Utilization of sweet sorghum biomass for profitable feed and bioethanol

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Abstract. Sweet sorghum has many benefits, including its biomass, as an alternative to fodder which contains sugars and stems containing sugar which can be fermented into bio ethanol. The Research and Development Agency has produced several varieties of sweet sorghum, including Super-1, Super-2 and Numbu varieties. In this regard, a study was conducted on sweet sorghum varieties that produce biomass with a designation as animal feed and bio ethanol sources that have beneficial economic value. The study was conducted at KP. Maros in August-December 2016, used the Split-Plot design with three replications. The main plot is six spacing (60 cm x 10 cm, 60 cm x 15 cm, 60 cm x 20 cm, 70 cm x 10 cm, 70 cm x 15 cm, 70 cm x 20 cm) and subplots in the form of three varieties of sweet sorghum (Super 1, Super 2, Numbu) . The results showed that based on the varieties, the three sweet sorghum varieties obtained stover results of 47.8-54.1 t/ha which provided revenue of Rp 16,740,500-18,938,500 with a profit of Rp 6,938,000-9,391,000/ha and the value R/C ratio 1.71 - 2.01; cost/kg stover ratio around Rp 174-205. The results of ethanol for health obtained as many as 830.64-1171.64 l/ha with a sales profit of Rp 11,443,284-27,073,399/ha (at a price of Rp 50,000/l) and an R/C ratio 1.38-1.86 with ratio of cost per liter of ethanol around Rp 26,893-36,224. Numbu variety obtained the highest profit and was more efficient both stover yield and ethanol yield. Production of stover biomass based on sixs pacing ranges from 39-76 t/ha and the acquisition of revenue of Rp 13,650,000-26,600,000/ha. Planting distance of 60 cm x 10 cm has the highest profit (Rp 16,712,000) compared to other planting distances, and is more efficient with an R/C value of 2.69 and a lower cost/kg stover ratio of Rp 130. Based on this sweet sorghum biomass can provide profitable income and provide nutritious animal feed needs so it is feasible to be developed.

1. Introduction
Sorghum is one of commodity that has the prospect to being widely developed. This commodity can be used as a source of food, feed and industrial raw materials. Has a broad agroecological adaptability and can grow better than other food commodities (rice, corn, soybeans), so it is relatively not competing with the main food crops. Sorghum is an alternative grain crop that can grow in a poorly managed environment, where other grain crops cannot grow properly [1], this plant was tolerant to drought stress, high temperature and has a wide adaptability [2]. In less optimal environments with stress inundation and drought and marginal land sorghum plants can still produce well [3,4].

Sorghum has many advantages, including high nutritional content, therefore the stover is proper used as a source of feed and industrial raw materials. Generally sweet sorghum is cultivated to obtain
roomie as raw material for ethanol and liquid sugar [3,5]. Sorghum stems contain sugar and can be processed into sorghum sugar which is very beneficial for human health and becomes bioethanol through fermentation as an environmentally safe fuel [6–10]. Energy crisis in several countries and the decreasing reserves of fuel oil, is the big opportunity of bioenergy production from sorghum. Bioenergy material from renewable sources is becoming crucial to address increasing demand of renewable energy. Sorghum as a ligninolysolitic biomass is one of alternative plant for bioenergy production in the interest as biofuel material [11]. In addition, utilization of sorghum plants as feed has very open opportunities, because the nutritional content of sorghum stems and leaves is almost on par with elephant grass [12]. Subagio and Syuryawati [13] explain that fresh sorghum leaves and the waste can be used as feed. Utilization of fresh stems and leaves (stover) of sweet sorghum plants as animal feed has been carried out in many areas including in Gunungkidul (Yogyakarta) and East Nusa Tenggara.

The total population of ruminant animals (cattle, horses and buffalo) in 2015 reached 17.7 million around Indonesia [14]. Requirement need of quality forage food is important to provide, sorghum planting can be done because it has a high growth ability. Utilization of sweet sorghum stover as feed material is one alternative that can be developed, especially to fill suboptimal lands and overcome the scarcity of food supply in the dry season. Sweet sorghum has a fairly high productivity of stover, land expansion and can be razed [15] without any more preliminary planting, so that production time can be faster which can help adequately feed livestock needs. Sorghum has strong and deep roots so that it has the ability to grow back after harvesting (ratoon) which can reduce production costs [16].

Utilization of bagage made silage for feed increases the content of gisi, the economic value of sorghum in the production of bioethanol. Making silage has business potential for farmers/ranchers because it has the opportunity to earn income from the sale of silage when the availability of feed is less mainly in the dry season. For farmers, the high cost of feed is often an obstacle in efforts to increase yields, so that if they are able to utilize cheap but highquality feed ingredients, decent profits can be obtained from these businesses.

According to Soekartawi [17], farmer or producer analysis conducted by farmers or producers aims to find out comparative advantages, low of diminishing returns, substitution effects, farm expenditure, and marketing (goal trade off). In connection with the foregoing, a research on sorghum maurus farming at various plant spacing and varieties with the aim of knowing sorghum biomass production based on spacing and varieties to be used as feed and bioethanol whose management provides benefits.

2. Materials and Methods

2.1 Research Approach

This research was conducted in conjunction with technical research. In order to find out the research objectives, an approach is carried out by following technical research activities in the field in order to know the use of production facilities and labor, from land preparation to harvest.

The study was conducted at the Maros Experimental Station in August-December 2016. The experiment used a Split Plot design with three replications. Anak Plot is a sweet sorghum variety, Super 1, Super 2 and Numbu. Main Plot is six spacing with population level:

1. Spacing of 60 cm x 10 cm = 166,667 plants/ha
2. Spacing of 60 cm x 15 cm = 111,111 plants/ha
3. Spacing of 60 cm x 20 cm = 83,333 plants/ha
4. Spacing of 70 cm x 10 cm = 142,857 plants/ha
5. Spacing of 70 cm x 15 cm = 95,238 plants/ha
6. Spacing of 70 cm x 20 cm = 71,429 plants/ha

There were 18 combinations of experiments that were repeated three times. The fertilizing dose used was 250 kg/ha urea + 200 kg/ha Phonska. The application of fertilizer is carried out twice at 10 and 35 days after planting (dap). Plant maintenance is carried out properly, such as weeding manually and herbicides, growing, and providing water.
2.2 Data and Technical Analysis

This research is reviewed from 2 aspects namely technical/agronomy and economically. This study focuses on economic aspects. Studies on the economic aspect, data collection includes the use and price of production facilities (seeds, fertilizers, herbicides, irrigation) labor use (HOK/ha) and wages start producing sorghum production and the process of producing ethanol, as well as production data of sorghum biomass and its value (in shape stover and ethanol).

The collected data is tabulated, then analyzed on the basis of costs, receipts, profits, R/C ratio and cost/kg ratio of seeds per treatment of farming activities applied. To find out, the following formula is used [18–20].

\[
\text{Beneficial Analysis: } \Pi = \sum_{i=1}^{m} Y_i P_{yi} - \sum_{i=1}^{n} X_i P_{xi}
\]

\[
R/C \text{ ratio Analysis } = \frac{\sum_{i=1}^{m} Y_i P_{yi}}{\sum_{i=1}^{n} X_i P_{xi}}
\]

- \( R/C > 1 \) means that sorghum farming is efficient, because the revenue it receives is greater than the expenditure.
- \( R/C = 1 \) means the break-even (income is equal to expenditure).
- \( R/C < 1 \) means sorghum farming is inefficient because revenue is less than expenses.

\[
\text{Cost/kg ratio Analysis of stover production (Rp/kg), ethanol production (Rp/l) } = \frac{\sum_{i=1}^{n} X_i P_{xi}}{\sum_{i=1}^{m} Y_i}
\]

Where: \( \Pi \) = Benefit (Rp/ha)

\( \sum Y_i \) = Number from \( i \) to \( m \) or \( n \)

\( Y_i \) = Production (kg, l/ha)

\( P_{yi} \) = Production price (Rp/ha)

\( X_i \) = Cost of farming (Rp/ha)

\( P_{xi} \) = Price of input (Rp/ha)

\( i \ldots m \) = Number of production obtained

\( i \ldots n \) = Number of inputs used

3. Result and Discussion

3.1 Production of Sweet Sorghum Biomass Based on Planting Distance and Income

Sorghum superior varieties to produce high production including stover need to pay attention to the regulation of plant population (spacing). Sorghum plantations based on six spacing are used which show the plant's growth and development is quite good. Pests and plant diseases do not significantly interfere with plant growth, control using pesticides is not done. Plant maintenance is carried out properly until the age of harvest. The sweet sorghum agromomic appearance based on spacing is shown in Table 1.

Spacing of plant spacing or plant population influences plant growth, which in turn results in stover and weight of the stems achieved. Soleh et al.[21] explained that the optimum spacing will provide good growth of the top of the plant causing it to be able to utilize more sunlight and the growth of the roots is also good, so that it can utilize more nutrients. Snider et al. [22] states that plant population
does not affect plant height, but it is very influential on stem weight. Barbanti et al. [23] states, sorghum is a C4 plant that is responsive to sunlight, but has a high value of efficient use of nitrogen (100 g/g). Tighter spacing results in higher plant populations, so plants must compete more tightly to obtain nutrients and sunlight to support the photosynthesis process. Severe competition in low input conditions can cause sorghum crops to experience a significant decrease in yield[24]. The results of this study indicate that a high plant population does not affect the growth of sorghum plants, this is because the inputs in the form of water and nutrients are given sufficient to meet the needs of plants in accordance with the recommendations [25–28].

Tabel 1. The agronomic performance of sweet sorghum is based on planting spacing at the age of 110
dap. KP Maros, South Sulawesi, 2016

| Plant distance | Stem length (cm) | Stem diameter (mm) | Number of nodes per stem | Stover Weight (t/ha) | Stem Weight (t/ha) |
|----------------|------------------|--------------------|--------------------------|---------------------|-------------------|
| 60 cm x 10 cm  | 297,7            | 18,8               | 12,1                     | 76,0                | 51,3              |
| 60 cm x 15 cm  | 300,7            | 19,2               | 12,9                     | 49,4                | 38,1              |
| 60 cm x 20 cm  | 299,9            | 20,1               | 12,9                     | 47,0                | 33,9              |
| 70 cm x 10 cm  | 303,9            | 18,9               | 12,1                     | 50,7                | 37,9              |
| 70 cm x 15 cm  | 314,0            | 20,2               | 12,8                     | 48,7                | 36,0              |
| 70 cm x 20 cm  | 300,5            | 20,3               | 12,4                     | 39,0                | 28,0              |

The biomass yield of sweet sorghum stover in the six planting spacing was quite varied, ranging from 39.0 to 76.0 t/ha (Table 1). The highest stover yield was obtained at a spacing of 60 cm x 10 cm (plant population 166,667/ha) of 76.0 t/ha and the lowest spacing of 70 cm x 20 cm (plant population 71,429/ha) of 39.0 t/ha. Crop stover production, besides being influenced by plant population or planting distance is also a variety and environmental factors. Research results at KP. Bajeng showed that the biomass weights of Watar Hammu Putih were 53.8 t/ha and Numbu 45.3 t/ha [29]. Research by Fatmawati and Yasin [30] at KP. Bontobili, South Sulawesi Gowa produced Kawai and Numbu biomass weights of 75 cm x 25 cm spacing of 21.38 t/ha and 25.82 t/ha, respectively. Subagio and Syuryawati [13] explained that generally high production is obtained from deep aged varieties and suitable for use as forage sorghum.

In this sorghum cultivation, before planting the land preparation is carried out with land management (rental system Rp. 1,000,000/ha). Sweet sorghum seeds that have been prepared are planted as much as 7 kg/ha. Planting is fertilized with 250 kg urea + 200 kg/ha phonska with the time of administration twice at the age of 10 and 35 dap. Weeding and cropping is done both manually and with herbicides. Weeding was carried out with herbicide twice using Glyphosate active ingredients, namely Gramoxon. Likewise the use of labor in every farming activity is recorded, recorded and monitored so that the effective use of labor. This is related to the achievement of farm efficiency produced can be optimal.

Sorghum farming costs based on plant spacing range from Rp 8,791,500 to Rp 9,888,000/ha (Table 2). The use of production facilities at all planting distances is physically the same so that the cost is the same as Rp. 3,345,000/ha. But on the use of labor the time is not the same so the cost varies, around Rp. 5,446,500-6,543,000/ha. The use of labor in the work day (HOK) is determined by the speed of work. The speed of work is influenced by several factors including labor age, experience and skills in farming, crop and land conditions, and production [31]. Expenditures on harvesting activities use a large cost of Rp 1,916,500/ha at a spacing of 60 cm x 10 cm. Expenditures which are also quite large in the activities of menyiang at all spacing of Rp 1,556,500-1,581,000/ha, because weeding in addition to spraying with herbicides, is also done manually using a hoe when the plants are 1-4 weeks after planting. The use of different farming costs affects the amount of farm income and profits.

In stover production, the amount of farm receipts obtained at six different plant spacing values, and the largest at spacing 60 cm x 10 cm yields 76.0 t/ha which is Rp. 26,600,000 (price of sorghum
stover Rp. 350/kg). Then the spacing of 60 cm x 15 cm of stover production is 49.4 t/ha in the amount of Rp. 17,290,000 and the lowest spacing is 70 cm x 20 cm in the production of stover production of 39.0 t/ha with Rp. 13,650,000. The biggest farm receipts at a spacing of 60 cm x 10 cm, also obtained a high farm profit of Rp 16,712,000, supported by a higher R/C value of 2.69 and the lowest farming cost ratio of Rp 130/kg of sorghum stover weight, which shows more efficiency than other planting distances.

Table 2. Average farming costs, production, profits, R/C and cost/kg ratio of sorghum stover based on spacing. KP Maros, South Sulawesi, 2016

| Description                | 60 cm x 10 cm | 60 cm x 15 cm | 60 cm x 20 cm | 70 cm x 10 cm | 70 cm x 15 cm | 70 cm x 20 cm |
|----------------------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Physical (t/ha)            | 76.0          | 49.4          | 47.0          | 50.7          | 48.7          | 39.0          |
| Value (Rp/ha)              | 26,600,000    | 17,290,000    | 16,450,000    | 17,745,000    | 17,045,000    | 13,650,000    |
| Cost of farming (Rp/ha)    | 6,543,000     | 5,446,500     | 5,741,000     | 5,768,000     | 6,445,000     | 5,722,000     |
| Production facilities      | 3,345,000     | 3,345,000     | 3,345,000     | 3,345,000     | 3,345,000     | 3,345,000     |
| Labor                      | 9,888,000     | 8,791,500     | 9,086,000     | 9,113,000     | 9,790,000     | 9,067,000     |
| Benefits (Rp/ha)           | 16,712,000    | 8,498,500     | 7,364,000     | 8,632,000     | 7,255,000     | 4,583,000     |
| R/C ratio                  | 2.69          | 1.97          | 1.81          | 1.95          | 1.74          | 1.51          |
| Cost/kg stover ratio (Rp)  | 130           | 178           | 193           | 190           | 180           | 201           | 232           |

Note: Stover price: Rp 350/kg  
Labor wage: Rp 50,000/person

3.2 Production of Sweet Sorghum Biomass Based on Variety and Income

Superior varieties that adapt to the marginal environment along with improved management of cultivation and farming to obtain high yields need to be provided for farmers [32]. The stover results obtained showed that the Super 2 variety was higher at 54.11 t/ha, then the Numbu variety was 53.44 t/ha and the lowest was the Super 1 variety 47.83 t/ha (Table 3).

Table 3. Agronomic performance of sweet sorghum based on varieties at plant age 110 dap. KP Maros, South Sulawesi, 2016

| Variety | Stem length (cm) | Stem diameter (mm) | Number of nodes per stem | Biomass weight (t/ha) | Stem weight (t/ha) |
|---------|-----------------|--------------------|--------------------------|-----------------------|-------------------|
| Super-1 | 303.7           | 18.87              | 11.47                    | 47.83                 | 33.7              |
| Super-2 | 343.5           | 19.97              | 13.34                    | 54.11                 | 40.1              |
| Numbu   | 261.1           | 19.99              | 12.76                    | 53.44                 | 38.8              |

The cultivation of these three sweet sorghum varieties, in terms of farming analysis shows that the use of production facilities is the same amount so that the costs used are the same as Rp. 3,345,000/ha. For the use of labor, the time used varies causing costs to differ from Rp 5,968,000 to Rp 7,045,500/ha, and the highest cost is used in Super-2 varieties and the lowest in Numbu varieties. These differences affect the amount of farming costs of each variety and have an impact on the magnitude of the benefits obtained.

In the three sorghum varieties planted, the lowest use of farming costs was in the Numbu variety, supported by stover yields which were quite high at 53.44 t/ha and a lower ratio of cost per kg of stover to Rp 174, causing the highest profits to be Rp 9,391,000, and an R/C ratio of 2.01 shows that it is more efficient because each time using the cost of Rp. 1 for the production of sorghum stover will give an income of Rp. 2.01 and to produce 1 kg of sorghum stover requires only Rp. 174 (Table 4).

Sorghum biomass in the form of fresh leaves and stems (stover) is one of the feed ingredients from several sources of cattle feed in its consumption needs. Nutrient composition of sorghum, rice and corn biomass did not differ much as in crude protein and crude fat for sorghum and rice the nutritional content was the same (4.40% and 4.50%) and corn 7.40%, whereas in fiber content coarse percentage
of sorghum straw/biomass is slightly higher than rice and corn. Similarly, the levels of NDF (Neutral Detergent Fiber) and ADF (Acid Detergent Fiber) sorghum are quite high. The Numbu, Hegari Early and Kawali varieties have NDF levels of 76.89%; 73.08%; 72.85%, while the ADF levels respectively 44.87%; 41.80%; 41.30%, this is still in accordance with the needs of ruminant animal feed sources [33]. Sorghum biomass contains 339 g cellulose, 375 g hemicellulose, 162 g lignin and 20 g ash in each kilogram of material [34].

Table 4. Average farm costs, production, benefits, R/C and cost/kg ratio of sorghum stover by variety.

| Description                          | Super-1 | Super-2 | Numbu |
|--------------------------------------|---------|---------|-------|
| Physical (t/ha)                      | 47.83   | 54.11   | 53.44 |
| Value (Rp/ha)                        | 16,740,500 | 18,938,500 | 18,704,000 |
| Cost of farming (Rp/ha)              | 3,345,000 | 3,345,000 | 3,345,000 |
| Production facilities                | 6,457,500 | 7,045,500 | 5,968,000 |
| Total cost                           | 9,802,500 | 10,390,500 | 9,313,000 |
| Benefits (Rp/ha)                     | 6,938,000 | 8,548,000 | 9,391,000 |
| R/C ratio                            | 1.71    | 1.82    | 2.01  |
| Cost/kg stover ratio (Rp)            | 205     | 192     | 174   |

Note: Stover price Rp 350/kg
Labor wage: Rp 50,000/person

In Australia, the stems and leaves of sorghum and sweet sorghum forage have been developed for feed [12]. Sufficiently of forage needs for feed in an area are important to adequate. An area is categorized as have the ability to provide animal feed if the amount of animal feed available in the region is greater than the livestock's living needs [35]. The average consumption requirement for a cow is approximately 85 kg of fresh forages per day for 435 kg cows weight to 108 kg for 635 kg cows weight [36]. Sorghum stover contains 74 ash, 48 CP, 770 NDF, 495 ADF, 53 lignin, 441 cellulose and 276 hemicellulose in g/kg base [37]. Each hectare of sorghum plant can produce 10.7-19.4 tons of dry matter [38]. Direct giving of fresh sorghum leaves to livestock must go through the process of withering in advance about 2-3 hours. Sorghum leaf nutrition is equivalent to elephant grass and sugarcane shoots. The nutrient content of sorghum waste is not significantly different from corn straw and sugar cane shoots. Good feed quality affects the high productivity of livestock. The low productivity of livestock is related to the availability of feed that fluctuates with low quality.

Utilization of sorghum waste such as crop stover for ruminant animal feed needs to be developed to get added value from sorghum farming that provides business profits. Fermentation of stover to produce silage that has high nutritional value and economic value has an impact on obtaining additional income for farmers and can be stored longer.

3.3 Production of Sweet Sorghum Varietal Bioethanol

Based on varieties, the highest average yield of ethanol was found in Numbu varieties, namely 1,171.64 l/ha, the lowest was in Super-2 varieties, yielding 830.64 l/ha. This result is very low due to rainfall and the high number of rainy days since the plants are two months old. In normal conditions where the panicle and stem harvests are carried out in the dry season, the production of stem biomass and juceis always higher in Super-1 and Super-2 varieties than in Numbu varieties [9,25]. But in this study where the conditions of high rainfall both varieties experienced a drastic decline in production.

In climatic conditions that experience deviations, with high rainfall and the number of long rainy days (La Nina) causes low ethanol yield. Thus, the production of ethanol produced will not be profitable if directed to biofuel, there fore farming for bioethanol is directed for health ethanol.

For the production of bioethanol from sweet sorghum stems (Super-1, Super-2, Numbu), the use of means for the fermentation process of sorghum juice results varies in an average of around Rp 4,342,966/ha to 4,501,101/ha, the highest in variety Numbu and the lowest variety is Super-2 (Table 5).
The use of labor, cleaning of sorghum stems done in bulk at a cost of Rp. 15,000/bunch (10 m²) sorghum stems, rack extortion and distillation shows costs ranging from Rp. 26,570,750/ha (Super-1) to Rp. 29,670,000/ha (Numbu). The total cost of processing ethanol varies between Rp 33,391,253 (Super-1) to Rp 39,496,101/ha (Numbu), this also depends on the skills or experience of the workforce and the conditions in the field at harvest.

The Super-2 plantations are not good because the plants are quite high and the rain has started to fall causing the stems to not fall as solid as the Numbu variety. In conditions of high rainfall, the Numbu variety gives 70% higher ethanol yield compared to the other two varieties, namely 1,171.64 l/ha with sales profit of Rp 27,073,399/ha at a price level of Rp 50,000 per liter (prices in Makassar di outside of Java) with a high R/C ratio of 1.86 and a lower cost per litre ethanol ratio of around Rp. 26,893/l. Prices outside of Java are higher because there are no ethanol plants while in Java there are a number of ethanol plants sourced from sugar cane drops. Thus, the use of sorghum sweet sorghum biomass as a bio ethanol feedstock provides a profitable income.

Table 5. Average farm costs, ethanol production, benefits, R/C ratio, and cost/liter ratio of ethanol in sweet sorghum, 2016

| Description                              | Super-1       | Super-2       | Numbu         |
|------------------------------------------|---------------|---------------|---------------|
| Ethanol production (l/ha)                | 981.20        | 830.64        | 1171.64       |
| Physical (70% ethanol)                   | 49,060,000    | 41,532,000    | 58,582,000    |
| Value (Rp 50,000/l)*                     |               |               |               |
| Cost of farming (Rp/ha)                  |               |               |               |
| Production facilities                    | 4,439,753     | 4,342,966     | 4,501,101     |
| Labor for fermentation                   | 26,570,750    | 25,745,750    | 27,007,500    |
| Total cost of the ethanol process        | 31,010,503    | 30,088,716    | 31,508,601    |
| Benefits (Rp/ha)                         | 18,049,497    | 11,443,284    | 27,073,399    |
| R/C ratio                                | 1.58          | 1.38          | 1.86          |
| Cost ratio/l ethanol (Rp)                | 31,605        | 36,224        | 26,893        |

Note: *Prices around Makassar City

4. Conclusion

Sweet sorghum biomass produced from Super-1, Super-2 and Numbu varieties, for stover production, ranges from 48-54 t/ha which gives an average benefit of Rp 6,938,000 to Rp 9,391,000/ha with an R/C value 1.71-2.01 and the cost per kg of stover around Rp 174-205. Numbu variety obtained the highest benefit (Rp. 9,391,000) and more efficient farming costs (R/C 2.01 and Rp 174/kg stover).

On the results of ethanol for health obtained around 830-1,172 l/ha with a sales price of Rp 50,000/l obtained a benefit of Rp 11,443,284-27,073,399/ha, with an R/C value of 1.38-1.86 and a cost ratio per litres of ethanol amounting to Rp 26,893-36,224. Numbu variety gives the highest benefit (Rp. 27,073,399/ha) and is more cost efficient for farming (R/C 1.86 and costs Rp 26,893/l).

Stover production at six spacing, produced around 39-76 t/ha and provides revenues of Rs. 13,650,000 to Rp. 26,600,000/ha. The highest benefit of spacing of 60 cm x 10 cm is Rp 16,712,000 and more farming efficiency is higher (R/C 2.69) and the ratio of cost per kg of stover is only Rp 130.

Sweet sorghum cultivation has many benefits including biomass that is used for nutritious feed and bioethanol production materials that are environmentally safe, in its management is beneficial because it provides added value to income.

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