Introduction of superior grasses as a part of regional partnership program to support livestock productivity in Bontoharu District within Selayar Island Regency, South Sulawesi, Indonesia

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Abstract

This paper describes all various attempts conducted as implementations to a community service program delivered to a group of local beef cattle farmers in a Bontoharu District, Selayar Island Regency, Indonesia. The main aim of the program was to support local farmers in improving their knowledge and capability in developing appropriate pastoral grasslands. To execute such a program, nonnative superior tropical grasses and legume were introduced here. The introduced plants for this purpose were comprise of seven grass types and one legume ***i.e.*** *elephant grass (Pennisetum purpureum), mini elephant grass (Pennisetum purpureum Schumach), Bengal grass (Panicum maximum), setaria grass (Setaria sphacelata), Australian grass (Brachiaria dilatatum), signal grass (Brachiaria decumbens), brachiaria grass (Brachiaria brizantha) and as many as 200 stems and 500 seeds of Indigofera (Indigofera sp.). As the Regency agricultural statistics in 2016 recorded that there was more than 25% of total beef cattle population reared in the area, whereas respective famers appeared to have a very limited access to any sources of quality forages there. This showed to be one of the main obstacles for the development of livestock industry within Selayar island regency. Moreover, based on statistics in 2016, the regency has a total of 3,159 hectares (Ha) marginal land unutilized, and nearly ten percent of that land type is located in Bontoharu district. In this district, such type of land had been partially utilized for traditional coconut plantations so far. Even though this plantation produced 50% of the total estate crop products in the regency, any possibility in developing vast areas of fertile soil underneath the plantation into integrated grasslands appeared to have never been explored. This may also indicate a lack of knowledge among the farmers in the area. In line with those most required technical supports for improvement, a counseling and discussion group consisting of 30 farmers was established to facilitate all technology transfers to them. Furthermore, related trainings to those farmers had been carried out by both academic staff and extension officers from the Field Agriculture Extension Services. A preliminary assessment on the livestock farming community acceptance to the implementation showed that they have been responding well and very enthusiastic to participate in this ongoing program.*

Introduction

Selayar Island Regency, South Sulawesi Province, Indonesia, encompasses 11 districts namely Pasimarannu, Pasilambena, Pasimasunggu, Taka Bonerate, East Pasimasunggu, Bontosikuyu,

Bontoharu, Benteng, Bontomanai, Bontomatene and Buki. Geographically the regency comprises of archipelagos totaling a land area of 10,504 km² and the rest is oceans. Bontoharu district is located directly adjacent to Benteng, which is administratively designated as the Capital city of the regency. The distance from Benteng to Bontoharu District is approximately 20 km, which is about a 15-minute drive either by car or motorbike.

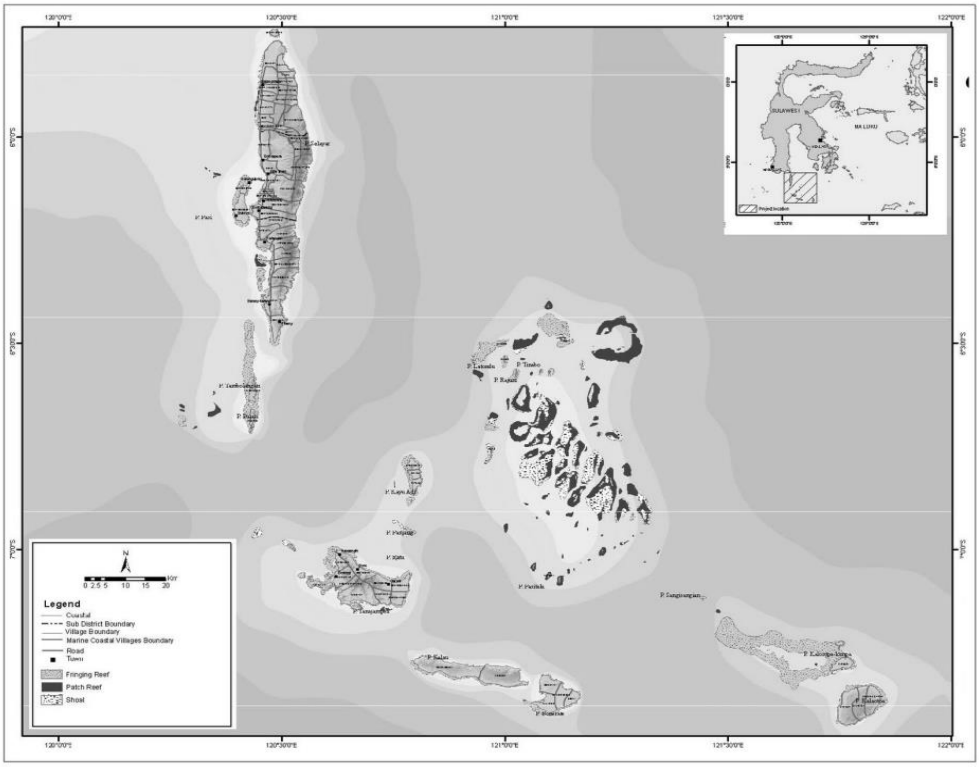

Figure 1. A phisical map of Selayar Island Regency, Adopted from Blog 0399 - Internet Clipping of Selayar Islands Regency (Kliping Internet Kabupaten Kepulauan Selayar), South Sulawesi Province, Indonesia.

Bontoharu district is administratively divided into eight villages, namely, Bontobangun, Putabangun, Bontolebang, Bontosunggu, Kahu-Kahu, Bontobarusu, and Bontotangnga village. Bontobangun village is the village that is located closest to the Arupala airport which is the most developed village compared to the surrounding one. The total area of Bontoharu district is 129.75 km² with a population of 12,959 people with an average population density of 101 people per km². The population in these two villages is 70% working in the agricultural sector with Gross Regional Domestic Product (GRDP) 233,858.37 million rupiah with a percentage of 1.09% of the GRDP of South Sulawesi. The regional poverty rate is quite high, as in 2005 was recorded as 22.71%; whereas slightly decreased in 2009 to 17.15% with an unemployment rate reaching 8.37%. There is, however, interesting to note that there had been no committed crime recorded in the area so far (close to a status of zero crime) (BPS, 2014; RKPD Selayar District, 2016).

Based on rainfall records in one of meteorological Stations in the regency, in Benteng, the average number of rainy days per month is around 10 days with 150 mm of average rainfall per month. Nearly all areas in the regency are relatively wet all year around, as a dry season has been mostly limited in the months of August and September. The topography conditions of Selayar Island Regency proved to be varied, as some are relatively flat; whereas some others are sloping. The elevation can only reach to as high as 607 meters above sea level, where the highest peak is located in Bontosikuyu District. Deforestation and degradation of land bio-covering seemed to have caused a

negative effect on the underground water reserve as has been estimated decreasing when measured primarily based on a total annual rainfall from November 2012 to December 2013 in Bua-bua and Parappa river basin (Gauk, *et al*., 2015)

Based on data reported in 2016 Agricultural Statistics in Selayar Island Regency by the Central Statistics Agency, livestock populations in eleven sub-districts have mainly been represented by beef cattle (16,756), goats (80,831), buffaloes (4,588), horses (3,766), native chickens (272,371), improved breed broiler chickens (8,732), improved breed layer chickens (11,613) and Muscovy ducks (5,692). These all appeared to be distributed almost evenly amongst sub-district areas, even though a beef cattle population in Bontoharu District was shown to be the highest (28.4%) out of the total beef cattle population in the whole regency. This figure seems to be promising for further development of livestock industry in the regency. However, local beef cattle farmers there appeared to have been hindered not only by their accessibility to available forage sources, but by a limitation in availability of good quality pastoral grasses and legumes as well.

Data on land use classifications for agricultural activities, which were published in a 2016 Report on Agricultural Statistics in Selayar Islands Regency by the Central Statistics Agency, summarized that matter into five main categories ***i.e.*** 1) traditionally irrigated wet land (paddy field) covering 1,464 Ha., 2) rainfall-dependent wet land (2,108 Ha), 3) temporarily utilized dry-land (5,156 Ha), 4) in the area unirrigated dry land mainly utilized for seasonal crops (5,820 Ha) and 5) marginal land (uncultivated land fields) totaling 3,159 Ha. In Bontoharu District alone is uncultivated marginal land, which recorded in 2015 covering a total area of 249 Ha (7.9% of a whole area in the regency). This type of land is actually feasible to develop into a more productive agricultural land (Fu ***et al***. 2014; Hornick and Parr, 1987; Kang ***et.al***., 2013). As showed that there was even though no specific land usage of any types dedicated for livestock to grazing in the areas, but fertile soil was only being cultivated with varieties of crops breadth along villages with no clear-cut partitions to separate between one land ownership to another. This seems to be very vulnerable for any social conflict to occur between livestock farmers particularly those, who are adopting a free-range livestock rearing system and some other land users, such as food crop producers.

Materials and methods

Challenges

Pasture is the main livestock feed source in pastoral environments. This is essential for both animal production and health as well. The implementation of community service program in the region should be therefore mainly addressed as follows: (1) To develop specific public grassland areas in order to make sufficient sources for forages of quality grasses and plants and also to make such areas available and accessible to all livestock farmers. (2) To provide ongoing knowledge-based trainings to livestock community in the regions, and (3) To establish comprehensive regulations and orders by appropriate authorities as can be made as preventive measures to any possible competition over water and pasture, which might lead to social conflicts and any possible severe related consequences, including the loss of human and animal life.

Problem Solving Approaches

Problems indicated in Suka Maju beef cattle farmer group, in Padangoge hamlet, Kalepadang village, Bontoharu sub-district, Selayar Island Regency can be solved main by introducing superior grasses and legumes. The first phase of the implementation was initiated with a socialization and focus group discussion (FGD) to local farmer communities. The discussion was also conducted and attended by the local government officers, representing the Department of Agriculture, Agriculture Field Extension Services, village leaders, hamlets, farmers, and members of Suka Maju farmer community. Basic principles on animal nutrion and advantageous of using improved qualiry grasses for better livestock productivities were cover in the discussion-based training. These materials were all delivered by related academic staff from the university. After these all theory-based trainings, practical exercises were given based a learning by doing approach. The main participants were all

farmers, including 30 people from each farmer discussion group, who were accompanied by respective agriculture field extension officers from the Selayar Islands Regency agriculture services. All of them were also given full demonstration of the introduced superior grasses/legume, and also a technology know-how on grass planting practices and also on agronomical aspects of the introduced plants in Padangoge hamlet, Kalepadang village, Bontoharu sub-district, Selayar Islands Regency. Information on the introduced superior plants is summarized in **Table 1**.

Table 1. Lists of superior grasses and a legume that were introduced in Bontoharu sub-district, Selayar Islands Regency.

No.	**Common names**	**Scientific names**	**Quantity**
1.	Elephant grass	*Pennisetum purpureum*	200 steams
2.	Small elephant grass	***Pennisetum purpureum (Schumach***	200 steams
3.	Benggala grass	***Panicum maximum***	200 steams
4.	Setaria grass	***Setaria spachelata***	200 steams
5.	Australia grass	***Paspalum dilatatum***	200 steams
6.	Signal grass	***Brachiaria decumbens***	200 steams
7.	Brachiaria grass	***Brachiaria brizantha***	300 steams
8.	Indigofera	***Indigofera sp.***	500 seeds

Results and discussion

The work that is presented here, has actually been inspired by the same kinds that had been reported in many parts of the world, including the one in Mediterranean areas of where particularly describing "a success story" about well adaptation was shown by *Pennisetum clandestinum* when introduced from south-western Australia to the areas (Nichols and Norton, 2016). The current study has however used some other types of improved plants, which resulted in a very promising preliminary outcome.

It is though appreciated that specific justifications for the selection of all plants in this current study were not merely on suitability of the plants to environmental conditions in the studied areas, but also on the plants' availability in place. The introduced plants comprising are seven types of grasses and one legume *i.e.* elephant grass (*Pennisetum purpureum*), mini elephant grass (*Pennisetum purpureum* Schumach), Bengal grass (*Panicum maximum*), setaria grass (*Setaria sphacelata)*, Australian grass (*Brachiaria dilatatum*), signal grass (*Brachiaria decumbens*), other brachiaria grass (*Brachiaria brizantha*) and indigofera (*Indigofera* sp.). These were selected with expectations to meet all requirements for local livestock farmers to develop their own quality forage resources in the areas. As known that the conditions there were found to vary with an average monthly rainfall of 10 days with a respective rate of 150 mm per month. Nearly all areas in the regency are considered being relatively wet all year around; whereas as a dry season had only been recorded in the months of August and September. Moreover, the topographical conditions of the Regency also proved to be divergence, as some are relatively flat; whereas some others are sloping. The elevation can reach up to as high as 607 meters above sea level. With some ongoing activities of clearing land covers, particularly in those sloping areas, erosion might have been happening as a result.

As previously mentioned, this current implementation program was focused mainly on introducing legumes and superior grasses as a pilot project to improve both accessibility and availability to/in sources of quality forages respectively. Ultimately, this would hopefully be able to boost up a sustainable beef cattle industry in the Selayar island district. There are however quite a number of things remain unraveled after completion of this first phase of the project implementation.

Some other areas of further studies are required to establish, particularly in regard to the development of potential site-specific genetic forage resources that are adaptable to sub-optimal and/or marginal lands of which have been solely utilized for coconut plantations so far. Studies on forage selection models to identify any tolerant forage cultivars to a medium up to high shade intensity are also being sought important, particularly in support of forage genetic-pool resource selection for the development of an integrated farming system between livestock industries and smallholder crops. The ultimate goal of such activities is to develop livestock farming from subsistent state to a more commercialized livestock industry, so that will bring up sustainable economy and welfare of population in the Selayar Islands Regency.

There are at least four categories have to be fulfilled when selecting any suitable types of fodder crops. Plants have to be able produce high yield of quality products, persistent to many conditions, able to grow well along with other plants and fertile to propagate. Having done to study all those categories, the introduced forage crops (Table 1) were then selected for such a program that could bring up a very promising outcome towards the availability of good quality forages in place. One study on forage resources in Selayar island regency conducted by a group of research workers from the University of Hasanuddin (Azis *et. al*., 2017) identified that existing native forages, which were consisting of grasses (11%), legumes (24%) and other plants (65%). Their nutritive values estimated in terms of crude protein (CP) contents were 5.7%, 9.5% and 7.2% respectively.

Brachiatia decumbens, one of selected species of *Brachiaria* grasses, is a plant originating from tropical areas of Africa. The grass is mainly propagated with a stolon. This was also applied as a plating method for the introduction of such a grass in Selayar Islands Regency. The grass is well known as one of the shepherd grasses, which not only has better productivities than that yielded by any other field native ones, but also has higher nutritive values as well. The plant is resistant to dry season and also suitable for tropical regions (Suharto *et al*, 2013; Trisnadewi *et al.,* 2017). Furthermore, this species of grass has been well known as a vegetation of choice for use in land conservation and as well as covering forage crop in any plantation lands (Fanindi and Prawiradiputra, 2005). These properties of *Brachiatia decumbens* are made the plant selected feasible to be introduced to many areas of Kalepadang village, Bontoharu sub-district, and some other areas in Selayar island Regency. On the other hand, one species of Setaria grasses, *i.e. Setaria pledida*, which is known to be resistant to cutting, but was not selected here as it contains oxalic acid of which can induce intoxication when given to cattle (Trisnadewi *et al*., 2017).

A preliminary assessment here was mostly undertaken qualitatively and this was carried out after all completion the first phase of the study, of which had actually been focused on delivering techniques and methods in disseminating and planting of the seven species of improved grasses and legume. Practices in pastoral management were also covered. Measures on early growth rate and adaptability amongst the plants were shown to be comparable with ranges of suggested standards (Kumar *et a*l., 2016). As previously highlighted that of the four selected grass genera, there were more *Brachiaria* grasses (species) used for this current study than the rests. It is interesting to note that many grass species in the genus of *Brachiaria* have been well known as being an important constituent of Savannah grassland ecosystem, which had been supporting millions of African herbivores for thousands of years (Kelemu *et al*., 2011). More on adaptability and high growth rate shown by *Brachiaria* grasses, a group of research workers in Brazil reported that such a genus had been the most extensively grown tropical forage grass worldwide, such as in the Latin American countries, Asia, South Pacific, and Australia, with an estimated coverage of 99 million hectares in Brazil alone (Jank *et al*., 2014). This figure may further suggest that *Brachiaria* species (spp) are plants of choice for pastoral development in many types of lands and climatic conditions. Furthermore, a comprehensive study conducted in Kenya had proved that *Brachiaria* grasses are capable of harbouring a diver's bacterial community of highly beneficial for the plant growth and development (Mutai *et. al*., 2017).

More specifically, there were three *Brachiaria* spp introduced in the current study. *Brachiaria brizantha* was one of the three selected. This species has been well known as the grass of an annual plant that thrives and reproduces itself with the rhizome. As mostly superior grasses of African origin, this species has thick leaves, and enable of growing well on dry soil, and also well known to be as a drought resistant grass as well. The plant was thus chosen as even though the studied area was reported to having relatively high monthly rainfall, but the region has been well known as having a very severe annual dry season of approximately for two months per year.

Setaria grass (*Setaria sphacelata*) was one of the seven selected superior forage grasses introduced in the current study. The plant was found to be adapting well to climatic conditions in the regency. As has been stated (Cumberbatch *et.al*., 1996; Jank *et al*., 2007; Ishak *et al*., 2018) that the grass grows well on acid coastal clay soils. Tolerance to both drought and flooded conditions is one of good characteristics made it possible to be selected suitable for the region. The grass can also withstand the occasional fire. This also made possible setaria to grow well a dry season on coastal areas of the islands, which might be more or less slightly similar as a moist subtropics' climate of the Northern Rivers, Mid Coast and Manning districts of New South Wales. As stated, that the grass is a summer-growing perennial one suited and performed best on coastal lowlands, where receiving more than 1000 mm average annual rainfall (Department of Primary Industry, New South Wales, Australia). Setaria grass is expected to become a forage crop of choice for use in developing pastures in coastal lowland areas of the regions. On the hand Indigofera, the only introced legume plant here in this project. This selection in this study was meant that the plant can become a forage resource to cater any livestock farmers practicing a cut and carry or a zero-grazing farming system. As the plant of well-known as a nitrogen fixing agent, this would be also an advantage for most semi-arid lands existing in the regions (Palmer, 1998)

This program was delivered to various livestock farmers both through a personal or group educational approaches, and also to regional extension officers and local agriculture services under approval from related local government authority. The scope of activities included the development of superior animal forage resources, accelerating all dissemination of appropriate livestock technology and innovation, augmenting any applied livestock sciences to livestock farmer groups, and field extension officers both from divisions of agriculture and animal husbandry. The implementation program for introducing forage grasses and legumes in that stage was also extended to carrying out a trial on cultivation of the introduced plants on the sidelines of various plantation crops and rice fields (Figure 1).

Figure 2. Participants of Padangoge livestock farmers were given an example on how to plant grass on sandy dry soil

As shown in Table 2 that a total number of cattle in Kalepadang village, Bontoharu sub-districts in 2017 were 546 heads, comprising of 420 females and 126 males. Data on their age variations were not stated here. There are five sub-villages in Kalepadang village *i.e.* Kalebonto, Irajalebo, Padangoge, East Palemba and Palemba. The highest population of cattle recorded in that year was in Padangoge sub-village. Based on direct observation, the area has some comparative advantageous than the rests, as the area covered with mostly fertile soil and apart from that, the livestock farmers there showed to express a relatively higher acceptance rate to the introduced program than that did in some other sub-villages. This was noticeable from the enthusiasm of the local community when they were introduced the program.

Table 2. Data on numbers of beef cattle in Kalepadang Village, Bontoharu District in 2018

Name of villages	Name of sub-village	Number of farmers	Number of Cattle		
			Female	Male	Total
Kalepadang	Kalebonto	28	102	29	131
	IrajaLebo	17	40	12	52
	Padangoge	22	108	36	144
	Palemba Timur	15	93	18	111
	Palemba	18	77	34	111
Total	Kalepadang	100	420	126	546

Data source: Field Extension Officer Bontoharu sub-district, 2018.

Figure 2. Training and focus group discussion (FGD) in a livestock development workshop held in Padangoge Hamlet, Kalepadang village, Bontoharu District, Selayar Islands Regency, South Sulawesi, Indonesia.

As proved by various studies that there is a positive correlation between an availability of quality forages and an increase in ruminant population. This has therefore been regarded as very crucial for the existing status in the regions; whereas a necessary of suitable lands for forages to grow well established which (Delima *et al*., 2015) is even of importance here. According to guidelines released by the Sub-Directorate for Animal Health of Indonesia (2013), the standard daily forage requirements per livestock unit in adult animals is as much as 30 kg/head/day, in young ones is as much as 15-17.5 kg/head/day, and in calves is as much as 7.5 - 9 kg/head/ day. These standards

suggested a very urgent need to increase the production of forage plants in the Selayar Island Regency.

Livestock farmers in the Selayar island region neither seemed to have never been experiencing in planting improved grasses and legumes, nor have sufficient knowledge-based expertise in developing pastures to properly feeding their livestock. However, they were shown to be awakened up by the current study to showing their willingness to move forward from subsistent agriculture practices towards commercial livestock industry.

Throughout the areas of Selayar island Regency, a large proportion agriculture land had been utilized for public coconut plantations. Records on total areas used for coconut plantation in the regency in 2015 was 19,496 Ha. If a spacing of 100 m^2 was required for one coconut tree to cultivate (Vergara and Nair, 1985; Opio, 1987), there would be an approximately 194 million of coconut trees in the regency. A vast area of improved grasslands can be developed beneath those tree stands. Based on South Pacific islands' experiences suggested that *Brachiaria* grasses are more suited for such a grazing pastures development (Paul and Ramkhelawan, 2016). A total number of 60 growing beef cattle weighing 250 kg is assumed as being an optimal herd size for a small-medium beef cattle farm in the regency (Moekti, 2018 personal communication). If a rotated grazing will be adopted here, a grassland area of totaling seven hectares will be required for one farmer to rotate graze his/her 60 cattle herd in a one-hectare paddock area, providing an average grass cover of 2,800 kg DM/Ha on grazing area at start (Genever, 2016). In a 19,496 Ha grassland developed, there would thus be expected as many as 2,785 small-medium beef cattle farms with a total rearing density of 167,100 heads.

The introduced superior grasses and legume presented in Table 1 included *Brachiaria* spp that is expected to be propagated to some extents of vast grazing area development. Furthermore, existing beef cattle distribution in various villages within Bontoharu sub-district, which is summarized in Table 2, showed that most cattle population here had been mostly concentrated in villages with fertile soil producing many types of crops including rice. There has been a relatively substantial water supply to that area from the Balanghibung River. As commonly found in most areas in Selayar district, in this area the main land covers are also predominantly coconut trees, walnut trees and also cloves. Attempts on planting superior grasses carried out by local farmers were only managed along sidelines of major plantations.

As previously mentioned, this current implementation program was focused mainly on introducing legume and superior grasses as a pilot project to improve both accessibility and availability to/in sources of quality forages respectively. Ultimately, this would hopefully be able to boost up a sustainable beef cattle industry in the Selayar District. There are however quite a number of things remain unraveled after completion of this first phase of the project. Some other areas of further studies are still required to establish, particularly on the development of potential site-specific genetic of forage resources that are adaptable to sub-optimal and/or marginal lands of which have been solely utilized for coconut plantations so far. Studies on forage selection models to identify any tolerant forage cultivars to a medium up to high shade intensity are also being sought important, particularly in support of forage genetic-pool resource selection for the development of an integrated farming system between livestock industries and smallholder crops. The ultimate goal of such activities is to develop livestock farming from subsistent state to a more commercialized livestock industry, so that will bring up sustainable economy and welfare of the Selayar Islands Regency residents.

Conclusion and suggestions

The introduced superior plants, comprising of seven grass types and one legume, into the Selayar Island Regency had shown to be all growing and adapting well. With specific agronomical characteristics of theirs, each improved selected plant here proved to will be able to fulfill the availability and the needs for quality forages in the regions, even though with obstacles due to their

divergence in land specificities, topographical conditions and type of soils. Various livestock farming systems can be made possible to developed ranging from a cut and carry system to integrated-interplantation grazing as well. Marginal soils and critical lands can be possibly improved into more productive pastures. It is however appreciated that there are still quite a number of things unraveled by only a conduct of the current study, as this was only focused on an initiation to further and more comprehensive studies, particularly on both sustainability and suitability of the introduced superior grasses in the development of integrated grassland together various crops and plantations.

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