SUSTAINABILITY OF SORGHUM AS ALTERNATIVE FOOD IN RAJI VILLAGE DEMAK REGENCY, CENTRAL JAVA PROVINCE, INDONESIA

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Abstract

Rice is an important source of carbohidrat in Indonesia, meanwhile rice demand still be a challenge. Because of that we try to explore another local source of carbohidrat, sorghum as alternative food. However, in Indonesia, sorghum has so far been regarded as a minor crop and its research and development remain insignificant. The the study aimed to explore the sustainability of sorghum as alternatif food. As alternative food sorghum has good future and sustain in economic, environment and social side. In economic side, sorghum is quite feasible, eventhough, there are no price certainty or guarantee from government, so that a lot of sorghum farmers switch to cultivate other profitable commodities. In enviroment side, sorghum is adaptable in drought condition and pest attact. In social side, cultivated sorghum is a culture. Farmer has strongly support sorghum as alternative food, base on it's benefit and function. Meanwhile farmer has high level of obstacle in processing procedure, unavailability of processing equipment and people more easily access other sources of carbohydrate.

Keywords: sustainability; sorghum; alternative food

1. Introduction

Most of the Indonesian population consume rice as a single staple food (BPS, 2018). In the last two years (2016-2017), Indonesia has significantly succeed to reduce rice import about 36% (FAO, 2017). Meanwhile, in the future, by increasing number of population, rice demand still be a challenge. Furthermore, the production of rice has been influenced by climate change (Nurhayanti and Nugroho, 2016, Ruminta 2016), especially vulnerable to pest and disease, also droughts (Ilham, et.al.2005, Irawan, 2018). In other side, high dependency on rice as a staple food has several negative effects such as import policy (Widyawati et.al., 2014), one of

them could be a constraint for the development of local food resources which gave implications on less research investment into non-rice-based foods.

Because of this, this research focused on shorgum. Since in Indonesia has conducted relatively little research on this crop and development remain insignificant. Sorghum (Sorghum bicolor L moench) is the world's fifth most important cereal, in terms of both production and areas planted in many semi-arid developed countries in Asia, Africa and America (Nedumaran et al. 2013). Sorghum can be planted in dry climate area and requires less inputs compare with other food crops. It is primarily grown in areas experiencing low rainfall. Most of these areas are unsuitable for the production of other grains unless irrigation is available (FAO and ICRISAT, 1996).

Sorghum can be utilized as food, feed and fuel (bio ethanol) source. As alternative food, Grain sorghum has better protein content (11% per gram) than that of maize or rice (Department of Health, 1992). Some sorghum varieties are rich in antioxidants and all sorghum varieties are gluten free, an alternative for wheat allergy sufferers (Annon 2, 2010). Unfortunately, the lack of commercial market has limited farmer interest in improving the management of this crop. Sorghum utilization is still limited because the post-harvest processing is difficult. Because of that, the study aimed to explore the sustainability of sorghum as alternative food.

2. Material and Method

Study area

Demak Regency is the one of sorghum areas in Central Java (Agriculture Agency of Central Java, 2015). As one of the sorghum-producing areas, the use of sorghum as an alternative food, in Demak is very limited. Sorghum growing areas in the District of Demak reach the area 70 ha (Statistic Bureau of Demak, 2014). Although well-adapted to Demak climate and soils, grain sorghum is a minor crop in the area. In fact, in recent years there is a trend of planting sorghum area tends to decrease. At this time, sorghum is cultivated only in one village that is Raji Village.

Demak precissely located on coordinate between 60 43'26'' to 70 09'43'' South Latitude and between 110027'58'' to 1100 48'4'' East Longitude. Administratively wide of Demak Regency are 89,743 ha, consist of 14 districts, 243 urban villages and 6 villages. As agrarian area which most of settle of living by agriculture, most of Demak Regency region consist of Wet Land wide 51.558 ha (57,45 percent), and rest are dry Land. The total population in Demak Regency was counted 1.106.328 people consist of 548.310 male (49.55 percent) and 558.133 female (50.45 percent). Research location was selected purposively in Raji Village Demak Regency that is the sole area that still cultivate sorghum. The study was conducted over three months from March to June 2015.

Farmer Interviews

Respondents are farmers who grow sorghum on their own/rented land. Information on farmers' perspectives was obtained through semi-structured and open-ended interviews. Total number of farmer households in this area were 620 families, 10 % for sampling are 62 farmer households. Sampling was done purposively with consideration that the conditions and farming activities were carried out by farmers in the study area were relatively equal or homogeneous (Nazir, 1988). Data collection techniques were implemented by survey method which is collect information directly from respondent through interviews using structured questions in the questionnaire. Secondary data collected from various sources/ literature, research reference, Central Bureau of Statistics, Department of Agriculture and other relevant agencies.

Data Analysis

The descriptive statistics employed includes frequencies and percentages ratios processing by SPSS 20. This was used to analyze the characteristics of the farmer as well as the constraints associated with sorghum production and other prospect of sorghum as food alternatif. Gross margin analysis is by definition the different between the gross farm income and total variable cost (Suratiyah, 2008). Normally, gross margin analysis is used to test the effects of changes that do not alter the fixed cost of production, especially the cost of land and other durable factors. It is used to determine the potential profitability and effect on farmer's farm income. It has the advantage of being simple as well as useful in the analysis of the profitability of small farms that have small fixed costs (Sams, 2009).

The gross margin analysis was estimated from costs and returns in sorghum production. Gross Margin model is expressed as follows:

GM = TR – TVC

Where:

TR = Total revenue or total value of output from the sorghum enterprise (Rp/ha). It is the product of average output per hectare multiplied by the market price. The price used was open market price of the year 2014.

TVC = Total variable cost or the costs that are specific in producing (sorghum) output (Rp/ha). TVC varies according to output and are incurred on variable inputs. This includes cost of inputs like seeds, fertilizer, and harvesting, processing, labor cost (hired/family). seeds, fertilizer, and harvesting, processing, labor cost (hired/family).

Efficiency ratio

$$BCR = \frac{\text{Discounted gross benefit}}{\text{Discounted total cost}}$$ (Gittinger, 1986)

If the value of the B / C ratio > 1 the business is eligible to run, meanwhile if the value of the B / C ratio < 1, the project is not viable

Linkert scala used to measure farmer perception about sorghum as alternative food and the obstacles. A Likert scale is a psychometric scale commonly used in questionnaires, and is the most widely used scale in survey research. In this research, the format of a typical five-level Likert item is: 1. Strongly disagree 2. Disagree 3. Neither agree nor disagree 4. Agree 5. Strongly agree (Javaras, 2004).

3. Results and Discussion

Social Economic Characteristics

Farmer resources have a crucial role in the sustainability of farming. Farmers who are productive, educated and supported by the good technology adoption will be success to manage their farm. In this research, data presented are primary data that derived from survey in 62 farmer household. The results of the social economic characteristics are presented in the picture below.

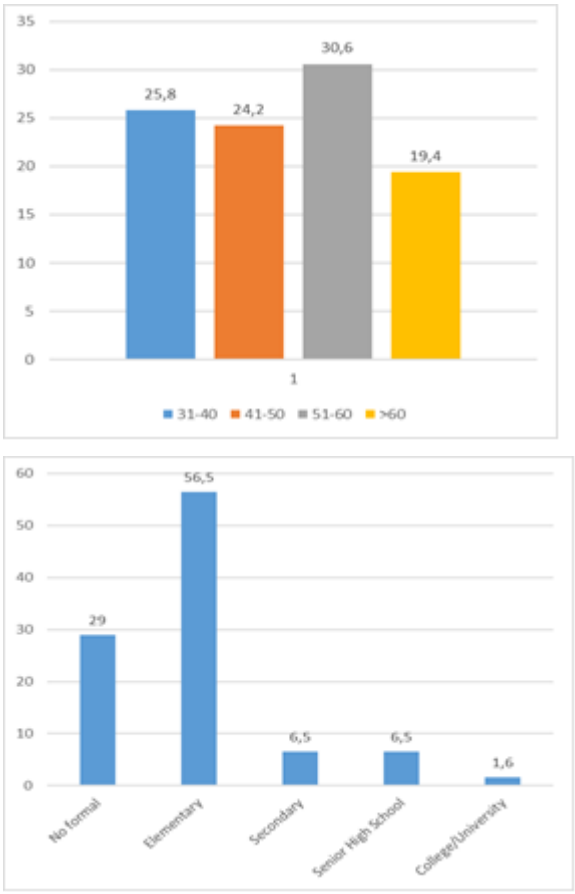

Figure 1. Age and Education of Respondent

Farmer's age spread evenly, but the average of farmers were more than 30 years old, none farmers below 30 years old. It's indicate the decreasing number of younger generations. The average age of farmers are in the productive age between 30-60 years. The highest is in the range of 51-60 years i.e. 30.6 % and the lowest is non productive age > 60, there are 19.4 %. Most of respondent's education were elementery school (56,5%). While 29% of respondents education were non formal education. 6,5% of respondents education were secondary and senior high school. And the rest (1,6%) were college/university. The fact showed that 40 % of the population in Raji village work as migrant workers (Figure 1).

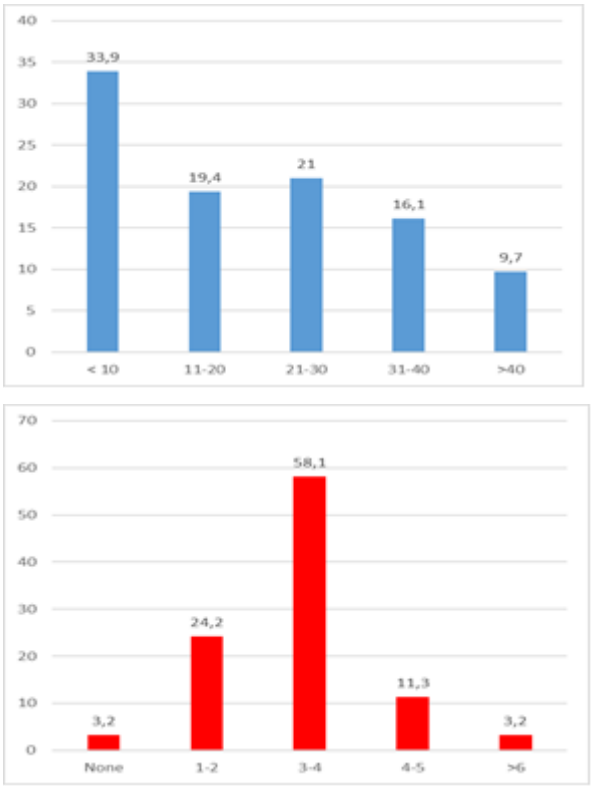

Figure 2. Left: Farming Experience (year), Right: Number of Dependence (person)

Most of respondents (33,9%) had less than 10 year farming experience, more than 21% of responden had 21-30 year experience in farming, 19,4% of respondent had 11-20 year farming experiece, 16,1% respondent had 31-40 years farming experience and the rest had more than 40 year farming experience. In line with the age of the farmer, the longer the experience of farming the less percentage of respondents. The highest distribution of respondents <10 years (33%), and the average experience of farming in the range of 11-40 years (Graphic 2). Respondent's number of dependence shows that 58,1% of respondent had 3-4 person in their household, 24,2% respondent had 1-2 person, 11,3% respondent had 4-5 person, and the rest had each 3,2%. Generally, the farmer respondents between the ages of 30-50 years have 3-4 dependent, while therespondents who over 50 years old have the number of dependents smaller, because their children already have their own income. The number of dependent in productive ages give an advantage for farmers as a source of labor.

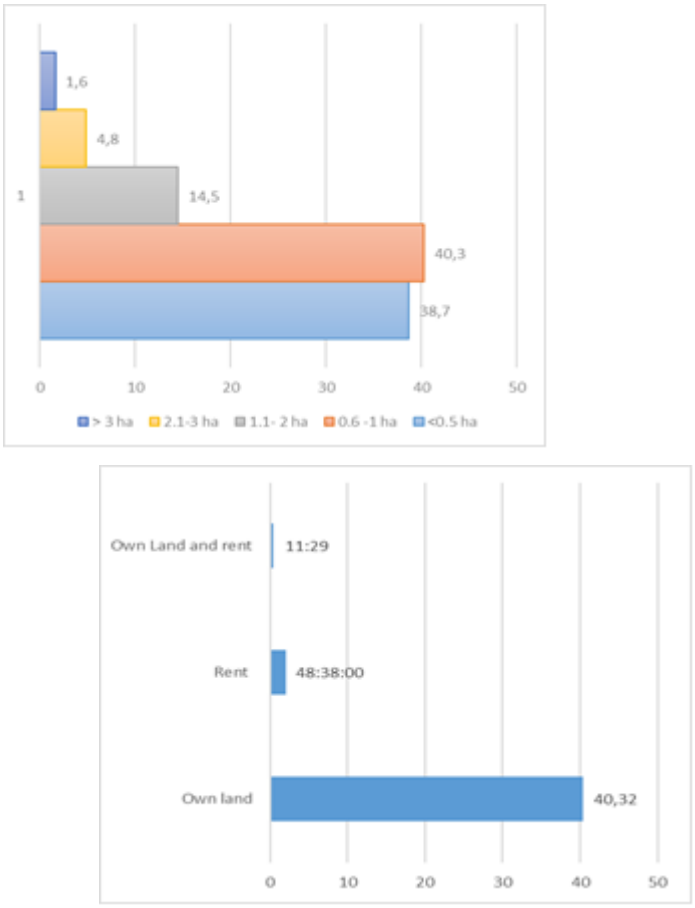

Figure 3. Left: Farmer land Area (ha), right Ownership (person)

Most of the respondents farmed in an area of 0,6 – 1 ha, ie by 40,3%. While 38,7% of respondents farmed in an area of less than 0.5 ha. 14.5% of the respondents farmed on an area of 1.1 - 2 ha. Land area becomes a crucial factor in agricultural production, the smaller land area, the smaller income. Overall, the size of paddy fields in Raji Village approximately 276 hectares consisting of 127 ha of tecnical irrigation, 76 ha 1/2 technical irrigation and 73 ha of rain fed land. Sorghum is usually cultivated in rain fed areas. Based on the survey results, the average area of land ownership were less than 1 ha (79%) and the rest were between 1-3 ha. Most area were the rental status which reached 48.38%.

Economic Viability

Revenue is the result of the cooperation of production factors of land, labor, capital, and management. Literally income can be defined as the remainder of the reduction in value of revenues generated by the costs incurred. To measure the success of farming can be done by analyzing farm

income, by doing this analysis can be seen farming picture at this time so it can do the evaluation for the planning of farming activities in the future.

To determine whether the sorghum farming a profitable analyzed BCR (Benefit Cost Ratio). B / C ratio is a measure that indicates the ratio between the value of Net Income (Benefit = B) and Total Cost (Cost = C). Within the limits of the amount of the B / C to know whether an attempt favorable or favorable (Gittinger,1986).

An attempt if the value of the net B / C ratio> 1, then the business is eligible to run, while the value of the net B / C ratio <1, then the project is not viable (Suratiyah, 2009). Based on the results of the calculation of the value of BCR is 1,79. BCR value > 1 means the farming of sorghum feasible taking into account the fixed ratio was still well worth the effort.

Seed is that independently cultivated by sorghum farmers in the village of Raji, in a hectare of land needed seeds ranged between 5-6 kg. The average of farmers stored seeds for the next planting needs. Seed saving is placed in sealed plastic bottles and still have the growing power in good conditions even without any treatment.

Table 1. Sorghum Economy Analysis per Hectare in Raji Village Demak

Description		Volume	Unit	Price/ Unit(Rp)	Total (Rp)
Production		4.020	Kg	3.663	14.726.600
Production Cost					8.225.000
1	Seed	15	Kg	10.000	150.000
2	Fertilizer				
	a. UREA	3	Kw	90.000	270.000
	b. TSP	3	Kw	110.000	330.000
	c. Ponska	3	Kw	115.000	345.000
3	Pesticide	2	Bottle	90.000	180.000
4	Labor Cost				
	Tillage	8	DPW	50.000	400.000
	Cultivation	10	DPW	50.000	500.000
	Fertilization	3	DPW	50.000	150.000
	Maintenance	3	DPW	50.000	150.000
	Harvest	15	DPW	50.000	750.000
	Post harvest	20	DPW	50.000	1.000.000
5	Land Rental				4.000.000

6	Others	500.000
7	Revenue	6.000.000

Source: Primary data processed, 2015

Conditions and Problems of Sorghum Development

Based on analysis of the feasibility of farming from the previous research, sorghum is feasible to grow by farmers in the Raji Village Demak. However, there is a decreasing tendency in acreage of sorghum in Demak during the past 10 years (2005 -2014). In 2005, production reached 1,619 tons and in 2014 only 404 tons or decreased 75%, which means a lot of sorghum farmers switch to cultivate other profitable commodities.

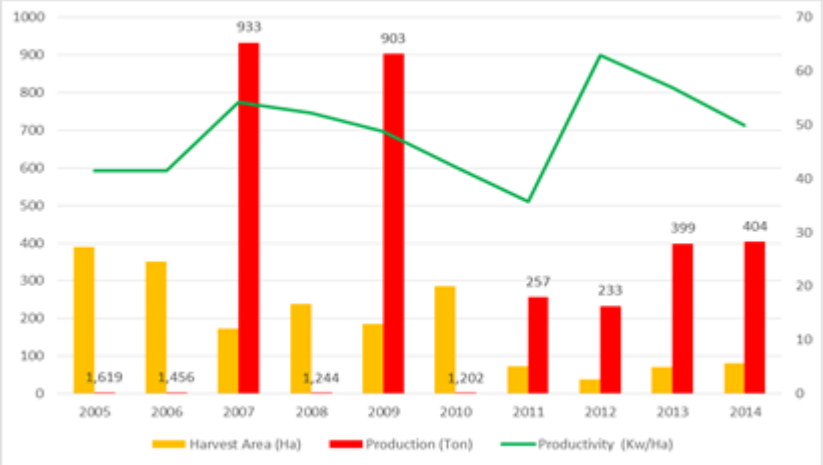

Figure 4. Harvest area, Production and Productivity (2004-2014)

Viewed from the side of the application of technology, most farmer have good agricultural practiced, sorghum productivity on average over the last 10 years 48 kw / ha, the average lowest productivity in 2011 is 35.69 kw / ha and the highest in 2012 amounted to 62.97 kw / ha. High yielding varieties of sorghum were released during the period 1970-2012 have a productivity of between 2.6 to 6 tons (Subagio and Aqil, 2013).

According to the House (1985), Sorghum has higher yield potency compared with rice and wheat. When soil moisture is not a limiting factor, the results of sorghum can reach 11 t / ha with an average of 7-9 t / ha. In areas with minimal irrigation, the average results of sorghum 3-4 t / ha.

The problem is an obstacle in the development of sorghum in Demak is the fluctuating price. During the last five years (2010 - 2014), the average price of sorghum in the lowest level around Rp. 2000, - and the highest Rp 3.500, -. This condition also caused traders collectors in this area is limited, so the price is controlled by the trader. Meanwhile, if the price in this year goes down then the next

year the sorghum is going down anyway, and if the price of sorghum high then next year will increase anyway.

Increasing and decreasing of the sorghum areas may be are affected by the seasons. In this area, planting season is divided to 3 times, in planting season I and 2, most farmer grow paddy and planting 3 palawija (such as soybean, corn, sorghum). Environmental constraints the main reason for choosing sorghum or other commodity for all households. The number of varieties a household plants also varies with changing growing conditions, especially rainfall. When the time of planting is still a lot of rain, the farmers will move to other commodities such as green beans or soybeans, meanwhile if it is comes in poor rainfall, the potential of sorghum land increased.

Currently, the use of sorghum is very limited because even though in the past local people consume sorghum as food but now people switch to practice food that is easy to access and easy to process, such as instant foods rice or noodles. As an alternative food, sorghum require post-harvest process that more difficult than other commodities and no processing equipment available in there, so most farmers sold sorghum yield as raw material only. Although the Raji village is the center of sorghum but no sorghum processing company in their area.

However, our study confirms others that show farmers prefer long-cycle varieties for their superior taste and yield, and grow them when rain and resources permit. It seems important, therefore to improve both long- and short-cycle FVs, and to help farmers to improve their ability to make choices that optimize production, such as increasing availability of plows and weather forecasts. In other words, crop improvement programs need to specificaly target farmer's growing environments, and to use local germplasm as the basis for this (Ceccarelli and Grando, 2002)

Efforts to improve the welfare of farmers is also one of the obstacles in the development of sorghum, especially in Demak. The Agricultural Agency of Demak Regency during the last 5 years has been no policy to support the development of sorghum. During this time, stimulant assistance for the development of sorghum coming from Province Government funding. While the policy in Demak Regency Government is to support increased self-sufficiency in rice, corn and soybeans from 2015-2017. This condition is explanatory in the development of sorghum in Demak Regency that is constrained by policies that do not provide positive support for the management of on-farm and of the farm.

Staple Food Consumption Patterns of the Farmers

The research results states 100% of respondents consume rice as main staple food. In fulfilling the basic food needs, farmers set aside part of the rice harvest in the second planting period for daily

food needs. As for sorghum, farmers generally save for seed needs in the next planting season and the rest sold to collectors.

Table 2. Staple Food Consumption Patterns of the Farmers

Staple Foods	Frequency	Persentage
Rice	62	100
Maize	0	0
Tubers	0	0
Other Commodities	0	0
Amount	62	100

Source: Primary data processed, 2015

Sorghum as local community in Raji Village in particular named it “cantel” and of some people call it "wheat", in fact on the past local people have consumed sorghum. But now there is a shift in the pattern of food consumption where since the ease of food, especially rice, people have started to rarely consume it.

Less than 10% of the respondents who currently still consume sorghum, not primarily as staple food but food interlude. Although the average of sorghum farmers set aside a small portion of their crops, it is generally used for the needs of sorghum seed not for consumption purposes. From the results of in-depth interviews, it is known that the lack of motivation of farmers in consuming because of the process of sorghum became a difficult and troublesome food. Mainly difficulties in polishing or making 'rice' sorghum. This condition is also caused by a shift in consumer tastes that prioritize flavors and practicality.

According to respondents who still consume sorghum as a food interlude, sorghum is usually processed into dodol. Sorghum consumed is what farmers call a "natural sorghum". It is a local varieties of sorghum that has long been developed, it has brown colour. Other types of sorghum that are also consumed are cream-colored (Numbu varieties).

Currently natural sorghum is much sought after, primarily used for health therapy. As for the type of white sorghum (UPCS varieties), less good to eat. According to Suarni (2009), sorghum varieties with rich seed varieties are rich in antioxidants and Fe minerals, in addition to containing dietary fiber, essential amino acids, oligosaccharides, β-glucans, including non-starchpolysaccharide carbohydrate components (NSP), so potential as a functional food source . The uniqueness of sorghum is the presence of tannins and pitic acid that controversy between negative impact and positive impact on health. The antioxidant properties of tannins are higher than those of vitamin E and C. Antioxidants of sorghum anthocyanins are more stable.

Farmer's Perception about Sorghum as an Alternative Food

To understand how farmers perspective to consume sorghum as alternative food, we used a linkert scala to measure potency and obstacle (Table 1 and Table 2). As can be seen on the table, totally farmer strongly support sorghum as food alternative, with linkert score 86 %. There are five statements, the first, slighty below of 50 percent that respondents agree that shorgum can be consume as carbohydrat source. In the past, farmers in that area had experience to consume shorgum when rice availibility was scarcity. While the current condition, the availability of rice is abundant and the price of rice is affordable that most farmers consume rice as staple food. Many farmers believe that sorghum has a high protein content, according data there are 45 % of farmer, meanwhile 27% of farmers neutral as well as the rest is disegree. There are image that sorghum as feed become less potencial food. But on the contrary, nowadays research of sorghum development as functional food make it as interesting research substance. Many researchers dig functional food componen base on sorghum. In Raji village, many farmers planted sorghum in drought season because sorghum more adaptable than any other crops. Even though in the last decades, farmers tend to chose more provitable commodity. Some farmers still preserve to consume sorghum eventhough not daily consume because sorghum has a unique taste, also can be processed into various types of processed foods. Efforts to develop sorghum as alternative food had been done as in 2013, had been socialized and training the development of sorghum as an alternative food by the Ministry of agriculture with the Central Java Provincial Office. Several respondents also participated in the training, among other things, making various processed foods based on sorghum. However, the information related to the utilization of sorghum as an alternative food that is represented by some members of the farmer's group was also still limited.

Table 3. Farmer Perception about Sorghum as Alternative Food

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Can be consumed as a source of carbohydrates	5	22	5	30	
sorghum has a high protein content		17	17	18	10
Has been cultivated and consumed for generations			40	10	12
Sorghum has a good taste		22	10	12	18
Sorghum can be processed into various types of processed foods		5	5	36	16
Total	5	66	77	106	56
Total Score	5	132	231	424	280
∑ score			1072		
Percentage			86		

Explanation: strongly disegree: 0-20, disegree 20,1-40, neutral = 40,1-60, disegree 60,1-80, strongly agree 80,1-100

Source: Primary data processed, 2017

Farmer's Perceptin about Sorghum's Obstacle as an Alternative Food

Even though, most farmer believe sorghum can be consume as alternative food. Farmers strongly agree that there are some obstacles to consume sorghum, such as constraint in processing procedure and unavailability of processing equipment. Sorghum utilization is still limited because the post-harvest processing is difficult. Tannin content is quite high, reaching 0,40−3,60% (Suarni 2009, Rooney and Sullines 1977). According to Suarni (2009), sorghum can be used as traditional or industrial processed foods. The weakness of sorghum is the presence of tannins in the aleuron, which is antinutrition and gives a sense of bitter on processed products. In the process of milling, the tannin concentration can be reduced / eliminated but some of the nutrients will be lost. Furthermore, today people more easily to find other sources of carbohydrate like rice, maize, potato, sweet potato, cassava, etc or other instant food such as instant noodle.

Table 4. Farmer Perception about Obstacle Sorghum as Alternative Food

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Constraint in processing procedure	5	13	12	27	5
Unavailability of processing equipment			5	27	30
Easily to find other sources of carbohydrate				12	50
Total	5	13	17	66	85
Total Score	5	26	51	264	425
∑ score			771		
Percentage			83		

Source: Primary data processed, 2017

4. Conclusion

As alternative food sorghum has good future and sustain in economic, environment and social side. In economic side, sorghum is quite feasible, eventhough, there are no price certainty or guarantee from government, so that a lot of sorghum farmers switch to cultivate other profitable commodities. In enviroment side, sorghum is adaptable in drought condition and pest attact. In social side, cultivated sorghum is a culture.

Farmer has strongly support sorghum as alternative food, base on it's benefit and function. Meanwhile farmer has high level of obstacle in processing procedure, unavailibity eguipment of processing and people more easily access other sources of carbohydrate.

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