BIO FUEL PRODUCTION POTENTIAL FROM AGRICULTURE WASTE IN LOMBOK ISLAND

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ABSTRACT

Lombok island faces agriculture waste and energy security problems. The processing of agricultural commodities produces agriculture waste, which can caused serious environmental pollution, but also can be a potential energy source for producing renewable fuel. There is a solution to solve the problems in Lombok Island in term of waste and energy security problems with utilize agriculture waste become bio-oil via pyrolysis process. The bio-oil production potential from agriculture waste such as cashew shell, coconut shell, corn cobs, corn stover, rice husk, rice straw and peanuts shell on Lombok island is investigated in this paper. Based on the collected agriculture waste data from five regencies in Lombok Island, Lombok island can potentially produce 1.813.685,4 ton/year of bio-oil and remove 4.818.510,00 ton/year of agriculture waste every year via pyrolysis process. Maize and paddy rice are the most favorable bio-oil production source in Lombok Island. Based on this investigation, it was concluded that the production of bio-oil from agriculture waste is suitable to apply in Lombok Island. For reaching the goal, the government must support these type of projects and provide some good policies for renewable fuel production.

Keywords: agriculture, bio fuel, waste

INTRODUCTION

Lombok Island is a small island with an area of 4738.7 km2, which more than 60% of the areas utilize agriculture sector. Agriculture is one of the important sectors in Lombok Island; paddy rice, maize, coconut and cashew are some of the largest agriculture products produced every year in Lombok island. The Agriculture waste from this sector is huge, where small amount of agriculture waste was recycled then the rests were thrown away. These unprocessed agriculture waste made an environmental problems, however recycled waste still have a problem if used for burning purposes. Since the energy crisis year, the energy utilization from agriculture waste has been received special attention, Agriculture waste contains a huge amount of organic matter and classified a high energy content (Omer, A.M., 2005). Utilizing this energy does not harmful to the environment such as produce greenhouse gases, but it helps the atmospheric carbon dioxide recycling (Demirbas, A., 2004). Converting Agriculture waste to renewable fuel via pyrolisis has been widely used, many researches have been investigated several agriculture wastes such as cashew shell (Das, P and Hanesh, A., 2003), coconut shell (Tsai *et al.*, 2006), corn cobs & corn stover (Mullen *et al.*, 2010), rice husk (Putun *et al.*, 2004), rice straw (Zheng, J.L., 2007) and peanut shell (Zhang *et al.*, 2011) to renewable fuel through pyrolisis technology. The pyrolisis liquid product (Bio-oil) from converting agriculture waste is almost near to petroleum fuels and can be considered to be a promising renewable fuel to substitute fossil fuel in the future (Da, P and Ganesh, A., 2003). This study mainly focuses on review and evaluate agriculture waste in Lombok Island that can be converted to renewable fuel and

give advantages when implemented on Lombok Island.

Potential of Bio Fuel Production From Agriculture Waste in Lombok Island

Lombok island produced more than 6.265 [Ton/Year], 49.138 [Ton/Year], 168.940 [Ton/Year], 1.069.923 [Ton/Year] and 19.002 [Ton/Year] of cashew kernel, copra, maize, paddy rice and peanuts, respectively, the details of the production are presented in Table 1.

Table 1. Several agriculture commodity production in Lombok Island (Nusa Tenggara Barat in Figures, 2014)

No	Area Production	Cashew Nut Kernel (Ton/Year)	Copra (Ton/Year)	Maize (Ton/Year)	Paddy Rice (Ton/Year)	Peanuts (Ton/Year)
1	East Lombok Regency	760,62	7333,98	82173	356318	1914
2	Middle Lombok Regency	836,70	14490,75	21033	430279	5163
3	Mataram City	0	47,15	46	30873	0
4	North Lombok Regency	3418,32	12643,14	33935	66139	10587
5	West Lombok Regency	1249,10	14622,58	31753	186314	1338

North Lombok, West Lombok, East Lombok and Middle Lombok are the major agricultural production regencies for cashew kernel and peanuts, copra, maize and paddy rice, respectively, consequence those regencies produced a huge amount of agricultural waste from their agriculture production. These huge amounts of agriculture waste could be considered as a potential source of renewable fuel production via pyrolisis process. Pyrolysis is thermal decomposition occurring in the absence of oxygen, three products are usually produced: gas, pyrolysis oil (bio-oil) and charcoal as shown in Figure 1.

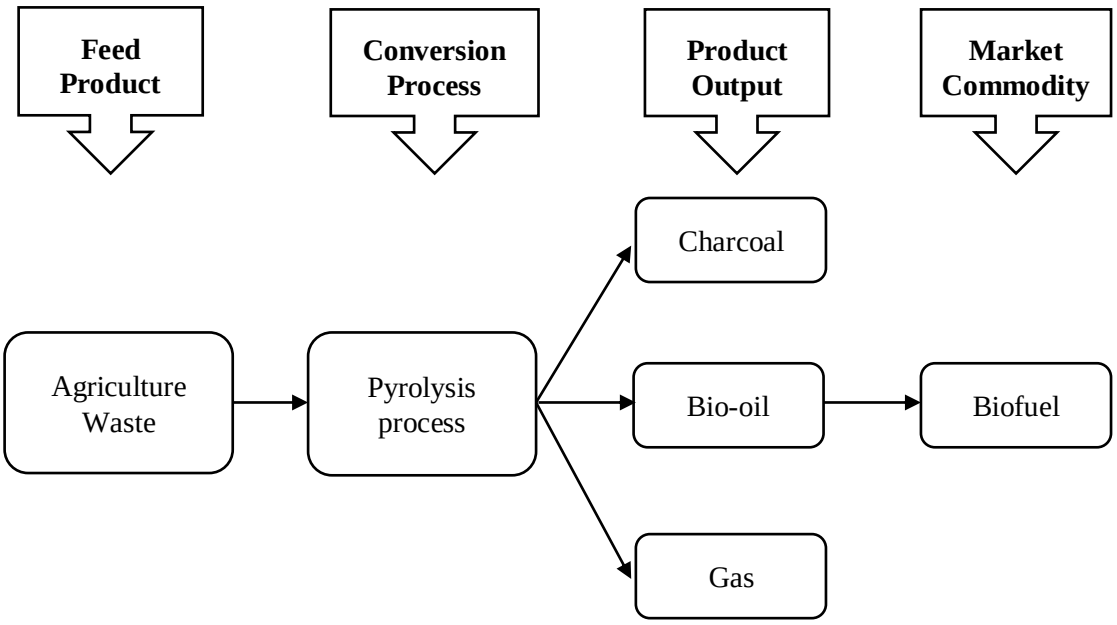

Figure 1. Products from pyrolysis conversion

The pyrolysis production may varied by several conditions, in one hand, lower process temperatures and longer vapour residence times tend to produce charcoal, in the other hand, high temperatures and longer residence times increase biomass conversion to gas, however moderate temperatures and short vapour residence time are optimum for producing liquids (Bio-oil). Apply pyrolysis technology on Lombok Island to produce bio-oil from agriculture waste has several advantages and disadvantages. Reduces greenhouse gas emissions and agriculture waste going to landfill, produces a marketable product (biofuel), low risk of water pollution, low risk of odours, minimal risk of health consequences and it can substitute fossil fuels in heat and power applications are the main advantages. However, technology is still evolving, high initial investment and development made pyrolysis need more attention to grow.

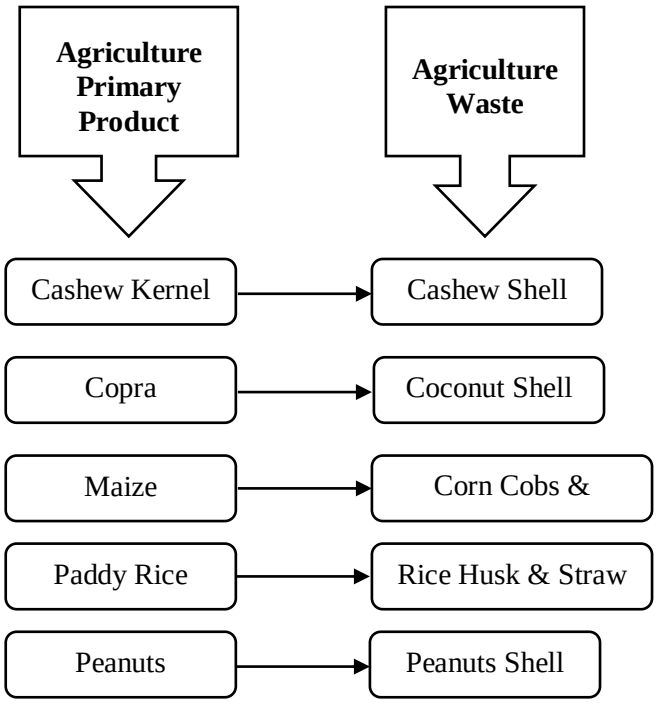

Figure 2. Agriculture product and their waste

The bio-oil contains hundreds of organic compounds that belong to alkanes, aromatic hydrocarbons, phenol derivatives and little amounts of ketones, esters, ethers, sugars, amines and alcohols with H/C molar ratio higher than 1.5 (Lu Q *et al*., 2009). Bio-oil is promising for substitute the fossil fuel because bio-oil flames are shorter, wider and brighter than fossil fuel flames at the same conditions and low calorific value (Stamatov *et al*., 2006). Basic data for bio-oils and fossil fuels are compared in Table 2.

The agriculture waste from primary products such as cashew kernel, copra, maize, paddy rice and peanuts are the potential feedstock for bio oil production in Lombok Island. After harvesting process, the primary products produce waste, such as cashew shell, coconut shell corn cobs and stover, rice husk and straw and peanuts shell as shown in Figure 2. An investigation made on the total amount of agriculture waste that produces from agriculture activities in Lombok Island shows that over 4,8 million tonnes of agriculture waste are generated annually, with high potential feedstock for produce bio-oil from cashew shell (564 tonnes), coconut shell (34.396 tonnes), corn cobs (42.235 tonnes) , corn stover (337.880 tonnes), rice husk (347.725 tonnes), rice straw (4.044.309 tonnes)

and peanuts shell (11.401 tonnes) as presented in Table 3.

Table 2. Typical properties of Wood Pyrolysis Bio-oil and Heavy Fuel Oil (Czernik,S and Bridgwater, A.V)

Physical Propertiess	Bio-oil	Fossil Fuel
Moisture Content (wt%)	15 - 30	0,1
pH	2,5	-
Specific Gravity	1,2	0,94
Elemental Composition (wt%)		
C	54 - 58	85
H	5,5 – 7,0	11
O	35 - 40	1,0
N	0 - 0,2	0,3
Ash	0 - 0,2	0,1
HHV (MJ/kg)	16 - 19	40
Viscosity, at 500 ^{o}C (cP)	40 - 100	180
Solid (wt%)	0,2 - 1	1
Destilation Residue (wt%)	Up to 50	1

Table 3. Agriculture waste potential

No	Agriculture Primary Product	Agriculture Waste	Total Agriculture Primary Product Production (Ton/Year)	Waste Factor	Total Amount Of Agriculture Waste (Ton/Year)
1	Cashew Kernel	Cashew Shell	1.879	0,3	564
2	Copra	Coconut Shell	49.138	0,7	34.396
3	Maize	Corn Cobs	168.940	0,25	42.235
4	Maize	Corn Stover	168.940	2	337.880
5	Paddy Rice	Rice Husk	1.069.923	0,325	347.725
6	Paddy Rice	Rice Straw	1.069.923	3,78	4.044.309
7	Peanuts	Peanuts Shell	19.002	0,6	11.401

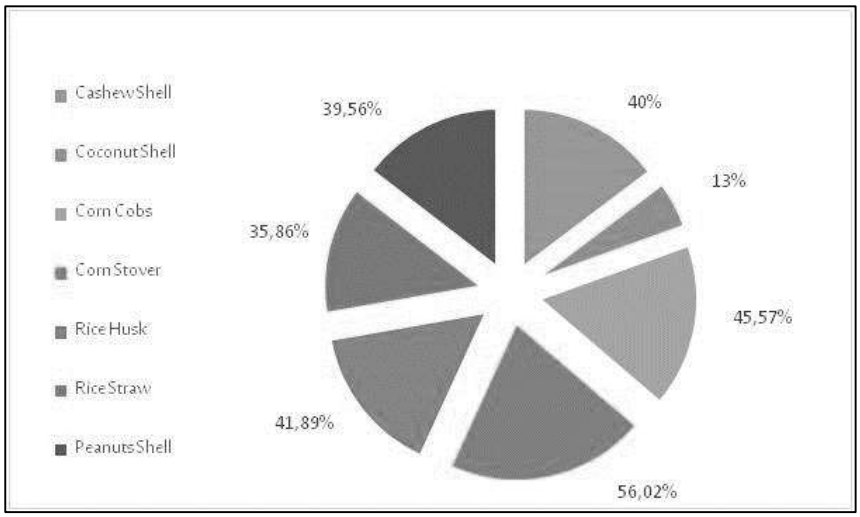

Figure 3. Oil Yield (%wt) produced from agriculture waste via pyrolysis process

The percentage of bio-oil production during the pyrolysis process from agriculture waste are presented in Figure 3 (Das, P and Hanesh, A., 2003), (Tsai *et al*., 2006), (Mullen *et al*., 2010), (Putun *et al*., 2004), (Zheng, J.L., 2007), (Zhang *et al*., 2011). Figure 4 shows the bio-oil production from several agriculture waste in Lombok Island and the total potential can be 1.813.685,4 ton/year. Waste from maize and paddy rice are the best potential for producing bio-oil in Lombok Island.

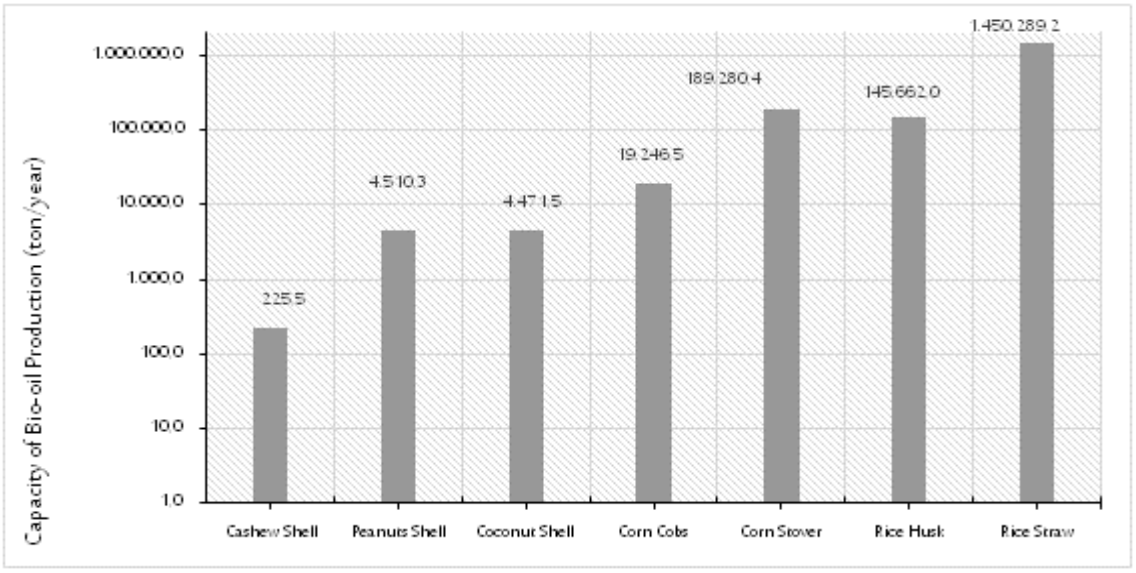

Figure 4. Major agriculture waste for production of bio-oil in Lombok Island

DISCUSSION AND CONCLUSIONS

At the moment, Lombok Island faces the biggest problems in waste and energy security problems. Unprocessed agricultural waste has caused serious environmental pollution, such as water contamination, odor problems and source of diseases in Lombok Island. There is the best solution to convert waste problem into improvement of energy security in Lombok Island with utilize agriculture waste become renewable fuel through a pyrolysis process. Agriculture waste has potential as an alternative fuel source in Lombok Island due to their lack of fuel condition at the moment. Even the bio-oil that is produced from agricultural waste will not solve the lack of fuel problem in Lombok

Island, but it can be the best solution to enhance the energy security, that still depends on fossil fuel, and also will contribute to decrease environmental problems because of agriculture waste. From this investigation it has been known that Lombok Island has great potential to produce bio-oil from agriculture waste.

From five regencies area in Lombok Island are estimated to be potentially produced 1.813.685,4 tons/year of bio-oil every year. Middle Lombok Regency is the best location to start the investment because it produce high amount of agriculture waste, located in the heart of Lombok Island and easy to transport the feedstock from around Lombok Island. The land price still low and good infrastructure are the promising points to develop the power plant.

Maize and paddy rice are the most favorable bio-oil production source in Lombok Island. Based on this investigation, it was concluded that the production of bio-oil from agriculture waste is suitable to apply in Lombok Island, especially in Middle Lombok Regency. For reaching the goal, the government must support these type of projects and provide some good policies for renewable fuel production.

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