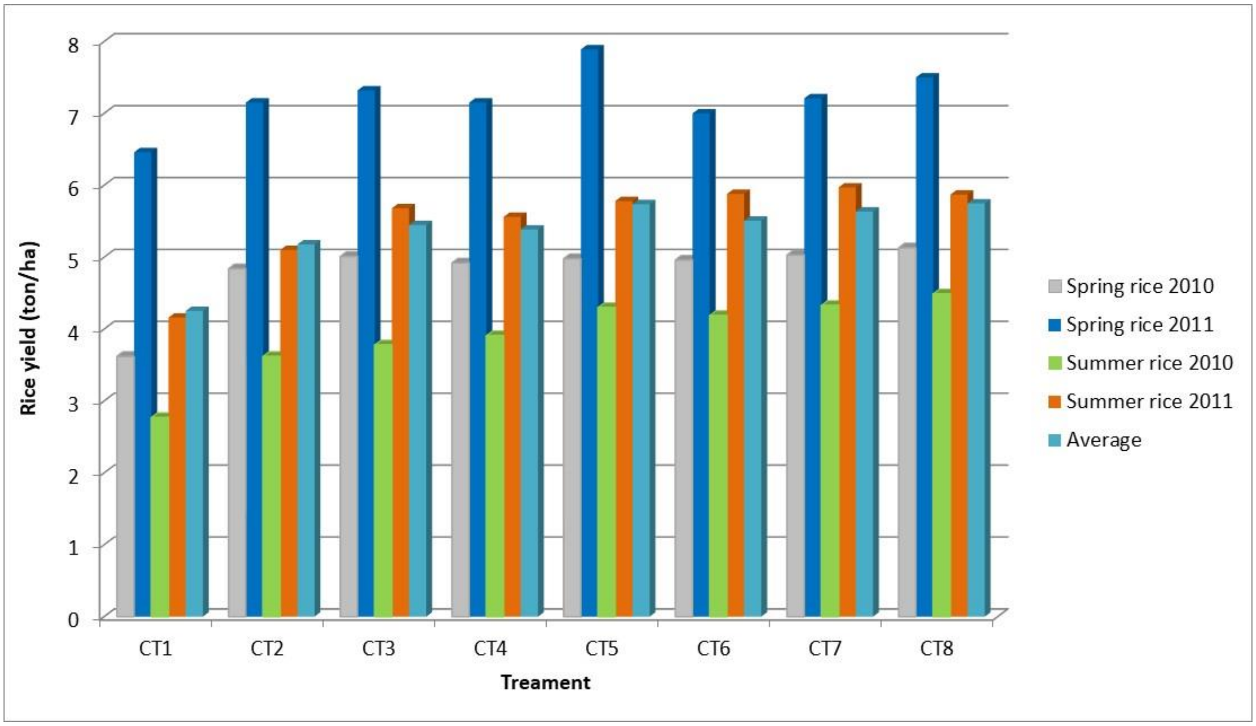

Figure 1. Rice yield on degraded acrisols with different fertilizer

Regimes of: T1: no organic material, no chemical fertilizer (control), T2: NPK: apply NPK without manure, T3: farm yard manure (FYM - 10 ton/ha/season) + NPK (farmer level), T4: a kg/ha/season biochar from rice husk + NPK, T5: b kg/ha/season biochar from rice husk + NPK, T6: c kg/ha biochar from rice straw + NPK, T7: d kg/ha/season biochar from rice straw + NPK, T8: e kg/ha/season biochar from rice straw + NPK. a and c factor are doses of applied biochar that were calculated depend on carbon content in the FYM and in biochar from rice husk and rice straw; b = a*2, d=c*2 and e=c*3. Source: Trinh MV *et al*., (2011a)

Figure 1 shows a field experiment to apply different kinds of organic materials (farm yard manure, biochar, NPK) with different doses which reported that the treatment of T5 (apply 3,000 kg of biochar/ha/season) and T8 (applied 4,500 kg of biochar/ha/season) to have highest rice yield in 4 season as well as in average (Trinh MV *et al*., 2011a)

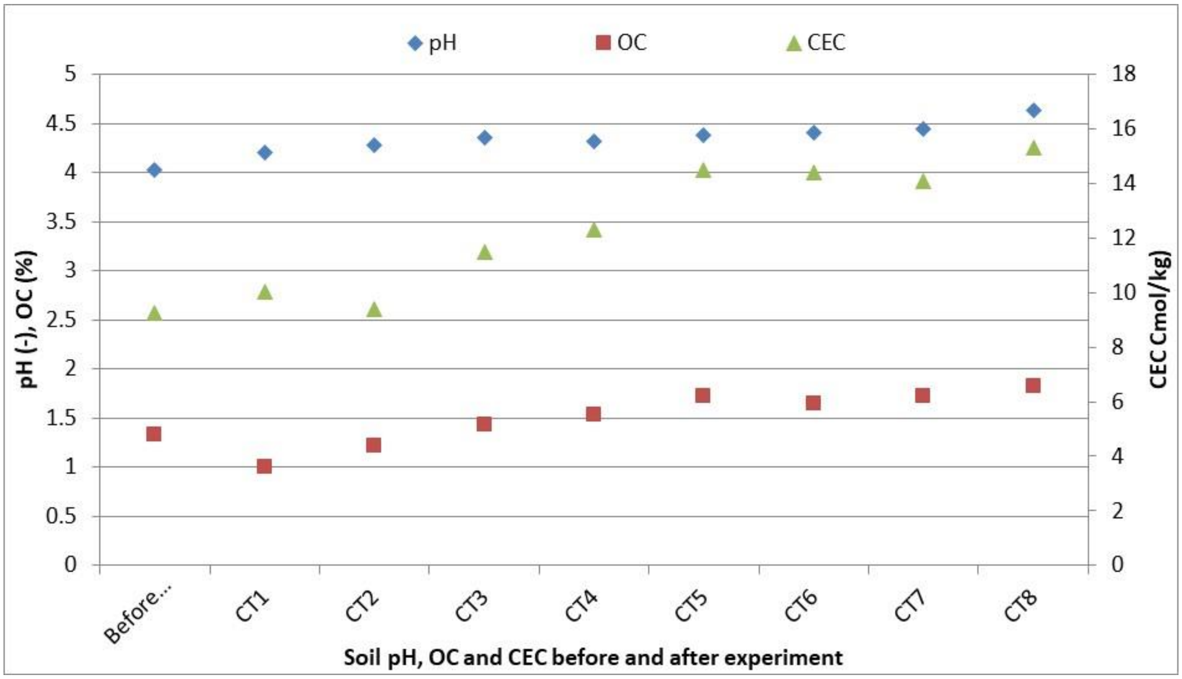

Figure 2. Soil pH, Organic carbon and cation exchange capacity (CEC) from field experiment before and after experiment.
Note: Treatments were described in Figure 1.

Biochar from crop residues has not only have an effect on increasing crop yield, but also has great co-benefits in raising soil pH because of biochar pH is about 9-10; increasing soil carbon because it's very slow decomposition rate and enhancing soil cation exchange capacity (CEC) as shown in Figure 2 where biochar was applied to the soil for 4 continuous rice seasons in 2010 and 2011 (Trinh MV *et al.*, 2011a).

The application of biochar for crop production increases quickly as its multi-effects. It started to be implemented in small pilot in one province in 2010 (Trinh MV *et al.*, 2011b) but is implemented largely nowadays in 10 provinces.

Organic agriculture

The annual demand for fertilizer consumption in the country reached about 11 million tons (Bui Thi Phuong, 2020) with more than 90% of inorganic fertilizers and the remaining as organic fertilizers of all kinds. NPK mixed fertilizers accounted for the largest proportion (35.5%), followed by urea (22.2%), DAP (10.1%) and single phosphate (9.0%).

Tables 3 and 4 show a huge potential to provide nutrients to crops from livestock wastes and crop residues that can replace a lot of inorganic fertilizers, reduce production costs and increase economic efficiency, increase soil fertility, crop productivity, quality of agricultural products and crop resistance to pests and diseases.

According to the organic agriculture project (Decision No. 885/QD-TTg, dated June 23, 2020 of the Prime Minister), by 2025 and 2030, the organic agricultural area is 1.5% and 3% of the cultivated area, equivalent to 225,000 hectares and 450,000 hectares. With N content in compost of 0.6%, the amount of compost needed to replace 100 kg N is 16 tons/ha and the amount of compost needed for the above areas is 3.6 and 7.2 million tons/crop in 2025 and 2030, respectively. Currently, only 15% of the cultivated area in the Red River Delta (Mekong Delta) is applied with organic fertilizer whereas in the southern provinces the rate is lower. To have the scale of organic agriculture production as above, the only way to meet are to combine these two sources of animal wastes and crop residues to produce compost to replace inorganic manure. To strive for a larger scale of organic agriculture, it is necessary to have plan for sufficient production of compost for organic farming.

Circulated farm

Circular economy in Vietnam's agricultural production has not shown systematically and is not at a large scale, but many evidences showed that at many processes of agricultural production, materials have been circulated well, such as, farmers using rice straw for pig's stable bed to mix straw and animal wastes to become farm yards manure (FYM). In another case, round loop of material in the VAC farm of garden – pond – animal stable – VAC, where material (most of the organic matter) from garden to feed animals in the stable and waste/residues feed fishes in the pond (Dang Gia Trang, 2020), which not only effectively uses wastes from this crop/animal system to other crop/animal system and reduces pollutions to the environment but also saves fertilizer inputs for crops or feed for animals in the other crop/animal system. For sugarcane production, circular agriculture has already been implemented for almost the entire cycle of sugar production, as described in the Figure 3. However, one thing still exists for this cycle production, and that is sugar leaves that the farmers left on the field after harvesting and the burning of them after 1 week of drying. The reason for such practice is to remove diseases and avoid difficulties for plowing. This practice should be stopped and used this material for other effective measures.

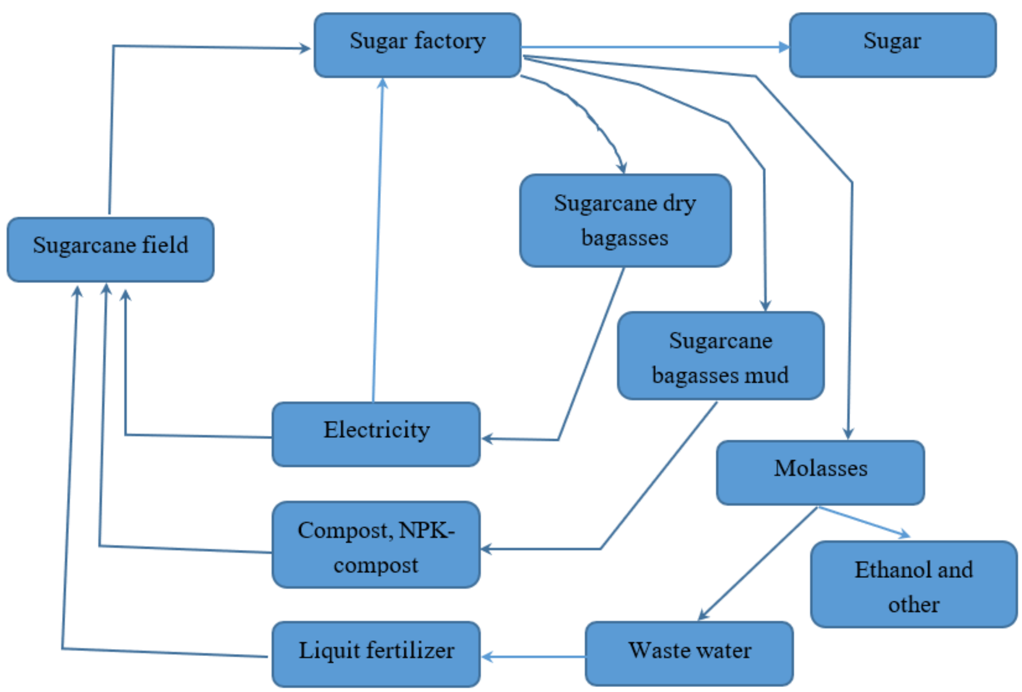

Figure 3. Circular production of sugarcane production
Source: Duong Bich Ngoc, 2019

Support circular agriculture

In green agriculture, circular agriculture and sustainable agriculture, all organic sources include farmyard manure and dry manure (e.g. poultry and cow manure), crop residues, organic household wastes, sludge, sludge from the bottom of biogas digester, wastewater after biogas, starch production wastes, slaughter and seafood processing have high nutritional value and valuable input for cultivation. The discharge of these organic resource to the environment is a waste. The use of these organic resources in all its forms brings economic and environmental values. If the farm owner is allowed to produce compost and sell them as a commodity to increase income (still comply with the provisions of the law will ensure that the products meet the registration standards) will reduce animal waste pollution and the burning of crop residues after the harvest seasons.

Environmental institutions, planning and conditions in the production of organic fertilizers are barriers for farmers to take advantage of organic sources for production and indirectly cause environmental pollution. Sub-licenses both hinder the production of organic fertilizers and cost social wealth. The agriculture sector has the responsibility to guide people to turn wastes into valuable products, increasing income for farms without unnecessary costs.

CONCLUSION

Annually crop residues can supply the equivalent of 43.4 million tons of organic matter, 1.86 million tons of urea fertilizer, 1.68 million tons of single super phosphate and 2.23 million tons of potassium sulfate and animal wastes can supply about 42 million tons of pure organic matter, 1.2 million tons of urea, 3.1 million tons of single super phosphate and 2.4 million tons of potassium sulfate. Both crop residues in crop production and animal wastes in livestock production can produce fertilizers equivalent to 85.4 million tons of organic matter, 3.06 million tons of urea, 4.78 million tons of single super phosphate and 4.63 million tons of potassium sulfate.

Currently, the use of crop residues and animal wastes is very low, not taking full advantage of resources, causing GHG emissions, and polluting the environment. In order to strengthen circular system and reuse these resources, we need to incorporate very well two sub-sectors of crops and livestock, and combine national policies to create a clear policy corridor and increase income from animal wastes and crop residues in farms to reduce pollution and obtain organic agriculture towards a circular economy and a sustainable agriculture. Some current practices of circular systems, such as, production of organic fertilizers from animal wastes and crop residues, incorporation of rice straw into the soil, stove gasification and carbonization for renewable energy and biochar, organic agriculture and circulated farm showing many advantages of effectively using animal wastes and crop residues for agriculture production to reduce environmental pollution, enhance soil fertility, generate clean energy and reduce synthetic fertilizers as well as reducing GHG emissions.

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COMPETING INTERESTS

I certify that there is no interest competing in this paper