Relationship between agricultural waste and greenhouse gases in Dong Thap Province

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Abstract:

Based on the assessment of the status of greenhouse gas (GHG) emissions in each field of agricultural production in Dong Thap Province according to IPPC and related studies, Project has proposed solutions to reduce GHG emissions in each respective field and estimate the effectiveness of GHG emission reduction. The results show that the total GHG emissions in 2021 and 2022 are 8,697.91 and 8,872.88 thousand tons of CO_2 equivalent/year; GHG emissions is mainly from farming activities (accounting for 73% to 78%), followed by agricultural waste (16% to 20%), aquaculture (about 6%) and livestock farming (< 1%). However, when applying the proposed solutions, the effectiveness of reducing GHG emissions reaches 73,4%. If afforestation is applied and maintained, Dong Thap Province will continue to reduce GHG emissions by about 80%. Besides, to be effectively and successful in GHG emissions reducing, it is necessary to have financial support from the Government and people's awareness in environmental protection.

Keywords: *Dong Thap Province; greenhouse gas emissions; agriculture sector; agricultural waste.*

JEL Classification: *Q15; Q53; Q56.*

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1. INTRODUCTION

Vietnamese agriculture accounts for about 30 percent of national GHG emissions. The main types of GHG emissions in the agricultural field include CH_4, N_2O and CO_2. Quantifying emissions of each type of GHG in agricultural production show that agricultural activities are also the cause of global climate change.

In Dong Thap Province, the agricultural sector accounts for about 8.62 percent GRDP, the agricultural land accounts for about 75.39 percent of the natural area of the Province [3]. To be able to evaluate the status of GHG emissions as well as the potential and effectiveness of reducing GHG emissions in agriculture, Dong Thap Province needs to deploy GHG emissions calculations in agricultural production sectors. Estimating GHG emissions can help the Province set quantitative emissions reduction targets in the next period, monitor and evaluate efforts to reduce GHG emissions compared to usual emissions scenarios according to timelines consistent with the national GHG inventory activity.

2. DATA COLLECTION

2.1. Overview of agriculture in Dong Thap Province in 2022 [3]

Dong Thap Province's agriculture sector has proactively implemented many production transformation solutions to promote growth, ensure food security and bring high economic efficiency to farmers.

Livestock farming: The Province's livestock industry has prospered, with many large-scale investment projects applying high technology in the form of production chains have been built and operated. The livestock industry is continuing to shift from small-scale farms, not ensuring biosecurity and low efficiency to medium and large-scale farms ensuring biosecurity.

Fishery: Aquaculture production and fishery catching reached 616.9 thousand tons, an increase of 1.05% compared to 2021, of which aquaculture production reached 596.7 thousand tons, accounting for 96.7%. Aquaculture area is concentrated in Tam Nong, Cao Lanh and Chau Thanh districts.

Crop production: Total production cereals reached 3,270.5 thousand tons, a decrease of 104.3 thousand tons compared to 2021, of which paddy production reached 3,235 thousand tons, a decrease of 104 thousand tons (Spring paddy production reached 1,384.8 thousand tons, a decrease of 50.2 thousand tons; Autumn paddy production reached 1,850.2 thousand tons, a decrease of 53.8 thousand tons). Perennial crops and fruit crops (oranges, tangerines, mangoes, longans) increased compared with in 2021.

Pesticides (plant protection chemicals) [13] : Dong Thap Province's paddy area ranks third in the country and its fruit tree area is quite large. Therefore, every year, people use many pesticides to prevent pests and diseases. According to the report of Dong Thap Plant Protection and Cultivation Sub-Department, the total amount of fertilizer used is 350,642 tons per year, and pesticides are 8,974 tons per year.

Fertilizers: Farmers are used to using chemical fertilizers for crops and are not used to using organic fertilizers. The amount of fertilizer used for rice cultivation is gradually decreasing with area; For other crops such as vegetables, corn, potatoes... the amount of fertilizer used gradually increases over cultivated area.

2.2. Agricultural waste

By-products in farming: According to statistics from the Institute for Agricultural Environment (2018), The amount of by-products from paddy is the largest with over 45 million tons of straw/year, followed by sugarcane with the amount of sheaths and old leaves is over 20 million tons/year, next leaf stalks of corn, cassava plant, vegetables and coffee husks[11]. Agricultural by-products are being left over and burned. They are not used effectively, causing emissions and environmental pollution. With the ratio of straw/paddy is 1.05/1 (Trần Anh Tuấn et al., 2019), the estimated number of straw by-products generated is about 3,396.75 thousand tons in 2022.

Livestock waste: livestock waste is mainly manure, dead animal carcasses, leftover animal food, bedding materials and other waste, with moisture from 50% to 83% and high NPK ratio. With the emission coefficient referenced from the study of Vũ Chí Cường (2013), the total amount of livestock waste is 1,531.75 tons of solid waste and 1,170 tons of liquid waste.

Aquaculture waste: Waste in aquaculture is wastewater, sludge... formed mainly from shrimp and fish feces, leftover food, algae, chemicals (lime, zeolite...) used in the farming process, with solid waste generated from shrimp farming is 123 tons/crop/ha and wastewater is more than 5,000 m^3/ha, the amount of solid waste generated from pangasius farming is about 33.3 tons of sludge/ha (including mud and water)[4]. Meanwhile, resources for aquatic environmental protection activities (including finance and human resources) are still limited.

3. POTENTIAL GHG EMISSIONS FROM AGRICULTURAL ACTIVITIES IN DONG THAP PROVINCE

3.1. GHG emissions due to agricultural activities in Dong Thap Province

In this report, CH_4, CO_2 and N_2O was chosen to calculate the ability emissions in 2021 and 2022 in Dong Thap Province. The GHG emission coefficient is calculated according to the guidance of The Intergovernmental Panel on Climate Change (IPCC) (2006), domestic and foreign research related to the field of agriculture and agricultural waste.

3.1.1. GHG emissions in livestock farming

According to the guidance of IPCC (2006), based on number of livestock, GHG emissions are calculated as follows:

Total CO_2 emissions = Number of livestock x emission coefficient x conversion factor

- CH_4 emission coefficient from food digestion (intestinal fermentation) of Cow is 27 (kg/head), Pig is 1(kg/head) and Buffalo is 49(kg/head).
- CH_4 emission coefficient from waste management process of Cow is 2.4 (kg/head), Pig is 7 (kg/head), Buffalo is 2.8 (kg/head), Poultry is 0.02 (kg/head).
- N_2O emission coefficient from waste management process of Cow is 39.59 (kg/head), Pig is 13.49 (kg/head), Buffalo is 44.38 (kg/head), Poultry is 0.02 (kg/head).

Table 1: GHG emissions in livestock activities

Pet type	Number of livestock (thousands) [3][10]		CH_4 emissions from food digestion (thousand tons/year)		CH_4 emissions from waste management process (thousand tons/year)		N_2O emissions from waste management process (thousand tons/year)	
	2021	2022	2021	2022	2021	2022	2021	2022
Cow	37.5	40.8	1.01	1.10	0.09	0.10	1.48	1.62
Pig	90.8	108	0.09	0.11	0.64	0.76	1.22	1.46
Buffalo	2.6	2.7	0.13	0.13	0.01	0.01	0.12	0.12
Poultry	6,841	6,485	-	-	0.14	0.13	-	-
Total			**1.23**	**1.34**	**0.87**	**0.99**	**2.82**	**3.19**
Aerobic treatment							**0.017**	**0.020**
The conversion factor to CO_{2eq} (IPCC, 2013)			28		28		265	
CO_{2eq} emissions (thousand tons of CO_{2eq}/ year)			**34.46**	**37.57**	**24.35**	**27.75**	**4.60**	**5.20**

▲ ***Note:*** *Total GHG emissions from livestock activities in 2021 is 63.41 thousand tons of CO_{2eq}/year, in 2022 is 70.52 thousand tons of CO_{2eq}/year*

3.1.2. GHG emissions in aquaculture

- Based on aquaculture area, GHG emissions are calculated as follows:

CH_4 emission coefficient from shrimp, fish is 0.63 kg CH_4 /ha.day (Hiraishi et al.,2013), aquaculture time of about 210 days/year for shrimp and 240 days/year for fish.

CO_2 emission coefficient from shrimp, fish is 60.4 ± 1.45 kg CO_2/ha/day (Nam., 2016)[6], aquaculture time of about 210 days/year for shrimp and 240 days/year for fish.

- Based on aquaculture production and N_2O emission coefficient is 0.00169 kg N_2O - N/kg seafood: total N_2O emissions = aquaculture production x 0,00169 x 44/28.

Table 2: GHG emissions from aquaculture activities

Types of aquacultures	Aquaculture area (thousand hectares) [3][10]		CH_4 emissions (thousand tons/year)		CO_2 emissions (thousand tons/year)		N_2O emissions (thousand tons/year)	
	2021	2022	2021	2022	2021	2022	2021	2022
Shrimp	0.9	0.9	0.12	0.12	11.42	11.42	0.005	0.01
Fish	4.8	5.1	0.73	0.77	71.25	71.25	1.49	1.57
Total			**0.84**	**0.89**	**82.67**	**87.12**	**1.50**	**1.57**
The conversion factor to CO_{2eq} (IPCC, 2013)			28		-		265	
CO_{2eq} emissions from aquaculture (thousand tons of CO_{2eq} / year)			**23.66**	**24.93**	**82.67**	**87.12**	**396.97**	**417.29**

▲ ***Note:*** *Total GHG emissions from aquaculture activities in 2021 is 503.30 thousand tons of CO_{2eq} /year, in 2022 is 529.34 thousand tons of CO_{2eq} /year*

3.1.3. GHG emissions in farming

** Rice cultivation:* Estimated CH_4 content released into the environment from paddy fields as follows.

Table 3: Estimated CH_4 content released into the environment from paddy fields

Rice cultivation	2021	2022
Land area for rice cultivation (ha) [3][10]	504,400	482,200
CH_4 emission coefficient of 1 ha/year (kg/ha)	382.77	382.77
CH_4 content released in rice cultivation (kg/year)	193,069,188	184,571,694
CO_{2eq} emissions from rice cultivation (thousand tons/year)	**5,405.94**	**5,168.01**

** GHG emissions due to fertilizer use:* Report calculated for two main types: Urea fertilization and lime.

- Emission coefficient of lime is kg 0.12 kg CO_2/kg lime (GL, 2006), average demand of lime 3,1kg/ha, thus CO_2 emissions from using lime is 0.37 kg CO_2/ha.

- According to research by Chojnacka et al. (2019), the CO_2 emission coefficient of urea is 3.47 kg CO_{2eq}/kg urea, average demand of urea 240kg/ha thus CO_2 emissions from using urea is 832.8 kg CO_2/ha.

Table 4: GHG emissions from fertilization in farming

Activities use fertilizer	2021	2022
Fertilized area (paddy + other crops) (ha)	541,319[3]	522,899[10]
Emission coefficient (kg CO_2/ha)		
+ Lime	0.37	0.37
+ Urea	832.8	832.8
CO_2 emissions from fertilizers (thousand tons/year)		
+ Lime	0.2	0.19
+ Urea	450.81	435.47
Total (thousand tons of CO_{2eq} / year)	**451.01**	**435.66**

** GHG emissions from pesticide:*

To calculate emissions from pesticides, it is necessary to estimate the amount of GHG emissions from agricultural pesticide production. Williams et al (2009) [1]used a linear regression method combined with an average energy value of types for pesticide production according to Green (1987), has calculated the global warming potential (100 years) is 0.069 kg CO_{2eq} per MJ of pesticide energy. Total CO_2 emissions from specific pesticides are as follows.

Table 5: GHG emissions from pesticides

No	Name of active ingredient commonly used in farming	GHG emissions (kg CO_{2eq} /year)	
		2021	2022
1	**Pesticides, spiders**		
	Abamectin	4,210,347	4,067,074
	Cypermethrin	39,308,264	37,970,649
	Chloryphyos ethyl	94,863,167	91,635,081
	Profenofos	37,890,092	36,600,736
	Pyridaben	9,767,513	9,435,136
	Other	16,143,825	15,594,469
2	**Fungicides**		
	Metalaxyl	4,885,949	4,719,686
	Mancozeb	21,418,596	20,689,746
	Carbendazim	220,521	213,017
	Hexaconazole	5,839,496	5,640,784
	Copper hydroxide	95,586,985	92,334,270
3	**Herbicide**		
	Glyphosate	367,118,567	354,625,941
	Paraquat	180,309,203	174,173,486
	Total	**877,562,525**	**847,700,075**
Total (thousand tons of CO_{2eq} / year)		**877.56**	**847.70**

3.1.4. GHG emissions from agricultural waste

In currently, no research to calculate GHG emission from waste biomass from farming as well as sludge from aquaculture. Therefore, emission coefficient of garden waste in the composition of domestic waste and wastewater (IPCC, 2006) was applied.

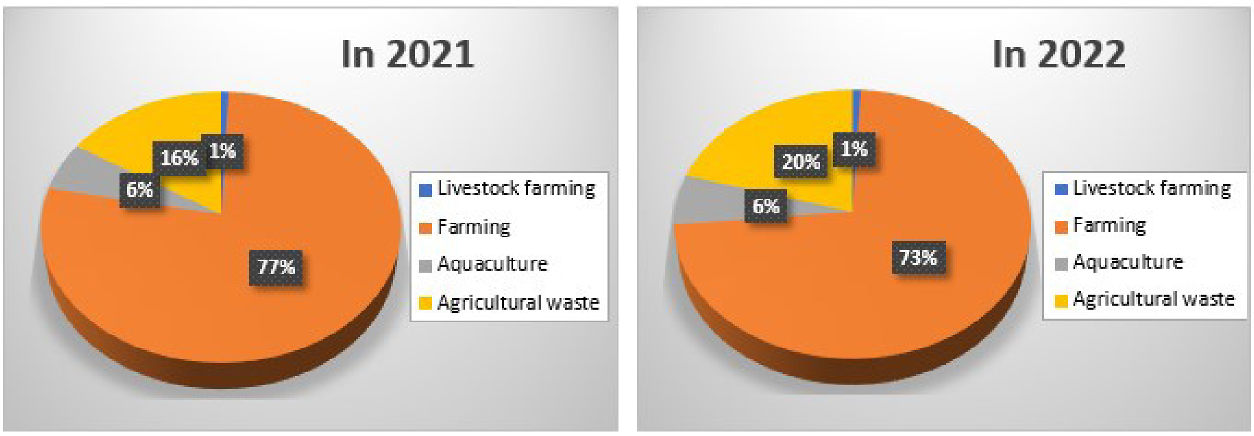
Table 6: GHG emissions in the waste sector in 2021 and 2022

Waste	Unit	2021			2022		
		CH_4	N_2O	Total	CH_4	N_2O	Total
Disposal of solid waste into landfills	Thousand tons of CO_{2eq} /year	1,389.61	-	1,389.61	1,815.62	-	1,815.62
Wastewater (untreated)	Thousand tons of CO_{2eq} /year	6.43	0.65	7.08	5.29	0.74	6.03
Total		**1,396.04**	**0.65**	**1,396.69**	**1,820.91**	**0.74**	**1,821.65**

3.2. Synthesize and compare GHG emission calculation results

Table 7: Summary of GHG emissions in the agricultural field in 2021, 2022

Sector	GHG in 2021 (thousand tons of CO_{2eq} /year)				GHG in 2021 (thousand tons of CO_{2eq} /year)			
	CO_2	***CH_4***	***N_2O***	***Total***	***CO_2***	***CH_4***	***N_2O***	***Total***
Livestock farming	-	58.81	4.60	**63.41**	-	65.32	5.20	**70.52**
Farming (rice growing, fertilizers, pesticides)	877.76	5865.75	-	**6734.51**	847.89	5603.48	-	**6451.37**
Aquaculture	82.67	23.66	396.96	**503.3**	87.12	24.93	417.29	**529.34**
Agricultural waste		1,396.04	0.65	**1396.69**	-	1820.91	0.74	**1821.65**
Total	**960.43**	**7335.26**	**402.22**	**8697.91**	**935.01**	**7514.64**	**423.23**	**8872.88**



▲ *Figure 1: GHG emission rate in the agricultural sector in 2021 and 2022*

▲ ***Note:*** *GHG emissions are mainly from farming activities accounting for 73% to 77%, followed by agricultural waste generation activities, accounting for 16% to 20%, emissions from aquaculture are low and livestock farming has the lowest proportion*

4. PROPOSED SOLUTIONS

4.1. Solutions to reduce emissions in farming

For rice cultivation

Applying the Alternate Wet and Dry paddy planting technique (AWD): Paddy fields are watered intermittently except for the rooting and flowering stages to reduce the time of flooding, which will reduce CH_4 emissions approximately 51% compared to the traditional [9]. However, this solution requires quite a large investment cost for irrigation pumping systems and dikes; therefore, if the Government does not support, it will not be attractive to farmers

Converting land from 2 to 3 paddy crops to 1 paddy crop and 1 vegetable crop: The conversion has contributed to reducing the GHG rate by 25% [9]. This is also a solution has been applied in some localities and has potential to be replicated because it brings higher economic efficiency than specialized rice cultivation. However, this solution requires specific planning on land, markets and investment costs to renovate irrigation systems and processing facilities.

Reuse 100% of biomass waste from farming activities: Limit burning of waste biomass and completely reuse them, such as composting from straw to fertilize plants and produce fuel from husk, waste from fruit trees is fermented to produce feed containing probiotics for livestock.

Solutions to reduce emissions in managing and using fertilizers and pesticides

Use fertilizers appropriately: There should be specific recommendations on using fertilizers for soil, should not fertilize too much urea, leading to high NO_x concentrations in the soil, that causing direct and indirect emissions of N_2O, NO_x, NH_3 and GHG effects; should use slow-release Nitrogen to reduce Nitrogen loss when fertilizing plants, while also helping to reduce GHG emissions into the environment. At the same time, people could use garden waste, sewage sludge and other organic waste from agriculture to compost, create organic fertilizer. According to the project "Sustainable paddy production and reduction of GHG emissions AgResults", using organic fertilizer in rice cultivation has helped cut 50% of GHG emissions into the environment.

Using biosafe pesticides, which are currently encouraged, including herbal pesticides and microbial pesticides...

+ *Herbal pesticides*: A type of pesticide that uses toxins which was extracted from plants or vegetable oils to inhibit and kill pests, such as: Neem tree juice (kill pests and aphids), solution from chili, garlic, ginger (kill pests and insects), Chrysanthemum tea (kill endothermic animal, insects and invertebrates), solution from nicotiana rustica (kills pests, butterfly pupae, aphids and mollusks such as slugs), millettia pachyloba drake (kill Taiwania circumdata, Empoasca sp., and mango hopper).

+ *Microbial pesticides*: active ingredients include microorganisms such as bacteria, viruses, fungi, algae or protozoa, which excrete fluids containing antibiotics, capable of eliminate pests. This bacterium secretes proteins that help repel insects to protect plants, especially potatoes and cabbage. Other types of microbial pesticides use the principle of competition for survival, bringing non-harmful microorganisms to plants and being natural enemies of harmful microorganisms to take over the habitat and repel micro-organisms from plants.

According to the results of the model "Rice cultivation reduces GHG emissions", the "1 right - 6 reduction" technical process has reduced the number of pesticides used in paddy fields by 30%.

Provide land management policies: It is necessary to advise people to manage well cropland, keep clear soil, avoid flooding, clean up plant and animal residues, and apply properly manure to limit decomposing Nitrogen into GHGs by bacteria.

Although many solutions to reduce GHG emissions in the agricultural field have been researched and proposed; However, the applicability and replication of each technology depends largely on the economic efficiency that the technology can bring to farmers in addition to its environmental efficiency. Therefore, the Government needs to have supportive policies to continue researching these solutions in each specific area to ensure that people continue to apply and replicate GHG emission reduction technologies in agriculture.

Maintain forest ecology

Tree planting activities will increase the ability to absorb CO_2 and help exploit and use 100% of bio-

Table 8: GHG emissions from forest ecosystems in 2022

No	Planting forests	Unit	2022
I	***The amount of C absorbed***		
1	Forest land area (including forestry land and land for perennial crops) [3][10] **(A)**	Thousand hectares	54
2	Ratio C of dry matter **(CF)**	ton C/ton dry	0.47
3	Average annual biomass growth **(G_{total})**	Dry tons/ha/year	188.49
4	CO_2 absorption and emission from intact forest land with respect to annual increase (**C_{gain} = A x G_{Total} x CFx (-44/12))**	Thousand tons of CO_2/year	-691.13
II	***Amount of C lost***		
5	Wood yield **(H)**	Thousand m^3/year	120.7
6	Biomass conversion factor into expansion factor (**$BCEF_R$**)	$(m^3 loss)^{-1}$	10
7	Ratio of below ground biomass to above-ground biomass (R)	(dry tons of above-ground biomass) $^{-1}$	0.2
8	Annual loss carbon due to tree loss ($Lwood_{-removals}$ **= H x $BCEF_R$ x (1 + R) x CF)**	Thousand tons of CO_2/year	68.25
9	Volume of firewood lost (**FG_{trees}**)	m^3/year	
10	Base wood density **(D)**	Dry tons/m^3	6.8
11	Annual loss carbon due to wood collection (**$L_{wood-removals}$** = **[FG_{trees} x $BCEF_R$ x (1 + R) + EG_{part} x D) x CF)**	Thousand tons of CO_2/year	78.28
12	Amount of C lost due to intervention (**$L_{other\ losses}$**)	Thousand tons of CO_2/year	0.00
	Total loss (8+11+12) (C_{loss})	**Thousand tons of CO_2/year**	**146.53**
		Δ (C_{gian} - C_{loss})	***-544.60***

mass from forests... so afforestation will be highly effective in reducing GHG emissions. Applying the calculation of GHG emissions according to IPCC (2006), the amount of CO_2 will be reduced by about -544.60 thousand tons of CO_2/year (2022).

4.2. Solutions to reduce emissions in livestock farming

CH_4 emissions from the rumen of cattle: There should be a program to provide nutritional cakes or other nutritional products to reduce the amount of methane produced from the digestive activities of cattle. According to Van Zijderveld et. al. (2011), digestive products could convert nitrate into NH_3, reducing CH_4 production in the cow's rumen by up to 50%.

Model for utilizing by-products from livestock farming:

+ Model of utilizing livestock waste to produce organic fertilizer and biogas as cooking fuel; treating livestock wastewater with a biogas tank not only reduces odors but also collects gas for cooking.

+ Model of utilizing animal manure to raise earthworms: Cow manure, pig manure and fillers such as grass, straw, water hyacinth, potato plants, peanut stems... or dry leaves are used as a substrate for earthworm farming. Cinnamon is used to produce organic food, anaerobic decomposition creates biogas, and produces bioenergy.

Table 9: Estimated GHG emissions reduction from agricultural activities

Emissions	GHG reduction plan (% GHG reduction)	Calculate GHG emissions in 2022		
		Initial GHG emissions (thousand tons of CO_{2eq}/year)	Applying mitigation options (thousand tons of CO_{2eq} / year)	Forest ecosystem (thousand tons of CO_{2eq}/ year)
(1)	(2)	(3)	(4)	(5)
I. Cultivation				
Rice Cultivation	+ Planting alternate wet and dry paddy (reduce 51%) + Plant rotation of 1 rice crop and 1arable crop (reduce 25%)	5,168.01	1,240.32	- ***544.60***
Fertilizer	Use organic fertilizer from agricultural by-products (reduce 50%)	435.66	217.83	
Pesticides	Herbal pesticides, microbial pesticides (reduce 30%)	847.70	593.39	
II. Livestock farming				
Castle raising	Using digestive products to reduce CH_4 emissions from food digestion (reduce 50%)	65.32	32.66	
Waste management	Collect biogas to generate electricity and reduce CH_4, N_2O emissions from waste management (reduce 100%)	5.20	0	
III. Aquaculture				
Aquaculture activities	+ Closed circular model (reduce 47.13%) + Recover P, N (reduce 30%)	529.34	279.86	
IV. Agricultural waste				
Solid waste and wastewater	+ Production compost from crop waste and livestock waste (reduce 100%) Collect biogas to generate electricity and reduce CH_4, N_2O emissions from waste management (reduce 100%)	1,821.65	0	
Total		**8872.88**	**2364.07**	**-544.60**
Total GHG reduction (3) - (4)		**6508.82**		

▲ ***Note:*** *The efficiency of reducing GHG emissions is about 73,4%. When applying and maintaining afforestation, GHG emissions will be reduced to about 80%*

4.3. Solutions to reduce emissions in aquaculture

Pond wastewater treatment: Recirculating water in aquaculture to reduce eutrophication is a sustainable method to reduce environmental impact by both reducing wastewater discharge and helping to control disease. This solution contributes to reducing the eutrophication rate compared to traditional farming by 43.66% - 47.13%[12].

Treatment of sludge from aquaculture ponds

+ Sludge from ponds is used to fertilize agricultural land. Currently, pond areas use settling ponds to remove suspended solids in waste quite effectively; however, it is necessary to have attention to the residue of dissolved nutrients in the waste source.

+ Phosphorus recovery: Current trends show that phosphorus resource regeneration is mainly implemented to reduce operating costs. Nutrient recovery is recognized to help control fouling in the sludge pipeline, improve sludge dewatering, reduce polymer consumption, treatment sludge volume, energy recovery. At the same time, with demanding high livestock farming and lacking land area for sludge treatment can be solved thanks to Phosphorus recovery techniques.

+ Nitrogen recovery: The main goal of Nitrogen recovery (reactive Nitrogen recovery) is to shorten the nitrogen cycle and convert Nitrogen in the waste stream into artificial fertilizer (precursor form). About 30% of the Nitrogen in the waste stream, representing 4% of the Nitrogen in the wastewater, can be recovered. Although Nitrogen recovery less than agricultural fertilizer needs, but Nitrogen recovery can be part of a sustainable solution.

5. CONCLUSION

The report analyzed and evaluated the situation and trends of GHG emissions in each field of agricultural production and agricultural waste, thereby providing analysis and assessment of opportunities and challenges for reducing GHG emissions in Dong Thap Province. The potential to reduce GHG emissions in the agricultural sector is huge. However, the biggest challenge comes from limited funding to invest in waste reduction technology; in addition to the awareness, consciousness, responsibility to protect the environment and reduce GHG emissions of local people are still limited.

Specific measures to reduce GHG emissions for each type of agricultural production in Dong Thap Province are as follows: Review and issue technical guidance documents on GHG inventory for departments and relevant units to refer to before implementing contents on GHG emission mitigation in agriculture; Expand cooperation with strategic partners such as C40 Organization, JICA, World Bank.... to seek funding sources; issue handbooks to guide actions to reduce GHGs in each production fields in agriculture ■

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