

Potential Surplus of Rice Straw as a Source of Energy for Rural Communities in Indonesia

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Keywords: Rice straw, Potential surplus, Source of energy, Rural communities.

Abstract : This study was conducted to identify the potential surplus of rice straw as a source of energy for rural communities in Indonesia. Rural communities need a source of energy for electrical energy and small industry. Determination of the potential surplus of rice straw performed by compared the total potential of rice straw produced and portion used for other usage such as animal feed and raw materials for industry. The remainder wasted was named as a potential surplus of rice straw in this study that can be used as fuel. The study shows the potential of rice straw in total, for animal feed, for industries raw materials, and for energy source. Each of which has increased average about 2% per year or increased about 10% over 5 years (2009-2013). The study is expected to be one of the alternative sources of energy to meet the electrical energy needs and energy requirements for small industries on rural communities in Indonesia.

Introduction

The potential of rice straw (RS) produced in Indonesia was quite large and increasing every year. Over 5 years of period, the potential of RS produced was about 96.60 million tons, 99.71 million tons, 98.64 million tons, 103.58 million tons, 106.31 million tons in 2009, 2010, 2011, 2012, and 2013, respectively. RS in Indonesia is used as raw material for industry (RSi) of about 7%, animal feed (RSa) of about 31%, and about 62% just burnt as waste [1]. Utilization of RS in Indonesia is targeted to increase approximately 40% for animal feed (RSa), approximately 30% for small industries (RSi), and approximately 25% for fuel (RSf). Thus RS as waste (SRw) is only about 5%. The potential of RS to be used as fuel, which is RS surplus is not used for industry and animal feed. Surplus of RS is wasted in the fields, generally burned to clear the land that will be used the next planting. Burning of RS should be avoided because it can damage the soil nutrients, reduce soil fertility, and produces air pollution. Burning of RS in the field can emit gases CO, CH₄, NO_x, and SO₂ into the atmosphere due to uncontrolled combustion processes [2].

This study was conducted to obtain the potential surplus of RS as an alternative source of energy for rural communities in Indonesia. The results of the study are expected to contribute to the policy makers and investors in order to develop the potential of RS to overcome the shortage of electric energy in rural areas.

Materials and Method

In determining the potential surplus of RS available in Indonesia each year, rice production (RP) data was analyzed for 5 years (2009 - 2013). As for determining the availability of potential surplus of RS in each province, performed data analysis of RP in 2013 [3]. Determination of RS available potential can be determined by using the value of Straw-to-Grain Ratio (S_{GR}) of 1.5 [2, 4-5] and the amount of RP every year, using the equation.

$$RS = S_{GR} \times RP \quad (1)$$

Determination of the potential surplus of RS can be used as fuel (SRf) in rural areas, can be determined by the equation:

$$RSf = RSt - (RSi + RSa + RSw) \quad (2)$$

where RS_t = rice straw produced overall rice production obtained by (Eq.1), RS_i = rice straw as raw material for small industries, RS_a = rice straw for animal feed, RS_w = rice straw as waste. Determination of potential energy of RH surplus can be done based on previous study [6-7], by the equation:

$$EP_{RS} = W_{RS} \times CV_{RS} \quad (3)$$

where W_{RS} = number of RS, and CV_{RS} = calorific value of RS.

Results and Discussion

Analysis of the potential of rice straw surplus

The potential of RS produced from RP in Indonesia in 2009 - 2013, can be analyzed using Eq. (1). While the potential surplus of RH can be determined by using Eq. (2) Analysis of the potential surplus of RS refers to the utilization of RS for animal feed (RS_a) of about 40%, RS as raw material for industry (RS_i) of about 30%, the RS surplus for fuel (RS_f) of approximately 25%, and RS as waste (RS_w) is about 5%. The analysis results of the potential surplus of RS are presented in Table 1.

Table 1. Potential surplus of rice straw in Indonesia in 2009 - 2013.

No	Year	RP (10 ⁶ ton)	RSt (10 ⁶ ton)	RSa (10 ⁶ ton)	RSi (10 ⁶ ton)	RSw (10 ⁶ ton)	RSf (10 ⁶ ton)
1	2009	64.40	96.60	38.64	28.98	4.83	24.15
2	2010	66.47	99.71	39.88	29.91	4.99	24.93
3	2011	65.76	98.64	39.46	29.59	4.93	24.66
4	2012	69.05	103.58	41.43	31.07	5.18	25.90
5	2013	70.87	106.31	42.52	31.89	5.32	26.58

Table 1 shows the development of RP, RSt, RSa, RSi, RSw, and RSf, increased significantly every year for 5 years. In 2009, the potential of RS in total obtained approximately 96.60 million tons, increasing to approximately 106.31 million tons in 2013. In this case an increase of approximately 10% for 5 years, or an average increase of approximately 2% per year, as shown in Fig . 1.

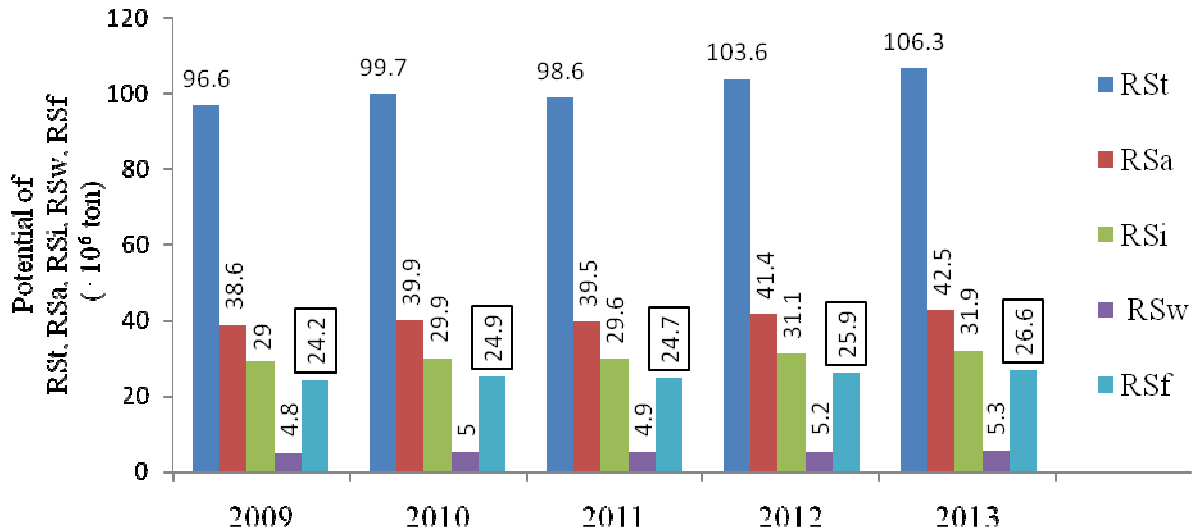


Fig. 1. The development of the potential surplus of RS in 2009 - 2013.

Fig. 1 shows a potential surplus of RS in Indonesia has good prospects as a future energy source of electricity in rural areas. Continuity of supply potential of RS will be assured will not be reduced and even be increased each year in Indonesia as one of producer and exporter of rice in the world. The main consideration for the smooth operating power plant is the availability and continuity of fuel supply [8-9].

The Potential surplus of rice straw in each province in Indonesia

Analysis of the potential surplus of RS in each province can be obtained by using Eq. (1), Eq. (2) and Eq. (3) with a calorific value of RS from the experimental results obtained approximately 12.56 MJ/kg. The availability of the potential surplus of RS, are presented in Table 2.

Table 2. Availability the potential surplus of RS in each province in Indonesia in 2013.

No	Province	RP (10 ³ ton)	RSt (10 ³ ton)	RSa (10 ³ ton)	RSi (10 ³ ton)	RSw (10 ³ ton)	RSf (10 ³ ton)	EP _{RSf} (TJ)
1	East Java	12,199	18,299	7,320	5,490	915	4,575	57,462
2	West Java	11,272	16,908	6,763	5,072	845	4,227	53,091
3	Central Java	10,233	15,350	6,140	4,605	768	3,838	48,205
4	South Sulawesi	5,008	7,512	3,005	2,254	376	1,878	23,588
5	North Sumatra	3,716	5,574	2,230	1,672	279	1,394	17,509
6	South Sumatra	3,295	4,943	1,977	1,483	247	1,236	15,524
7	Lampung	3,093	4,640	1,856	1,392	232	1,160	14,570
8	West Sumatra	2,368	3,552	1,421	1,066	178	888	11,153
9	West Nusatenggara	2,114	3,171	1,268	951	159	793	9,960
10	South Kalimantan	2,086	3,129	1,252	939	157	782	9,822
11	Banten	1,866	2,799	1,120	840	140	700	8,792
12	Aceh	1,789	2,684	1,074	805	134	671	8,428
13	West Kalimantan	1,300	1,950	780	585	98	488	6,129
14	Central Sulawesi	1,024	1,536	614	461	77	384	4,823
15	Jogyakarta	946	1,419	568	426	71	355	4,459
16	Bali	866	1,299	520	390	65	325	4,082
17	Central Kalimantan	756	1,134	454	340	57	284	3,567
18	East Nusatenggara	699	1,049	420	315	53	262	3,291
19	Jambi	625	938	375	281	47	235	2,952
20	North Sulawesi	615	923	369	277	46	231	2,901

21	Bengkulu	582	873	349	262	44	218	2,738
22	East Kalimantan	553	830	332	249	42	208	2,613
23	Southeast_Sulawesi	516	774	310	232	39	194	2,437
24	Riau	512	768	307	230	38	192	2,412
25	West Sulawesi	413	620	248	186	31	155	1,947
26	Gorontalo	245	368	147	110	18	92	1,156
27	Papua	138	207	83	62	10	52	653
28	Maluku	84	126	50	38	6	32	402
29	North Maluku	66	99	40	30	5	25	314
30	West Papua	30	45	18	14	2	11	138
31	Bangka Belitung	23	35	14	11	2	9	113
32	Jakarta	11	17	7	5	1	4	50
33	Riau Islands	1	2	1	1	0	1	13
Total		69,044	103,566	41,426	31,070	5,178	25,892	325,204

Table 2 shows the potential surplus of RS and the potential energy for each province is vary in number. In total, potential surplus of RS for fuel (RSf) obtained approximately 25.892 million tons with the energy potential of around 325,204 TJ.

Conclusion

The potential surplus of RS is one source of energy that can be used to supply electrical energy to rural communities in Indonesia. Rural communities need a source of energy to meet the electrical energy needs and small industries. The potential of RS produced, is used for animal feed, for small industries raw materials, and for use as fuel. The analysis shows the potential of RS increased each of about 10% for 5 years, or an average increase of approximately 2% per year. The potential surplus of RS in each province various in number, where the largest and smallest was East Java and Riau Islands, respectively. The study is expected to be one of the alternative sources of energy to meet the electrical energy requirement and energy needs of small industries in rural areas in Indonesia.

Acknowledgment

The authors are grateful to the Ministry of Higher Education Malaysia for the RU Grant, Vot 05H25 and Research Management Centre, UTM for the financial and management support.

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