Potential incomes and sustainable agriculture from the brown sugarcane production

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Abstract. Brown sugar produced from sugarcane is a promising business for small-scale farmers, which can create employment, improve farmers’ incomes, and contribute to land conservation with the use of appropriate technology. The potential is explored through the utilization of marginal land to cultivate sugarcane and to create value-added from producing brown sugarcane. By using a case study in Wajo District, South Sulawesi, Indonesia, the results show that the investment value of brown sugar processing unit is varied between IDR 75 and 750 million with milling capacity 7-50 TCD (tons of cane day) or equivalent to IDR 3-5 million per hectare and sugarcane plantation investment IDR 4-7 million per hectare. Additionally, sugarcane farming is able to create two job opportunities per hectare, one person in the plantation and one person in the processing unit. The gross value of brown sugar production is around IDR 42-90 million/hectare, with a 10 percent brown sugarcane conversion factor and 60-90 tons of cane per hectare.

I. Introduction

Increasing demand for food driven by rapid population growth has caused uncontrolled use of land resources. Around 110,000 hectares per year of agricultural land has been converted into non-agricultural land, which is not balanced to the area of new rice fields built by the government using the state budget, which only reaching 20,000 to 40,000 hectares per year [1]. Some of the lands that are converted into rice fields are drylands that have not been cultivated yet. The statistics of agricultural land show that there are 5,262,030 hectares of fields and 14,245,408 hectares of unutilized land [2], not including 11,947,956 hectares of dry land, some of which are cultivated as suboptimal farming and marginal land. Marginal land has low fertility and is only overgrown by reeds. In fact, some of these fields have the potential for the development of integration between the production of brown sugar from sugarcane and beef cattle farming.

The utilization of appropriate technology (AT) by small-scale farmers has the potential to overcome problems in the agricultural sector, including low productivity, employment, and land conservation. Sugarcane can be cultivated on less productive land and can be used as a conservation crop on land prone to land degradation due to intensive farming activities or land with high elevation. The
production of brown sugar from sugarcane using an energy-efficient cooking stove as a form of appropriate technology provides value-added, as farmers have only been selling their sugarcane as raw materials for sugar production. In addition, increasing the production of brown sugar has the potential to contribute to reduce imported sugar and even turn into one of the potential export commodities.

Sugarcane is a valuable agricultural commodity that can be profitable for farmers and provide employment opportunities in rural areas. This can attract the labor force to work in the agricultural sector, which has been oriented working in urban areas. Various forms of employment opportunities in the non-agricultural sector began to be abandoned and moved to the agricultural sector in the form of self-employment.

Sugarcane can be planted on a regular basis using marginal and less productive land use, allowing to reduce the use of external inputs [3,4]. Sugarcane can be harvested every day in the rotation and lasts for 7-8 months per year, outside rainy seasons. Farmers' households can harvest 0.5-1 tons per day, depending on the size of the area planted with sugarcane. This crop provides sugarcane shoots that can be used as ingredients for livestock feed. In addition, it also has a sugarcane drop generated from the process of cooking the sugarcane into brown sugar. These drops are a good ingredient for beef cattle feed. The integration of brown sugar production and beef cattle farming is an innovation that can improve farmers' knowledge and skills about organic farming and conservation of land resources [5–7]. This integration will improve and maintain productivity, protect the environment through the adoption of a sustainable agriculture system [8].

Brown sugar production from sugarcane using appropriate technology (AT) in the form of energy-efficient cooking could reduce the use of fuel sourced from wood and other agricultural products. Sugarcane bagasse as waste from the brown sugar production is used as the fuel of the cooking stove in the brown sugar cooking process. The common brown sugar consumed is produced from palm and coconut, which are traditionally processed and use wood as fuel in the cooking process, which may damage the forest. In fact, brown sugar is mostly produced in the forest, due to the availability of wood as fuel. Adding the value of sugarcane into brown sugar has the potential to increase domestic sugar production, reduce sugar imports, utilizing marginal land, idle or less productive land, and preserve the environment. Brown sugar production from sugarcane is a promising rural economic development because it can utilize unproductive agricultural lands, increase livestock populations, provide employment opportunities, reduce poverty levels in rural areas, and empowerment of female workers.

The study aims to analyze the value of investment transforming marginal land into productive land through sugarcane plantation and production of brown sugar as well as the potential impact on rural communities. Many studies conducted related to brown sugar produced from sugarcane is more on the business analysis [9–12], feasibility and marketing [13], and integration with beef cattle farming. However, utilization of energy-saving cookstove as an appropriate technology for the utilization of marginal land in this context is limited and is addressed in this paper.

2. Research method
This research was conducted in Wajo district, involving three farmers groups. This includes Situjue Farmer Group in Labawang Village, Makmur Farmer Group in Longka Village, and Ellung Mangenre in the Uraiayang Area. Information about the formation of farmers groups and businesses, land size for sugarcane plantation and its development plans, processing machine capacity and its investment, and institutional development plans were collected during the study. Several points of analysis are (a) value of investment needed to utilize the less optimal land and marginal land, (b) employment opportunities creation, and (c) income potential for farmers.

3. Results and discussions
3.1. Producing brown sugar from sugarcane
Brown sugar can be produced using sugarcane by utilizing appropriate technology (AT) made from sugarcane pressing machine and energy-saving cooking stoves fueled by sugarcane bagasse [14]. The AT pressing machines can be made by local workshops, and cooking stoves can be made by farmers at a relatively low cost.
Brown sugar is produced by three farmer groups located in Wajo District: Situjue Farmer Group in Labawang village, Tani Makmur in Longka village, and Ellung Mangenre Group in the subdistrict. These three farmer groups have been producing brown sugar from sugarcane at different starting times, 2012 for Ellung Mangenre and Tani Makmur Farmer Group, and 2013 for Situjue Farmer Group. The investment value of the processing unit varies according to the milling capacity with a range of IDR 75-340 million or equivalent to IDR 3-5 million per hectare of sugarcane land. The investment value will decrease along with the milling capacity.

| No. | Description                            | Unit | Situjue   | Makmur     | Ellung mangenre |
|-----|----------------------------------------|------|-----------|------------|----------------|
| 1.  | Factory building                       | IDR  | 25,000,000| 60,000,000 | 50,000,000     |
| 2.  | Sugarcane pressing machine             | IDR  | 15,000,000| 75,000,000 | 150,000,000    |
| 3.  | Cooking stove                          | IDR  | 10,000,000| 25,000,000 | 45,000,000     |
| 4.  | Carrier transporter                     | IDR  | 15,000,000| 20,000,000 | 15,000,000     |
| 5.  | Investment value                        | IDR  | 75,000,000| 180,000,000| 260,000,000    |
| 6.  | Maximum capacity                        | TCD  | 2         | 30         | 50             |
| 7.  | Rendiment                              | %    | 9         | 9-12       | 10             |
| 8.  | Origin of the pressing machine          |      |           |            |                |
|     |                                        |      | Makassar  | Sulsel     |                |
|     |                                        |      | Malang,   | Jawa Timur |                |
|     |                                        |      | Malang,   | Jawa Timur |                |
| 9.  | Land size                              | Ha   | 8         | 24         | 20             |
| 10. | A potential area for sugarcane plantation |      | 15        | 50         | 80             |
| 11. | Marketing                              | Local|           | Local      | Local, Makassar|
|     |                                        |      |           |            | dan soy sauce  |
|     |                                        |      |           |            | factory        |
| 12. | The investment ratio of the factory (6:10) | IDR/ha | 5,000,000 | 3,600,000  | 3,250,000      |

Makmur and Ellung Mangenre Farmers Group’s sugarcane plantation were financially supported by KKP-E (Food and Energy Security Credit) scheme and social assistance. The formation of farmers groups and the expansion of the area for sugarcane plantation were intended to increase the size of farmers’ arable land, increase production and income of farmers and to meet the needs of the raw material supply for sugar mills. Both groups utilized dry land both in the form of rain-fed rice fields and dry fields. Ellung Mangenre group has enormous potential, with around 500 hectares of unutilized land where the status of the acquisition of the land is based on the buffalo grazing area by the local community.

3.2. Institution for brown sugar production
Ellung Mangenre and Makmur Group play a role as brown sugar processors while also manage some area of sugarcane plantation. Some farmers concentrate on cultivating sugarcane only. All the sugarcane plantations were built using support from the government. These farmer groups developed a core-plasma system based on processing. The system is 35 percent part of the core as the processing services, and 65 percent is for farmers. This scheme will encourage farmers to plant sugarcane and raising cattle if the land is available or not being cultivated. If this approach develops well, farmers living around the brown sugar processing factory will be encouraged to grow sugarcane because the seedlings are available locally.

On the other hand, the Situjue group aims to build an independent sugarcane plantation and its brown sugar processing. Sugarcane cultivation uses a simple method without using soil processing tools results in low productivity. The intention of this group is to build their sugarcane processing
gradually due to their limited capital. The profit obtained from brown sugar production will be used to build a sugarcane plantation with a proper sugarcane cultivation system. This model is expected to reduce farmers’ dependency from government programs. With this approach, farmers are expected to produce brown sugar on a household scale. In addition, brown sugar production can be integrated with cattle farming. Sugarcane shoots can be used as a source of livestock feed, while livestock waste (manure and urine) can be used as fertilizer on sugarcane fields.

Through the institutional development of brown sugar production and beef cattle farming integration, the use of less fertile and abandoned land is expected to stimulate the expansion of the sugarcane area. The potential impacts are (1) developing sugarcane farmers’ businesses through increasing the size of arable land and cattle farming; (2) increasing farmers’ incomes and meeting sugar mill capacity requirements through increasing sugarcane production; 3) increasing sugar production in the context of contributing to meet domestic sugar demand, and 4) increasing the competitiveness of farmers’ through productivity improvement supported by other related services and businesses.

3.3. Employment creation opportunity

Employment opportunities in brown sugar production can be created both on pre-harvest (cultivation) and post-harvest activities (cutting, transportation, and processing). Apart from that, employment in cattle farming can be created as well if the product is integrated with cattle farming.

Sugarcane farming and brown sugar production can provide employment opportunities around 1-1.5 workers per hectare throughout the year with a wage around IDR 1.5-2 million/ha per month or a minimum equivalent to the minimum wage in South Sulawesi of IDR 1,440,000.

| No. | Items                                      | Value (IDR) | %    |
|-----|-------------------------------------------|-------------|------|
| 1   | Land rent                                 | 500,000     | 8.33* |
| 2   | Farmer’s income                           | 1,900,000   | 31.67 |
| 3   | Input                                     | 300,000     | 5.00* |
| 4   | Labor on-farm                             | 300,000     | 5.00* |
| 5   | Labor for harvesting                      | 600,000     | 10.00 |
| 6   | Labor for transportation                  | 200,000     | 3.33  |
| 7   | Labor for brown sugar processing          | 1,000,000   | 16.67 |
| 8   | Processing fee                            | 1,200,000   | 20.00 |
|     | Cost of goods sold                        | 6,000,000   | 100.00|

* The proportion decreases if the productivity increases

Labor wage in brown sugar production is IDR 2,100,000, with farmers' income IDR 1,900,000 from one ton of brown sugar or equivalent to 10 tons of sugarcane. The minimum wage (UMR) of South Sulawesi Province in 2013 was IDR 1,440,000, suggesting that wage in brown sugar production is higher. Employment opportunities created for one ton of brown sugar business is around 1.46 labor for post-harvest activities and 1.32 labor for cultivation activities. If the productivity of sugarcane is 50 tons of sugarcane or 5 tons of brown sugar (10% rendiment) per hectare, it means that labor needed for sugarcane farming with a land size of one hectare is minimum of 6.6 labor per year or 0.55 labor per month. Farmers should manage a 1.80 ha sugarcane farming with the assumption that the farmer is the manager, hires labor, and pays for land rent.

Labor wage in post-harvest activities is IDR 1,800,000 or equivalent to 1.25 labor. Thus, every one hectare of sugarcane with a productivity of 50 tons/hectare can provide employment opportunities 6.25 labor/hectare per year or 0.52 Labor/hectare per month. The total workforce needed for one hectare of sugarcane with a productivity of 50 tons/ha/year is 1.07 Labor/hectare/year.

All of the assumptions used in the estimation above are very pessimistic because the price of sugar used is IDR 6,000/kg, and the productivity of sugar cane is 50 tons/ hectare/year. Sugar prices are commonly between IDR. 7,000-8,000/kg and sugarcane productivity around 70-80 tons/ha/ year. Thus,
sugarcane farming for processing brown sugar can provide labor about two people per hectare consisting of one person for the cultivation and one person for processing.

3.4. Brown sugar production in South Sulawesi
Potential areas for sugarcane development in South Sulawesi were still around 205,665 hectares in 2010, dominated by unutilized rice fields and dry land. Rice fields and dry land that are not used and part of pasture land can also be used for sugarcane farming, which can encourage the development of household-scale brown sugar industry.

| No. | Land type                        | Hectares 2007 | Hectares 2010 | Changes  | (%)   |
|-----|----------------------------------|---------------|---------------|----------|-------|
| 1   | Rice fields not planted with rice| 7,527         | 7,368         | 159      | 2.11  |
| 2   | Rice fields not cultivated temporarily | 4,194     | 2,987         | 1,207    | 28.78 |
| 3   | Unused dry land                  | 114,297       | 86,753        | 27,544   | 24.10 |
| 4   | Pasture / grassland              | 111,500       | 108,555       | 2,945    | 2.64  |
|     | Total                            | 237,518       | 205,663       | 31,855   | 13.41 |

Source: Department of Agriculture for Food Crops and Horticulture Prov. South Sulawesi, 2011

If fifty percent of the land (205,663 hectares) is used for sugarcane farming, it means there are around 52.5 thousand hectares. With an average potential sugarcane production 70 quintals/hectare, 10% rendiment for brown sugar, the production of brown sugar can be achieved around 367.5 thousand tons or about 13 percent of national production. This has the potential to substitute about 20 percent of sugar imports and additional cattle population that can be raised at least 500 thousand head of cattle or about 50 percent additional livestock population in South Sulawesi.

4. Conclusion
Brown sugar produced from sugarcane has the potential to utilize less productive, not cultivated, or marginal land as one model for agricultural development that can increase sugar production, farmers’ incomes, and conservation of agricultural land resources. Institutional forms that can be developed is farmer groups that play a role as the manager of a brown sugar processing and also a provider of seeds and the cost for sugarcane farming. The expected profit-sharing system from the partnership is 65 for the farmer and 35 processors (65:35). This model can be developed with an investment value of IDR 10-12 million per hectare. This consists of investment for processing plants IDR 3-5 per hectare and a plantation of IDR 3-7 million per hectare. The total investment is IDR 100-500 million per unit business (farmers group). The investment value of brown sugar business is inversely proportional to the land size of the sugarcane farming. The investment value is IDR 5 million for 8 hectares, 3.6 million for 14 hectares, and IDR 3.25 million for 20 hectares.

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