Economics of Aren Brown Sugar Production in Indonesia: Supply Analysis at Farm Level

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Abstract: This study aims to describe the Aren brown sugar production process, and to examine factors that influence the supply of Aren brown sugar in Southeast Sulawesi. This study describes that there were seven activities in Aren brown sugar production process, namely tapping preparation, sap tapping, sap cooking, molding, packaging, storage, marketing. We found that factors influencing supply of Aren brown sugar are the age of the Aren brown sugar farmer, business experiences, labour, quantity of Aren tree, and dummy for risk, while dependent of family, and price of Aren brown sugar were not influence it. Age of the Aren brown sugar farmer have a negative effect, while business experiences, labour, quantity of Aren tree, and dummy for risk, has a positive effect on the supply of Aren brown sugar. This study has implications for exploring the promotion of palm sugar as an organic sweetener products in terms of raw materials and production processes, as well as to explore the factors that can increase the number of Aren brown supply in the Indonesian and to scale the world trade.
1 Introduction

Sugar is a strategic commodity because it has used worldwide. [1] According to Dubai’s Sugar Yearbook data 2007 shows that sugar consumption was the smallest in Sub-Saharan Africa, at 8 million tonnes of sugar and 15.2 kg in per capita terms, then comes North America, at 11 mln tonnes, Eastern Europe, at around 13 mln tonnes, the Middle East and North-Africa, at around 15 mln tonnes and Western Europe, at around 18 mln tonnes. All these four regions show a per capita consumption of at least 32 kg or more. Both the Indian Subcontinent and Latin America are consuming around 27 mln tonnes of sugar a year, but per capita consumption in the Indian Subcontinent was only 16.3 kg while in Latin America it was much greater at 47.2 kg.

The sugar has assumed the status of political goods’ like wheat, [2]. It can be explained that the sugar is consumed by most people in a country, as well as in Indonesia. Sugar is white sugar. Similarly, the amount of sugar needs of Indonesian society cannot be met by domestic production. According to [3] that the total consumption of white sugar to the people of Indonesia by 5.7million tons, while the total production of 3.7million tons only. The low production of white sugar because a decrease in the planting area of sugar cane up to 18 thousand hectares in 2014.

According to [4] that the brown sugar is potentially a good substitute white sugar as a sweetener in terms of the benefits, value of health, social, and economic. Furthermore, [5] said that there are seven reasons of people in brown sugar production of white sugar because a decrease in the processing of white sugar. It is produced by large-scale industries. Generally, brown sugar processing businesses in Southeast Sulawesi are characterized by a very simple technology and rely solely on family labor or even just doing one or two people. Supply of brown sugar fluctuates widely in these conditions.

The fluctuating supply of brown sugar can weaken the Southeast Sulawesi potential market of brown sugar. Meanwhile, the certainty supply is requirement for good trade of brown sugar mainly for export purpose. Understanding of risk analysis is also important in this case. This is as proposed by [10] that is not everyone knows the inherent risks involved in investing or how to strike a correct balance between risk taking and making a profit. Therefore, it becomes very important to describe the risks of brown sugar business risk that influence the supply of brown sugar that is highlighted in a mathematical model. It is very important to realize Southeast Sulawesi especially and Indonesia generally as a regional exporter of brown sugar which has many health benefits.

2 Problem Formulation

Qualitative analysis was is done to description about brown sugar production process, and linear regression analysis by OLS (Ordinary Least Square) methods is done to analysis the factors affecting the supply of brown sugar.

Hypothesis: supply of brown sugar is influenced by age of respondent, business experiences, dependent of family, labour, price of brown sugar, quantity of brown tree, and risk.

Hypothesis testing is done by using a form of the supply function approximated by a linear regression analysis with OLS,[11].

$$Y_t = \beta_{1,23} + \beta_{12,3}X_{21} + \beta_{13,2}X_{31} + \epsilon_i$$ (1)

Formulation in this study:

$$Qs = b_0 + b_1A + b_2E + b_3F + b_4L + b_5P + b_6Plm + b_7D + \epsilon$$ (2)

Where: 
$$Qs = \text{supply of brown sugar (kg)}$$
b₀ = intercept
A = age of aren brown sugar farmer (year)
E = business experiences (year)
F = dependent of family (person)
L = labour (person)
P = price of aren brown sugar ($)
Plm = Quantity of aren tree (tree)
D = dummy for risk, 1 = high risk; 0 = less risk
e = error term

Ho : ri = 0
Ha : ri ≠ 0

Testing criteria:
- If significant value of t-stat where (α = 5%) > 0, H₀ is accepted. It means supply of aren brown sugar is not influenced by age of respondent, business experiences, dependent of family, labour, price of aren brown sugar, quantity of aren tree, and risk.
- If significant value of t-stat where (α = 5%) < 0, H₀ is rejected. It means supply of aren brown sugar is influenced by age of respondent, business experiences, dependent of family, labour, price of aren brown sugar, quantity of aren tree, and risk.

There some of the problems that arise in the linear regression analysis are whether there is autocorrelation, heteroscedasticity, and multicollinearity. This is known as the classical assumption [11]. Autocorrelation problems often found when we use time series data. This study used cross section data, so autocorrelation relation testing is not necessary, but heteroscedasticity, and multicollinearity testing is important.

Heteroscedasticity arise in the event of an error or residual of the observed models do not have a constant variance of an observation to other observations, [12]. Heteroscedasticity testing performed by seeing whether there is a specific pattern on a graph of the relationship between the residual value of the regression model with the predicted value of the dependent variable [13]. There is Heteroscedasticity if there is a pattern visible on the graph (scatter plot).

Multicollinearity is a linear relationship between the independent variables in the regression [14]. There is multicollinearity if r > 0.85.

\[ r_s = 1 - 6 \left( \frac{\Sigma d_i^2}{n(n^2 - 1)} \right) \]  

Source: [15]

The accuracy of the regression model used (goodness fit) was tested with the coefficient of determination (R²) and F-test.

\[ R^2_{x1x2} = \frac{\hat{\beta}_1 y_1 x_1 + \hat{\beta}_2 y_2 x_2}{\Sigma y_i^2} \]  

\[ R^2_{AEFLPPDm} = \frac{\hat{\beta}_1 y_1 A_1 + \hat{\beta}_2 y_1 P_1 + \hat{\beta}_3 y_1 Plm + \hat{\beta}_4 y_1 D}{\Sigma y_i^2} \]  

The model is quite good (fit) if the value of R² closer to one.

F test was done, next:

\[ F = \frac{\Sigma (y_i - \hat{y})^2 / k}{\Sigma e^2 / n-k} \]  

(6)

where:

\[ \Sigma e^2 = \Sigma y_i^2 - \hat{\beta}_1 \Sigma yA - \hat{\beta}_2 \Sigma yE - \hat{\beta}_3 \Sigma yF - \hat{\beta}_4 \Sigma yL - \hat{\beta}_5 \Sigma yP - \hat{\beta}_6 \Sigma yPlm - \hat{\beta}_7 \Sigma yD \]  

(7)

The goodness fit of model was shown by significance F_stat.

Regression coefficients for the factors that influence supply of aren brown sugar were got from formulas below:

\[ \hat{b}_i = \frac{\Sigma xy_i}{\Sigma x_i^2} \]  

(8)

where: \[ \Sigma xy_i = \Sigma (X_i - \bar{X}_i)(Y_i - \bar{Y}_i) \], and \[ \Sigma x_i^2 = \Sigma (X_i - \bar{X}_i)^2 \]

3 Problem Solution

3.1 Testing of Classic Assumption

Linear regression has to test about classic assumptions. Significant violations of the classical assumptions will lead to predictions become biased. Multicollinearity and heteroscedastic testing consecutive shown in Table 3 and Figure 1 as below.

Table 3 showed that correlation value of independent variables in this study lower than 0.50, except the correlation between A and E variable (0.883). It indicated that there was multicollinearity indication but it was not serious.

Tabel 3. Multicollinearity test with correlation between independent variable

<table>
<thead>
<tr>
<th>Correlation of Independent Variables</th>
<th>D</th>
<th>Plm</th>
<th>A</th>
<th>P</th>
<th>F</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>1.000</td>
<td>0.088</td>
<td>-0.056</td>
<td>0.350</td>
<td>-0.281</td>
<td>0.085</td>
</tr>
<tr>
<td>Plm</td>
<td>0.088</td>
<td>1.000</td>
<td>-0.085</td>
<td>-0.228</td>
<td>-0.246</td>
<td>0.099</td>
</tr>
<tr>
<td>A</td>
<td>-0.056</td>
<td>-0.085</td>
<td>1.000</td>
<td>-0.217</td>
<td>0.265</td>
<td>-0.883</td>
</tr>
<tr>
<td>P</td>
<td>0.350</td>
<td>-0.228</td>
<td>-0.217</td>
<td>1.000</td>
<td>-0.372</td>
<td>0.171</td>
</tr>
<tr>
<td>F</td>
<td>-0.281</td>
<td>-0.246</td>
<td>0.265</td>
<td>-0.372</td>
<td>1.000</td>
<td>-0.084</td>
</tr>
<tr>
<td>E</td>
<td>0.085</td>
<td>0.090</td>
<td>-0.883</td>
<td>0.171</td>
<td>-0.084</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Heteroscedasticity test that was shown in the Figure 1 below.
There was no heteroscedastic on regression in this study. It was shown in Figure 1 where absence of a specific pattern of that graphic. Visible observation points spread.

### 3.2 Aren Brown Sugar Production Process

*Aren* brown sugar derived from the sap of aren trees or palm (*Arenga Pinnata* (Wurmb) Merrill) sap of aren trees that are tapped for raw materials of *aren* brown sugar is a tree that grows wild around the residence or plantation of *aren* brown sugar farmer. Overall, all the activities in the *aren* brown sugar processing business is still very simple and has a high dependence on nature.

Generally processing of *aren* brown sugar production in the Southeast Sulawesi is still house hold scale. All of the processing activity of *aren* brown sugar production was done without labor rent, [4].

Sap tapping requires preparation. There are some preparatory activities of sap tapping, namely cleaning of *aren* trunks from fiber and other impurities as well as opening its fronds. Cleanliness trunk greatly will affect the amount and quality of the sap that will be generated by *aren* trees [4]. The process of sap tapping can be seen in Figure 2.

- Rocking and beating are done to flower bunches of *aren* trees that are ready to be tapped. Beating of flower bunches is done by using timber with rotating direction from the tip to the base and then the opposite direction as much as 3-6 times the round. It is done carefully and with deep feeling so as not to damage the flower bunches. This activity aims to enlarge the pores and soften the flowers bunches of so easy sap out. This activity is carried out every two days for 3 weeks.

- Setting up of bamboo stairs in the *aren* tree that are ready to be tapped. Bamboo used is usually obtained by cutting himself in the woods so there is no cost incurred.

Tapping activities carried out by the *aren* brown sugar farmer, without labor rent. Sap tapping process begins with the setting up of cisterns or bamboo tube on the flowers bunches that have been cut edges. Furthermore, the skin incision of flowers bunches as thin as possible by using a very sharp knife. Tapping process is carried out twice in one day, that morning around at 7 to 8 am and in the afternoon around 4 to 5 pm.

Sap of afternoon tapping as soon as possible boiled over low heat until the next morning to further mix with the sap of morning tapping. Both, sap of afternoon and morning tapping then boiled in conjunction with a larger flame for 4-8 hours. It aims to make the water contained in the sap can be more volatile and thickens until it becomes *aren* brown sugar.

The next process is the printing of *aren* brown sugar. There are varied molds of *aren* brown sugar, including coconut shell, wood glass, wood molding, and plastic cups. *Aren* brown sugar will be storage for 1 to 3 days until broker comes to buy it. *Aren* brown sugar that has been printing will be packaged by brokers. Several types of natural materials for packaging, such as banana leaves, corn leaves of palm leaves and *lapi* leaf.
3.3 Factors Influencing the Supply of Aren Brown Sugar

Aren brown sugar trade in Indonesia as producer country is still local-scale, as well as in Southeast Sulawesi [16]. It could be explained that most aren brown sugar processing was done by household. This condition causes aren brown sugar supply was only sufficient local market [17]. Several factors of family, labour, price of age of respondent, business experiences, dependent of family, labour, price of aren brown sugar, quantity of aren tree, and dummy for risk. Results of the regression analysis are presented in the Table 4 below.

Table 4. Factors influencing the supply of aren brown sugar

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Coefficient</th>
<th>SE</th>
<th>Tstat</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant (C)</td>
<td>-2.989</td>
<td>1.704</td>
<td>-1.754</td>
<td>0.093</td>
</tr>
<tr>
<td>age (A)</td>
<td>-0.047</td>
<td>0.031</td>
<td>-1.522</td>
<td>0.142</td>
</tr>
<tr>
<td>business experiences (E)</td>
<td>0.070</td>
<td>0.029</td>
<td>2.434</td>
<td>0.023</td>
</tr>
<tr>
<td>dependent of family (F)</td>
<td>0.178</td>
<td>0.186</td>
<td>0.957</td>
<td>0.349</td>
</tr>
<tr>
<td>labour (L)</td>
<td>3.126</td>
<td>0.420</td>
<td>7.436</td>
<td>0.000</td>
</tr>
<tr>
<td>price of aren brown sugar (P)</td>
<td>0.001</td>
<td>0.000</td>
<td>0.535</td>
<td>0.598</td>
</tr>
<tr>
<td>quantity of aren tree (Plm)</td>
<td>1.657</td>
<td>0.239</td>
<td>6.941</td>
<td>0.000</td>
</tr>
<tr>
<td>dummy for risk (D)</td>
<td>0.906</td>
<td>0.408</td>
<td>2.220</td>
<td>0.037</td>
</tr>
</tbody>
</table>

R-Squared 0.909
Adjusted R-Squared 0.909

*significance at α 5%
*significance at α 15%

Based on Table 4, mathematical model of factors influencing the supply of aren brown sugar, as below:

\[ Qs = -2.989 \times 0.047 A + 0.070 E + 0.178 F + 3.126L + 0.001 P + 1.657 Plm + 0.906 D + e \]  \( (9) \)

Hypothesis testing was done with statistical tests performed with less adjusted R², F-test and T-test below.

a. Adjusted (R²)

The resulting regression models in Table 4 have the Adjusted R-Square value of 0.909. It means that approximately 91.1% factors that influence the supply aren brown sugar commodity is not analyzed. Independent variables in the regression is only able to explain about 90.9% of all the factors which affect the consumption of sugar.

b. F-test

F-test is used to determine the overall significance level of the independent variables simultaneously to the dependent variable. The results showed F-test equal to 43.558 with significance 0.000. This indicates that all variables significantly affect the consumption of aren brown sugar.

c. T-test

T-test is used to determine the level of significance of each independent variable to dependent variable. The results of the analysis of regression showed that fourth independent variables on α 5% between six variable that affect the supply of aren brown sugar on, significantly.

Age of respondent

Age of respondent have significant influence (α 15%) to supply of aren brown sugar. Coefficient regression of this variable was -0.047 (see Table 4). Negative sign indicated that aren brown sugar supply will be reduced if the age of the respondent increases. Sugar processing requires a lot of time and energy. Meanwhile, after aren brown sugar farmer passed their productive age who were getting older, their energy will decrease and so their ability to supply aren brown sugar availability in the market.

Regression coefficients value was very small. It showed that in an effort to supply aren brown sugar, although the older age of the respondent, their produce did not much changed. It can be explained that they has been so used to process aren brown sugar hereditary.

Business experiences

Business experience has significant influence (α 5%) to supply of aren brown sugar. Coefficient regression of this variable was 0.070 (see Table 4). Positive sign indicated that aren brown sugar supply will be increase if business experiences increase. People who have more experienced will knower the ins and outs of his business. It will increasingly attempt to allow it to be more productive. Regression coefficients value of business experience was very small. Business experience increased one year then aren brown sugar supply will increase 0.07 kg, only. It could be explained that aren brown sugar business was a traditional business and without rent labor. Therefore, it was difficult to more increase the supply of aren brown sugar even though respondent have enough experience.

Labour

Labour has significant influence (α 5%) to supply of aren brown sugar. Coefficient regression of this variable was 3.126 (see Table 4). Positive sign indicated that aren brown sugar supply will be increase if labour increase. The addition of the labor will increase by 3 kg of aren brown sugar supply. Aren brown sugar processing business consists of three types of activity, namely the process of tapping the sap from aren tree in the morning and
evening, the cooking process takes 3 to 5 hours, and marketing. Therefore aren brown sugar processing requires a lot of labor so that aren brown sugar supply could be improved.

**Quantity of aren tree**

Quantities of aren tree have significant influence (α 5%) to supply of aren brown sugar. Coefficient regression of this variable was 1.657 (see Table 4). Positive sign indicated that aren brown sugar supply will be increase if quantity of aren tree increase. Aren tree produces sap which is the main source of raw material for aren brown sugar commodity. Thus the number of tapped aren tree that will determine the amount of aren brown sugar produced.

**Dummy of Risk**

Risks in aren brown sugar processing business are very important to be considered in this study for the existence and development of business scale and its quality in the future. This is in line with [18] who said that business risk is fundamental to the long term success of a company and the achievement of its goals. We can make a developing strategy of aren brown sugar business by identifying the risk of this small business. Risks can be classified in various ways. There are basic categories of risk such as production risk, and market risk.

Dummy of risk have significant influence (α 5%) to the supply of aren brown sugar by the aren brown sugar farmer. It could be explained that the most of respondent said that there was some risk in activities of aren brown sugar processing. Some respondents did not process the aren brown sugar continuously or just make it as a side job because it considers the high-risk job.

We can identify the risks in aren brown sugar processing business by attention to the stages of aren brown sugar processing as shown on Figure 2. Stages of aren brown sugar processing were including; tapping preparation, sap tapping, cooking sap, packaging, storage, and marketing. There were some risks in each.

Base on Figure 2, production risks were at tapping preparation, tapping, sap cooking, printing, and packaging activities, while marketing risks were at storage and marketing activities. Some risks in the aren brown sugar processing clearly, namely:

a. **Tapping preparation**
   This activity will determine the success of the subsequent process of tapping. Tapping preparation include cleaning aren tree and beating bunches that will be tapped. Cleaning aren tree should be done carefully. Aren tree has a lot of fibers in its trunk. These shall be cleaned carefully.

b. **Tapping process of sap**

(1) Accidents on tapping process. Work accidents could impact death or lifelong disability if the requirement about skills and health of the palm tapper is not fulfilled.

(2) The fluctuation of the amount of sap as the main material for aren brown sugar. It is influenced by the season (rainy season, dry season), tapping routines, cutting techniques of mayang (bunches), laying container roomie, and the use of tools can affect the amount of sap that can be tapped. Blunt knife will make the a little sap and bunches tapped die quickly before they run out.

(3) The quality of sap namely durability and viscosity was strongly influenced by the cleanliness of the nature container and the characteristic of sap that very easily sour (stale).

c. **Sap Cooking**
(1) Quality of aren brown sugar. How to stir, and fuel quality greatly affects the quality of aren brown sugar. It certainly can affect the price of aren brown sugar.

(2) Type and quality of firewood can affect whether or not a fire heat to cook the sap. The less heat fire causes wastage of time in cooking sap. Otherwise the fire did not also be too big to fit into the skillet and lick and burn the sugar was being cooked. This can lead to burnt aren brown sugar, bitter taste and the color black.

(3) The amount of firewood used was also a source of risk. One of the major problems faced in processing of aren brown sugar was high fuel consumption. Aren brown sugar processing needed fuel supplies from outside the system.

d. **Another source of risk to the neatness molding and packing of aren brown sugar that can affect the durability of aren brown sugar and its price.**

e. **Storage activities either by the processor or merchant of aren brown sugar may pose a risk, like a decrease in the quality of aren brown sugar and a drop in price. The aren brown sugar durability was only about 2-3 months since it has been molded. The risk of a decline in the quality of aren brown sugar is its color changing (become darker) and its texture becomes soft.**

f. **Marketing**
Price uncertainty was a risk, especially at the level of aren brown sugar farmer. Decline of
aren brown sugar’s market price were be received by aren brown sugar farmer more quickly than the rise of aren brown sugar’s price. This also leads to aren brown sugar farmer s receive low prices longer than high prices.

These risks should be minimized so that the aren brown sugar farmer has an incentive to process aren brown sugar more intensively. Thus the supply of aren brown sugar can be improved also, so that aren brown sugar cannot meet the local market only but international market also. Moreover, it can even develop product diversification of aren brown sugar.

Dependent of family and price of aren brown sugar were not influence aren brown sugar supply. It could be explained that respondents have other work to meet the needs of his families. Price of aren brown sugar was not an incentive for respondent to meet the supply of aren brown sugar. They more consider about the risk in aren brown sugar processing.

4 Conclusion
Several things can be concluded in this study. This study describe that there were seven activities in aren brown sugar production process, namely tapping preparation, sap tapping, sap cooking, molding, packaging, storage, marketing. Factors influencing supply of aren brown sugar in Southeast Sulawesi are the age of the respondent, business experiences, labour, quantity of aren tree, and dummy for risk, while dependent of family, and price of aren brown sugar are not influence it. Age of the respondent have a negative effect on aren brown sugar supply, while business experiences, labour, quantity of aren tree, and dummy for risk, has a positive effect on the supply of aren brown sugar.

This study has implications for exploring the promotion of palm sugar as an organic sweetener products in terms of raw materials and production processes, as well as to explore the factors that can increase the number of aren brown supply in the Indonesian and to scale the world trade.

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[1] Baron, P. Thinking Outside the Barrel. 4th Dubai Sugar Conference. 3-5 February. Dubai. 2008
