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Agriculture and Agricultural Science Procedia 9 (2016) 386 – 395

Agriculture and Agricultural Science
Procedia

International Conference on Food, Agriculture, and Natural Resources, FANRes2015

Endeavoring to Food Sustainability by Promoting Corn Cob and Rice Husk Briquetting to Fuel Energy for Small Scale Industries and Household Communities

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Abstract

Sustainable agriculture production is a key on achieving food consumption adequacy in developing country but many farmers should struggle more in fulfilling production sustainability whilst keeping on with the economical target. The research was endeavored to seek a viable application on achieving agricultural sustainability and recognizing farmers and community biggest obstacles such as energy by turning agricultural waste such as corn cob and rice husk into bio briquettes. The temperature, caloric value, the ash content, CO, CO_2 and HC were evaluated, result concludes that the briquette might be included on promoting the sustainability and uphold both energy and food safety on adaptability in reducing the negative of climate change impact. Further research need to increase on its quality and economically value. Previous data on rice husk and corn cob briquette has been investigated in developing country and documented but was met with data shortage especially on the concept of making money through turning agricultural waste into energy. The research will benefit in opening possibilities for the farmers by making money from turning waste into energy, increasing agricultural product added value thus increasing annual income. Better income will trigger farmers to plant rice and maize and reduce dependency on import. The results show that the composition of the rice husk and corn cub might be possible to be used on suited small scaled and household industry.

Keywords: corn cob rice husk ;briqueting; energy; food sustainability

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doi:10.1016/j.aaspro.2016.02.154

1. Introduction

Sustainable agriculture production is a key on achieving food consumption adequacy in most developing countries nevertheless many hurdles were recognized in developing countries including Indonesia to fulfill demand on food supply e.g. reducing wetland for paddy in Indonesia, a lower productivity, and abiotic stress. Recorded from the statistic Indonesia (2014), the average productivity during 2009-2013 was under 5 tones/ha, and corn was below this rice number. Increasing the abiotic stresses such as drought had reduced yield of crops around 25 to 75% in East Java (Swastika et al., 2004); flood and salinity, and more also the stressed of the environment due to human activities that lead to increase on the greenhouse gas (GHG). As a consequence, farmers should take further steps by using more available land on the vicinity and rival their crops against other purposed land due to limitation of viable agricultural soil. It means farmers have to struggle more in fulfilling production sustainability whilst keeping on with the economical target.

Nomenclature

GHG	Greenhouse gas
CO	Carbon monoxide
CO_2	Carbon dioxide
HC	Hydro carbon

The research was endeavored to seek a viable application on achieving agricultural sustainability and recognizing the farmers and communities biggest obstacles such as energy, by turning agricultural waste such as corn cob and rice husk into bio briquettes.

Previous data on rice husk and corn cob briquette has been investigated in developing countries and documented (Yahaya and Ibrahim, 2012; Oladeji, 2010) but was met with data shortage especially on the concept of making money through turning agricultural waste into energy. The research will benefit in opening possibilities for the farmers by making money from turning waste into energy, increasing agricultural product added value thus increasing annual income. Better income will trigger farmers to plant rice and maize and reduce dependency on import.

Many other materials might be mixed to the rice husk briquetting available to the locals e.g. to increase their caloric value such as cashew nut shell by Sengar et al. (2012), residue of charcoal, or charcoal from wood residue by Nurhayati et al. (2015 unpublished data). Many reason of using rice husk to be briquette, i.e. is economical in processing and affordable for rural communities, aesthetically accepted for cooking and industrial food, its energy efficiency might be increased by an addition of small amounts of charcoal of unwanted wood, reducing deforestation by cutting wood just for fuel alone (Nurhayati et al., 2015 –unpublished data; Yahaya and Ibrahim, 2012). Also its renewable, can be sustained as long as there is locals that planting rice, the more rice plants the more energy can be harvested that will also supporting the sustainability of food, especially for both most important food crops i.e. rice and corn. Addition of corn cob to rice husk will increase caloric value of rice husk, and can be incorporated to routing management of annually sustainability harvesting grain for favorable seasons in the local area of East Java to increase the income and adequacy of rice and corn. But in fact this routing of rice and corn is not a simple task for the farmers as their land owners in average only under 0.364 ha (Fig. 2).

Farmer with owning irrigated land less than 0.5 ha were classified as poor farmer by Swastika et al (2004), those with 0.5 to 1.0 ha were medium farmers, and those owning more than 1.0 ha as rich farmers-and dry land areas, poor farmer less than 0.5 ha, and medium farmers in 0.5 ha areas-2.00 ha area, and rich more than 2 ha areas (Swastika *et al*., 2004). Based on the classification, we grouped of 100 farmers in the area of Jember district based on their actual size of their owning land in the rural area of Patemon village-sub district of Tanggul Wetan, district of Jember-east Java Indonesia based on the data of farmers group on December 2014 as shown at Fig1b. From the figure it can be seen that 72% of 100 farmers were categorized of poor, 25% middle and 3% were rich.

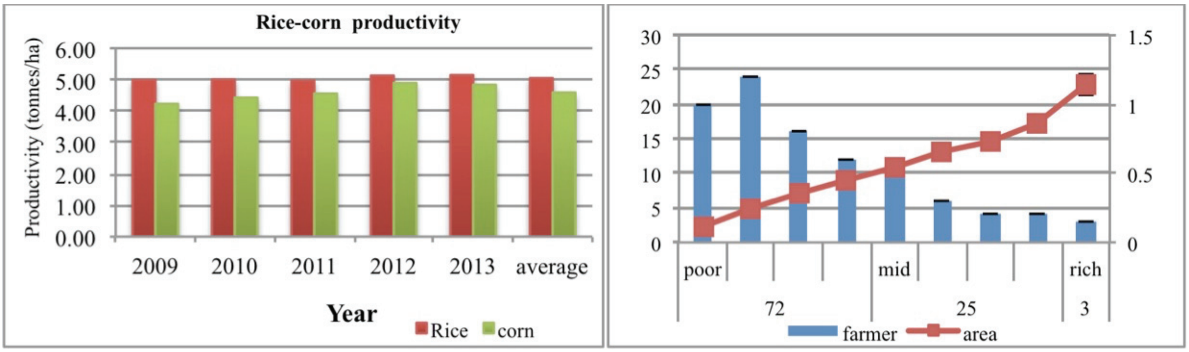

Figure 1. (a) Rice and corn productivity in Indonesia and average between 2009-2013 (BPS statistic Indonesia), (b). The real time condition of farmer and the ownership of land of Jember district, sample of 100 farmers as the condition in December 2014-from Patemon villages-sub district Tanggul Wetan –Jember East Java Indonesia, the name of the farmer was validated by the head of the village, adapted to match the criterion, with actual area of 39.119 ha, average of (0.3912 ±0.247) ha

Fig. 2 (a Wood used on the small industry; (b)) the consistent of fire were needed

To bring back farmer on the paddy field, we encourage farmer to use their corn cob and rice husk, and leave it the other product such as rice straw and other part of maize for feeding animal-as another chance of increasing the productivity and income while keeping the environment clean, and helping others by creating jobs. Corn is the second largest important cereal crop after rice, and east Java were around 33% supported production in Indonesia (Swastika, *et al.,* 2004) and together with central Java contributed to 50% of national demand. If the production can be maintained over the reduced area, the imported money can be used to strengthen the local farmer and community on the effort on sustainability their product. By simultaneously increasing the productivity of rice and corn in the area, the economic grouped farmer income will be increased. By more people producing the briquette the more people need the rice husk and corn cob, and more producing of rice and corn that will support the sustainability of producing.

The energy for fuel is one of the biggest problems on the community. As the kerosene no longer exist on the rural and the liquid petroleum gas (LPG) getting expensive and sometime difficult to find, they more using the substitute for fuelling the small industry such as wood and raw corn cob (Fig 2a, and Fig 3a) and rice husk. During the wet seasons, the wood become difficult to find and more expensive and reduce more their return. Collecting the wood and corn cob and rice husk during harvesting time also caused much space to use (Fig 3a). Increasing the energy for fuelling were struggling more for small industry to keep their break event point (BEP) that threat their industry and the worker. Using briquette as fuelling of small industry and household is not only providing the energy, but also keeping on the people jobs in the industry also for farmer job as well (Fig 3b). Rice production in East Java area has unique position for the farmer as the first priority source of carbohydrate, family worked place (men and wife) and women job on planting time and after harvesting(Fig 3b). Keeping sustainability of rice production is reducing import and keeping farmers and women job. Only by agricultural management and policy farmers, they will do the rest to keep the sustainability of rice and keeping their job.

While increasing prosperity of the people on developing countries was urgent, effort should be done by reducing the impact and the risk for people by upholding the sustainability of the planet, as a consequence, farmers should take further steps by using more available land on the vicinity and rival their crops against other purposed land due to limitation of viable agricultural soil. It means farmers have to struggle more in fulfilling production sustainability whilst keeping on with the economical target.

Household is a person or a group of persons who live in physic/census building and usually live together and manage their foods in a kitchen. Household engaged in agricultural sector is a household with at least one of members of household manage/rule/do business crop with the purpose to sell and responsible to the business rusk (Sensus pertanian 2013-BPS statistics Indonesia).

Figure 3. (a) Wood and corn cob, and cracker drying in a small home industry in Jember district East Java Indonesia. (b) Rice harvesting in paddy field, women working on the small size land to keep sustainability income to their family.

2. The Experiment Methods

2.1. The briquette Preparation

The corn cob was collected from the corn mile and the rice husk was collected from the rice mill. The corn cob were sieved to make even portion and dried. Here we used the 10 cm height to suit the small industrial need. Combination corn cob to rice husk were made of carbonized corn cob and rice husk to make proportion of the ratio of corn cob : rice husk of B(70%:30%), C(50% :50%) and D(30%: 70%), and corncob A2 (100%) briquette, to compare to homogeny briquette of 100% corncob (A1) non carbonized and A2 (100%) carbonized. Cassava starch was added. Those three combinations of briquette (B, C, D) were targeted and should be visible to made and cost reduction on the process of briquetting. The piston gauge to compress biomass of five briquettes in every compacted was used. For statistically purposed we replicated four time in every composition of 20 briquettes in total of every treatment. In the research the 100% of rice husk briquettes did not made to promote the increasing corn production and encouraging the use of the combination corn cob and rice, and sustainability production food by different routing on annual harvesting, and feasible condition to farmer. Based on the interview of the farmer of Patemon village on August 2015, planting maize have more return than rice on the similar size area. Given that the RC of corn was greater than rice and the BEP was smaller, the briquette made was for combination of the corn cob and rice husk. The research was aimed to increase the income of farmer while also support the sustainability of productivity, therefore only corn cob that being used for maize plant and leave it the leaves and shoot as the feedstock.

2.2. Briquette Characteristic analyses

Different composition of rice husk and corn cub has been evaluated; its caloric value, moisture and ash content; CO, CO_2 and HC content; temperature reached and its distribution and duration life and rate, and flame.. CO-CO_2 and HC content were analyzed by *Emission Analyzer* model MX-002 (Mexa-554J) in the Transportation department Bondowoso- East Java (UPT PKB Dinas Pariwisata Pemuda Olah Raga dan Perhubungan Kabupaten Bondowoso.

3. Result and Discussion

3.1. Characteristic Briquettes

The first characteristic briquette for fuelling should meet environmental-sustainability, and the corn cob and rice husk briquette were considerably clean, and were under the permissible limits of the ministry rule of energy and natural resource no 47, 2006 (Permen ESDM no 47, 2006). The emission level of carbon monoxide (CO) was far under 7.26 %. The CO emmited from burning corn cub and rice husk briquettes of all the composition were found lower in range between 0.004% to 0.058 % measured from 10-40 minutes. The higher of CO_2 was emited by briquette nar carbonized with the 1.372%, and briquette with 50% corn cob, the result was under threshold of health ministry Indonesia (Permenkes No 1077, 2011) for indoor working of 10%. This result showed that the briquette under permissible limits. The briquette produced has lower of carbon dioxide content of coal as compared to Pilusa *et al.* (2013). The ash content was ranging around 11.06 ±0.52)% to (31.41 ±1.11)% (Fig. 5) comparable to Pilusa et al. 2013 which has ash content of 28.4%.

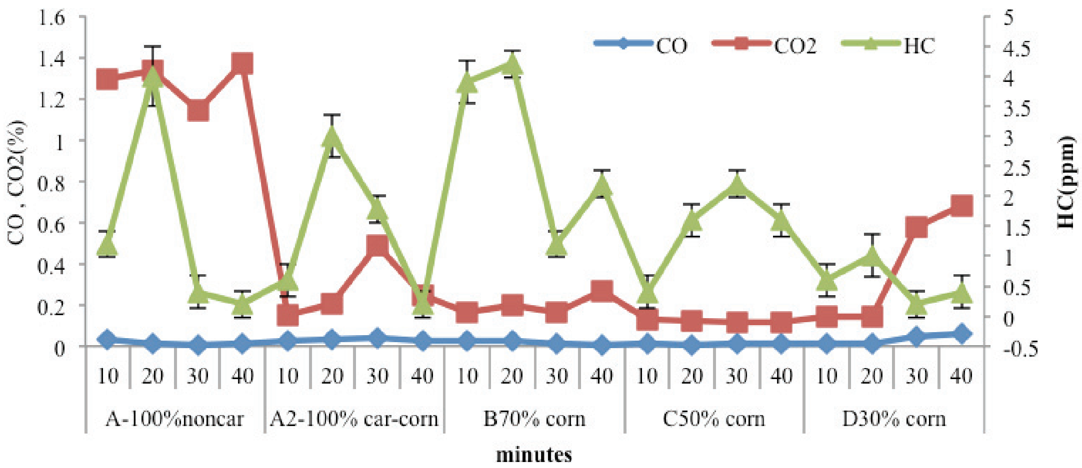

Figure 4. The CO, CO_2 and HC emited from burning conrcob and rice husk briquettes (A1-100% corn cob non carbonized, A-2 100% carbonized corn cob, and mixture of carbonized corn cob and rice husk with B-70% Corn cub:30% rice husk; C 50% rorncob : %0% rice husk, and D 30% corncob and 70% rice husk).

Increasing of the composition of rice husk on the briquetting had increased the average ash content (Figure 3). The carbonizing process had reduced the ash content from 30% of un-carbonized BB to 10%, and briquette with composition of 70% of carbonized rice husk has nearly the same ash content as the un-carbonized of 100 % corn cob. Yet our result showed that the 100% of rice husk has the biggest of ash content compared to the mixture of rice husk and wood charcoal (Nurhayati et al., 2015), it has an effect on reducing the ash content of bio-briquette.

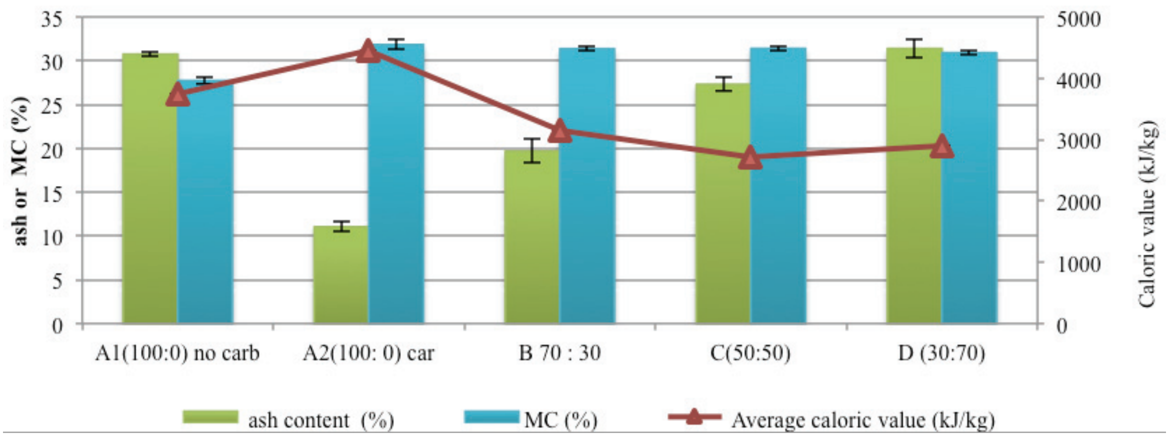

Figure 5. The characteristic of briquette in the different composition of corn cob and rice husk, A1(100% of corn cob non carbonized), A2(100% corn cob carbonized, B (70% corn cob carbonized and 30% rice husk), C(50% corn cob :50 % rice husk), D (30% corn cob: 70% rice husk), (a) ash content and moisture content and (b) average caloric value.

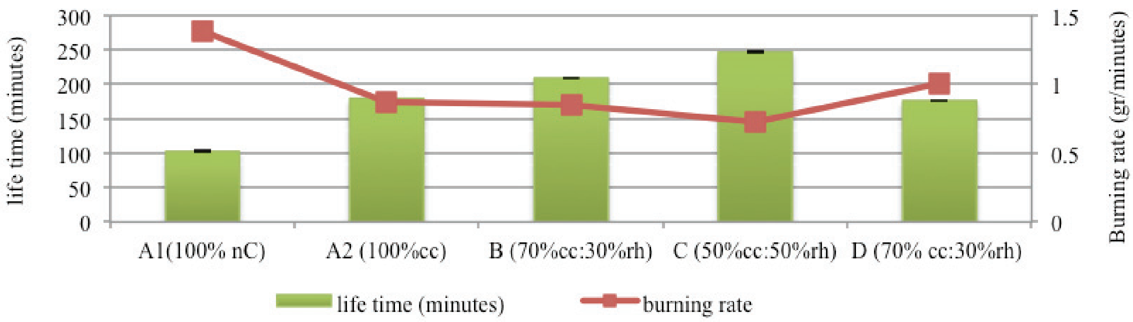

Figure 6. The life time of burning briquette (minutes) and the burning rate (gram/minutes)

All the measurement was based on the moisture content between 27.75% and 31.85% of naturally dried under the sun. The higher of MC was not acceptable on the commercially market, the need of drying technique without much costly to reduce time or need longer time under sundried. The smaller caloric value of the briquette (Fig 3) compare to eco fuel briquette of 18.9 MJ/kg, or coal for 25.9 MJ/kg than 2.7MJ/kg and 4.4MJ/kg of 50% corn cob to 50% rice husk and 100% carbonized of corn cob. Husk Briquette with the 70% corn cob and rice 30% rice husk has caloric value on average of (3.158 ±1.519) MJ/kg. The caloric value of corn cob briquettes were smaller than national standard Indonesia for 5600 kcal/kg or around 23.43MJ/kg or the corn cob only have 1061.78 kcal/kg far under 5600 kcal/kg.

The heating value of the briquettes were smaller than rice husk briquette from Oladeji (2010) which had heating value for rice husk briquettes and corn cob briquettes of 13389 and 20890 kJ/Kg each from rice husk and corn cob. The possible explanation might be due to higher moisture content compared to Oladeji of 12.67 and 13.67 for rice husk and corn cob. Burning characteristic afterglow time for briquettes of rice husk is 354 s, and corn cob is 370 s, while flame propagation rate were 0.1 cm/s and 0.12 cm/s. The longer afterglow time and slow propagation rate for corn cob briquettes imply that corncob briquettes will ignite more easily and burn with intensity for a long time than rice husk.

The optimal briquettes of targeted in the research was based on the small scale industry of cracker industry, the criterion was the temperature should be reach 400 °C and can be maintained during frying time. The briquette should be easy to store and reduced the space for replacing the wood (Fig. 1a.). The opaque should be thin enough and smokeless to use on indoor working. The result shown that the briquette produced was satisfied the demand.

It can be seen that all of the corn cob briquettes has a stable temperatures during burning time at 10 minutes to 60 minutes (Fig 7). Temperatures reached were in a around about 500 ºC. The temperature was well suited small scaled industries such as cracker industries (Fig 1b). For a non-carbonized briquette of 100% corn cob the temperature reached was also suited for a small industry, but it has a lowest temperature at the first 10 minutes, while for a-100% of carbonized of corn cob briquette was more stable during the 60 minute burning. It appeared that homogenous corn briquette was better on reached temperature than a composite of corn cob briquettes of rice husk and corn cub. In term of the temperature reached, for a food industry i.e. cracker, this would be a good substitute for wood as a cooking fuel.

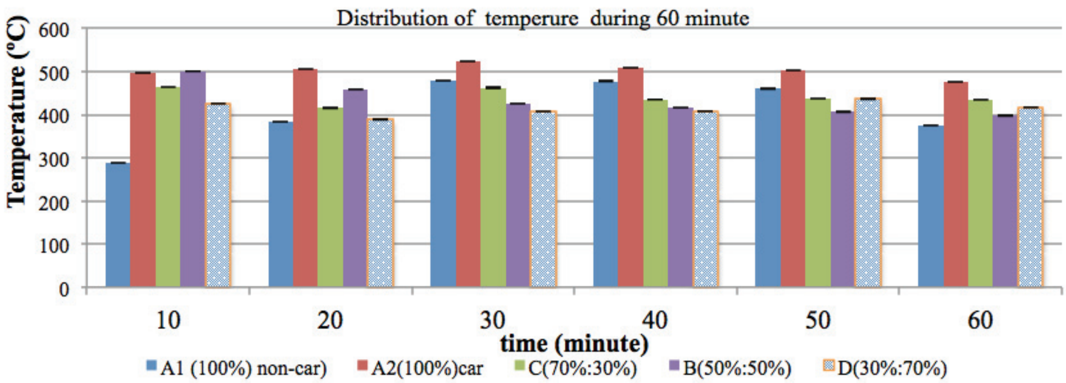

Figure 7. Distribution temperature reached by briquette for 10, 20, 30, 40, 50 and 60 minutes

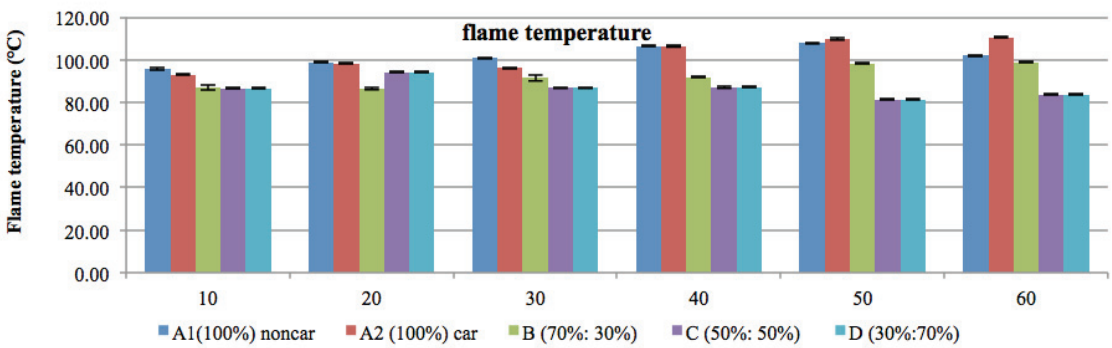

Fig 8. Distribution of flame temperature reached by briquette for 10, 20, 30, 40, 50 and 60 minutes

The greater of particle size (mesh size) of corncob briquette have the greater of higher energy value and percentage volatile matter with moderate ash content (Adetogun *et al*. 2013), while low levels of moisture and high numbers of air pockets (aeration) showed importance and significance in the efficiency of the material as biofuel (Yerima and Isa, 2012.)

3.2. Rough analysis based on small industry and household

In 2010 the production of rice husk 66.41 million ton increase annually. In every of kg of milling of rice produced in around 16%-26 % rice husk depending on the rice mill. By assuming of the 20% of rice husk generated from 1 ton paddy, farmer will harvest 600 rice (60%) for food, 200 kg of rice husk (20%), 120 kg animal feed stock (12%), 80 kg loss (8% for handling and loss). The simplest calculation for supporting sustainability production of rice as followed. The 600 kg of rice can feed around 500 household meals; 200 kg rice husk or 250 briquettes that can be generate fuel for approximately 15-16 small industry /day or 15 day working hour/small industry; or fuelling 62-63 household/day, and another chance of 120 kg feed stock e.g. for fish or chicken. If the rice production can be increased will be huge quantities of briquettes were produced during one season of harvesting. The prediction 16 briquettes were enough for 3.5 hours production and small cracker industry for frying need or similarly industry.

For 10 tons/ha of harvesting of rice by increasing management of planting rice and increasing of capability of soil, there are possibility of 5000 household meals, 150 day working for a small industry of fuelling of 620 house hold. This can be done by three farmers (based on the land owner by farmer as in Fig. 2) working together on making the briquettes, to save time and quickly done the job and reduce cost. By doing this it means there is possibility to create the job for farmer, with the available energy for around 50 days for three smalls industry, or around three months for one small industry, or at least every farmer will get energy for fuel in around 200 days, by working together.

Addition of corn cob to rice husk, can increase the caloric value of the rice husk briquette. The caloric value of the rice husk and corn cob briquette can be increased by addition of unused wood, and wood waste. It can be seen that life of single briquette was around 150-200 minutes, suitable for household cooking, while for industry might be adjusted to suit the need. Farmer also can make the briquette for briquette production. Production of briquettes from rice husk and corn cob showed profitable with addition at least of IDR 16000/day for one industry or around US $1.28 (1$=IDR 12500) or approximately for 5 household energy fuel for a daily need. Production of briquettes from rice husk and corn cob showed profitable with addition at least of IDR 16000/day Continuing production will increase the income and reduce the poverty of the farmer. By turning agricultural waste such as rice and corn cob there is a chance to increase the status from poor to middle. Increasing the value added product to the farmer land will strengthen the income. Production of bio-briquette can be used to lessen poverty by strengthening of the energy of the depressed sectors of locals. Biomass briquettes is an alternative renewable energy which can be managed sustainably as long as there are farmers whom prefer planting rice and maize instead of relying on expensive imported cereal products. High quality bio briquettes can be increased by adding the higher of the caloric value of the material, and viable ro be used and adjusted to suite industrial and house hold used. The energy and temperature could be suited and as a result briquette might replace expensive gas or kerosene.

Rough economic analysis suggest that corn cob and rice husk briquetting could be included on promoting the sustainability and uphold both energy and food safety and adaptability on reducing the negative impact of climate change. Using wood during the cooking process have the yellow flame throughout the cooking (Yahaya and Ibrahim, 2012), with many ash left, and thick opacity (Nurhayati et al., 2015) and some left black colour on the cooking utensil and dusty work area (Fig. 3). The colour of the flame was pale yellow initially but as it stabilized the colour become pale blue which signifies complete combustion and high heating efficiency. Application of rice briquette will open the chance for people working on the cleanliness working place, reducing the risk of inhaled poisonous gas, and avoiding money for health costs. The emission from the burning of agricultural waste briquettes contributes little or nothing to global warming (Musa, 2012).

Figure 9 (a) A hand use of briquette pressing for producing briquette (b), the colour flame of briquette red first (c) turning to blue (d).

Using rice husk and other agricultural residues will have farmer and community to reduce their biggest problem on energy fuel. As long as there are paddy production there are will be energy to be harvested as well. The research will benefit in opening possibilities for the farmers by making money from turning waste into energy, increasing agricultural product added value thus increasing annual income. Better income will trigger farmers to plant rice and maize and reduce dependency on import.

Further research can be done to increase the heating value, e.g. by increasing starch level from 20% to 40% such as in Ogwu et al (2014), addition sawdust for small household use such as by Sanchez. et al (2014) or increasing the MC to briquette 12.67%-13.47%) as in the Oladeji (2010).

4. Conclusion

Turning agriculture waste into bio-briquette will reduce the need of natural gas as fuel. The result has shown that fuelling the small based industry and community based income and household is possible. The sustainability of bio-briquettes will be ensured as long as there are people that planted rice and maize. Different composition of rice husk and corn cub has been evaluated, of the caloric value, moisture and ash content; CO, CO_2 and HC content; temperature reached and its distribution and duration life and rate, and flame. Rough economic analysis suggest that corn and rice husk briquetting might be included on promoting sustainability development to uphold both energy and food safety and adaptability on reducing the negative impact of climate change. The results have shown that the composition of the rice husk and corn cub might be possible to be used on suited small scaled and household industry.

The research will benefit in opening possibilities for the farmers by making money from turning waste into energy, increasing agricultural product added value thus increasing annual income. Better income will trigger farmers to plant rice and maize and reduce dependency on import.

For a continued improvement, the need for an entire set on applied technological research as well as biophysically monitoring to induce the more farmers on growing maize and rice. Immediate emphasis should be placed on increasing the potential productivity of rice varieties and on reducing constraints that limit the growth effectiveness of the innovation. Productivity constraints faced by farmers low grain prices during harvest and in rainy seasons, lack of farmer capital needed to scheme income, encourage farmer to selling on the ready product to increase return capital, and not selling before harvesting. Increasing of government policy in protecting farmer and farmer product such as by buying farmer products rather than import, and improving the transaction system.

Acknowledgements

The authors would like to thanks the head of the village and secretary sub district of Patemon, Manggisan and Darungan for the data, farmer community Tanggul, and the local buyer of rice and corn and home cracker industry Mr. Sujito and the students who had participated on the projects.

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