HERBST UMWELT TECHNIK

INDUSTRIAL UNIVERSITY OF HOCHIMINH CITY

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Valorization of Agricultural Residues

Towards Climate-Smart Agriculture in South-East Asia

on the 4th – 5th of April 2019 in Ho Chi Minh City

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Foreword

Globally, food and agriculture production consume 30% of the world's energy and produce around 20% of the worlds greenhouse gas (GHG) emissions[1]. Acknowledging increasing global food demand, this highlights the urgency to move towards a Climate Smart Agriculture in South-East-Asia and beyond to tackle the global climate challenge. Valorization of agricultural residues is a promising approach but faces challenges in technology, logistics and feasibility under current economic and legal conditions.

With an average annual increase of more than 6% since 2000, Viet Nam belongs to the countries with the fastest growing GDP[2]. One primary driver for this development is the agricultural sector contributing with 16 % to the national GDP in 2016[3]. Agricultural production leads inherently to production of residual biomass from crop growing, livestock breeding and food production.

Rice with a yield of 45.2 million tons in 2014 (world rank 5) is the most important agricultural GDP contributor[3]. Nevertheless, it leads to the production of 51.5 million tons of rice straw. Similar to India and China, the majority of the rice straw is burned in the rice fields causing air pollution on a supra-regional scale[4]. Other components of the rice straw, are incorporated into the soil of the flooded paddies, causing CH_4 emissions[5]. A second crucial agricultural sector is livestock farming. With 75 million cattle and pigs as well as high annual growth rates (up to 3,7%)[3], this sector is rapidly gaining importance for the Vietnamese economy. Due to the lack of compliance with emission control standards (QCVN 62-MT:2016/BTNMT[6]), this development comes along with adverse environmental effects.

Together with the intensive use of fertilizers in the rice fields, the disposal of manure from livestock farming contributes largely to the pollution of water and soils, to the loss of nutrients, and to the emission of greenhouse gases. Frequently, manure is treated in small-scale household biogas digesters (up to 15 cows or 50 pigs). Nationwide the installation of

[1] FAO 2011, Energy-smart Food for People and Climate. Issue Paper.

[2] IMF, 2017, World Economic Outlook Database, April 2017

[3] General Statistics Office Of Viet Nam, 2016

[4] E. Sanchis, Met al., "Gaseous and particulate emission profiles during controlled rice straw burning," Atmos. Environ., vol. 98, pp. 25–31, Dec. 2014.

[5] J. Zhang, et al., "Interactive effects of straw incorporation and tillage on crop yield and greenhouse gas emissions in double rice cropping system," Agric. Ecosyst. Environ., vol. 250, pp. 37–43, Dec. 2017.

[6] National technical regulation on effluent of livestock farming into water bodies

158,000 plants were supported by the Vietnam Biogas Programme[7], 47,800 of these plants (more than 30%) are situated in the Mekong Delta. Due to the insufficient heating energy demand at the households, the excess biogas is released to the atmosphere. Furthermore, biogas leaks from the plants altogether result in a methane loss up to 40%[8,9].

According to [8,9,10], and observations during the surveys of previous Vietnamese-German projects like INHAND and BioRist or UKAVita, also the 1,000 mid- (for 50 to 2,000 pigs or 16 to 80 cows) and large-scale (for > 2,000 pig or > 80 cows) biogas plants show a need for technological improvement along the entire process chain: a) substrate preparation, selection, and mixture, b) reactor design, process management and the conditioning of biogas and c) residues as well as biogas storage treatment and usage.

Beyond severe local environmental problems, the future of agriculture needs to be discussed in the context of the Vietnamese energy market and climate policy. In 2011, the Vietnamese government promulgated a Masterplan for power development in which it is stated that the capacity of the bio-energy sector shall be increased to 500 MW by 2020 and 2,000 MW by 2030 (Decision No.: 81208/QD-TTg). Therefore, an adaptation towards efficient and cleanly operating biogas plants is crucial. In 2008 a 'National Target Program to Respond to Climate Change' had been published to create the necessary conditions for adaptation towards climate change effects and mitigation of GHG emissions. The „Intended Nationally Determined Contribution" (INDC) indicates that Vietnam is capable of reducing the CO_2 emissions, with international support, by 25% by 2030 in comparison to the business as usual scenario (BUA).

However, it is important that in searching for appropriate responses to this situation solutions has to be adapted to the local conditions, which means that the specific geographical conditions, climate, culture and society must be considered to contribute to a holistic approach beyond sole technical and administrative solutions but also to enhance science, research and education.

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[7] SNV 2016 Viet Nam Biogas Programme | SNV World

[8] H. Roubík et al., "Addressing problems at small-scale biogas plants: a case study from central Viet Nam," J. Clean. Prod., vol. 112, pp. 2784– 2792, Jan. 2016

[9] S. Bruun, et al., "Small-scale household biogas digesters: An option for global warming mitigation or a potential climate bomb?," Renew. Sustain. Energy Rev., vol. 33, pp. 736–741, May 2014.

[10] C. T. Thien et al., "Manure management practices on biogas and non-biogas pig farms in developing countries – using livestock farms in Viet Nam as an example," J. Clean. Prod., 14 vol. 27, pp. 64–71, May 2012.

After two successful conferences on “Valorization of agricultural residues in Vietnam” in Spring 2017 and 2018 the organizing committee from the Industrial University of Ho Chi Minh City and the Technische Universität Berlin successfully established a joint forum for the Vietnamese scientific community and international scientists and experts. This success has convinced us when announcing the 3rd International Conference “Valorization of Agricultural Residues - Towards Climate-Smart Agriculture in South-East Asia”, and we are glad to present an interesting program sponsored by the DAAD, the German Academic Exchange Service and BMBF, the German Ministry of Education and Research.

This year, many contributions are focusing on strategies, technologies and ideas, to mitigate GHG emission from agricultural activities, emphasizing the increasing scientific attention. Therefore, we hope that our conference is a starting point for new scientific ideas, cooperations and innovative solutions to tackle the related challenges.

We wish you a fruitful and interesting workshop!

Prof. Dr.-Ing. Vera Susanne Rotter & **Prof. Dr. Le Hung Anh**

Conference's Agenda

Program Thursday (04.04.2019), location: Industrial University of Ho Chi Minh City

08:00 – 8:30	Registration	
08:30 – 8:50	Valorization of agricultural residues towards climate- smart agriculture in South-East Asia	Prof. Vera Susanne Rotter - TU Berlin Prof. Le Hung Anh - Industrial University HCMC
Topic 1: Biomass resources		**Chairperson: Prof. Le Hung Anh**
08:50 – 9:10	1. Keynote – Rice, sustainability	Björn Ole Sander International Rice Research Institute
09:10 – 9:30	2. Review of phosphorus in waste sources in Southern Vietnam: Potential for phosphorus recovery	Vu Dinh Khang University of Liege
09:30 – 9:50	3. Rice husk ash generation and management in An Giang Province	Prof. Dr. Trung Thanh Nguyen VNU HN University of Science
09:50 – 10:10	4. Biomass potential and nutrient analysis – A case study in Hậu Mỹ Bắc B, Tiền Giang Province	Oliver Larsen TU Berlin
10:10 – 10:25	Discussion	
10:25 – 10:50	Coffee break and group photo	
Topic 2: Environmental impacts		**Chairperson: Prof. Vera Susanne Rotter**
10:50 – 11:10	1. Climate impact assessment of a novel rice straw management approach	Trang Hoang TU Berlin
11:10 – 11:30	2. The occurrence of veterinary antibiotics in agricultural wastes: a case study of South Vietnam	Thuy Hoang Thi Thanh HCM University of Natural Resources and Environment
11:30 – 11:50	3. Development and application of a device for continuous and simultaneous monitoring of BOD and pH: A novel approach in wastewater characterization	Prof. Pham Hung Viet VNU HN University of Technology
11:50 – 12:05	Discussion	
12:05 – 13:05	Lunch break	
13:05 – 13:45	Poster presentations	
Topic 3: Sustainable technology – biogas and more		**Chairperson: Prof. Nguyen Trung Thanh**
13:45 – 13:55	1. Our company „Herbst Umwelttechnik GmbH" and the „BioRist" – Project	Dr. Leonhard Fechter Herbst Umwelttechnik Company
13:55 – 14:15	2. The BioRist process – Rice straw fermentation in the Tien Jiang Province	Marcel Spahr Herbst Umwelttechnik Company
14:15 – 14:35	3. Rice byproduct-derived biochar improved rice growth and mitigated methane emissions from salt- affected soil	Dr. Nguyen Thanh Binh Industrial University HCMC
14:35 – 14:55	4. Effects of two-stage anaerobic digestion on methane yields of pig manure and water hyacinth	Dr. Nguyen Thanh Phong Hoa Sen University
14:55 – 15:10	Discussion	
15:10 – 15:35	Coffee break & Teatime	
Project workshop: Empowering Vietnamese-German research proposals – Facilitator: Mr. Oliver Larsen		
15:35 – 15:50	Presentation of Vietnamese-German funding schemes	Dr. Ute Arnold Vietnamesisch-Deutsches Zentrum
15:50 – 17:30	Interactive development of project ideas	
17:30	Closing	

Gala Dinner (04.04.2019) Location: Sau Linh restaurant, 18:00 – 21:00

Program Friday (05.04.2019), location: Industrial University of Ho Chi Minh City

09:00 – 09:10	Welcome	
Topic 4: Sustainable technology - composting		**Chairperson: Prof. Michael Boehme**
09:10 – 09:30	1. Investigation on the household scale of biogas plants in Mekong Delta region	Dr. Nguyen Xuan Hoang Can Tho University
09:30 – 09:50	2. Composting brewery sludge mixed with agricultural residues for organic fertilizer production	Prof. Le Hung Anh Industrial University HCMC
09:50 – 10:10	3. Composting quality of organic waste with a household model in Vietnam context	Prof. Nguyen Van Duy Nha Trang University
10:10 – 10:30	4. Review of research on mechanization on grain drying in Vietnam	Dr. Nguyen Thanh Nghi Nong Lam University
10:30 – 10:45	Discussion	
10:45 – 11:10	Coffee break	
Young researcher forum – Facilitator: Mr. Oliver Larsen		
11:10 – 11:35	DAAD - German Academic Exchange Service	Tran The Binh DAAD HCMC
11:35 – 11:50	My Ph.D. journey in Germany	Dr. Minh Hanh Le Vietnamese-German University
11:50 – 12:10	10 Things you should know as a DAAD host	Prof. Dr. Michael Böhme Humboldt University of Berlin
12:10 – 13:20	Lunch break	
Topic 4: Policy & management		**Chairperson: Dr. Nguyen Xuan Hoang**
13:20 – 13:40	1. Keynote – Biomass Energy in Viet Nam - Status, perspectives, and future support	Nguyen Lan Chi MOIT/GIZ
13:40 – 14:00	2. Collecting and processing of organic residues in urban and rural regions – regulations and quality security for composting in Germany and challenges and perspectives for Vietnam	Prof. Dr. Michael Böhme Humboldt University of Berlin
14:00 – 14:20	3. Use of forest land among ethnic minorities: A case in Cat Tien National Park	Dr. Dinh Thanh Sang Thu Dau Mot University
14:20 – 14:35	Discussion	
Closure of the conference		
14:35 – 15:00	Award ceremony for best poster and best presentation	
15:00	Conclusions and farewell	

Extended abstracts of presentations

RICE HUSK ASH GENERATION AND MANAGEMENT IN AN GIANG PROVINCE

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*** Faculty of Environment and Natural Resources, Ho Chi Minh City University of Technology, VNU-HCM, Ho Chi Minh City, Vietnam*

1. INTRODUCTION

An Giang is one of the biggest rice production provinces of Vietnam with 600,000 ha of paddy field and paddy production of around 4 million tons/year. Accordingly, rice milling industry generates huge amount of rice husk (e.g. 22% w/w of paddy) which are mostly using as fuel in boilers, dryers, and brick kilns around the province. The ash from rice husk combustion, including bottom ash and collected fly ash, is also environmental concern. Rice husk ash (RHA) is estimated at around 25% w/w of the raw rice husk which caused environmental issues for soil and water where it is dumped. On the other hand, with composition of amorphous silica, carbon and other minerals, RHA can be used in many scientific and industrial applications such as ceramics, glass, steel, cement, paints polymer composites, rubber, plastic, refractory and semiconducting materials, soaps, and pharmaceuticals (Pode, 2016; Prasara-A and Gheewala, 2017; Kumar *et al.*, 2013). However, the utilization of RHA in Vietnam is still very limited, especially in agricultural provinces such as An Giang. Therefore, this study focus on surveying and analysing the current situation as well as the awareness of enterprises and community on the utilization, management, treatment, and disposal of RHA in An Giang Province in order to look for a sustainable use of RHA for this province as well as other rice production provinces of Vietnam.

2. MATERIAL AND METHODS

The survey was conducted among 4/12 districts with highest rice production yeild of An Giang Province, including Chau Thanh, Chau Phu, Phu Tan, Cho Moi. The study includes reviewing the current governmental legislation and policy in rice husk ash management, collecting information about generation source and amount of RHA, surveying about the socio-economic status of related people, analysing and evaluating the current situation on RHA management. Methods for information collection included using questionnaire, group discussion, and expert consultation methods. Stakeholders in this study included expert representatives from Department of Natural Resources and Environment of the province and 4 districts, enterprises, and households. The information was then processed and analyzed by Microsoft Excel and SPSS software for obtaining the results.

3. RESULTS

Results from the survey showed that rice husk is mostly used as fuel in paddy dryer (46.9%), Hoffman brick kiln (39.1%), distillery (10.9%), and traditional brick kiln (3.1%). The average consumption of rice husk is 1863.4 ton/year with an average price of 1.13 million VND/ton. The rice husk was mostly from An Giang Province (51.6%) and within local districts (43.8%). The average ash generation of 862.4 ton/year for each enterprise/factory.

Current RHA disposal is displayed in Table 1. Around half of the enterprise reused rice husk ash or sale it for utilization in other factories. There was 56.3% of enterprise disposal of rice husk ash in their private landfill and 1.6 to 6.3 % directly disposed to the river or in soil.

Table 1. Current RHA management

RHA management	N	Percentage (%)
Dumping to river and water source	1	1.6
Dumping on land	4	6.3
Dumping in ash storage	36	56.3
Selling for fertilizer production	35	54.7
Selling for building material production	7	10.9
Selling as fertilizer for farmer	13	20.3

4. CONCLUSIONS

The study was conducted in An Giang province for obtaining information about rice husk ash management situation in the province. There was 93.3% of enterprises and 100% of people surveyed told that they aware of the impact of rice husk ash on the environment. Interestingly, only 2% of people aware that rice husk ash can be utilized for other purposes. This implies that public awareness and attitude about rice husk ash is very low. Therefore, it is necessary to raise public awareness about the reuse and utilization of rice husk ash, which reduces the environmental impact and contributes to the sustainable development of the rice production not only in An Giang but also in Mekong Delta.

REFERENCES

S Kumar, P Sangwan, R Mor V Dhankhar, and S Bidra (2013), Utilization of rice husk and their ash: A review, Res. J. Chem. Env. Sci, vol. 1, n. 5, 126-129.

Ramchandra Pode (2016), Potential applications of rice husk ash waste from rice husk biomass power plant, Renewable and Sustainable Energy Reviews, vol. 53, 1468-1485.

Jittima Prasara-A and Shabbir H. Gheewala (2017), Sustainable utilization of rice husk ash from power plants: A review, J. Cleaner Prod., vol. 167, 1020-1028.

NITROGEN TURNOVER, STOCKS AND FLOWS, IN AN INTENSIVE RICE CROPPING AGRICULTURAL SYSTEM

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1. INTRODUCTION

The BioRist project aims to design a technically feasible rice straw digestion process. The pilot-scale set up of the innovative loop-reactor design, developed by Herbst Umwelttechnik GmbH, successfully demonstrated digestion of rice straw with cattle dung at a C/N ratio of about 40 – well above, what is generally deemed to be the optimal range (25-35) [Mussoline et al., 2013]. The C/N ratio of rice straw as a pure substrate is found to differ widely in literature [Chandra et al., 2012; Guillemot, 2014 cited by IRRI, 2016] and in local samples (42±10.2). Thus, there is an effective N-demand of about 0.3 ±0.6 kg N/t RS.

A typical source of N-rich co-substrate is livestock manure, especially cattle manure. However, the density and availability of local livestock farming are low (>1 head/ha). For potential commercial biogas, other substrates are required to satisfy the demand of nitrogen, as sustainable as possible – the save N turnover, according to the updated planetary boundaries [Steffen et al., 2015] is already by far exceeded thus we need to avoid additional increase but cascade nutrients. This abstract explores the overall nitrogen stocks and flow for the sectors crop production, animal husbandry in a rough and simplified overview as a preliminary result of a local material flow analysis for nutrients and carbon.

2. MATERIAL AND METHODS

The BioRist project study site is located in (Hậu Mỹ Bắc B) HMBB in the north-west of Tien Giang province of the Vietnamese Mekong Delta. The village is chosen due to its typical characteristic for intensive rice crop production in the Mekong Delta. Animal feed, crop fertilizers, and human food have been identified as major input nitrogen flow to the system. Output flows for nitrogen are the crop productions and livestock sold, volatilization of applied fertilizer. As well as the nitrogen run off to aquifers or directly to surface water bodies and thus “flushed” out of the system with the current. Nitrogen runoff is assumed to constitute of fertilizer runoff and animal as well as human excreta. Crop residues and water hyacinths are considered as temporary stocks in the system.

The material flow analysis has complied in STAN 2.6 with data from the statistical yearbook of HMBB 2015 and 2017, FAOstat, IPCC Guidelines for national GHG inventories 1996 (Vol. 3) and 2006 (Vol. 4), and scientific literature. Due to the very general statistical data used, an uncertainty of ±50 % has been assumed for all flows, except for fertilizer input (±200 %).

3. RESULTS

The result from the material flow analysis to be seen in figure 1. Rice crop production is dominating nitrogen flows in the village HMBB. Fertilizer application accounts for almost 1,600 t N/a, of which optimistically approx. 45 % are taken up in plants and transferred to crop and residues, 38.5 % are assumed to be lost to run off while 16.5 % are emitted to the atmosphere. In contrast, the input and output flows of human consumption and animal husbandry are by at least one order of magnitude smaller.

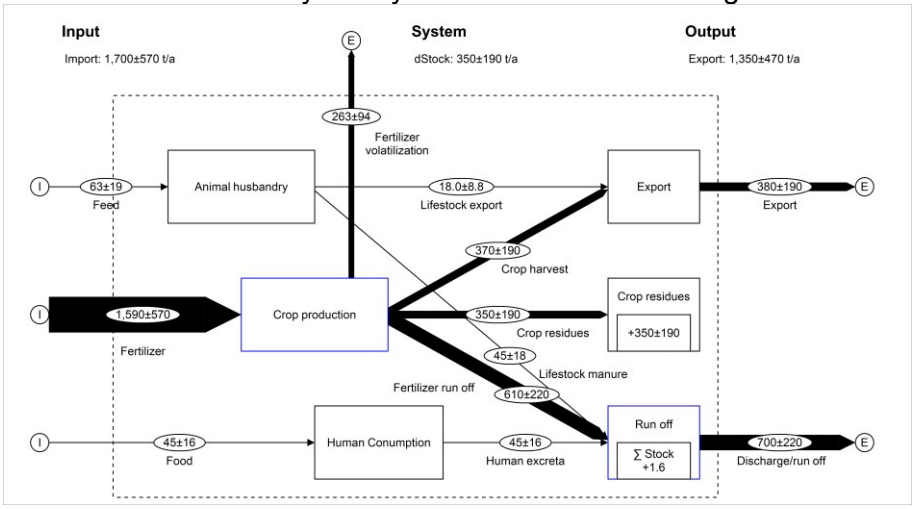

Figure 1: Aggregated nitrogen stocks and flows (t N/a, tons per year) MFA; HMBB, 2017

4. CONCLUSIONS

With about 1,750 ha agricultural land the application of nitrogen for crop production amounts to 0,9 t N/ha. The largest amount of unutilized nitrogen is discharged and runoff from the system. A recycling of the nutrients from the water bodies has the highest potential, but eventually a rather low concentration. The stock formation from growing water hyacinths (s. process runoff) does not retain significant amounts of nitrogen in the system. Therefore, the flows livestock manure and human feces represent the only potential sources to satisfy the effective nitrogen demand of a commercial rice straw biogas plant.

REFERENCES

[Chandra et al., 2012] Chandra, R.; Takeuchi, H.; Hasegawa, T.: Methane production from lignocellulosic agricultural crop wastes: A review in context to second generation of biofuel production. Renewable and Sustainable Energy Reviews 16(3): P. 1462–1476. 2012. [http://dx.doi.org/10.1016/j.rser.2011.11.035].

[IRRI, 2016] IRRI: IRRI Rice Knowledge Bank: Rice straw. IRRI Knowledge Bank. 2016. [http://www.knowledgebank.irri.org/step-by-step-production/postharvest/rice-by-products/rice-straw]. Access date: 09.09.2016.

[Mussoline et al., 2013] Mussoline, Wendy; Giovanni, Esposito; Giordano, Andrea; Lens, Piet: The Anaerobic Digestion of Rice Straw- A Review. Critical Reviews in Environmental Science and Technology 43(9): P. 895–915. 2013.

[Steffen et al., 2015] Steffen, Will et al.: Planetary Boundaries: Guiding Human Development on a Changing Planet. Journal of Education for Sustainable Development 9(2): P.235–235. 2015. [http://journals.sagepub.com/doi/10.1177/0973408215600602a].

CLIMATE IMPACT ASSESSMENT OF A NOVEL RICE STRAW MANAGEMENT APPROACH

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1. INTRODUCTION

Rice production is an important anthropogenic source for greenhouse gas (GHG) emission [1]. The emission results not only from the cultivation directly but also from rice straw open field burning after the harvest [2]. However, this residue can be used to produce biogas through anaerobic digestion and eventually be converted into energy [3], while the solid digestate from the process can be used as an organic fertilizer for the rice field. BioRist is a project which targets at with proper rice straw management including a novel rice straw fermentation process reducing greenhouse gas emissions over the entire value chain [4]. Prelimnary results are presented here.

2. MATERIAL AND METHODS

The project field is located in Hau My Bac B village (HMBB), Tien Giang province Mekong Delta, Vietnam. Firstly, the baseline scenario is defined as the continuation of using electricity from the grid in Viet Nam and the current practice on the rice field in HMBB: burning rice straw (RS) after the harvest and using mineral fertilizer for the field. The BioRist project is using rice straw for anaerobic digestion producing biogas then generate electricity, while the solid digestate as the by-product of the process will be used as an organic fertilizer on the rice field. The functional unit for the emission calculation is kg CO2 eq/ton of rice straw.

The emission of the baseline includes emissions from burning rice straw, rice cultivation, using national grid energy and the production of mineral fertilizer. The calculation equation for the baseline emission is as follows:

$$\boldsymbol{BE_y = BE_{RS\ burn,y} + BE_{rice\ grow,y} + BE_{gird\ elec.,y} + BE_{gird\ heat,y} + BE_{fert.\ pro.,y}}$$

The emission of the project includes emissions from the collection and transport rice straw after the harvest, emission from rice field and the biogas leakage. The calculation equation for the project emission is as follows:

$$\boldsymbol{PE_y = PE_{RS\ collect.\&transport,y} + PE_{rice\ grow,y} + PE_{biogas\ leakage,y}}$$

Emissions from rice cultivation in baseline and project scenarios are estimated with the emission factors, which resulting from own field measurements of GHG emission in the rice field with the closed flux chamber method. Other emissions are calculated based on the approved CDM methodologies and/or the IPCC methods in combination with Vietnam-specific emission factors.

The emission reduction achieved by the BioRist project activities is calculated as the difference between the baseline and the project emission.

3. RESULTS

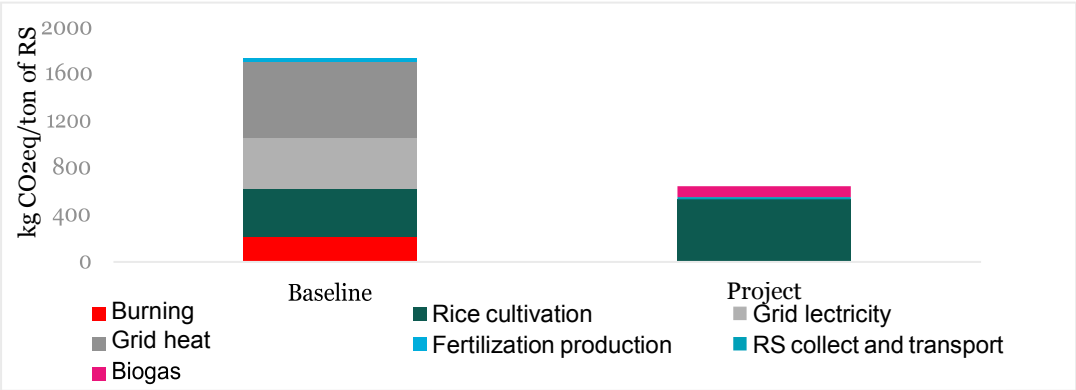

Figure 1. Emission reduction by project activities

The calculated results are shown in Figure 1, indicating the contribution of sources to the GHG balance for the baseline and project. The total emissions from the baseline and BioRist scenarios are 1738 and 645 kg CO2 eq /ton of RS respectively. In the baseline, more than 62% of emissions result from using energy from the national grid with a rapidly increasing share of coal-based electricity and resulting high emission factor. Project activity triggers a modest increase in the emission from rice cultivation, but it mitigates emissions from grid energy production and from rice straw burning. Overall, the project can reduce approx. 1000 kg CO2 eq/ton of managed RS.

4. CONCLUSIONS

Compared to the conventional RS burning practice in Mekong Delta, Vietnam, biogas technology using RS is a more climate-friendly solution, not only produce biomass based-energy but also an alternative fertilizer for the rice farmers.

ACKNOWLEDGMENTS

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REFERENCES

[1] FAO. Greenhouse Gas Emissions from Agriculture, Forestry and Other Land Use; 2014. Available from: URL: http://www.fao.org/assets/infographics/FAO-Infographic-GHG-en.pdf.

[2] Romasanta RR, Sander BO, Gaihre YK, *et al.* How does burning of rice straw affect CH 4 and N 2 O emissions? A comparative experiment of different on-field straw management practices. Agriculture, Ecosystems & Environment 2017; 239: 143–53 [https://doi.org/10.1016/j.agee.2016.12.042]

[3] Ram C, Abhinav, Trivedi, Bhaskar, Jha, Amit Ranjan V, Virendra Kumar V. Energy Generation from Paddy Straw An Analysis of Bioenergy Models: Centre for Rural Development and Technology, Indian Institute of Technology Delhi; June 2017.

[4] Technical University of Berlin. BioRist Project Homepage; 2016. Available from: URL: http://www.biorist.tu-berlin.de/.

THE OCCURRENCE OF VETERINARY ANTIBIOTICS IN AGRICULTURAL WASTES: CASE STUDY OF SOUTH VIETNAM

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1. INTRODUCTION

The use of veterinary antibiotics has shown an increasing tendency in Vietnam. Recently, a variety of veterinary antibiotics compounds have been detected in the environment as well as their potential negative ecological significance on non-target species. The paper reported the primary study on the usage and occurrence of selected veterinary antibiotics (fluoroquinolones and tetracyclines) in South Vietnam.

2. MATERIAL AND METHODS

The wastewaters and sludge from different agricultural farms (cow, pig, and chicken) have been collected in 2012 and 2013. The samples have been analyzed for eighteen antibiotics categorized into two different groups (fluoroquinolones: FQs and tetracyclines TCs). The analytical method, equipment, and level of detection limit (LOD) for wastewater and sludge were shown in Table 1.

Table 1. The method to detect veterinary antibiotics

Veterinary antibiotics	**Method/Equipment**	**LOD (ppm)**	
		Wastewater	**Sludge**
FQs: Enrofloxacin (ENR), Ciprofloxacin (CIP), Flumequin (FLU), Norfloxacin (NOR), Sparfloxacin (SPAR), Ofloxacin (OFL), Difloxacin (DIF), Danofloxacin (DAN), Levofloxacin (LEV), Oxolinic Acid (OXA), Marbofloxacin (MAR), Nalidixic Acid (NAL), Gatifloxacin (GAT) and Sarafloxacin (SAR)	BS EN 15662/ LC-MS-MS	<1	<3
	BS EN 15662/HPLC	<1,3	<2
TCs: Tetracycline (TET), Oxytetracycline (OXY), Chlortetracycline (CTC), Doxycycline (DOX)	BS EN 15662 (LC/MS/MS)	<1	<1

3. RESULTS

FQs: The concentrations of FQs in cow farm were relatively low. All of fourteen FQs were below the detection limits. For pig farms, CIP and DAN were the most frequently antibiotics detected both in wastewater and sludge. NOR, OFL, MAR, and NAL were detected only in pig farms of Dongnai province. To a lesser extent was FLU and OXA, which detected in both wastewater and sludges of pig farms. The developed animal husbandry in Bienhoa city, Dong Nai province caused the elevated concentrations of FQs in this area. The maximum levels of FQs in agricultural wastes were OXO (296 µg/l) and FLU (3,900 µg/kg), respectively. However, the level of CIP was relatively low in comparison with China (Zhao et al., 2013).

TCs: Similarly as FQs, the TCs levels in wastewater and sludge collected from cow farm in Hochiminh City were lower than LOD. In contrast, TCs were detected in wastewater from pig farm in Dongnai and Binhduong provinces. In especially, elevated TECs concentrations have been observed in sluges (TET: 7,143, OTC: 1,927, CTC: 14,305 and DOX: 9,532 µg/kg dw). This data was comparable with data from China (Chen et al., 2011).

4. CONCLUSIONS

Although veterinary antibiotics are detected at trace level but that not related with the risks against human health. The most serious impacts of antibiotics was the development of antibiotic resistant bacteria. Thus, an appropriate monitoring program of these contaminants is urgently needed in order to protect the ecosystem.

ACKNOWLEDGEMENTS

This research was supported by the Ministry of Natural Resources and Environment, Project TNMT.04.30.

REFERENCES

Chen YS, Zhang HB, Luo YM, Hu GJ, Zhao YG,Song J (2011). Investigation of 14 selected antibiotics in sediments of the typical cross sections of Tiaoxi River. Huan Jing Ke Xue 667-672

Zhao L, Dong YH, Wang H (2013). Residues of veterinary antibiotics in manures from feedlot livestock in eight provinces of China. Sci Total Environ 408(5):1069-1075

DEVELOPMENT AND APPLICATION OF A DEVICE FOR CONTINUOUS AND SIMULTANEOUS MONITORING OF BOD AND pH: A NOVEL APPROACH IN WASTEWATER CHARACTERISATION

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1. INTRODUCTION

Biochemical Oxygen Demand (BOD) and pH are two important parameters to assess the water quality. While pH changes can be followed by a pH meter, BOD curve, which is the cumulated oxygen consumption, is quite complicated and time-consuming (usually five days in the usual BOD_5 test). In recent years, some studies have developed different methods to measure BOD rapidly [1]; however, long-term monitoring of BOD can bring interesting results about the kinetics of biodegradation [2], and even odor [3]. The combination of BOD and pH data with mathematical models can be a novel approach in the characterization of wastewater for simulating and optimizing the treatment process. The problem is that there is a need for continuous BOD and pH data (sampling frequency can be every 5 minutes) for a long time (about 20 days), which is not met by current equipment.

The device developed in this study will be the first device that is capable of simultaneously and continuously measure both BOD and pH for calibrating mathematical models to gain more useful information on wastewater characteristics. In addition, this BOD/pH device can replace the current commercial devices in determining BOD_5.

2. MATERIAL AND METHODS

Before starting the design and fabrication of the BOD/pH device, a survey was conducted to find existing devices in the market and nearby laboratories. After that, a prototype device was built to test the feasibility of the concept and device, and then final fabrication of the device was developed. A software, BOD Data Logger, was developed base on C# platform for graphical displays, BOD calculation, online data acquisition, and other calculations.

For the cross-check between purpose-built BOD/pH device and the similar commercial BOD equipment, the BOD Trak II device (from Hach, USA) was used. The samples used in the test were real wastewater samples collected from a pig farm in Hanoi.

3. RESULTS

After fabricating the device and building the data logger software, the BOD/pH device was applied to continuously monitor of BOD and pH in a wastewater sample collected from a pig farm (Figure 1). It can be seen that the Hach's equipment could only monitor BOD continuously for 10 days while the device developed in this study had up to 20 days, even more. The BOD values obtained by two devices are almost similar during the first 10 days with errors not exceeding 15%. In this case the pH of the sample changed slightly between 7.0 and 8.0 that is a suitable range for the growth of bacteria [4]. These results show that the BOD/pH device can operate efficiently and reliably for a long time with a high frequency of sampling.

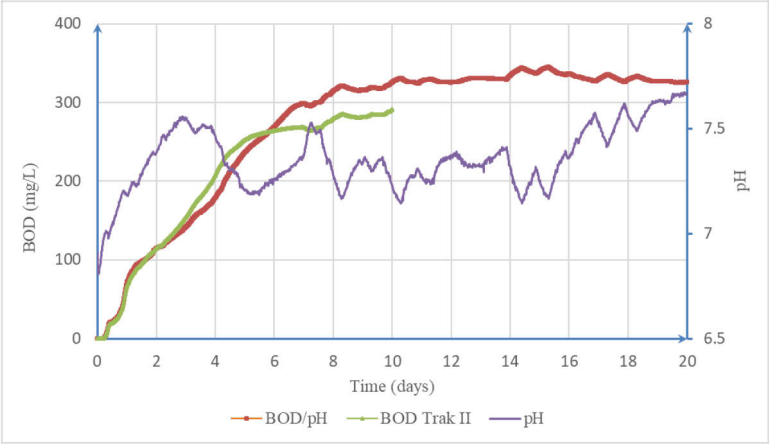

Figure 1. Comparing results between the prototype BOD/pH device and commercial device (BOD Trak II, Hach)

4. CONCLUSIONS

In this study, a novel purpose built BOD/pH device based on the respirometric principle was developed successfully. This is the first equipment that can operate continuously for simultaneously monitoring BOD and pH over a long period of time.

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REFERENCES

S. Jouanneau, L. Recoules, M.J. Durand, A. Boukabache, V. Picot, Y. Primault, A. Lakel, M. Sengelin, B. Barillon, G. Thouand (2014), Methods for assessing biochemical oxygen demand (BOD): A review, Water Research, 49: p. 62-82.

Fialova, A., Boschke, E., & Bley, T. Rapid monitoring of the biodegradation of phenol-like compounds by the yeast Candida maltosa using BOD measurements. International biodeterioration & biodegradation, 2004, 54(1): p. 69-76.

Onkal-Engin, G., Demir, I., & Engin, S. N. (2005), Determination of the relationship between sewage odour and BOD by neural networks. Environmental Modelling & Software, 20(7): p. 843-850.

Ali Waheid Alattabi, Clare Harris, Rafid Alkhaddar, Ali Alzeyadi, Muhammad Abdulredha, Online Monitoring of a Sequencing Batch Reactor Treating Domestic Wastewater, Procedia Engineering, Volume 196, 2017, Pages 800-807.

THE BIORIST-PROCESS – RICE STRAW FERMENTATION IN THE TIEN GIANG PROVINCE, VIETNAM

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1. INTRODUCTION

In recent years, Vietnam has become one of the biggest rice grain chambers in Asia. In 2016 on around 7 Mill. ha up to 43 Mill tons of rice were produced [1]. Vietnam counts with about 5.2 Mill. tons to the fifths largest exporter worldwide. Accordingly, the biogenic residues (rice straw - RS) must be managed. With a relation between grain and straw of 1:1,2 an RS mass flow up to 50 Mill. tons per year can be assumed [2]. RS burning and incorporation emitted up to 5,0 kg CO_2 eq./ha [3]. Additionally, to the greenhouse gas (GHG) emissions, the particulate matter must be adopted. Chemical bounded energy from straw will be lost. The energy potential of straw can be assumed up to 13-14,4 MJ/kg respectively, which is just marginally lower than the caloric values of wood (14,4 MJ/kg) [4]. Regarding the potential of RS and optimization of GHG emissions from rice farming, the innovative technology for RS fermentation is carried out. The anaerobic, two-stage technology, called loop-reactor technology, was developed by Herbst Umwelttechnik (HUT) and was described in international patent WO/2018/138368 A1 in August 2018.

During the two-step fermentation process, a specific biogas production for RS of up to 420 Nm³/ t volatile solids (VS) was obtained. This corresponds to energy supply of 2.3 MW/t VS or 1.75 MW/t RS. From 1 t of RS (89% dry matter) 665 $kW_{el.}$ as well as 910 $kW_{th.}$ can be achieved. Furthermore, in combination with manure, a high-quality organic fertilizer is produced, which is also suitable for incorporation on rice fields. It is intended to close the carbon cycle, starting with rice cultivation, using the residues for the production of biogas and applying the organic fertilizers from the biogas plant back on the field, and thus to minimize the GHG emissions for the entire process.

2. MATERIAL AND METHODS

In the first step, microorganisms were sequenced in the laboratory of HUT for its suitability for the fermentation of lignocellulose-containing biomasses, isolated and examined in the form of batch tests. The investigations took place under both aerobic and anaerobic conditions. Several batch tests evaluate thermophilic biological pretreatment with subsequent methane fermentation. Afterward, a scale up to 30-litre meso-phillic stirred reactor (STR) and 5 litre hyperthermophillic reactor (TR) was constructed in the laboratory of HUT. During the operation time of 2,5 years, important process parameters (trace elements content, retention time, relation straw to manure, and nutrient balances) was evaluated to their optimum value. As of last step, a 2m³ pilot plant was constructed in one 20ft. container and was sent to Tien Giang Province. In a separate 20ft. container a laboratory and control container was implemented.

The Herbst-Loop-Reactor consists of a mesophillic (MR) and a TR. Both digesters was designed with automatic stirring and heating device. The TR was implemented as a bypass behind the MR. For a stable digestion, a mechanical treatment of straw to fibre lengths of 30-40mm was done. Practical tests with Hungarian straw crusher shown a spec. energy input of 7-8 $kW_{el.}$/t straw respectively. For comfortable feeding regime, the straw was mixed with manure and process water (filtrate after separation) in a mixing

tank. With the add of pumps, the suspension were feed 12 times/day automatically in the mesophilic reactor. For feeding the hyperthermophillic reactor, a spec. amount of mesophilic sludge was be treated with environmental air and then pumped into the TR. The oxygen was needed to inhibate the methanogenese, which was unwanted in the thermophilic step. After 35 days of incubation, the mesophilic residues was separated in solid and liquid phases with the help of separators. The liquid fraction was reused as dilution fraction for the suspension. The practical test with the pilot plant was carried out over a period of 13 months in which relevant operating parameters were evaluated and optimized on the basis of the results of the pilot plant scale.

3. RESULTS

It was shown, that during bacterial cultivation spec. hyperthermophilic, facultative aerobic microorganisms (Chlostridium spp.) appear to be useful for fermentation. It was found out, that cultivation of RS with selected microorganisms followed by methane fermentation in a batch process can achieve biogas formation rates up to 500 Nm^3/t VS straw, respectively. The two-stage process allows to separate the hyperthermophilic bacteria from mesophilic Archaea and optimize their optimum metabolism separately. Biological thermophilic treatment of biomass has not been considered as a pre-stage, cause of its high potential of hydrogen methane emissions.

The first results of the batch tests were verified by the construction of a pilot plant in the scale of 30 litre volume. It was shown that the specific biogas formation was reduced from 500 Nm^3/t VS to an average around 400 Nm^3 / t VS, which can be explained by the occurring short circuit currents from fed batch proceedings. At the end of the practice phase, spec. biogas formation rates of 400-420Nm^3 biogas/t VS RS can be achieved with a mean methane content of 55Vol%.

4. CONCLUSIONS AND OUTLOOK

With the development of a two-stage technology for the production of biogas from RS, HUT can offer an alternative process, according to incineration and incorporation on the fields. Results from all stages of process development showed comparable spec. gas yields of up to 420 Nm^3/t VS, respectively. The addition of slurry into the RS fermentation, also offers the opportunity to improve the waste management of life stocks. In the end of the Herbst-process, a storable energy is created which can be used local and on demand as well as a high-quality organic fertilizer.

HUT is currently planning the construction of a demonstration plant with a capacity of 75-150kW_{el}. In the future it will convert up to 170kg RS/h and manure into storable, decentralized energy. The quantity of manure can be adjusted regarding the mass flows nearby.

REFERENCES

[1] Bayer Crop Science. Problem lösungen für kleinbäuerliche Reisfarmersungen: Das weisse Gold aus Vietnam [cited 2019 January 4] Available from: URL: https://www.cropscience.bayer.de/de-de/stories/2016/problemloesungen-fuer-kleinbaeuerliche-reisfarmer-das-weisse-gold-aus-vietnam.

[2] IRRI - International Rice Research Institute. Rice Straw Management: The value of sustainable rice straw management [cited 2019 January 4] Available from: URL: https://irri.org/rice-straw- management.

[3] Romasanta RR, Sander BO, Gaihre YK*, et al.* How does burning of rice straw affect CH 4 and N 2 O emissions? A comparative experiment of different on-field straw management practices. Agriculture, Ecosystems & Environment 2017; 239: 143–53 [https://doi.org/10.1016/j.agee.2016.12.042]

[4] AGRAR PLUS GmbH. Heizwerte/-äquivalente; 2019. Available from URL: https://www.agrarplus.at/heizwerte-aequivalente.html.

NUTRIENT RECOVERY FROM COW URINE FOR COMPOSTING OF COW DUNG AND RICE STRAW

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1. INTRODUCTION

Recycling nutrients from cow urine have many advantages: rather than diverting directly into canals and rivers as it is common practice in Vietnam. The valuable nutrients can be recovered by transforming into compost products. Cow urine can be considered as a renewable source for a sustainable agricultural development due to high nutrient content. Fresh cow urine contains 305mg/L of phosphate and 105mg/L of ammonium (Prabhu and Mutnuri, 2014). Urine is suitable for the use or recycling of nutrients in it because it contains essential nutrients necessary for plant growth. Indeed, Saunders (1982) found that cow urine increased significantly agricultural product due to high nutrient concentrations. The high nutrient concentrations in urine have a marked effect on the chemical composition of herbage (Saunder, 1982). Another study has showed that cow urine is a rich source of macro nutrient (2.5% of urea) and micronutrients (2.5% of mineral salts, hormones and enzymes) and contains disinfectants and prophylactic properties thus it can improve soil fertility. The application of cow urine can be regarded as a suitable agricultural practices for farmers because of low cost and renewable resources for sustainable agricultural development (Pathak and Ram, 2013; Khanduja et al., 2017). Unfortunately, studies focused on the recycle of cow urine are rare, probably caused by urine collection and time consuming procedures. This study was conducted to evaluate differences in composition and parameters of composting material with and without urine addition during the composting processes.

2. MATERIAL AND METHODS

The experiment was conducted from March to June in 2018 in the laboratory of Hoa Sen university, located in district 12 in Ho Chi Minh city. In this study, fresh cow dung and rice straw were collected in the small farm in Long An province and transported to Ho Chi Minh city. The rice straw was cut into from 1 to 2 cm long pieces before composting to ensure uniformity conditions during composting. Cow urine was collected at the collection pitch of the milk cow farm daily so that it was not diluted with water. The collected urine was stored in a 20L closed container in order to avoid ammonia emissions. Then, it was transported to laboratory after 48 hours. In total 1300kg cow dung, 45 litres cow urine and 225kg rice straws were used for the experiment. The objective of the study was to test the application of cow urine in the composting. To achieve this aim, two compost piles were set up in the lab scale, in which one pile was applied with cow

urine pile (UP) and another pile with water (WP) as a control.

The temperature, moisture, pH, EC were recorded every day. In addition, total nitrogen, phosphorous and NH_3 emisisons were analysed weekly according to Vietnamese national standard methods.

3. RESULTS

The pile with cow urine application (UP) showed an increase in temperature right after composting started. The temperature in the UP treatment reached highest at 70°C after 1 weeks, while the control treatment (WP) needed 2 weeks to reach highest temperature. Then, temperature in both piles gradually decreased afterwards.

The water holding (WH) capacity of both compost piles varied from 65 to 82%. The WH decreased gradually during the composting duration in both UP and WP treatments. The WH in the UP was mostly lower than the WP. At the end of the composting, WH of UP was 65%; whereas, WH of WP was 75%. In fact, the lower moisture content in the UP could be explained by the fact that higher temperature in the UP. Higher temperature led to higher amount of water evaporation.

Total Nitrogen (N) and Phosphorus (P) are two of the parameters which are usually used to assess the quality of compost products. The total N value of the UP was higher than the WP during the composting process, and the highest in the UP was 0.61%, and 0.48% of dry matter for treatment WP. In the first 2 weeks, the P content in compost with urine addition was lower than compost without urine. However, at the end of the experiment, it was observed that the P content in compost with urine addition higher than compost without urine. The highest P content was 1.73% for treatment UP and 1.49% of dry matter for treatment WP. The increase of nutrients in the compost product with cow urine addition could be explained by the concentration of nutrient in cow urine, which was added in the compost pile.

4. CONCLUSIONS

This study showed that cow urine addition influenced the composting process. There were differences between compost quality with and without cow urine. The application of urine increased Nitrogen and Phosphorus in the compost product compared to compost without cow urine addition. Cow urine is a good source of phosphate and it can be recovered from livestock waste for composting. Our results indicate that 14:1 mixing ratio of composting material (cow dung and rice straw) and cow urine increased 0.4% phosphorous concentration in the final compost product.

REFERENCES

Prabhu M. and Mutnuri S. (2014). Cow urine as a potential source for struvite production, International Journal Recycle Organic Waste Agriculture, 3-49.

Saunders W. H. M. (1982). Effects of cow urine and its major constituents on pasture properties, New Zealand Journal of Agricultural Research, 25:1, 61-68.

Pathak R.K. and Ram R.A. (2013). Bio-enhancers: A potential tool to improve soil fertility, plant health in organic production of horticultural crops, Progressive Horticulture, Vol. 45, No. 2.

Khanduja S., Jain P., Sachdeva S., and Phogat J. (2017). Cow Urine Keratopathy: A Case Report. Journal of Clinical and Diagnostic Research, 11(4), 3

COMPOSTING BREWERY SLUDGE MIXED WITH AGRICULTURAL RESIDUES FOR ORGANIC FERTILIZER PRODUCTION

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1. INTRODUCTION

Biosolids are used in term of stabilized sludge, which defined as solid waste, semi-solid or liquid generated from wastewater treatment systems (Lesław Swierczek et al., 2018) (José G. Ascencio et al., 2018). Food industry has produced a large volume of sludge or biosolids whilst biosolids management is one of the most complex issues due to the sluge handling and disposal costs. In Vietnam, only a small proportion of biosolids is used as fertilizer; hence solid waste disposal and landfilling have caused not only serious environmental pollution but also affected human health. This study aims to reuse bio-sludge and rice husk ash from brewery industry to produce high quality organic fertilizers for crop production.

2. MATERIAL AND METHODS

Brewery sludge and rice husk ash were mixed with coconut fiber for composting. Bioproducts were added to the compost mixture to estimate fertilizer quality. Bioproducts including two Vietnamese types Micro EM Fert-1, JumBo-A were added to the compost mixture to estimate fertilizer quality. This study used “turned windrow composting” in pilot scale of 2 tons of a compost mixture pile. Each mixture was repeated twice through three successive experiments.

This study used “turned windrow composting” with pilot scale of 2 tons of a compost mixture pile, each mixture was repeated twice through three successive experiments.

3. RESULTS

The compost products with the best performance was created by mixing 80% sludge, 10% rice husk ash, and 10% coconut fiber. The treatment of compost with Jumbo-A (T3) gave a compost product having the quality in accordance with the current standards of an organic fertilizer. The analysis results of the compost treatments are shown in Table 1. The best performances of compost and a current commercial compost produced from coconut fiber were mixed with sand in different mixing ratios as a medium for production of leaf mustard sprouts. Samples fertilized with the mixture of 75% compost and 25% sand gave the highest yields, 25.1 g sprouts/1.0 g seeds.

Table 1. Analysis results of the compost treatments

Indicator	**T1**	**T2**	**T3**	**Circular No.41/2014/TT-BNNPTNN**
Temperature ^{0}C	39	42	41	
pH	6.67	6.8	7.04	
Total nitrogen (g/kg)	24.07	25.68	31.16	>2%
Phosphorus (g/kg)	6.18	6.88	7.08	
Moisture %	50,15	47,72	45,74	<30%
OM%	52.05	50.85	53.47	>15%
Nitrogen fixing bacteria (CFU/g)	$1.5x10^2$	$1.6x10^5$	$6.3x10^6$	
Phosphate solubilizing bacteria (CFU/g)	$1x10^4$	$3x10^5$	$7x10^6$	
Cellulose-degrading bacteria (CFU/g)	$2x10^3$	$1x10^6$	$2.5x10^6$	
E.Coli (CFU/g)	NA	NA	NA	$<1.1x10^3$
Salmonella (CFU/g)	NA	NA	NA	NA

4. CONCLUSIONS

Using rice husk ash and coconut fiber as bulk agents combined with sludge in the ratio of 10%:10%:80%, respectively could give the best performance. The addition of bio-products to the mixture could improve the quality of the compost. Pathogenic microorganisms were not found in the product with nutrient content supply. Experimental trials with sprouts show high seeds growth on the media of the compost. Compared the growth of sprouts using brewery compost with sprouts growth using current commercial composting products, the brewery compost yielded higher productivity; the grew seeds were stronger. The mixture of compost and sand at a ratio of (3:1) can possibly be applied in a real scale to economize the composting process and to improve the moisture retention of composting products.

REFERENCES

C. Stocks,1,2 A.J. Barker1 and S. Guy (2002) The composting of brewery sludge, Journal of the Institute of brewing, Vol 108, No. 4, 452–458.

E. Kalatzi and Eleni Sazakli, Hrissi K. Karapanagioti, Michalis Leotsinidis (2016) Composting of brewery sludge mixed with different bulking agents. https://www.semanticscholar.org/paper/Composting-of-brewery-sludge-mixed-with-different-Kalatzi-Sazakli/a7e590565425f2aa6144afad3325822b81736113

Emmanuel Nkosinathi Cele and Mark Maboeta (2016) Amelioration of iron mine soils with biosolids: Effects on plant tissue metal content and earthworms. Environ Sci Pollut Res, Received: 30 March 2016 /Accepted: 22 August 2016.

José G. Ascencio, Natalia Fuentes and Tatiana S. Britto (2018) Eco-Bricks: A Strategy for the Use of Wastewater Biosolids. Contemporary Engineering Sciences, Vol. 11, No. 87, 4321 - 4328.

Lesław Swierczek, Bart łomiej Michał Cieslik, Piotr Konieczka (2018) The potential of raw sewage sludge in construction industry - A review., Journal of Cleaner Production 200, 342-356.

Ministry of Agriculture and Rural Development, Circular No.41/2014/TT-BNNPTNT on guidance Decree No.202/2013/ND-CP of the management of fertilizer under the state management responsibility.

COMPOSTING QUALITY OF ORGANIC WASTE WITH HOUSEHOLD MODEL IN VIETNAM CONTEXT

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1. INTRODUCTION

Nowadays, the use of bio-fertilizer plays a vital role in agriculture; moreover, it is very important that raw materials for fertilizer are from organic wastes in household activities. This not only makes easy to cultivate and avoids erosion but also returns the soil nutrients. Furthermore, using bio-fertilizers help minimize the abuse of chemical ferilizers.

There are many studies related to organic fertilizer from household wastes. This report is no exception. The report focuses on monitoring and evaluating indicators of composting process and quality of compost.

2. MATERIAL AND METHODS

The materials include dry leaves, vegetable wates and dried cow dung. The report applied 2 ratios on wet mass of mixing feedstocks (adjusted from Kalamdhad, 2008 and 2014) as shown in Table 1. The initial moisture content of 2 ratios was calculated between 60% and 55%, and C/N ratios were measured around 15.74 and 20.55 respectively.

Table 1. Feedstock materials

Using cow dung					
Number	*Ratio*	Vegetable waste	Dry cow manure	Sawdust	Dry leave
1	*5:4:1*	4,5 kg	3,6 kg	0,9 kg	1kg
2	*2.5:2:1*	3,6 kg	4,5 kg	1,8 kg	-
Using EM					
Number	*Ratio*	Vegetable waste	EM (Effective microorganisms)	Sawdust	Dry leave
1	*5:4:1*	4,5 kg	12,8 g	0,9 kg	1 kg
2	*2.5:2:1*	3,6 kg	10,8 g	1,8 kg	-

The 45L container was used with holes surrounding. At the bottom, leachate drain was setup with mesh. Container number 1,2,3,4,5 were the first ratio, in which container number 4&5 using dry cow manure.

Container number 6,7,8,9,10 were the second ratio, in which container number 9&10 using EM – Fert 1. Container 1 and 6 were the initial tests; therefore, the evaluation was not based on them.The reaction temperature was monitored with a thermometer. The pH was determined in a water extract (1:5 by weight) from the compost sample after shaking for 60 min. The moisture content was analyzed by drying oven method at 105^0C for 24h (APHA, 1995). The TOC was analyzed by Vietnam standard (TCVN 9294:2012), TN was monitored by using Kjeldahl method (AOAC 993.13).

For microbiological safety, *E. coli* and *Salmonella* were tested. The amount of *E. coli* was analysed followed Vietnam standard (TCVN 6846:2007). The presence of *Salmonella* was exampled followed Vietnam standard (TCVN 4829:2005). All samples were tested in triplicate.

3. RESULTS

According to Circular 41/2014 formed by Vietnam Ministry of Agriculture and Rural Development, Container 2 met the requirements for composting quality. According to Circular 41/2014 formed by Vietnam Ministry of Agriculture and Rural Development, the presence of *E.Coli* and *Salmonella* bacteria isused to evaluate the quality of composting which is produced by organic waste. In this experiment, *E.Coli* and *Salmonella* were not detected.

4. CONCLUSIONS

It can be concluded that household organic waste is an abundant resource used as fertilizer, especially in the currently abusing chemical fertilizer in the developing countries.

REFERENCES

Tweib, S. A., Rahman, R. A. and Kalil, M. S. 'A Literature Review on the Composting', International Conference on Environment and Industrial Innovation, 12, pp. 124–127, (2011).

Cerda, A., Artola, A., Font, X., Barrena, R., Gea, T., Sánchez, A. 'Composting of food waste: Status and challenges', Bioresource Technology, (2017).

Sudharsan Varma, V. and Kalamdhad, A. S. 'Evolution of chemical and biological characterization during thermophilic composting of vegetable waste using rotary drum composter', International Journal of Environmental Science and Technology, 12(6), pp. 2015–2024, (2015).

Iyengar, S. R. and Bhave, P. P. 'In-vessel composting of household wastes', Waste Management, 26(10), pp. 1070–1080, (2006).

Bhange, V. P. et al. 'Green Waste As a Resource for Value Added Product Generation: A Review', 4(1), pp. 22–33, (2012).

Kalamdhad, A. & Kazmi, A. 'Mixed organic waste composting using rotary drum composter', International Journal of Environment and Waste Management, 2, pp. 24, (2008).

Sellami, R. Jarboui, S.Hachicha, K.Medhioub, E.Ammar, 'Co-composting of oil exhausted olive-cake, poultry manure and industrial residues of agro-food activity for soil amendment', Biores. Technol, 99, pp. 1177–1188, (2008).

Ajay S. Kalamdhad, A.A. Kazmi, 'Effects of turning frequency on compost stability and some chemical characteristics in a rotary drum composter', Chemosphere, 74, pp.1327-1334, (2009).

Mathava Kumar, Yan-Liang Ou, Jin-Gaw Lin, 'Co-composting of green waste and food waste at low C/N ratio', Waste Management, 30, pp. 602-609, (2010).

Y.A. Abdullahi, J.C. Akunna, N.A. White, P.D. Hallett, R. Wheatley, 'Investigating the effects of anaerobic and aerobic post-treatment on quality and stability of organic fraction of municipal solid waste as soil amendment', Bioresource Technology, 99, pp.8631-8636, (2008).

COLLECTING AND PROCESSING OF ORGANIC RESIDUES IN URBAN AND RURAL REGIONS – REGULATIONS AND QUALITY SECURITY FOR COMPOSTING IN GERMANY, CHALLENGES AND PERSPECTIVES FOR VIET NAM

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1. INTRODUCTION

Following a regulation of the European Union from 2010 and later on, the waste disposal, the Bio-waste as garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises as well as comparable waste from food processing plants should be separate collected and not dumping in landfills (COM235 final, 2010). EU Member States produce between 118 and 138 Mio tons of bio-waste each year. Bio-waste comprised up to 50% of municipal solid waste. Currently, in average 40% of this material is landfilled, in some EU countries up to 100%. Disposal in landfill leads to the diversion of carbon and nutrients in the bio-waste away from ecosystems, making it unavailable for reuse. In addition, the uncontrolled decomposition of organic materials in landfills leads to the emission of greenhouse gases such as methane (ECN Factsheet, 2016). Therefore, the aim in the EU is the reduction on the landfilling of municipal waste to a maximum of 10% by 2030. In the legislations of the EU for is postulated the necessity to increase the collecting and use of bio-waste in the Waste Framework Directive (COM235 final, 2010). In many documents is statet that the prevention of waste is the best option, followed by re-use, recycling and energy recovery. The separate collection of bio-waste is a precondition for the recycling of organic substances and nutrients. In Germany there are ca. 405 companies offering for about 67.5 Million inhabitants the bio-waste boxes. In these boxes are collected about 52 kg bio-waste per capita. In Germany contribute the collecting and use of bio-waste yearly with a reduction of ca. 56 million tons of CO^2 equivalent in comparison to 1990. This is mainly a result of the separate collection of household bio-waste in the last two decades.

2. COMPOSTING

The best and sustainable way to convert the bio-waste from different sources in organic fertilizer is composting. Composting is one possibility for sustainable use of organic wastes from farms, households in the communes and food industry. In Germany in average are collected more the 100 Kg Bio-waste and green waste per capita, this are 4 million Tons household waste in separate boxes. Additional about 5 million Tons of biomaterial from gardens and parks are collected, that are more than 9 million Tons of organic waste material per year. All together gives the possibility to produce 7 million Tons compost. This compost is used with 55.6% in agricultural crop production, 15.4% in substrate producing companies, 9.3% in landscaping and re-cultivation, 9.1% in hobby gardening, 4.3% for specific horticultural crops as asparagus or strawberries, 3.3% in market gardening and horticulture and 3.1% for other purposes.

Based on the origin of the substances used, the compost is differentiated in:

- Green compost- containing green-waste from gardens and parks
- Bio-waste compost – waste from the bio-boxes at the households, food industry, residues from agricultural crops or food residues from stables.

Regarding the fermentation processing and characteristic of the composts are differentiated in

- Fresh-compost with a duration of composting two to six weeks and
- Ready for use compost, with a composting duration of five to ten weeks

In Germany are used near to 1.000 composting plants with a yearly capacity of 10 million tons compost. The half of this plants is using bio-waste and green waste and the other half is using only green waste.With the converting of the bio-waste to compost comparably low cost organic fertilizer can be produced. Following our investigations, the supply of NPK for agricultural crops is realized in Germany with about 40% by use of compost and e.g. in Vietnam with 1% only.

3. QUALITY SAFEGUARDING

Very important for all users of the different compost types - is the safeguarding of the compost quality. The German Federal Compost Association developed a quality control system and all members of the association have to follow in order to get one of the six RAL certificates for different products (BGK/ GFCA, 2019). Compost used needs to consistently meet high quality specifications and exhibit defined physical, chemical and biological properties (GFCA Methodology, 1998).

Content of the RAL (BGK) certificate is:

- Sanitary harmlessness
- Stability of decomposing level
- Characteristics and nutrient content
- Confirmation regarding the origin of material based on EU and/or German regulations

For every compost product is given also a Test Certificate with the product description, Producer, RAL (BGK) certificate, adequate labelling following the regulation concerning use of fertilizers, purpose of the compost and filed of application and the confirmation of the regular testing of quality by the BGK).

4. SITUATION IN VIETNAM

In Ho Chi Minh City were analysed (2015) the sources of the solid waste was as follow: 58.8% from households, 23.9% marketplaces, 7.4% streets and 9.9% from others as factories and public places. From this waste were collected 70% and 30% are not collected. From the collected waste between 70 and 80% were disposed in landfills, up to 15% composted and up to 15% recycled (Böhme and Le Anh, 2015). The Municipal waste in tons per year increased in Vietnam from 6,400,000 in 2003 to an amount of 12,802,000 in 2008. The high amount of waste discharged in landfills and the low amount composted or used in biogas plants is showing the big challenge for a better collection and use of the bio-waste in particular in the households and marketplaces.

REFERENCES

BGK/ GFCA. (2019). Bundesgütegemeinschaft Kompost/ German Federal Compost Association, www.kompost.de

Böhme M. H. and Le H. Anh (2015). Sustainable Technology for Using Bio-Waste in Rural and Urban Regions in South- and South-East-Asia. Procedia CIRP, 13th Global Conference on Sustainable Manufacturing - Decoupling Growth from Resource Use, Volume 40, Pages 547-550

COM235 final (2010). Communication from the commission to the council and the European parliament on future steps in bio-waste management in the European Union, LexUriServEnglish.do., SEC(2010) 577

ECN Factsheet (2016). Factsheet Bio-waste: The valuable organic resource in a Circular economy. EUROPEAN COMPOST NETWORK ECN e.V., www.compostnetwork.info / www.ecn-qas.eu / @ECNnetwork

GFCA Methodology (1998). Methodology for analyses of compost. Published by the German Federal Quality Association eV. - Standards for Compost Quality, 4th edition, ISBN 3-928179-32-2

USE OF FOREST LAND AMONG ETHNIC MINORITIES: A CASE IN CAT TIEN NATIONAL PARK

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1. INTRODUCTION

Cat Tien, an important national park in Vietnam, protects one of the largest areas of lowland tropical raiforest ecosystem with high value of biodiversity. However, the forest resources continue to be degraded owing to a lot of pressures. The local ethnic minorities (EMs) within and around the park have depended much on the forest land resources for generations and have caused the major loss of this park. So they are considered as a key element for sustainable management of the forest land resources in the area. Based on the surveys in Cat Tien National Park (CTNP), this paper explores the situation of forest land use among the EMs.

2. MATERIAL AND METHODS

Overall, 170 households in 6 sampled hamlets of CTNP were interviewed. In-depth interviews and the Rapid Rural Appraisal (RRA) method were implemented to obtain the data through the field surveys. Pearson Chi-Square Test was used to analyse the data.

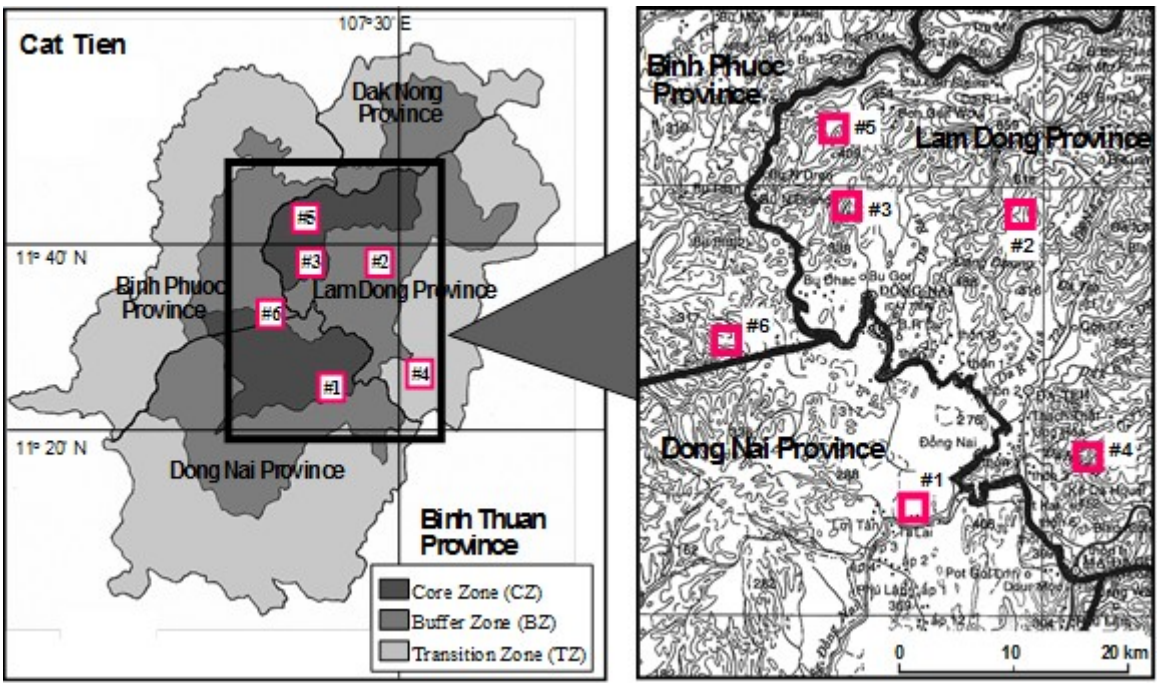

Figure 1. Location of the study sites in CTNP

3. RESULTS

Table 1. Sample size of the selected sites in CTNP

Code	Survey Site	District	Province	Total households	Interviewed households		Sampled people
					Number	%	
#1	Hamlet 4, Ta Lai	Tan Phu	Dong Nai	383	46	12.0	244
#2	Da Nhar, Quoc Oai	Da Teh	Lam Dong	234	24	10.3	111
#3	Brun, Gia Vien	Cat Tien	Lam Dong	18	18	100.0	78
#4	Hamlet 2, Da Oai	Da Huoai	Lam Dong	122	21	17.2	106
#5	Hamlet 4, Phuoc Cat	Cat Tien	Lam Dong	26	24	92.3	112
#6	Hamlet 1, Dang Ha	Bu Dang	Binh Phuoc	333	37	11.1	158
		Sum		1,116	170	15.2	804

Overall, the ethnic minorities in the reserve extracted and used encroached forest land to cultivate crops (49.4% of the total interviewed households). Approximately 35.3% of the surveyed households of indigenous ethnic minorities (IEMs) encroached forest land, whilst 100% of households of migrant ethnic minorities (MEMs) did this activity. The ratio of use of the natural resources in terms of encroached forest land differed significantly between the IEMs and the MEMs (Pearson Chi-Square Test, $p = 0.000$). Hence, the forest land use and conservation impacts were likely to be different between two these groups.

The result shows that the more the EMs participated in natural resource management and conservation activities the less they extracted the forest land resource. More than 62.1% of the nonparticipants encroached forest land for cultivation, but the figure of the participants was only 38.6%. The areas of encroached forest land differed significantly between the participants and the nonparticipants (Pearson Chi-Square Test, $p = 0.002$).

4. CONCLUSIONS

In conclusion, more MEMs, as well as more households who did not involve in natural resource management and conservation activities, encroached forest land illegally. It is recommended that more participation of the EMs in forest management or environmental services may be one of the effective strategies for sustainable management of the forest land in CTNP. Group-based arrangements would promote collaborative management and collective actions. So, different management arrangements between two groups are necessary.

REFERENCES

Dinh, T.S., (2013). Participation of ethnic minorities in management and use of natural resources: A case study of Cat Tien Biosphere Reserve, Vietnam. PhD Dissertation, Kyushu University, Japan.

Dinh, T.S., Ogata, K. & Yabe, M., (2010). Contribution of forest resources to local people's income: A case study in Cat Tien Biosphere Reserve, Vietnam. Journal of the Faculty of Agriculture, Kyushu University 55 (2): 397-402. Japan.

Ostrom, E. Gardner, R. and Walker, J., (1994). Rules, games, and common-pool resources. Ann Arbor: University of Michigan Press.

Extended abstracts of posters

EFFECT OF INCREASING INCLUSION RATES OF TOFU BY-PRODUCT IN DIETS OF GROWING PIGS ON NITROGEN BALANCE AND AMMONIA EMISSION FROM MANURE

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1. INTRODUCTION

Inclusion in animal feeds of by-products from the food industry not only is of interest because of the reduction of competition between human food and animal feed. In a former study, four fibre-rich by-products from agricultural activities and food processing were compared, suggesting some potential for the by-product of tofu production to stimulate hindgut fermentation while enhancing animal performance although ammonia emission from manure was not reduced. This might have been related to its low dietary inclusion level. Hence, with the current research, the potential of a tofu by-product to stimulate hindgut fermentation and reduce ammonia emissions without impairing animal performance was further assessed in a dose response study.

2. MATERIAL AND METHODS

Two experiments were conducted including a control diet (Con) without tofu by-product, containing 160 g/kg dietary non-starch polysaccharides (NSP) and three diets including 122, 246 and 360 g tofu by-product/kg DM (TF122, TF246 and TF360, respectively) to reach 220, 280 and 340 g/kg NSP. All diets had the same level of crude protein and protein digestible in the small intestine which particularly was realised by exchanging rice bran by tofu by-product. Animal performance was assessed in a first experiment with forty growing barrows with an initial body weight of 26.6 ± 1.80 kg (M±SD) being allocated to the one of the four treatments, during two growth phases (i.e. until 50 kg BW and from 50 to 80 kg BW). Experiment two was conducted to assess digestibility, nitrogen balance and ammonia volatilization from manure. For this purpose, sixteen pigs with body weight of 62.8 ± 3.6 kg (M±SD) were assigned to either one of the four treatments. Ammonia emission was measured in a laboratory system according to the procedure described by Canh et al. (1998) with some methodological modifications which were described in detail by Nguyen et al. (2018) together with the collecting sample plan (d1, 2, 4 and 7).

3. RESULTS

Feed intake and ADG of pigs fed increasing amounts of tofu by-product were linearly reduced ($P<0.05$). Increasing the inclusion rate of tofu by-product linearly reduced ($P<0.05$) urinary nitrogen (g/d), urinary nitrogen expressed as percentage of total nitrogen excretion, the ratio of urinary nitrogen and faecal nitrogen and the ratio of purine bases nitrogen to faecal nitrogen ($P<0.05$) (Table 1). While there was no difference in faecal VFA between treatments. Slurry pH did not differ between treatments. The effect of dietary treatments on the accumulated ammonia emission (mg/pig) over the 7-day period is illustrated in Fig. 1. At none of the 4 measurement days, ammonia emission from slurry differed between treatments.

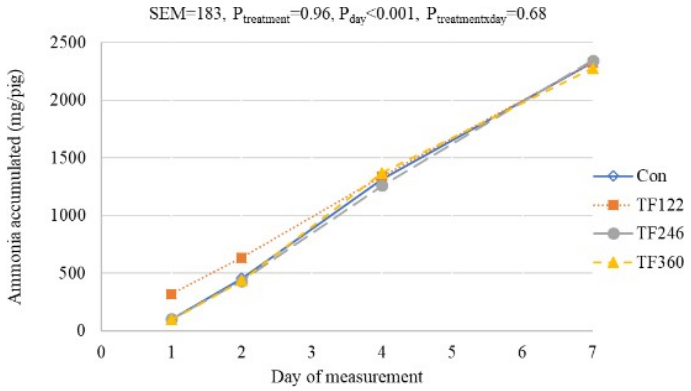

Figure 1. Accumulated ammonia emission over a 7-day.

Table 1. Nitrogen balance and, faecal concentration of purine bases and volatile fatty acids.

Variable	Diet				SEM	P-value	
	Con[1]	TF122[2]	TF246[3]	TF360[4]		Linear	Quadratic
Daily N intake (g/d)	44.9	45.3	44.6	37.3	2.66	0.07	0.18
Daily faecal N (g/d)	8.22	9.55	9.52	8.08	1.04	0.93	0.21
Daily urinary N (g/d)	19.2[a]	16.1[ab]	14.5[b]	12.1[b]	0.95	<0.01	0.70
Total N excretion (% NI)[5]	61.2	56.4	54.0	55.4	2.81	0.14	0.28
N-urine (% NE)[6]	70.1	63.3	60.5	60.0	3.11	0.03	0.33
N retention (g/day)	17.5	19.7	20.5	17.1	1.84	0.98	0.16
Urinary N/faecal N	2.47	1.80	1.62	1.50	0.28	0.03	0.34
Purine bases (g/g DM)	0.57	0.59	0.64	0.53	0.04	0.78	0.16
Purine bases N/faecal N	0.08[a]	0.07[ab]	0.07[ab]	0.06[b]	0.005	0.01	0.28
Faecal VFA (g/kg DM)							
Total VFA	37.1	38.5	41.6	41.8	5.08	0.47	0.91

[1,2,3,4]Con= Control treatment, Con, TF122, TF246, TF360: diet containing 0, 122, 246, 360 g tofu by-product per kg feed, resulting in a NSP content of 160, 220, 280 and 340 g/kg, respectively. [5]NI = Nitrogen intake, [6]NE = Nitrogen excretion

4. CONCLUSIONS

Inclusion of TF up to 250 g/kg DM in pigs' diets did not impair animal performance and apparent total tract digestibility of nutrients for growing pigs. However, increasing dietary NSP by using TF did not mitigate ammonia emission from pigs' slurry.

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REFERENCES

Canh, T. T., Aarnink, A. J. A., Mroz, Z., Jongbloed, A. W., Schrama, J. W., Verstegen, M. W. A., (1998). Influence of electrolyte balance and acidifying calcium salts in the diet of growing-finishing pigs on urinary pH, slurry pH and ammonia volatilisation from slurry. Livest. Prod. Sci.,56, 1-13.

Nguyen, Q.H., Le, P.D., Chim, C., Le, N.D, Fievez, V., (2018). Potential to mitigate ammonia emission from pig slurry by increasing dietary fermentable fiber through inclusion of tropical byproducts in practical diets for growing pigs. Asian-Australas. J. Anim. Sci

EFFECTS OF TWO STAGES ANAEROBIC DIGESTION ON METHANE YIELDS OF PIG MANURE AND WATER HYACINTH

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1. INTRODUCTION

Pig manure and water hyacinth are two most popular organic waste sources in Vietnam which can be reused to produce energy by anaerobic digestion process. However, pig manure is diverting directly into canals and rivers as it is common practice in Vietnam (Sebesvari et al., 2012); whereas, water hyacinth is abundant on the rivers and canals. It causes transportation problems. Anaerobic digestion is one of the good ways not only to generate more energy for the country's development butalso to reduce environmental pollution. Especially, in Vietnam biogas can be produced easily as the ambient temperature allows methanogenesis without additional heating. Generally, anaerobic digestion consists of four processes: hydrolysis, acidogenesis, axetogenesis and methanogenesis (Bajpai, 2017). In fact, all processes take place in a digester. Most of the previous studies considered only on biogas production or investment cost (Nguyen et al., 2016). There is still missing data concerning the efficiency of a simple two- stage anaerobic digestion process and results are sometimes conflicting. For example, hydrolysis seperation to anaerobic processes associated to the different input material were often excluded in previous studies. The aims of the study were to find out the methane yields of a good phase separation between hydrolysis/acidification and methanogenesis. The study was also aimed to find influent factors to methane yields such as organic loading rates, mixing ratio, temperature and hydrolysis to anaerobic processes.

2. MATERIAL AND METHODS

The series of batch experiments were conducted to analyse methane yields of different input conditions such as temperature (35°C, 45°C and 55°C), different mixture (pig manure and water hyacinth), different organic loading rates (substrate/inocculum) and different pretreatment of input material (hydrolyse with water and with effective microorganism (BIO-EM)). The experiments were carried out using Bio-Methane Potential (BMP) modeling test. The BMP test was performed in three glass bottles of 500mL each (Figure 1). The first bottle was partially filled with substrate and inoculum according to the fixed ratio. Water was added up to ensure the moisture of substrate for anaerobic digestion. pH was measured before starting and after ending the experiment. The bottle was sealed with a thick gumming cap. The bottle was connected by capillary tube to the second glass bottle which was inverted and containing an 2% alkaline

solution (NaOH). The capillary tube was equipped on both ends with a needle to pierce the thick gumming cap to enable gas transfer through the two connected bottles. Daily methane production was monitored measuring the volume of alkaline solution displaced from the measure bottle and collected in a third 500mL glass bottle. The displaced liquid was measured daily by a cylinder. The CO_2 contained in the biogas was dissolved in the alkaline solution; therefore, it did not affect the volumetric methane measurements. Temperature and pH in each BMP bottle were monitored at the beginning and the end of the experiment. All bottles were shaken once a day for 30 second by hand.

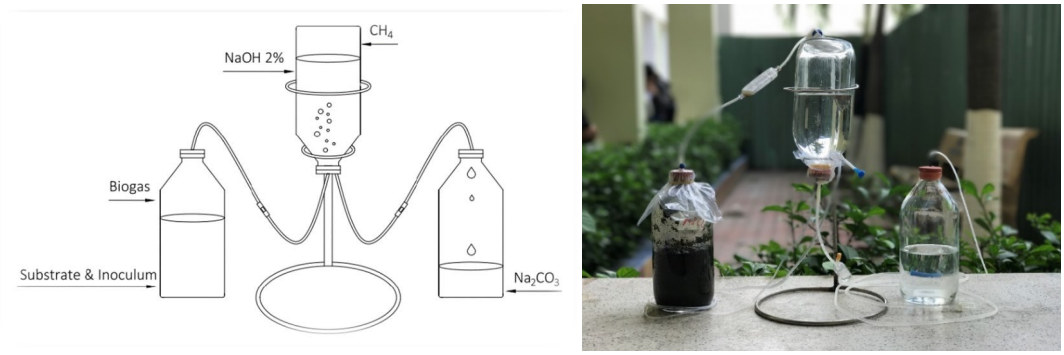

Figure 1. Schematic of a simplified test for Bio-Methane Potential (BMP)

3. RESULTS

The study found that if the temperature increased, the methane generation was decreased. The methane production was highest at 35ºC (688 LCH_4/KgVSS) in the experiment. At 35ºC, the input pH was neutral which raged from 6.9 to 7.2, mixture of pig manure and water hyacinth at the ratio of 75% Pig Manure (PM) + 25% Water Hyacinth (WH) at the loading of 0.6 VSS/VSI achieved the highest methane yield (104 LCH_4/KgVS). Pretreatment of input material by hydrolyzing with BIO-EM increased significantly methane production. The methane productions were 474 LCH_4/KgVSS and 474 LCH_4/KgVSS at the experiment 5 days and 10 days hydrolysis respectively.

4. CONCLUSIONS

Results showed that the combination of pig manure and water hyacinth for anaerobic process for biogas generation can be a solution to the environment as well as in economic and social aspects. It contributes greatly in generating renewable energy and reducing pollution. The results of this study indicated that the two-stage anaerobic digestion (hydrolysis seperation) system is suitable for increasing methane yields of pig manure and water hyacinth.

REFERENCES

Bajpai P. (2017). Basics of Anaerobic Digestion Process Anaerobic, Springer Briefs in Applied Sciences and Technology

Nguyen T. T. N., Tran V. K., Nguyen T. P. (2016). The efficiencies of small-scale biogas digesters in pig manure treatment in the mekong delta, Scientific Journal of Thu Dau Mot University, 6(31), 55-58.

Sebesvari Z., Le T. T. H., Pham V. T., Arnold U., and Renaud F. G. (2012). Agriculture and Water Quality in the Vietnamese Mekong Delta, Springer Environmental Science and Engineering.

WATER BALANCE CHANGES IN THE UPPER PART OF DONG NAI RIVER BASIN

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1. INTRODUCTION

The Dong Nai (ND) river basin is the largest national river basin and originates in the Central Highland region of Vietnam. The Upper Part of the Dong Nai (UPDN) river basin, a forest areas higher than the rest, covers an area of 972,460 ha and most of which belongs Lam Dong province. In recent decades, changes in land use and land cover (LULC) due to activities of socio-economic development have altered the hydrologic system. Climate change coupled with LULC change has posed distinctive challenges in the management practices of water resources in terms of hydrological conditions and water balance. To provide quantitative information that would allow stakeholders and decision makers to make better choices regarding land and water resources management, the objectives of this study are: (i) to create LULC maps for three Landsat images (1994, 2004, and 2014) and observe LC changes in 20 years (1994 – 2014); (ii) to evaluate the impacts of climate and LULC changes on on stream-flow by using SWAT model; and (iii) to calculate water balance based on the scenario of LULC and climate of 2014.

2. MATERIAL AND METHODS

The hydrological cycle is simulated in the SWAT model based on the water balance equation (Neitsch et al., 2011):

$$SW_t = SW_0 + \sum_{i=1}^{t} (R_{day} - Q_{surf} - E_a - w_a - Q_{gw}) \quad (1)$$

where SW_t is the final soil water content. SW_0 is the initial soil water content on day i. t is the time (days). R_{day} is the amount of precipitation on day i. Q_{surf} is the amount of surface runoff on day i (mm H_2O). E_a is the amount of evapotranspiration on day i. w_{seep} is the amount of water entering the vadose zone from the soil profile on day i. Q_{lat} is the water percolation past bottom of the soil profile in the watershed for day i. Q_{gw} is the amount of return flow on day i. All water units are in mm H_2O.

The key datasets that are required by the SWAT model are the Digital Elevation Model (DEM) map, LULC map, soil map and weather data (Can et al., 2015).

DEM map with 12.5-meter resolution downloaded from the website of the NASA: ttps://urs.earthdata.nasa.gov/users/new. Climate data were achieved from 4 weather stations (Da Lat, Lien Khuong, Bao Loc, and Dac Nong). Soil data were obtained from the 1:100,000 soil map of Department of Natural Resources and Environment (DONRE) Lam Dong province. The LULC maps are derived from classifying Landsat images based on maximum likelihood classification (MLC) algorithm, a commonly used

method on Landsat images (Phiri and Morgenroth, 2017). Addition, stream-flow data were collected from the Thanh Binh and Ta Lai gauge station located at the upstream and downstream of the basin. The monitoring stream-flow is used for calibration and validation of the SWAT model.

3. RESULTS

The classification results of Landsat images indicated that the forest has been dominant land cover types of the UPDN river basin, the rate of forest cover of 1994, 2004, and 2014 was 706,803 ha (72.68%), 520,359 ha (53.51%), and 485,908ha (49.97%), respectively. In contrast to the reduction in forest area, there have been increased agricultural land, in which the area of 1994, 2004, and 2014, was 249,230 ha (25.62%), 425,239 ha (43.73%), and 440,688 ha (45.31%), respectively. The result shows that change in climate condition and land use has affected the hydrological responses in 1994, 2004, and 2014, see Figure 1. The effects of the LULC change on water yield were not significantly different for LULC scenarios in 1994, 2004, and 2014. However, the annual precipitation variations have changed water yield from HRUs (hydrologic response unit) in the watershed.

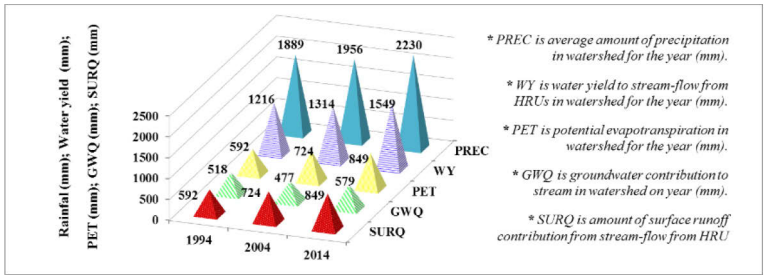

Figure 1. Hydrographs for hydrologic response to climate change and change in LULC

With the scenarios of LULC 2014 of whole basin scale, the yearly total water resource was 25.53×10^9 m^3 and the yearly total water use was 2.32×10^9 m^3. The consumption of irrigation water was the highest with 68.2% and significantly changed between the seasons (70.5% in the dry season compared to 29.5% in the rainy season).

4. CONCLUSIONS

The results indicated that climate change and change in LULC has fluctuated (increased and decreased) in stream-flow for the whole watershed in 1994, 2004, and 2014. The changes in water yield (stream-flow) have mainly been driven by historical climate variations. The irrigation water has been the dominant water use types of the UPDN river basin.

REFERENCES

Can, T., Xiaoling, C., Jianzhong, L., Gassman, P.W., Sabine, S., José-Miguel, S.P. (2015). Assessing impacts of different land use scenarios on water budget of Fuhe River, China using SWAT model. Int J Agric & Biol Eng 8, 95-109.

Neitsch, S.L., Arnold, J.G., Kiniry, J.R., Williams, J.R., (2011). Introduction and history, Soil and Water Assessment Tool Theoretical Documentation Version 2009. Texas Water Resources Institute Technical Report No. 406, Texas A&M University System College Station, Texas 77843-2118, pp. 6-10.

Phiri, D., Morgenroth, J. (2017). Developments in Landsat Land Cover Classification Methods: A Review. Remote Sensing 9, 1-25

ABILITY OF *CHLORELLA VULGARIS* ALGAE FOR NUTRIENTS REMOVAL IN WASTEWATER AND COLLECTION OF ALGAE BY FERRATE

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1. INTRODUCTION

Microalgae are emerging as a very promising and sustainable environmental technology due to its ability of nutrient consumption in wastewater and CO_2 adsorption in air. High rate algae ponds are considered as more simple but high efficient and stable than traditional biological treatment such as aerobic, anoxic, and anaerobic methods for removal of nitrogen and phosphorous. Moreover, biomass of microalgae is a valuable product that could be used for biofuels and compost production (Mulbry et al., 2005). Microalgae technology are essential role in the sustainable development of agriculture: microbial fertilizers from microalgae provide high nutrients for plants (Zepka et al., 2010). *Chlorella vulgaris* is a genus of single-celled green algae belong to the *Chlorophyta* family, which survives in brackish water, salt water and even in polluted environments (Canovas et al., 1996; Janczyk et al., 2006), which is widely applied for wastewater treatment. However, the improper collection after wastewater treatment could cause algae bloom and eutrophication, which is a serious water pollution (Aslan and Kapdan, 2006).

In this study, we aim to employ *Chlorella vulgaris* algae for removal of nutrients in wastewater and collect the produced algae by ferrate after treatment. The performance of algae for ammonia, nitrite, nitrate, and phosphate removal in domestic wastewater was investigated for batch and continuous tests. The applicability of ferrate for algae collection after water treatment was also evaluated.

2. MATERIAL AND METHODS

The growth of the alga was conducted in F/2 synthetic medium and in actual domestic wastewater and evaluated by using optical density and *Chlorophyll-a* parameters for determining the growth phase. The removals of nitrogen and phosphorous by algae were then investigated for low and high nutrient concentrations using wastewater after biological treatment in both batch and continuous experiments. The collection of produced alga biomass was done by coagulation under different conditions of solution pH (5 – 9) and dosage of alum (5 – 25 mgAl/L) and ferrate (4 – 20 mgFe/L).

3. RESULTS

Results showed that specific growth rates in the exponential phase were 0.23 and 0.35 day^{-1} for medium F/2 and domestic wastewater, respectively, proving the suitability of wastewater for algae growth. The removal efficiencies of NH_4^+-N, NO_3^--N, and PO_4^{3-}P in domestic wastewater were observed to be 89 - 93, 64 - 76, and 69 – 88%, respectively. In the algae collection test, pH 8 is the optimal pH to remove algae and ferrate had higher algae removal ability than alum under each optimal condition with removal efficiency of 84 - 97% at ferrate dosage of 12 mgFe/L.

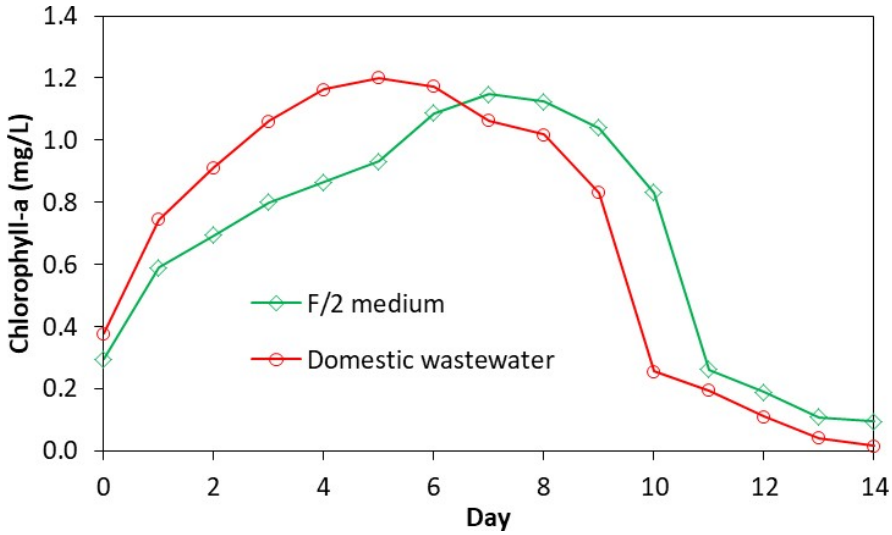

Fig. 1. Growth of *Chlorella vulgaris* in F/2 medium and domestic wastewater

4. CONCLUSIONS

Chlorella vulgaris alga was applied for nitrogen and phosphorous removals in domestic wastewater. Results showed that domestic wastewater is a very suitable environment for the growth of the alga with high ammonia, nitrate, and phosphate observed during the experiment. The suitable condition for algae removal using ferrate was also obtained at pH 8 and ferrate dosage of 12 mgFe/L. These results suggest that microalgae are promising alternatives for removing of nutrients in wastewater treatment due to the high uptake capacity of nitrogen and phosphorous and the effective collection of algae after treatment by ferrate.

REFERENCES

Sebnem Aslan and Ilgi Karapinar Kapdan (2006), Batch kinetics of nitrogen and phosphorus removal from synthetic wastewater by algae, Ecological Engineering, vol. 28, n. 1, 64-70.

S Canovas, B Picot, C Casellas, H Zulkifi, A Dubois, and J Bontoux (1996), Seasonal development of phytoplankton and zooplankton in a high-rate algal pond, Water Science and Technology, vol. 33, n. 7, 199-206.

P Janczyk, Martina Langhammer, Ulla Renne, V Guiard, and WB Souffrant (2006), Effect of feed supplementation with Chlorella vulgaris powder on mice reproduction, Archiva Zootechnica, vol. 9, 122-134.

Walter Mulbry, Elizabeth Kebede Westhead, Carolina Pizarro, and Lawrence Sikora (2005), Recycling of manure nutrients: use of algal biomass from dairy manure treatment as a slow release fertilizer, Bioresource technology, vol. 96, n. 4, 451-458.

Leila Queiroz Zepka, Eduardo Jacob-Lopes, Rosana Goldbeck, Leonor Almeida Souza-Soares, and Maria Isabel Queiroz (2010), Nutritional evaluation of single-cell protein produced by Aphanothece microscopica Nägeli, Bioresource technology, vol. 101, n. 18, 7107-7111.

BIOSORPTION COMBINED WITH LIPID PRODUCTION AND GROWTH INHIBITION OF COPPER ON THE MICROALGA *PEDIASTRUM* SP.

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1. INTRODUCTION

Microalgae have been considered a promising tool for the need due to their ability to remove various heavy metal from wastewater (Kumar et al., 2015; Zeraatkar et al., 2016), and their great potential in producing biodiesel (Chen et al., 2018). Therefore, the coupling deals of advanced wastewater treatment and biofuel production based on microalgae is a promising solution. Many green alga such as *Scenedesmus* spp., *Chlorella* spp. have been employed as for removal haevy metals from wastewater and to produce biodiesel (Xin et al., 2010). Other microgreen algae species including *Pediastrum* spp., *Ankistrodesmus* spp., *Staurastrum* spp. are common present in wastewater ponds but little known about their ability to removal of heavy metals from contaminated waters. There are many unexplored algae species with high ability to removal of toxic metal in natural environment. Therefore, in this study, the green algal *Pediastrum* sp. was isolated from the Nhieu Loc – Thi Nghe canal, a polluted canal in Ho Chi Minh city, and used to examine the effective removal of Cu ion and investigate lipids accumulation. The biosorption and bioaccumulation of Cu from aqueous solution were investigated.

2. MATERIAL AND METHODS

The microgreen alga species (*Pediastrum* sp.) was collected from the Nhieu Loc – Thi Nghe canal. The stock solutions 1000 mg/L of copper Cu(NO3)2 (Titrisol, Merck, Germany) was used to prepared experimental solutions with concentrations of 0, 0.1, 0.5, 2, 5 and 15 mg/L. The alga was tested for the ability of removal, biosorption of copper and growth inhibition experiment. The total lipid content and concentration of Cu in alga biomass was measured.

3. RESULTS AND DISCUSSION

Results also indicated that different concentration of Cu resulted in different effects on the algal growth. Cu at low concentration from 0.1 to 0.5 did not caused significant effect on algal growth, but at 2 mg/L or higher, Cu caused significant decline on the cells concentration of *Pediastrum* sp. The algal growth

inhibition was increased and dose dependence of Cu. The EC_{50} values of Cu for inhibition of 50% of algal growth after 96h was 6.67 mg/L. Cu at the concentration of 2 mg/L or higher caused significant effects and dose-dependent increases on the growth of *Pediastrum* sp. Cu at 15 mg/L inhibited completely the growth of *Pediastrum* sp.

Results indicated that different concentration of Cu caused different effects on total lipid content. Cu at concentration of 0.1 and 0.5 mg/L led to a significant increase in total lipid production. However, Cu at the concentration of 2 mg/L did not influence lipid production. Further increasing of Cu (5 and 15 mg/L) drastic decreased in total lipid production in *Pediastrum* sp.

Results showed that metal removal rate was higher at higher initial metal concentrations up to 2 mg/L. *Pediastrum* sp. attained a Cu removal rate approximately 100% at the lowest initial metal concentration tested (0.1 mg/L); the maximum removal rates (80.5–83.5%) were observed in the treatment with 1 and 2 mg/L of Cu. When exposed to the higher concentration (5-15 mg/L), a significant decrease of Cu removal capacity was observed. Probably, the inhibition on growth of *Pediastrum* sp. has resulted in significant reduction of removal capacity of Cu in the treatment with 15 mg/L.

4. CONCLUSIONS

This study indicated that the green algae *Pediastrum* sp. exhibited the ability to biosorb and bioaccumulate Cu, and has potential for lipid production. Both initial metal ion and biomass concentrations had effected on Cu uptake and removal. Cu at high level could caused toxic to the green algae and consequently decreasing removal rate as well as reducing total lipid production.

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REFERENCES

Chen J., Li J., Dong W., Zhang X., Tyagi R.D., Drogui P. and Surampalli R.Y. (2018). The potential of microalgae in biodiesel production. *Renew Sust Energ Rev* 90: 336-346.

Kumar S.K., Dahms H.-U., Won E.-J., Lee J.-S. and Shin K.-H. (2015). Microalgae – A promising tool for heavy metal remediation. *Ecotoxicol Environ Saf* 113: 329-352.

Xin L., Hong-ying H. and Jia Y. (2010). Lipid accumulation and nutrient removal properties of a newly isolated freshwater microalga, *Scenedesmus* sp. LX1, growing in secondary effluent. *New Biotechnol* 27(1): 59-63.

Zeraatkar A.K., Ahmadzadeh H., Talebi A.F., Moheimani N.R. and McHenry M.P. (2016). Potential use of algae for heavy metal bioremediation, a critical review. *J Environ Manage* 181: 817-831.

THE STUDY OF VIETNAMESE BONECHAR SYNTHESIS AND ITS APPLICATIONS IN REMOVAL ORGANIC COLOR

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1. INTRODUCTION

The goal of this study is to find the process of Vietnamese bonchar (VNBC) synthesis from bovine bone waste. Simultaneously, VNBC product then is measured by analysis methods to determine the surface properties. Further, we try to apply VNBC product as an adsorbent to remove the organic colors such as KMnO4 and Methylence blue (MB) in solution. In detail this works, the samples of bovine bone waste are treated and calcinated then in conditional without oxygen at different temperature and time to find the optimal condition burning. The optimal VNBC sample then are chosen and measured surface properties by analysis methods. The effects of conditional temperature and time to adsorption capacity on VNBC are also investigated.

2. MATERIAL AND METHODS

Many samples of the bovine bone wastes collected from cow slaughterhouse and experiments to VNBC synthesis are performed at the Faculty of chemical engineering, Industrial University of Ho Chi Minh City of Vietnam.

3. RESULTS

3.1 The process to VNBC synthesis

Table 1: The effects of burning temperature to VNBC synthesis.

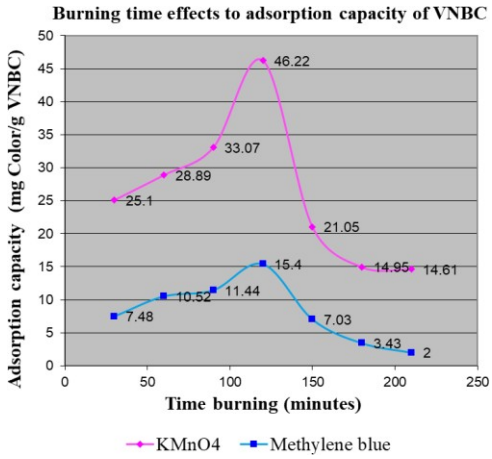
BBs Sample	T_b	m_1	m_2	E
400- 60	400	86.84	80.05	92.18
450- 60	450	105.5	85.36	80.91
500- 60	500	98.32	87.35	88.84
550- 60	550	100.68	87.77	87.18
600- 60	600	104.32	88.93	85.25
650- 60	650	93.1	81.32	87.35
700- 60	700	90.01	77.93	86.58
750- 60	750	96.64	84.22	87.15
800- 60	800	98.3	83.46	84.90

3.2. Adsorption capacity on VNBC with colored KMnO4 and MB solutions

The resulted adsorption capacity is given with KMnO4 and MB which the relation between time burning and adsorption capacity, presented in Figure 1.

3.3. The resulted characteristic surface of optimal VNBC

The resulted FTIR spectra is measured, and shown in Figure 3.



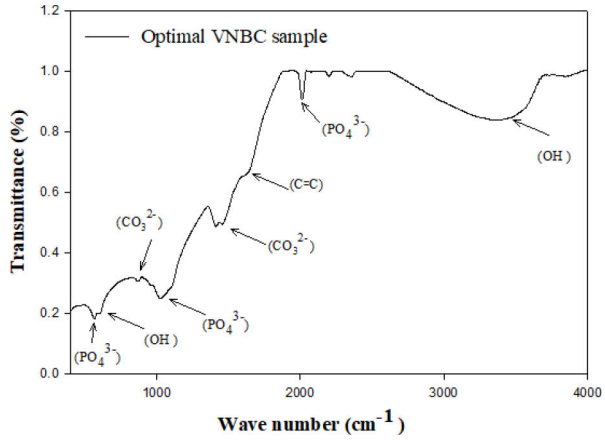


Figure 1. Chart of time changes effected to adsorption capacity on bonechar

Figure 2. FTIR results of bovine bone after calcined at optimal condition

4. CONCLUSIONS

From investigations, we draw some conclusions in following: 1. The steps of process to VNBC synthesis, many samples of bovine bone waste are calcinated in laboratory which VNBC sample found at optimal condition of 650 °C, corresponding with 120 minutes. 2. The results of colored solution adsorption on optimal VNBC sample is obtained with highest capacity adsorption of KMnO4 to be from 33.51 to 46,22 mg color/g VNBC, and MB from 12.1 to 15,04 mg color/g VNBC, respectively.

In these analysis methods, SEM can be helpful to describe the morphology of VNBC at nanoscale level with a crystalline size of from 200 to 250 nm. FTIR and XRD technique given us to find out that crystalline nature of VNBC, existing the calcium metal is combined with PO4-3, CO32-, and OH- groups, to which structural crystal was Ca10(PO4)5.65(CO3)0.64(OH)3.45 compound (calcium carboxyl-apatite). Furthermore, the BJH technique can be used to distinguish the types of pore material and adsorption capacity of adsorbents. Hence, the resulted specific surface area of 120.315 m2/g with pore diameter of 87.48 Å (8.75 nm) measured to what VNBC sample in this study is a good adsorbent and as a mesoporous material having potential applications in industry.

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REFERENCES

[1] Bawa, K.J.K.S.K.R.A.S. (2012) Utilization of byproducts and waste materials from meat, poultry and fish processing industries: a review, J Food Sci Technol, 49: 278-293.

[2] Omole, A.S.O. D. O. (2013) An evaluation of slaughterhouse wastes in south-west Nigeria, American Journal of Environmental Protection, 2: 85-89.

[3] Edwin Ambani AmesoS.A.B. (2017) Charles Owuor Olu, ngah and Tobias Haller, Ethnography of the slaughterhouse: A case of Nanyuki slaughterhouse in Laikipia County, Rift Valley, Kenya, Ameso et al. Pastoralism: Research, Policy and Practice 7, 32.

[4] Nasser, M.S.K. Omran, A.M. Faheem A. Sheikh, Hak Yong Kim, (2009) Extraction of pure natural hydroxyapatite from the bovine bones bio waste by three different methods, journal of materials processing technology, 209: 3408-3415.

[5] Nazia Bano, S.S.J. Hatijah Basri, A.H.N. Sharifah Adzila S. Abu Bakar, (2017) Natural Hydroxyapatite Extracted From Bovine Bo, Journal of Science and Technology, 9: 22-28.

ESTIMATION OF GREENHOUSE GAS EMISSION FROM RICE FIELD IN CAI BE DISTRICT, TIEN GIANG PROVINCE, VIETNAM WITH DNDC MODEL

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1. INTRODUCTION

In Vietnam, rice cultivation plays an important role not only in national GDP but also in the national greenhouse gas emission. In the year 2013, the emission from rice cultivation was approximately 42500 ton CO2 eq, contribute 12.6% to the total emission from Viet Nam [1]. However, the inventory is done using tier 1 and the default emission factors from IPCC Guideline, which contains uncertainty [2]. Recently, using models to simulate and estimate emission from rice paddies has been received attention from scientists due to the low labor-demand and fewer difficulties comparing to field measurements. DeNitrification & DeComposition (DNDC) model is commonly used to model greenhouse gas emissions from rice fields and several countries have developed their own DNDC models [3]. However, the DNDC model version, which can simulate the emission from paddy field specified for Vietnam is not yet available. This study focuses on using the DNDC model to estimate greenhouse gas emissions from irrigated rice cultivation in Mekong Delta, Vietnam.

2. MATERIAL AND METHODS

The site study of this research is Hậu Mỹ Bắc B commune (HMBB), Tien Giang province - a typical rice production area with 3 crops per year in Mekong Delta. To conduct this study, the information on local climate and farming practices in the site study in one year from 05/03/2017 to 04/03/2018 were collected as model input data. The DNDC model was adjusted according to the conditions found in the local rice paddies. This adjusted model was used to simulate and estimate greenhouse gas emissions from rice cultivation in 1 year. This study also analyzed the sensitivity of the model to the variations of different factors including climate data, soil characteristics, and farming practices. For the sensitivity tests, the result of the model running with the actual data will be the baseline while the other scenarios have the changes of the test factors within a reasonable range. The results of the test will indicate which input parameters are most sensitive or in other words having a significant impact on CH_4 and N_2O emissions from the rice field.

3. RESULTS

The simulated results show that the one-year emission factors for CH_4 and N_2O emission from rice field in HMBB were 8311 kg CO_2eq/ha and 8208 CO_2 eq/ha respectively. Sensitivity analysis indicated that CH_4 emissions were significantly influenced by temperature and flooding time while N_2O emission was influenced by soil characteristics including soil pH, soil organic carbon and soil texture. Daily precipitation and the total amount of mineral fertilizer used per year have negligible effects on greenhouse gas emissions from the rice field.

Greenhouse gas	**N_2O**	**CH_4**
Emission factor	17 kgN/h	293 kgC/ha
GWP (kg CO2eq/ha)	8311	8208
Net GWP (kg CO2 eq/ha)	23864	

4. CONCLUSION

DNDC model has demonstrated the relative accurate estimations in other countries, there are several research studies show that DNDC can estimate relative exactly greenhouse gas in Vietnam. Therefore, we need more research about these problems in different times and places on Viet Nam. On the other hand, the DNDC model can be used for management land, SOC content, soil organic content, the amount of water used to research and design an optimal farming method for farmers.

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REFERENCES

[1] Ministry of Natural Resources and Environment, Socialist Republic of Viet Nam. The second biennial updated report of Viet Nam to the United Nations framework convention on climate change; 2017 [cited 2019 March 31] Available from: URL: https://unfccc.int/files/national_reports/non-annex_i_parties/biennial_update_reports/application/pdf/97620135_viet_nam-bur2-1-viet_nam_-_bur2.pdf.

[2] 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 4: Agriculture, Forestry and Other Land Use; Chapter 5: Cropland.

[3] Gilhespy SL, Anthony S, Cardenas L, *et al.* First 20 years of DNDC (DeNitrification DeComposition): Model evolution. Ecological Modelling 2014; 292: 51–62 [https://doi.org/10.1016/j.ecolmodel.2014.09.004]

THE IMPACT OF LAND USE CHANGE ON THE CARBON STOCK IN MANGROVE FOREST SOILS IN THE MUI CA MAU NATIONAL PARK, VIETNAM

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1. INTRODUCTION

Mangrove forests have been lost dramatically over the last decades, approximately 1% per year. Regional estimates in Southest Asia were as high as 2 – 8% per year (Polidoro 2010). Causes of loss include development of industrial and urban areas, logging for woods, pollution and conversion to agriculture land and fish and shrimp ponds. Mangrove forests provide critical ecological services and functions such as regulation of water quality, provision of biological diversity. Such ecosystems are also a source of nutrients or energy for adjacent habitats and, importantly, a major carbon (C) sink in the tropics.

Despite the limited number of studies on the mangrove forest conversion to fish and shrimp ponds, such land-cover changes are suggested to result in carbon exporting and release. Mangroves sequester atmospheric carbon dioxide (CO_2) into biomass as well as detritus in soils and allochthonous organic carbon during the permanent flooding condition (Alongi 2014). Most of the C in mangrove ecosystems was sequestered in the belowground C pools found in soils and belowground vegetation. On average, soil C pools constituted 89% of the ecosystem C stocks, ranging from 266 Mg C ha^{-1} in the Dominican Republic to 1564 Mg C ha^{-1} in Indonesia (Kauffman et al. 2017). Previous studies also estimated the global mean rate for soil carbon burial as 163–226 g C m^{-2} yr^{-1} in mangrove wetlands (Breithaupt et al. 2012, McLeod et al. 2011).

Within mangrove forests undergoing conversion into shrimp ponds, there were significant losses of soil C associated with conversion. Kauffman et al. (2017) suggested that 54% of belowground C pools (consisting of soils and roots) is lost through conversion. Areas subjected to land conversion had mean ecosystem C stocks that were 40% of the intact mangrove stocks they replaced. In addition, 84% of the estimated carbon emissions in form of GHGs from shrimp pond conversion were attributed to declines in soil C pools of mangrove forests (Kauffman et al. 2017).

This study aims to investigate the effects of agricultural land use change on carbon stock in mangrove forest, specifically: a) to explore the status of land use changes related to shrimp in mangrove forests in Ca Mau province, b) to review the carbon cycle in mangrove forest soils, and c) to evaluate the differences of soil carbon stocks from 3 unique patches in mangrove forests (mudflat, natural forest and shrimp pond). We also measured other environmental factors to explore the significant correlations providing references for management implementation.

2. MATERIAL AND METHODS

2.1 Study sites

Soil samples were collected from three sites (Mud flat (S_1) - 8°39'5.82"N and 104°48'42.36"E; Natural forest (S_2) - 8°39'2.20"N and 104°49'10.91"E; Shrimp pond (S_3) - 8°38'58.19"N and 104°49'10.19"E) in mangrove forests in Ngoc Hien district, Ca Mau province (Figure 1).

Figure 1. Sediment cores and sampling sites in mangrove forest in the Mui Ca Mau National Park

2.2 Sampling methods

Soil samples were collected from mudflat (S_1), natural forest (S_2) and shrimp pond (S_3) using stainless core samplers (3cm diameter and 1m length, 2 cores per site) (Figure 1). Soil cores were divided into 9 sections, each with approximately 10cm in length. All samples are sealed in plastic bag and preserved at 4°C to bring to the lab.

2.3 Chemical analysis

Soil measurement were also carried using standard methods (i.e., bulk density (0-30cm in depth), pH, water content (WC), N-NH3, N-NO3, and total Kjehdal nitrogen).

2.4 Statistical analysis

Nonparametric tests were run using SPSS. Data was presented using Sigma Plot. Specifically, Kruskall Wallis analysis was used to analyze the differences in SOM contents of sediments across sites. The

relationships between variables were evaluated using correlation analysis.

3. RESULTS

The depth profile of SOMs in shrimp ponds is different from that of natural forest and mudflat (Table 1). The highest SOM content was observed in shrimp ponds, approximately 13.776 ± 4.432%, and lowest in the natural forest, 9.764 ± 3.450% respectively. The results showed that there was a significant positive correlation between soil water content (P <0.05) and pH (P, 0.01) with SOMs. In addition, soil water content was significantly correlated with ammonia nitrogen (P <0.01) and Kjeldahl nitrogen (P <0.01).

Table 1 Summary of physical-chemical parameters (mean ± SD)

	[(a)]D_b (kg/m3)	pH	WC (%)	SOM (%)	$N\text{-}NH_3$ (mg/g dry soil)	$N\text{-}NO_3$ (mg/g dry soil)	TKN (mg/g dry soil)
Mudflat	804,754 ± 109,012	7,22 ± 0,45	44,85 ± 15,30	10,015 ±7,162	0.019 ± 0,013	ND	191,671 ± 212,022
Natural forest	500,682 ± 111,358	6,46 ± 0,61	47,56 ±6,09	9,764 ± 3,450	0,041 ± 0,100	ND	139,215 ±53,817
Shimp pond	703,132 ± 183,991	6,21 ± 0,57	49,23 ±9,82	13,776 ±4,432	0,028 ± 0,017	ND	200,035 ± 136,297
Kruskal-Wallis test	P <0,05	P < 0,001	P < 0,05	P < 0,01	P < 0,05	Not significant	Not significant

(a) statistical results for the upper 30 cm sediment layer

D_b – bulk density, WC – water content, SOM – soil organic matter, $N\text{-}NH_3$ – nitrogen in form of ammonia,

$N\text{-}NO_3$ - nitrogen in form of nitrat, TKN – total Kjeldahl nitrogen

By using the conversion factor of 2.0 and the mean soil weight value measured in this study to calculate the carbon stock for a soil layer of 1-m depth, the estimation of average SOCs are 402.980 ± 288.182 tons C/ha of mudflat, 244.433 ± 86.367 tons C/ha of natural forest and 484.317 ± 155.814 tons C/ha of shrimp ponds, respectively (Howard & Howard, 1990). These estimations are consistent with another study of the Ca Mau mangrove forest carbon stocks (Lu et al., 2007).

4. CONCLUSIONS

In conclusion, this research had initially confirmed the changes in carbon stocks by mangrove forest conversion to shrimp ponds and explored the presence of factors affecting the carbon cycle in mangrove soils. However, due to the short time and funding, the results could be limited in explaining changes in carbon stocks under the pressure of land use changes in mangrove forests. The results could present the characteristics of the ecosystem at the beginning of the dry season. In order to increase data integrity, representative samples should be collected over different temporal and spatial scales.

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REFERENCES

Alongi D.M. (2014). Carbon cycling and storage in mangrove forests. Annual review of marine science, 6, 195-219.

Kauffman B.J., Arifanti V.B., Hernández Trejo H., del Carmen Jesús García M., Norfolk J., Cifuentes M., Hadriyanto D. & Murdiyarso D. (2017). The jumbo carbon footprint of a shrimp: carbon losses from mangrove deforestation. Frontiers in Ecology and the Environment, 15, 183-188.

Breithaupt J.L., Smoak J.M., Smith III T.J., Sanders C.J. & Hoare A. (2012). Organic carbon burial rates in mangrove sediments: Strengthening the global budget. Global Biogeochemical Cycles, 26.

Howard P.J.A. & Howard D.M. (1990). Use of organic carbon and loss-on-ignition to estimate soil organic matter in different soil types and horizons. Biology and Fertility of Soils, 9, 306-310.

Mcleod E., Chmura G.L., Bouillon S., Salm R., Björk M., Duarte C.M., Lovelock C.E., Schlesinger W.H. & Silliman B.R. (2011). A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. Frontiers in Ecology and the Environment, 9, 552-560.

Polidoro B.A., Carpenter K.E., Collins L., Duke N.C., Ellison A.M., Ellison J.C., Farnsworth E.J., Fernando E.S., Kathiresan K., Koedam N.E., Livingstone S.R., Miyagi T., Moore G.E., Ngoc Nam V., Ong J.E., Primavera J.H., Salmo S.G., Sanciangco J.C., Sukardjo S., Wang Y. & Yong J.W.H. (2010). The loss of species: mangrove extinction risk and geographic areas of global concern. PloS one, 5, e10095-e10095.

Lu Ngoc Tram Anh, Vo Hoang Anh Tuan và Vien Ngoc Nam, (2007) Soil carbon accumulation of mangroves in Con Ngoai, the Mui Ca Mau National Park, Vietnam Journal of Science and Technology, pp. 38-41.

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