Sorghum development for staple food and industrial raw materials in East Nusa Tenggara, Indonesia: A review

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Abstract. East Nusa Tenggara/NTT has been known as one of the poorest provinces in Indonesia which has a dry climate with very low rainfall. Poor food security is partly due to community dependence on rice as a staple food while rice cannot grow well in NTT. These also has an impact on the poor nutritional status of the community, such as the high prevalence of stunting. Sorghum previously was cultivated as a local food however, it had long been abandoned. Fortunately, nowadays sorghum began to consume again by the community. This paper presents the potential and challenges faced in developing sorghum as a staple food and raw material for industry in NTT, especially in East Flores. The data and information was collected from the survey, secondary sources as well as journal and personal communication with sorghum stakeholders. After a long time being forgotten, sorghum has grown back about a decade ago. Various local varieties of sorghum are in NTT and have been identified. The main focus of the development of sorghum is that the community re-consumes sorghum, only a small portion is sold. Likotuden is a complete center for developing sorghum from the supply of seeds, cultivation to processing and marketing of sorghum seeds. The factor of rapid development of sorghum is supported by various parties, including NGOs, local government, central government and universities. The extent of marginal land in NTT, the availability of sorghum superior seeds, the suitability of agro ecology and socio-economic and cultural sorghum with various functional advantages will foster the development of sorghum. Besides, the support of local government programs such as the pajaleso program (corn rice, soybean plus sorghum) sorghum will be foster the development sorghum in NTT. However, some obstacles are still found, among others, the need for agriculture machineries, both pre-harvest for land preparation and planning and post-harvest. In addition, socialization and training also need to be encouraged, especially in areas where other food crops are difficult to grow.

Keywords: Sorghum, NTT, staple food, local varieties, agroindustry

1. Introduction
Sorghum (*Sorghum bicolor* L. Moench) is originated from Africa and become subsistence crop for many farmers. Data from FAO reported that sorghum was ranked at the fifth largest food sources produced in the world, after wheat, rice, corn and barley [1]. Moreover, the largest sorghum producers was USA 12.1 million tons per year, Nigeria 6.9 million tons per year, Sudan 6.4 million tons, and Mexico 5 million tons. However, sorghum production from Indonesia was hardly taken into account. Sorghum has wide range of environmental adaptability mainly to dry lands, like East Nusa Tenggara (NTT) with...
only two months of rainfall period. This province is characterized by low rainfall and prolonged drought, 8–10 months, and a short rainy season (3–4 months). A total of 92.32 percent or about 1.5 million hectares of total agricultural land in NTT is dry land [2]. Sorghum is a dry climate adapted crops, able to produce 2–5 tillers of sorghum clamp with similar size of stem as well as its panicles, 4–5 times ratoon. Meanwhile, a local sorghum variety can be cultivated without fertilizer and yields 3–4 ton per hectare. These are the reason that sorghum is one of the most suitable food crops to be developed in NTT.

In this province, the development of sorghum is very prospective because of its ability to grow in marginal areas, the nutritional value is equivalent to corn, and most importantly, these foods are previously consumed by local residents. However, as in other provinces, the basic food pattern of the NTT community has undergone to shift to consume rice. The dependence of the basic food pattern on rice is feared to cause food insecurity, especially during crop failure. The people of NTT have planted sorghum since 1993/1994 in a small area (26 ha) with productivity reaching 1.5 tons/ha [3].

In addition to conformity with agro-ecology in NTT, sorghum turned out to be very instrumental in supporting the achievement of self-sufficiency in food in NTT. To achieve food independence, sorghum farmers in NTT have also formed the organization of the Sorghum Farmers Association for Food Sovereignty (P2SKP) NTT. Moreover, sorghum has also been programmed as an environmentally friendly commodity because of its cultivation without input of chemical fertilizers and pesticides, reducing the effects of greenhouse gases and combating stunting in children due to its high nutritional content. Stunting is one of the main health problems in this province. Data shows that stunting sufferers in NTT are the highest in Indonesia [4]. For this anti-stunting program sorghum is combined with Moringa leaves as a nutritious commodity that also grows in NTT and has high protein content (solor program: sorghum-kelor). This program works in collaboration with the local health services. Local food program derived from sorghum in Flores island also closely connected with Sustainable Development Goals (SDGs), i.e. goal 1 (No poverty), goal 2 (Zero hunger), goal 3 (Good health and Well-being), goal 12 (Responsible consumption & production), and goal 13 (Climate action) [5].

Besides for achieving food self-sufficiency, sorghum also has developed as raw materials for agroindustri in East Flores. Located at Likotuden village, a complete center for agroindustrial developing sorghum has been established. Activities in this farmer group consist of supply seeds, cultivation, processing and marketing of sorghum seeds. However, some problems still exist in developing sorghum in East Flores such as land management and postharvest handling and processing. This paper presents the potential and challenges faced in developing sorghum as a staple food and raw material for industry in NTT, especially in East Flores.

2. Potential

2.1. Government program

Although sorghum is yet become main staple food source in Indonesia, however some regions have officially regulated sorghum as the priority food source cultivation, such as in Rote Ndao and Sumba regencies of NTT [6], and not explicitly mentioned as part or priority of national staple food officially [7]. The fact also found that sorghum plant has yet publicly known by the people, especially farmers. Among the factors that cause underdeveloped sorghum is that sorghum market is still limited and sorghum cultivated only in specific regions. Moreover, the tendency of some degenerative like diabetic and autism, people search other alternative of food sources and diversifying their consumption. Sorghum as local resource is one of important candidates to process as gluten-free food. Besides, the Food Law (UU No. 12 of 2012) mandates the need for further regulation with Government Regulations for a number of important matters, including diversifying food and improving community nutrition. Based on this mandate, the government then issued Government Regulation Number 17 of 2015 concerning Food and Nutrition Resilience. This Regulation explains that food diversification is an effort to increase diverse food availability and should base on local resource potential [8]. Government program that include sorghum in local food also foster the rapid development of sorghum. Such government programs
such as the pajaleso program (corn rice, soybean plus sorghum) sorghum, will be foster the development sorghum in NTT. Another program is anti-stunting program, sorghum grain is combined with Moringa leaves to improve the nutritional content especially protein content as Solor program (sorghum-kelor).

2.2. Sorghum

Data of sorghum development since reintroduce in 1994 has been increasing sharply. Support from Kehati institute which engaged since 2012 accelerated the development as shown at Table 1. Furthermore, the sorghum development ultimately gained the attention not only from the Ministry of Agriculture through Indonesian Agency for Agricultural Research and Development; Ministry of Villages, Development of Disadvantaged Areas and Transmigration. Other parties like local government and NGO also have program in sorghum plantation. In 2019 planting season, local government allocate budget for 250-hectare area for a sorghum development program in East Flores. Data showed that Indonesian government has released 13 superior sorghum plant varieties with production potential of 6 ton/ha [7]. Moreover, a NGO namely Yaspensel from Larantuka Diocese foundation also have assisted farmer in NTT to cultivate sorghum at several district throughout NTT. During 2018 sorghum area assisted by Yaspensel were 492 ha, spread at several regencies namely: (1). East Flores: 320 ha; (2). Lembata: 40 ha; (3). Sikka: 22 ha; (4). Ende: 52 ha and (5). West Manggarai: 58 Ha [9]. Statistical data showed that area of sorghum development throughout NTT are as follow: Sumba Barat, Sumba Timur, Manggarai, Ngada, Ende, Sikka, Flores Timur, Lembata, Alor, Timor Tengah Utara, Kupang, Belu, Timor Tengah Selatan dan Rote Ndao. In East Flores, the center of sorghum development is located at Likotuden. In this village the sorghum area plantation reach 71 ha.

Table 1. Data of sorghum development by Kehati on 2012–2019.

| No | Year       | Area (Ha) | No. of District | Regency                  |
|----|------------|-----------|----------------|--------------------------|
| 1  | 2012–2013  | 2         | 1              | East Flores              |
| 2  | 2013–2014  | 11        | 2              | East Flores, West Manggarai |
| 3  | 2014–2015  | 60        | 4              | East Flores, West Manggarai |
| 4  | 2015–2016  | 102       | 9              | East Flores, West Manggarai, Ende |
| 5  | 2016–2017  | 120       | 10             | East Flores, West Manggarai, Lembata |
| 6  | 2017–2018  | 150.5     | 11             | East Flores, Manggarai Barat |

Source: Kehati [10]

Since sorghum have been planted in this province since long years ago, sorghum is one type of food crops that has been well adapted and cultivated by the people of NTT. Moreover, NTT has many local varieties of sorghum which have previously been well developed in NTT communities. Local varieties have been defined as variable plant populations adapted to local agro-climatic conditions which are named, selected and maintained by the traditional farmers to meet their social, economic, cultural and ecological needs [11]. Therefore, sorghum has a different local name each region. In East Flores, sorghum is known as watablolo, solo corn, or watuholot, in Sumba, it is called as wataruhemutuji, in Timor known as benwuka or bennina, Rote people call it jagung rote, Ende people call it watar, in Lembata known as watuwolq. The local sorghum in NTT has a high diversity, with 13 collected accessions. These types have distinctive features such as color, shape, and different seed size. The colors of the seeds are white, yellow, brownish red, and black indicated that sorghums are rich in phytochemical compounds that are beneficial to human health. In addition, each type has a panicle that is also different depending on the type of sorghum [12]. Among many varieties of sorghum have different adaptability as mentioned by Benggu n Nguru, [13] that Local sorghum from Belu and Numbu variety were semi or moderate tolerant to salinity while local sorghum from Sabu-Raijua was sensitive.
2.3. Export commodity
Another promising factor that help development sorghum is the previous success experience. During the period of 1950–1960, sorghum production from Indonesia have been exported to Singapore, Hong Kong, Taiwan, Malaysia and Japan as raw material for feed, food and beverage industries [14]. By the rapid development of the plantation in NTT and other provinces the export opportunity in the future is still promising. Besides NTT, some areas that have known as center production of sorghum in Indonesia are Lampung, West Java, Central Java, DI Yogyakarta, East Java, South Sulawesi, Southeast Sulawesi, and West Nusa Tenggara. The rapid development of sorghum will be sustain from the evidence obtained by farmers and other stakeholders that sorghum has good economic value, besides its benefit for food or functional food, feed and energy.

3. Challenge

3.1. Seedling
The main requirement for increasing the productivity of sorghum is the use of seeds quality. According to Subagio and Suryawati [15], availability of sorghum seed both quantity and quality at farm level have not been fulfilled. The three important aspects related to the quality of seeds are (1) correct seed production techniques, (2) techniques to maintain the quality of distributed seeds, and (3) seed quality detection techniques. The use of superior quality seed varieties contributes significantly to phenotypic appearance and yield components of plants [16]. Research showed that farmers in East Nusa Tenggara have not been able to produce superior seeds, unavailable of storage facilities, and markets uncertain of seeds affect the success of farmers or breeders in providing sorghum seed [12]. However, since 2015 IAARD, through Indonesian Cereal Research Institute (ICERI) has conducted research and disseminated sorghum varieties to sorghum farmer in East Flores. The amount of sorghum seed disseminated in 2017–2018 was more than 3200 kg from several varieties such as Numbu, Kuali, Super-1 and Suri, and cultivated at several districts [16]. Moreover, ICERI also teach farmer to become sorghum seed breeder. The sorghum seed to be distributed to farmer was yellow labelled seed, and centralized at Likotuden Village at UB Sorgum.

3.2. Shifting Program
The former program of self-sufficiency which rest on rice several decades ago have lost sorghum crops. The existence of local sorghum began to be replaced by other food crops that have a better economic value such as corn and rice. Fortunately, since a decade ago sorghum grow rapidly. According to Mukkun et al [12], the cropping systems based on sorghum used mainly local varieties which are part of their strategy to reduce the risks in the constraining areas.

3.3. Pre and postharvest treatment
Problems faced in developing sorghum in East Flores are land management, postharvest handling and processing. Rocky and uneven land in NTT causes difficulties in preparing land for cultivation. Problems in postharvest handling related to the structure of sorghum seed with hard shell that need special treatment to process to become rice sorghum, using agriculture device especially thresher and moxerizer to accelerate the process. Another problem is the short life of sorghum seeds because of its susceptibility against fleas attack. According to Pabbage [17] the fleas of Sitophilus sp is the most rapid growing species in sorghum seed during storage, followed by species of Tribolium castaneum as secondary pest. Another problem related to the high tannin content in the seed of sorghum which is around 0.4–0.6 depending on its variety. Processing of sorghum grain and flour to become variety of food especially novel food also a challenge for people in NTT. Familiarisation and technical assistance of sorghum-based diversification should continue to be carried out especially for farmer women.
3.4. Sorghum management

In the field, farmers still need more assistance and information on the sorghum cultivation technology including irrigation system, addition of fertilizer, pest and disease control. Moreover, cooperation and synergy should be conducted by stakeholders in cultivating sorghum plants, including many sectors such as agriculture, husbandry, industry, and electricity/energy institutions [18]. Study of sorghum development in Africa reported that the most important sorghum production constraints were bird damage, parasitic weeds, drought stress and postharvest insect pests. The traits of sorghum varieties preferred by farmers were good taste, high yield, resistance to bird damage, insect pests (weevils), and diseases, early maturity and drought tolerance. The farmers also needed better sorghum varieties to increase production and to reduce pre and post-harvest losses [19]. Adoption of new varieties also another challenged to be faced. Several factors affecting the adoption of improved varieties sorghum di Tanzania were as follow: demonstrating the superiority of improved sorghum varieties will have a more effective outcome when applied to households with limited networks. Learning by doing or learning from other peers and public policies such as targeted input subsidies will have a high impact. Classroom training and demonstration plots can end information asymmetry and increase the knowledge threshold, which will jump-start and scale-up the adoption process [20]. The participation of young farmer is very important factor to fasten and sustain the sorghum development in NTT. Evidence suggests that young farmers in NTT, especially at Adonara island, East Flores since 2016 started to grow sorghum and the plantation area growing well. The resources and knowledge from media are increasingly help in adopting improved sorghum varieties [20].

4. Prospect of sorghum agroindustrial development

Prospect of sorghum development in East Flores and NTT is quite promising. A complete center for developing sorghum has been established at Likotuden village. Likotuden is known as a village of sorghum and is a well-known center for developing sorghum. This village is located about one hour from Larantuka city. In this place, UB Sorghum is managed by the community with members of sorghum farmers and has production house facilities with various sorghum processing machines, such as threshing machines, social machines, sweet sorghum juice press machines, chopper machines, and packing machines. Other factor prospering sorghum development are as follows:

- The focus of the development of sorghum is that people want to go back to consuming sorghum as a staple food. Farmers are encouraged to plant and maintain local plants as a source of food. Nowadays, people in East Nusa Tenggara are getting used to and familiar with sorghum being consumed as staple food, hence, they are no longer depended upon rice anymore.
- Continuing the campaign to consume local food as has been done in Likotuden through the provision of sorghum intake as additional nutrition for children under five. Local food consumption campaigns will also target school children and adults.
- The product of sorghum from Likotuden has a fixed market in Bali, Jakarta, Surabaya, even from abroad. The development of sorghum in addition to substituting rice is also intended to replace flour. There are already many types food products made from sorghum flour. Local processed food products have been sold at their showroom at Larantuka city and are expected to be typical souvenirs for tourist visited Flores. According to Widowati [21] the diversification of sorghum consumption in the form of various sorghum-based products (sorghum rice) and sorghum flour and sorghum processed products are expected to increase food availability, then can increase food security while anticipating food insecurity.

5. Summary

The sorghum development in East Flores increase food security, create a healthy society, improving nutrition and overcoming stunting. Besides, promoting the fact that sorghum is nourishing and that with a healthy community, the economy will improve and the community welfare will be achieved.
Successful elements of governments supported research is comprehensiveness of the government programs, collaboration among stakeholders as well as research activities including characterization of physico-chemistry of several varieties of local sorghum and its development for staple foods, processing technology for sorghum for food and liquid sugar, integrated agribusiness model for sorghum, development of planting equipment and postharvest handling machinery as well as processing.

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