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RESEARCH ARTICLE

Emission and management for rice husk ash in An Giang Province, Viet Nam

Hiện trạng phát thải và quản lý tro trấu trên địa bàn tỉnh An Giang, Việt Nam

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An Giang province is one of the largest rice producer regions in Vietnam with 600,000 hectares of paddy field and 4 million tons of rice production every year. The rice milling industry generates a huge amount of rice husk (~23% of paddy rice). The rice husk is currently used as fuel around the province generating rice husk ash (RHA) which causes environmental and health issues. This study focuses on surveying and analyzing the current situation for utilization, management, treatment, and awareness of enterprises and community about generated RHA via a household investigation method. The results showed that, in average, a factory generates 862.4 tons of RHA per year, whereas half of them are reused or are sold for re-utilization in other factories, 56.3% are disposed in the private landfill of the factory, and 1.6 to 6.3 % are directly disposed to nearby rivers or in soil. Most of the interviewed citizens reported that they were aware of the RHA impact on the environment nevertheless, only 2% knew that RHA can be re-utilized for other purposes. Therefore, it is necessary to raise public awareness about the reuse and utilization of RHA to reduce the environmental impact and contribute to the sustainable development of the rice production.

Tỉnh An Giang là một trong những vựa lúa lớn nhất Việt Nam, với diện tích khoảng 600.000 ha và sản lượng gần 4 triệu tấn/năm. Cùng với lúa, lượng trấu phát sinh từ quá trình xay xát đang được tái sử dụng làm nhiên liệu đốt cho các quá trình sản xuất khác ở địa phương. Tuy nhiên lượng tro sau quá trình đốt nhiên liệu trấu cũng đang tạo nên một áp lực lên chất lượng môi trường. Do vậy, nghiên cứu này tập trung vào việc khảo sát và phân tích hiện trạng sử dụng, quản lý, xử lý và nhận thức của cơ sở sản xuất hay cộng đồng đối với vấn đề phát thải tro trấu thông qua phương pháp điều tra thực tế. Kết quả cho thấy trung bình mỗi cơ sở phát sinh 862,4 tấn tro trấu/năm với khoảng phân nửa trong số đó được tái sử dụng, 56,3% xử lý bằng cách chôn lấp; 1,6% đến 6,3% xử lý bằng cách đổ bỏ. Hầu hết những người được phỏng vấn biết việc phát thải tro trấu có ảnh hưởng đến chất lượng môi trường, tuy nhiên chỉ có 2% hộ nhận thức được tro trấu có thể tái sử dụng cho các mục đích khác. Điều này cho thấy cần có biện pháp nâng cao nhận thức của cộng đồng đối với việc tái sử dụng tro trấu, nhằm góp phần giảm áp lực của phát thải lên môi trường và đóng góp vào sự phát triển của ngành sản xuất lúa gạo theo định hướng bền vững.

Keywords: rice husk ash, environmental management, agriculture by-products

1. Introduction

Viet Nam is a country known for its high amount of rice production. Between 2013-2017, Viet Nam produced in average 44 million tons of rice per year, with 42.7 million tons in 2017 (General Statistics Office of Vietnam, 2018). Rice husks account for 23% of raw rice (Prasara-A and Gheewala, 2017), this means that approximately 10 million tons of rice husk are generated every year. Since 2005, rice husk has been utilized for production of solid fuel used in wood-firing boilers or plywood used in construction and in interior decoration. However, 50% of the rice husk is usually directly discharged into the environment and not reused (Zwebe, 2012).

An Giang province is the second biggest rice producer provinces after Kien Giang in Vietnam with a rice yield of about 3.8 million ton/year, accounting for 9% of the total rice production in the country, which contributes significantly to ensure food security and export of rice (with other Mekong delta provinces) in Vietnam (General Statistics Office of Vietnam, 2018). At the same time, the rice milling industry in the province also developed with hundreds of enterprises generating in average about 775.8 thousand tons of rice husk per year (General Statistics Office of Vietnam, 2018).

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In An Giang, rice husk has been used as fuel for brick kilns and rice dryers, thus, the value of rice husk is high. In addition, citizens in An Giang Province also use rice husks as a raw material to produce rice husk firewood and local bricks. The use of rice husk as fuel usually generates 10 – 20% residue as ash (RHA) which causes environmental pollution for surrounding area such as air pollution by dust and surface water pollution by solid matter (Kumar *et al.*, 2013). Therefore, rice husk ash management after burning is one of the environment issues in An Giang, especially in districts with large number of household brick kilns such as Cho Moi, Chau Thanh, and Chau Phu. On the other hand, with compositions such as amorphous silica, carbon and other minerals (Pode, 2016; Prasara-A and Gheewala, 2017; Kumar *et al.*, 2013; Malhotra *et al.*, 2013), 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. Besides, rice husk ash was also studied for lab-scale environmental applications such as water treatment and air pollution control (Thanh, 2016; Phan *et al.*, 2018; Nguyen *et al.*, 2019; Phan *et al.*, 2019). However, the industrial utilization of RHA in Vietnam is still very limited, especially in agricultural provinces such as An Giang.

This study was conducted to assess the situation of rice husk ash emission and management at community and household levels with the aim to contribute to the sustainable development of rice production in An Giang province.

2. Methods

A survey was conducted among four districts with the highest rice production yield of An Giang province, including Chau Thanh, Chau Phu, Phu Tan, and Cho Moi districts. The total brick kilns and rice dryers of those districts amount for about 50 – 60% of An Giang province, as in Figure 1. The study involved 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, interviewing and field observing the current reuse and disposal status of RHA. Methods for information collection included a questionnaire for enterprises and households, and expert consultation method for expert officers from Department of Natural Resources and Environment (DoNRE) of the province and four districts.

Secondary data was collected from documents and studies related to the management and use of rice husk ash. In addition, secondary data was collected and analyzed for documents and reports on rice husk ash management from Department of Agriculture and Rural Development and DoNRE of four studied districts. Data on natural - economic - social conditions were also collected from An Giang Statistical Office and Statistical Office of these four districts from year 2012 to 2017.

Primary data was collected by interviewing experts and households. For experts, data were collected from a direct survey of an officer from DoNRE and four environmental management officers from these four studied districts. At household level, direct surveys were conducted in August 2018 for 114 households at four districts of An Giang province by pre-classified and random stakeholders. In order to collect valid and reliable information from enterprises and households, an interview schedule containing both open and closed-form questions was developed considering the objectives of the study.

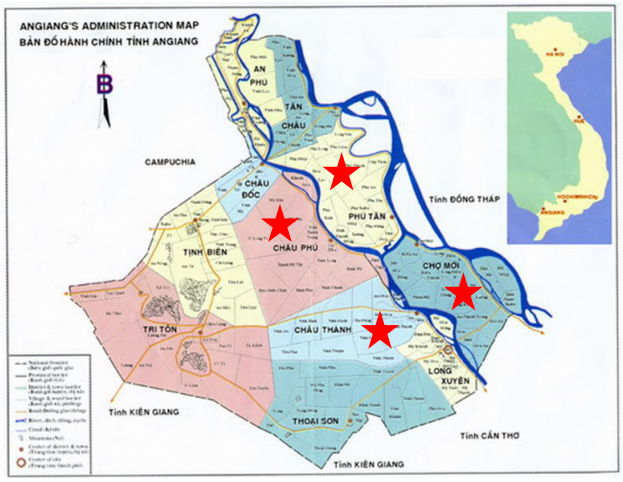

Figure 1. Four surveyed districts of An Giang

After collecting the data (Table 1), statistic methods were applied for analyzing the characteristics of enterprises and households in the studied area such as age and level of education of the interviewees and production scale of the enterprises. Besides, the data related to the status of rice husk ash production and awareness of the people on the status of rice husk ash emissions and management were also collected. The data was then analyzed using the SPSS 22.0 software. The information was then processed and analyzed by Microsoft Excel and SPSS software for obtaining the results.

Table 1. Sample distribution of four studied districts and type of production

Research district	Enterprises		Households	
	n*	%	n*	%
Chau Thanh	10	15.6	10	20.0
Cho Moi	24	37.5	15	30.0
Chau Phu	8	12.5	10	20.0
Phu Tan	22	34.4	15	30.0
Total	64	100.0	50	100.0

**n: number of samples*

3. Results and discussion

In An Giang, rice husk is the main source of fuel in dryers used for agriculture products. The surveyed results of rice husk used is presented in Figure 2. Result shows that most RHA production is from rice drying kilns (46.9%) and Hoffman brick kilns (39.1%) while alcohol distillery and traditional brick kiln only comprise of around 14%.

As presented in Table 2, the average age of the interviewees is 48.4 year old with the highest and smallest age of 74 and 28, respectively. In general, most of the interviewees are still in the working age. In terms of education level, the interviewees have an average level of grade 8 (middle of junior high school) with the highest and lowest level of grade 12 and 2, respectively. Since most of the enterprises are private and the interviewees are also the owners, the low level of education of people in the enterprises makes them face difficulties in making decision in their production.

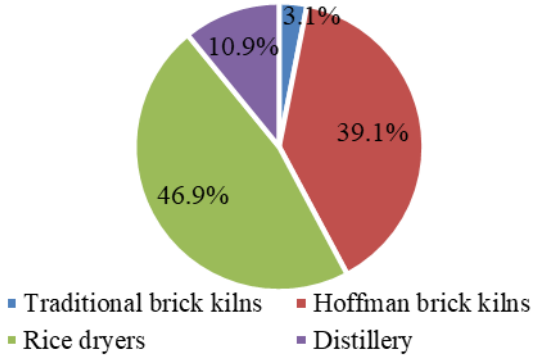

Figure 2. Types of production using rice husk (n = 64)

Table 3 shows that the amount of rice husk utilized by enterprises varies greatly from 6 to 30,000 ton/year with an average of about 1,863.4 ton/year. Accordingly, the amount of RHA generation varied from 0.6 to 27,500 ton/year with an average of about 862.4 ton/year.

Table 2. Social-economic information of employees

Characteristic	Medium	Max	Min	Standard Deviation
Age (years)	48.4	74.0	28.0	10.6
Education (grade)	8.2	12.0	2.0	3.1
Experience (year)	13.5	40.0	1.0	8.0

As also presented in Table 3, rice husk has a price from 0.6 to 3.2 million VND/ton. However, this number is not evenly distributed according to local, regional, type of production and seasonal in Mekong delta with an average price of 1.1 million VND/ton. The average expenses of an enterprise is about 1.8 billion/year for buying rice husk. Production of rice-husk in the year is uneven. The structure of rice production by season and it has the same structure for rice husk by proportional relationship in equation. Considering this structure for 10 years from 2001 to 2010, the percentage after harvest of winter-spring rice crop is the most account, ranging from the lowest 47.24% (2004) to the highest 49.06% (2006). Similarly, the summer-autumn rice crop has the percentage in ranging from the lowest 25.94% (2001) to the highest 29.42% (2008). During the season rice crop, the percentage fluctuates between 22.51% (2005) and 25.87% (2001) (Quyen *et al.*, 2012).

Table 3. Status of using rice husk and generating ash from production facilities

Characteristic	n	Medium	Min	Max	Standard Deviation
Mass of rice husk (ton/year)	58	1,863	6.0	30,000	4,116
Mass of rice husk ash (ton/year)	58	862	0.6	27,500	3,715
Cost of rice husk (USD/ton)	58	48.8	25.9	138	16.0
Total cost of buying rice husk (USD/year)	58	77,844	233	1,166,810	162,155

In the four surveyed districts (Table 4), more than half of the rice husk is collected from An Giang province (51.6%), in which there are 43.8% of rice husk source from four local districts. About 32.8% of rice husk is imported from outside An Giang province, such as Dong Thap, Can Tho and Kien Giang provinces.

As displayed in Table 5, Hoffman brick kilns with an average capacity of 423.065 brick/year, was the type of production that consumed the most rice husk. The average rice husk consumption using Hoffman furnace varies from 250 to 30,000 tons/year, depending on the working time and scale of enterprises, with an average of 4,226 tons/year. With the amount of rice husk used as in Table 5, the average amount of RHA generated from Hoffman brick production enterprises is about 2,073 tons/year. Therefore, it is necessary to have a suitable management plan for RHA from these sources.

Table 4. Source of rice husk used in studied areas

Source of rice husk	n	%
Local districts	28/64	43.8
From An Giang province	33/64	51.6
Outside An Giang province	21/64	32.8

Note: one factory can use rice husk from different sources

Table 5. Status of rice husk use and ash generation from waste sources

Information	Hoffman brick kilns	Rice drying kilns	Distillery
Production capacity (brick/ton/liter per year)	423,065	42.7	267
Mass of rice husk (ton/year)	4,226	353	143
Mass of rice husk ash (ton/year)	2,073	70.5	50.6
Cost of rice husk (USD/ton)	41.7	52.8	56.5
Total cost of buying rice husk (USD/year)	172,139	18,073	7,097

The use of rice husk instead of fossil fuel or electricity attracted lot of attention from both the authority and community because the rice husk has lower price than other fuels. However, the large amount of waste RHA generated after combustion could lead to significant environmental impacts in case of improper management. The results in Figure 3 shows enterprises' awareness of RHA impact on the environment, in which 93.8% reported that RHA causes dust pollution in the air and 6.3% said that RHA causes water pollution. At the same time, 42.2% of the enterprises agreed that the improper disposal of RHA could have effects on the productivity and life quality of surrounding community (Figure 3). However, only 22% from the total number of interviewed enterprises have participated in training courses of handling RHA such as reduction of dust emission, safe storage in pits, proper disposal, spraying with water to prevent dust, training in RHA management (e.g., awareness, fire protection, and environmental protection), and instructions for selling RHA (Figure 4). Thus, the rate of trained enterprises is low and not proportional to the rate of enterprises that generate RHA in the area.

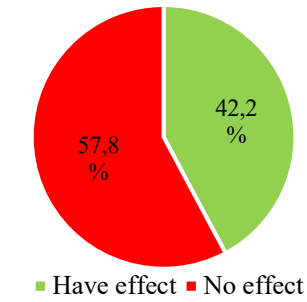

Figure 3. Survey results on the effect of rice husk ash on daily life and production

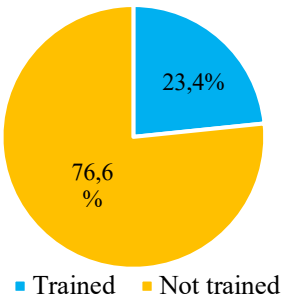

Figure 4. Percent of enterprise participated in training to handle rice husk ash

In the studied area, the enterprises currently apply various measures to handle RHA depending on their actual conditions (Figure 5). Thus, more than half of the generated ash is poured into the ash pit (private landfill) for treatment purposes (56.3%). Besides, enterprises can sell the RHA for reuse purposes in case of large amount generated (Figure 6). The most common use of RHA is to produce fertilizer (54.7%). The cost of RHA range from 0.65 to 12.0 USD/ton with an average of about 4.0 USD/ton.

The factors that affect the knowledge, attitude, and practice of people on RHA was also investigated by surveying the residential communities around enterprises. The aim of the survey was to assess people's awareness about the RHA impact, as well as the status of RHA generated from the enterprises. The age of the interviewees was in the range of 23 to 80 years old with average age of 48. In terms of educational attainment, the interviewees have an average level of grade 4.3 (elementary school) with the highest grade of 12 (high school) and some without going to school (Table 6). Percentage of women participating in the interviews is higher (54%) than that of men (46%).

As showed in Table 7, 88% of respondents said that RHA generated from enterprises leads to dust pollution of the air. Other 18.0 believed that RHA dumping to soil could pollute the cultivated land because of the high salt content of RHA. About 10% of respondents think that RHA could cause water pollution of rivers and canals as well as noise. These results from the citizens are quite in contrast to those from the enterprises, where only 57.8% of the interviewees were aware of the negative effect of RHA.

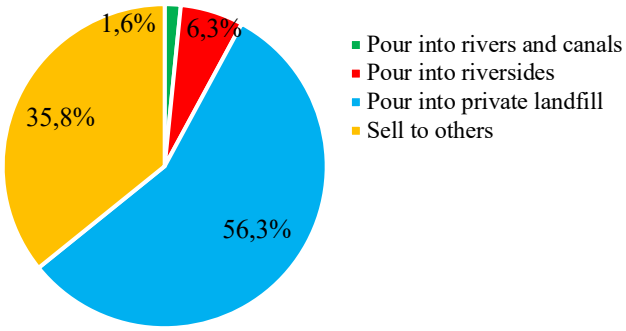

Figure 5. Rice husk ash treatment methods (surveyed results)

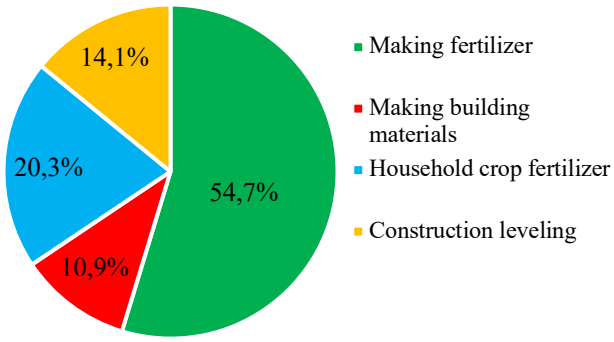

Figure 6. Rice husk ash selling for reuse

Table 6. Characteristics of people interviewed

Information	Medium	Max	Min	Standard Deviation
Age	48.8	80.0	23.0	12.9
Education	4.3	12.0	0.0	3.9
Sex				
Male	46.0%			
Female	54.0%			

Table 7. People's awareness of the effects of rice husk ash on the environment

Effects of rice husk ash on the environment	n	%
Cause dust in the air	44/50	88.0
Contaminate to farmland	9/50	18.0
Cause pollution of rivers and canals	5/50	10.0
Make noise	5/50	10.0

Note: people can choose different answers

When asked about the impact of RHA on daily life activity and production, 66% of the interviewed households said that RHA generated from production processes causes some respiratory diseases such as small dust causing breathing difficulties while 44% of households reported that RHA affects their daily activities, including potential effect on their health through odor and noise. Besides, RHA from enterprises is believed to cause skin itching and allergy (26%) and damage to crops such as stunted plant growth, defoliation, and leaf covering by dust (20%). Rarely, the households reported the impact of RHA on their life as well as environment to local authorities. Only a few households complained with local government about the dust and noise from RHA (Table 8), possibly because they do not want to involve into a conflict with the enterprises as well as a complicated procedure for reporting of environmental issues to the police or government in Vietnam.

Table 8. Awareness of people about the effects of rice husk ash on life from interviews

Effects of rice husk ash on life	n	%
Cause some respiratory diseases	33	66.0
Cause some skin diseases	13	26.0
Cause difficulties for daily activities	22	44.0
Damage to family crops	10	20.0

In general, the households living near the enterprises using rice husk as fuel recognize the negative impacts of RHA on the environment and their daily life. Besides, most of people have not taken any benefits of rice husk ash. Among 50 households interviewed, only one (2%) effectively reused RHA for their production. The reason most households are not interested in using RHA is because households have less need for utilization of RHA in their daily life as well as their production and most households do not have sufficient knowledge on the benefits of RHA for effective utilization.

4. Conclusions

Research results showed that the amount of rice husk used by production facilities varies greatly from 6 to 30,000 ton/year depending on the scale, capacity and type of production with average of 1,863.4 ton/year. Accordingly, the amount of ash generated is ranged from 0.6 to 27,500.0 ton/year with average of 862.4 tons/year. Both enterprise and household recognized the negative impacts of the ash on the environment and living condition of the community. However, the number of enterprises participating in training courses on rice husk ash management and treatment is still very low at about 22%. The usual treatment of RHA is to dump on the shore, pour into the river, pour into the ash pit (56.3%) or sell the generated ash (35.8%). In particular, rice husk ash are also sold for crop farming (20.3%), fertilizer manufacture (54.7%), and construction material making (10.9%). However, only 1 household interviewed (2%) aware that RHA can be reused for other purposes. Therefore, it is necessary to raise public awareness about using rice husk ash to encourage people to take advantage of local rice husk source for agricultural and industrial activities.

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