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Sorghum Cultivation, Production and Utilization at Kupang District of Nusa Tenggara Timur, Indonesia

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Abstract

Sorghum bicolor that includes in the family Poaceae has very high potency to support the national program of staple food diversification and bioenergy in Indonesia. Sorghum has been cultivated for a long time ago, especially in Nusa Tenggara Timur (NTT) province. In Indonesia, sorghum is not explicitly mentioned as part or priority of national staple food officially. Since 2005 - 2011, the production and productivity of sorghum in Indonesia increased, however the sorghum harvest area decreased. Program of sorghum development has been conducted by State-Owned Enterprise Indonesia (BUMN) during and after that period, including at Kupang, NTT. The aim of the study was to find out sorghum cultivation areas, productions, cultivation system and utilization at Kupang district. Literature studies, data collections from 2005, surveys, interviews and discussions with the farmer groups, women groups and staff of local government have also been conducted in 2016. Sorghum was cultivated at 1 district until 21 districts per year in Kupang regency during 2005 until 2015, with total harvested area of 3 ha - 1874 ha and production in between 3 ton – 1499 ton per year. Productivity of sorghum plants at Kupang was still low namely in between 0.55 ton – 1.10 ton per ha.

Keywords: Sorghum, Kupang, Nusa Tenggara Timur, Production, Harvest Areas, Productivity

1. Introduction

Sorghum bicolor (Moench) and 31 other species of *Sorghum* are the member of Poaceae plant family [1], [2]. [3]. The species is originated to Africa and has been distributed all over the world [2]. Since its domestication, sorghum has spread throughout many agricultural areas of Africa and Asia from India to Indonesia [4].

Sorghum plants could be used for many purposes, the grain is utilized for human food, i.e. sorghum rice, bread, porridge gruel, beer, pop sorghum, various cake and noodle. Sorghum stem and foliage are used for green chop, hay, silage and pasture. The stem of sorghum could be used for bioindustry, such as bioenergy (biopellet and bioethanol), biomaterial (particle board, broom) and for substitute of sugarcane/sweet sorghum (MSG and sugar), as well as seed industry [2], [5], [1], [6].

In Indonesia, sorghum has been cultivated in some provinces including Lampung of Sumatra, West Java, Central Java, East Java, South Sulawesi, Southeast Sulawesi, West Nusa Tenggara Barat (NTB) and Nusa Tenggara Timur (NTT) [7]. Farmers have cultivated sorghum mostly for food source using monoculture, intercropping and overlapping shifts system [7]. Before 1970, sorghum cultivation was conducted due to food

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insecurity and to fulfill the need of people food. In accordance to self food sufficiency program of the Indonesian government, the priority of staple food was mostly for rice. This caused the reduction of Sorghum cultivation areas, and then changed to paddy, corn and soybean [7].

Since 2012, the areas of sorghum cultivation center has been changed from Java to Sulawesi and Nusa Tenggara. The change was due to the availability of more marginal land for sorghum cultivation, opportunity to integrate with husbandry and the need of raw material for industry and also due to competition of agricultural commodities. In Sulawesi island, sorghum was developed at the regencies of Bone, Luwu Timur, Sidenreng Rappang and South Konawe; whereas in NTT province, sorghum was developed at areas of Lembata, Flores Timur, Ngada, Alor, Ende, Nagekeo, Rote Ndao, Sikka, Timor Tengah Selatan, Manggarai, Timor Tengah Utara, Belu, Sumba Barat Daya, Kupang and Sumba Timur. Whereas in NTB province, sorghum was developed at areas of Dompu, Bima and Sumbawa [7]. In Indonesia, sorghum officially become the priority of food source cultivation only in Rote Ndao and Sumba regencies of NTT [8], and not explicitly mentioned as part or priority of national staple food officially [9].

Kupang Regency of NTT is located at the southeast part of Indonesia, that comprised of 24 districts with total area of 5.431,23 km². Kupang included to the dry area or D4 and E4 types of L.R. Oldeman classification. It means only limited rainy season namely 3 months. The condition influences the agriculture sector at the region, where 3 % of the area is dry paddy field and 97% of the area is dry land as yard or moorland [10]. Sorghum plants has become second priority of food crops after corn at marinal land of NTT. There were already 14 districts at NTT has used sorghum plants also for livestock feeding, including Kupang, East Sumba and Belu districts [7]. Since Kupang is one regency of NTT Province as source of sorghum plants and also included as the development area of sorghum cultivation during 2012-2014, it is very important to know the sorghum cultivation condition in Kupang district. The aim of the study was to find out sorghum cultivation areas, productions as well as sorghum cultivation system and sorghum utilization by the farmers at Kupang district.

2. Methods

The available data regarding Kupang district, data of sorghum production and distribution areas of its cultivation in Kupang district from 2005 until 2015 were gathered from Statistics Center Bureau (BPS) [14] and also from the district official website and from the literature, except of the year 2013 due to unavailability data. Surveys and interviews with local government, farmer groups and farmers in Kupang, NTT were also conducted in 2016.

3. Result and Discussion

3.1. Production and Distribution Areas of Cultivation

Data of harvested areas, productivity and production of sorghum at Kupang Regency is presented at Figure 1 and data of districts that cultivated sorghum at Kupang

Regency could be seen at Table 1. The data of the year 2013 was not included at the discussion of the paper, due to unavailable data of sorghum cultivation at Kupang regency. The harvested areas and production of sorghum plants from 2005 until 2015 at Kupang regency were in between 3 ha – 1874 ha and in between 3 ton – 1499 ton, respectively (Figure 1 and Table 1). The largest area and highest production of sorghum at Kupang regency occurred in 2008, i.e. 1874 ha and 1,449 ton of sorghum grain, correspondingly. On the other hand, the smallest area and the lowest production of sorghum at Kupang regency was in 2011, i.e. 3 ha and 3 ton of sorghum grain, respectively (Figure 1 and Table 1). For comparison, the data from 2005 until 2011 of total sorghum harvested area in Indonesia were in between 2264 until 3659 ha and production of sorghum were in between 4241 until 7695 ton [8]. From the same data, it is known that the harvested sorghum area in Indonesia decreased, on the other hand the production and productivity increased during the period.

The harvest areas of sorghum in Indonesia from 2005 until 2011 tend to decrease with the average rate of 1,5 % per year, however the productivity and the production of sorghum during those year increased from 6,2 % until 6,5 % [7], [8], [9]. The increase of sorghum harvest area occurred from 2009 until 2011, namely 20 % per year. The development of sorghum area was also supported by Indonesian State Owned Enterprises (BUMN).

As many as 28 districts of Kupang regency areas were cultivated with sorghum plants during 2005-2015 (Table 1). At the year 2008, a new regency was established at East Nusa Tenggara province, and six districts that included at Kupang regency before 2009 were changed into new regency, i.e. Sabu Raijua regency. Those six districts were Raijua, Sabu Barat, Hawu Mehara, Sabu Timur, Sabu Liae and Sabu Tengah. From data at Table 1, sorghum plants were cultivated at those six districts since 2005 until 2008 namely before becoming parts of Sabu Raijua regency. The largest area and highest production of sorghum plants in 2008 were those from Hawu Mehara district, i.e. 1773 ha and 1418 ton (Table 1). Hawu Mehara district included Kupang regency until 2008. This could be the main reason for reducing harvested area and production of sorghum significantly after 2008 in Kupang regency. In 2010, The most number of districts that their areas were cultivated with sorghum plants occurred in 2010, i.e. 21 districts. Total harvested areas in 2010 were in between 1 ha - 9 ha (Table 1). This could be caused by the development of sorghum cultivation program conducted by BUMN in 2010. Actually 14 districts from 21 districts areas have sorghum plants areas in between 1 ha until 4 ha more than the harvested areas (the data is not shown). This might be due to possibly birds pest or other reasons that caused unsuccessful sorghum harvest/production. There were significant reduction of harvested areas in 2011 as compared to planting areas in 2010. In 2011 and 2012 only 1 districts that cultivated sorghum plants (Table 1).

The productivity of sorghum plants in Kupang were in between 0.55 ton – 1.10 ton/ha (Figure 1), this amount was lower as compared to average productivity of sorghum in Indonesia during the period namely in between 1.67 ton until 2.73 ton/ha. According to farmers and leader of farmer groups at Kupang during interview in 2016, sorghum plants were cultivated without tillage farming system, no irrigation system and

also used only very limited or no fertilizer. There were also still different cultivation method in planting sorghum plants, for example plant spacing, fertilizer amount and irrigation system. Bird pest was also reported as caused of the harvesting of sorghum unsuccessful during the period.

Table 1. Districts and their sorghum harvested areas of Kupang Regency that Cultivated Sorghum from 2005-2015

No	District	Year and Harvested Area (ha)									
		2005	2006	2007	2008	2010	2011	2012	2014	2015	
1	Raijua*	240	93	93	-	-	-	-	-	-	
2	Sabu Liae*	323	314	314	21	-	-	-	-	-	
3	Sabu Barat*	-	35	35	76	-	-	-	-	-	
4	Kupang Tengah	-	2	2	-	-	-	-	-	-	
5	Hawu Mehara*	-	-	-	1773	-	-	-	-	-	
6	Amarasi Barat	-	-	-	2	1	-	-	22	22	
7	Amfoang Timur	-	-	-	1	3	-	-	-	-	
8	Semau	-	-	-	-	8	-	-	-	-	
9	Semau Selatan	-	-	-	-	6	-	-	10	10	
10	Kupang Barat	-	-	-	-	5	-	-	-	-	
11	Nekamese	-	-	-	-	7	-	-	-	-	
12	Taebenu	-	-	-	-	9	-	-	85	85	
13	Amarasi	-	-	-	-	1	-	-	-	-	
14	Amarasi Selatan	-	-	-	-	2	-	-	-	-	
15	Amarasi Timur	-	-	-	-	6	-	-	-	-	
16	Amabi Oefeto Timur	-	-	-	-	7	-	-	-	-	
17	Amabi Oefeto	-	-	-	-	4	-	-	10	10	
18	Fatuleu	-	-	-	-	4	-	-	-	-	
19	Fatuleu Barat	-	-	-	-	5	3	-	-	-	
20	Fatuleu Tengah	-	-	-	-	7	-	-	-	-	
21	Takari	-	-	-	-	3	-	-	-	-	
22	Amfoang Selatan	-	-	-	-	2	-	-	-	-	
23	Amfoang Barat Daya	-	-	-	-	6	-	-	-	-	
24	Amfoang Utara	-	-	-	-	4	-	5	3	3	
25	Amfoang Barat Laut	-	-	-	-	7	-	-	-	-	
26	Amfoang Tengah	-	-	-	-	8	-	-	5	5	
27	Kupang Timur	-	-	-	-	-	-	-	1	1	
28	Amfoang Barat Laut	-	-	-	-	-	-	-	-	1	
Total Harvested Area (ha)		563	444	444	1874	105	3	5	134	134	

Notes: * = Districts of Raijua*, Sabu Liae*, Sabu Barat* and Hawu Mehara* were not included at Kupang Regency Areas since 2009, but changed to new Regency, i.e. Sabu Raijua Regency

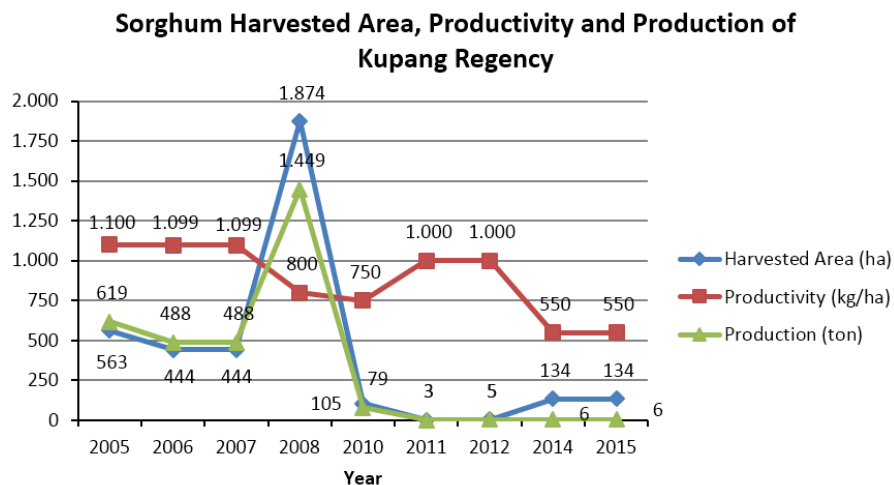


Figure 1. Harvested area, productivity and Production of sorghum plant at Kupang Regency from

2005-2015

3.2. Cultivar

Farmers at Kupang have cultivated sorghum mostly for food source (the grain) and for animal feeding (leaves) using monoculture, intercropping and overlapping shifts system. According to the leader of Division of Agriculture of Kupang Regency, people commonly knows 2 varieties of sorghum, namely white sorghum grain (grains do not covered with husks, thick stem, drought resistant plants, and several birds like to eat the grain), and red sorghum grain (grain covered by husks, lower plants, drought resistant planta, and birds do not like to eat the grain). Other information from Kupang regency office staff mentioned that people of Kupang has cultivated 3 types of sorghum grain, namely white, red and black. In fact, until 2016, Assessment Institut for Agricultural Technology (BPTP) Kupang had collected as many as about 20 accession numbers of local sorghum from East Nusa Tenggara (pers. comm, 2016). Indonesian government has released 13 superior sorghum plant varieties and develop 6 other varieties of sweet sorghum [7].

As many as eleven varieties of sorghum have been released by the government in Indonesia since 1970 until 2012 with potency of production of 6 ton/ha [7]. After the year 2001, Maros Research Institute for Food Crops has conducted research on sorghum plants and has developed sorghum accessions with high potency of ethanol until 4758,32 l/ha beside developed the accessions for high biomass potential (Subagio and Aqil 2013). National Nuclear Energy Agency of Indonesia (BATAN) has also resulted superior variety of sweet sorghum through gamma radiation treatment [7].

The study at 7 districts and 15 villages of NTT has found a total of 53 sorghum accession with various characteristic and different local names. Based on skin colour of the seeds, the accession was grouped into white, light yellow, black, brown and red [11].

3.3. Cultivation System, Uses and Post Harvest

Sorghum is known as drought resistant plant and also resistant to salty media and high Aluminium content [2]. Most of farmers at Kupang cultivated sorghum using no-till farming system. BPTP Kupang was one of government institutions that inform the farmers regarding no tillage farming system in cultivated sorghum. Department of Food Crops and Department of Food Security of Kupang Regency have cultivated red grain sorghum plants near the office using intercropping system with coconut, fruit plants, lontar and legume (lamtoro and cover crops Mucuna).

Information regarding cultivation system and post harvest of sorghum plants from some farmer groups and woman groups regarding sorghum cultivation in Kupang is summaries in this chapter. The farmer group Santa Maria Lores explained that they have cultivated sorghum in 2013 as large as 100 ha for the first time in cooperation with NGO and bishop of the church. The seed were sowed in November during rainy season, and using monoculture system with organic fertilizer addition. The production of sorghum grain at first year reached until 4 ton/ha. However the second year of sorghum cultivation was fail due to birds attacked.

Another farmer group of Tani Suka Maju Group from Manusak village mentioned that in 2012-2013, they started to cultivate red grain sorghum for the first time. Sorghum plants were cultivated in between 100 cm x 100 cm apart, together with other intercropping plants. No fertilizer and irrigation system was applied to the plants. Only rain water was used for irrigated the plants. However the member of the farmer group do not know yet how to cook sorghum grains, most of them were not originally from East Nusa Tenggara.

The farmer group of Tani Manekat of Fatukanutu village explained that they cultivated red grain sorghum plants in January 2016 after getting information from the government office. They have prepared to cultivate sorghum as large as 10 ha area using intercropping system. No fertilizer and irrigation system was applied at sorghum plants with spacing of 40 cm x 40 cm, and no pest attacked the plants at that time. The product of harvest was used for their own food and for seeds stock.

According to the woman groups and the farmer groups at Kupang regency, the uses of sorghum grains was as food source, for examples to be cooked as rice or fried as popcorn. The flour of sorghum grain could also be used as material for making cake or other snacks after being mixed with wheat flour as much as 50 % of composition. However, there were still some farmers did not know how to use or cook sorghum for food sources. In fact, cake or other snacks using sorghum flour were still used for display during the exhibition and very rare to be found at local market. This mean that more technology on post harvest of sorghum plants need to be informed and applied at Kupang regency. Other studies that concluded the same, namely the need on the technology of post harvest sorghum plants by the people/farmers has also occurred at Bandung regency, Bandung city, Cimahi city, and Wonogiri regency [12], [13].

3.4. Challenges

From the results of data on sorghum land and harvest area, productivity, and production at districts of Kupang regency as well as the results of interview with farmer groups and woman groups at Kupang regency, there are some challenges for sorghum plant commodity at Kupang regency as follows:

- a. Farmers need more information on the sorghum cultivation technology including irrigation system, addition of fertilizer, pest and disease control
- b. Farmers and Women need more information on the uses of sorghum plants, post harvest of sorghum grain, and cooking/processing sorghum grain and flour.
- c. There were only limited districts and areas at Kupang regency that cultivated sorghum plants. There will be very potential and beneficial for people when more sorghum areas at Kupang are endeavored.
- d. More cooperation and synergy should be conducted by stakeholders in cultivating sorghum plants, including many sectors such as agriculture, husbandary, industry, and electricity/energy institutions.



4. Conclusion

Sorghum plant was cultivated at 1 district until 21 districts in Kupang regency during 2005 until 2015, with total harvested area of 3 ha until 1874 ha and production in between 3 ton – 1499 ton per year. The split of sorghum production area center from Kupang regency to Sabu Raijua regency caused the reduction of sorghum production at Kupang regency after 2008. The sorghum development program of government affected on the number of districts in cultivated sorghum plants in 2010 or after that. Productivity of sorghum plants at Kupang was still low namely in between 0.55 ton – 1.10 ton per ha. The use of sorghum plant mostly for food source. There were still limited knowledge of postharvest and processed of sorghum grain of the farmers at Kupang regency.

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6. References

- [1]. Berenji J, Dahlberg J, Sikora V, Latkovic D. Origin, history, morphology, production, improvement, and utilization of broomcorn (*Sorghum bicolor* (L.) Moench) in Serbia. *Economic Botany*. 2011; 63 (2): 190-208
- [2]. House LR. A guide to sorghum breeding, 2nd ed. International Crops Research Institute for the Semi-Arid Tropics. Patancheru, India: ICRISAT; 1985
- [3]. Iriany RN, Makkulaku AT. Origin and taxonomy of sorghum plant. In: Sumarno, Damardjati DS, Syam M, Hermanto, editors. Sorghum technology innovation and development. Indonesian Agency for Agriculture Research and Development. Ministry of Agriculture: IAARD Press; 2013
- [4]. De Wet JMJ, Price EG, Plant domestication and indigenous African agriculture. In: Harlan JR, de Wet JMJ, Stemler A, editors. Origin of African plant domestication. The Hague, The Netherlands: Mouton; 1976. p. 453-464
- [5]. Suarni. Potency of corn and sorghum flour as substitute of wheat flour for processed food. *Iptek Tanaman Pangan*. 2009; 4 (2): 181-193
- [6]. Romadhoni AR, Fuada S, Novitasari N, Fatmawati DN, Kristiana YI. Dry sorghum noodle as healthy and nutritious typical food from Lamongan (Innovative bussiness opportunity and economic impact)(in Indonesian). Proceeding of National Seminar on Renewable Food, Feed and Energy, 21-23 October 2014. Yogyakarta; 2014. p. 452-458
- [7]. Subagio H, Aqil M. Development of sorghum production in Indonesia. Proceeding of National Seminar on Agriculture Innovation. BPTP Kalimantan Selatan. 2013; p 199-214
- [8]. Directorate of Cereal Cultivation. The policy of Directorate General of Food Crop in the development of corn, sorghum and wheat commodities. Directorate

- General of Food Crop, Ministry of Agriculture of the Republic of Indonesia, Jakarta; 2013
- [9]. Department of Agriculture and Estate of NTT Province. Condition of Land and harvest area, productivity and production of rice and other food crop production of the year 2011. Department of Agriculture of Kupang, NTT Province. 2012
- [10]. Anonymous. Climate (in Indonesian). Official Website of the Government of Kupang Regency. 2018. Available online from: http://kab-kupang.go.id/kupang2010/2010/?page_id=21
- [11]. Mukkum L, Lalel HJD, Richana N, Pabendon MB, Kleden SR, The diversity of local sorghum (*Sorghum bicolor* L. Moench) in Nusa Tenggara Timur Province. IOP Conf. Series. *Earth and Environmental Science*. 2018; 144 (012065): 1-7
- [12]. Syafruddin M, Harisudin M, Widiyanti E. The Strategy in Developing Sorghum at Wonogiri Regency (in Indonesian). 2015; *SEPA* 12 (1): 70-81
- [13]. Dyahrini W, Gusni. The potency of sorghum as an alternative food of replacing rice at Bandung Raya to increase the wealthness of the society to support national food security (in Indonesian). Proceeding of the concerence on Management and Behavioral Syudy. Taruma University. Jakarta. 2016; p.371-382
- [14]. BPS-Statistics Center Bureau of Kupang Regency. Data of Kupang Regency 2005 until 2015. Statistics Center Bureau of Kupang Regency. 2005 – 2015