Seed Source Potential and In Situ Conservation of Kulim (Scorodocarpus borneensis Becc) In PT. Arara Abadi, Riau, Sumatera

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Abstract. Kulim (Scorodocarpus borneensis Becc.) is one of Indonesian wood species with high economic value. Kulim wood is widely used for house construction, bridges and shipbuilding, while its fruit is used for cooking for its garlicy fragrance. Unfortunately, this species is currently rare in the wild due to habitat disturbance. Re-planting efforts require good quality seeds which can be collected from designated seed sources. The aim of this study was to identify the potential of Kulim stand in the arboretum of PT. Arara Abadi, Riau which covers 26.2 ha. Data collected from the site include tree height, diameter, geographic position as well as stand conditions. Total of 152 individual trees (121 trees, 23 poles, 5 saplings and 2 seedlings) were found in the area of study. The area is accessible, relatively safe from interference and well managed. The quality of the stands is quite good with no significant attack from pests or diseases. Fruits, seedlings and saplings were also found in the forest floor. The stand is therefore appropriate to be designated as Identified Seed Stand of Kulim based on the criteria of regulation concerning implementation of forest seeds. This stand can also be reserved as an insitu conservation area of Kulim.

1. Introduction
Kulim (Scorodocarpus borneensis Becc, family Olacaceae), also known as wood garlic, jungle garlic, garlic nut tree or woodland onion is a kind of tree whose wood gives off a strong smell of garlic. Kulim naturally occurs throughout the lowland rain forests and is often found in hills and valleys. It generally grows in areas where the soil is dry enough [1]. The distribution of kulim in Indonesia is also limited to only in Sumatra and Kalimantan [2].

Kulim is one of forest tree species that is widely utilized by community. Kulim wood is used as raw materials for ships and buildings while the fruit is used as a seasoning for cooking. The bark has a potential to be developed as natural antibacterial agents against pathogenic bacteria and antioxidant sources [3]. In East Kalimantan, kulim is known as "forest onion" and is used as a substitute for the aroma of garlic (seeds and bark), as well as vegetables (leaves), traditional medicines (roots and leaves) and ritual ceremonies (bark and fruit) [2]. The essential oil is obtained from its leaves by steam distillation and it is a new natural anti-microbial agent for oral pathogens [4].
Kulim population is currently being threatened due to its extensive exploitation while its regeneration process is very slow (annual increments of 0.2-0.3 cm) [5]. Meanwhile [6] specified issues concerning kulim population are low natural regeneration and illegal exploitation by the community with minimal planting effort. Cutting down productive trees would impede natural regeneration.

Planting efforts of kulim require good quality seeds. This paper presents the potential and distribution of kulim at the Arboretum of PT Arara Abadi, Minas-Rasau Kuning District, Siak Regency, Riau Province to assess whether the stand is appropriate to be designated as seed sources referring to the Regulation of the Minister of Forestry No P.01/Menhut-II/2009 that has been revised to P.72/Menhut-II/2009 concerning the Implementation of Forest Seed and the Regulation of the Director General of Land Rehabilitation and Social Forestry No: P05/V-SET/2010 concerning Guidelines for Implementing Standard of Seed Source.

2. Experimental methods

2.1. Location
The study was located at the protected area (Arboretum) of PT. Arara Abadi, Minas-Rasau Kuning District, Siak Regency, Riau Province which covers about 175 Ha. However, kulim trees have been found to distribute in the area of 26.2 hectares.

2.2. Materials and tools
GPS Map 62s/78S, Digital Camera, Thematic Map (Working Map of PT. Arara Abadi-Rasau Kuning), Phiband, Machete, Hagameter/Vertex, Pita Sateen, rope, Data sheet and stationery.

2.3. Data collection
The information gathered includes the characteristics of the kulim trees, namely stem diameter at 1.3 m from the ground surface (cm), total tree height (m), coordinate points (GPS), photos of tree. The implementation of this activity was carried out by observing the entire Arboretum and inventory the kulim trees.

3. Results and discussion

3.1. Location description
The Arboretum is situated in a lowland forest ecosystem with flat sloping and rolling topography. In 2018, its annual rainfall was 5,143 mm. The lowest average temperature (26.05°C) occurred in November while the highest average temperature (32.50°C) occurred in August. Air humidity ranged from 51.35-73.06%. The details are explained in Appendices 1, 2 and 3.

3.2. Criteria of Identification for Arboretum of Kulim as Seed Source
Referring to the Directorate General of Land Rehabilitation and Social Forestry No: P05/V-SET/2010 concerning Guidelines to Implementation for Standard of Seed Sources, there are 2 methods to obtain seed sources, i.e. designating existing stands and developing seed sources. The arboretum is, as an existing stand, therefore proposed to be designated as a seed source of kulim, using the following criteria:

3.2.1. Accessibilities
The location of the Kulim stand is relatively easily accessible by the road with 4-wheel vehicles (Figure 1).
3.2.2. **Number and size of mother trees**

PT Arara Abadi has identified, mapped and labeled every single kulim trees with dbh of more than 20 cm (Figure 2). In total, there are 121 parent trees of Kulim at the Arboretum. Regulation of the Director General of Land Rehabilitation and Social Forestry No: P05/V-SET/2010 requires a minimum number of parent trees to exist at a natural stand to be proposed as seed source. The minimum number of 25 trees is a general guideline ("rule of thumb"), more is preferable. The more parent trees lead to better genetic variation and better gene flow in the stand that will serve good quality seeds.

A stable population usually has a typical age distribution in a particular area. Sometimes an age class, especially young individuals, is not found or only exist in a small number. This indicates the population reduction in the future. Conversely, if the seedlings and individual trees are in large numbers, the population will be in a stable state and may even experience an increase [7]. Based on the classification of growth stage by [8], the population of kulim standing in the Arboretum were found in various levels of growth as shown in Figure 3.
Figure 3. Distribution number of kulim stands at the Arboretum

Figure 3 shows the structure of the abnormal kulim stand in the Arboretum where there are fewer plantain smaller diameter classes compared to bigger ones. Such stand structure is also found in the kulim stands of Sei Gelawan forest group, Kampar District, Riau Province [9]. Kulim is a slow growing tree with average annual diameter increment in natural forests in Malaysia ranging from 0.2 to 0.3 cm. For example, 30 years old kulim trees had been recorded to have average diameter of 10-29 and total height of 18-21 m [5]. Thus, its growing characteristic combined with inter species competition occurred in natural forest have made this species requires a relatively long time to increase its population.

3.2.3. Stand quality

Stand quality is a very important criterion to determine whether the stand could be nominated as a seed source. The kulim stand at the Arboretum is in good condition (Figure 4) and evenly distributed in the arboretum area (Figure 5.), indicating that this stand is more likely to produce good quality seeds.

Figure 4. Aerial photography of forest cover of the Arboretum (a) and kulim tree at the Arboretum (b)
3.2.4. Fruiting
During the course of inventory, only a few numbers of kulim fruits and seedlings were found at the forest ground. This may be caused by the local people collecting kulim fruits in this stand. Flowering and fruiting season was identified by asking the people who regularly collect kulim seeds from the stand. Initial flowering is in April and peak flowering in June. Initial fruit ripening is in January and peak fruit ripening in August. Flowering season of Kulim in this area therefore conform with the information by [5] who stated that kulim trees usually flower in January - July and bear fruit most of the year, in Peninsular Malaysia and in Borneo usually bear fruit between June – September. There are 300-350 fruits/tree/year. Nevertheless, this information needs to be proven by observing the flowering phenology of kulim to obtain accurate data on the current flowering and fruiting time of this stand as climate change is disrupting natural phenological patterns of many species [10].

3.2.5. Security
The kulim stand in the Arboretum is well preserved and protected from illegal logging. The threat to the sustainability of this stand is that the local people still enters this area to collect the fruits and the
fact that the fruits are favored by various types of animals, such as wild boars (*Sus scrofa*) and porcupines (*Hystrix brachyura*), deer (*Muntiacus muntjak*), mouse deer (*Tragulus javanicus*), and squirrel (*Lariscus* sp) [11]. Should the stand be designated as a seed source, accessibility of people to the stand must be controlled. The collection of mature seeds needs to be done properly and immediately before being eaten by animals. Placing fine-meshed nets under the trees during the period of seed fall [12] could be an alternative method of collecting kulim’s fruits to prevent the fallen fruits consumed by animals on the forest ground.

3.2.6. Health
Kulim trees identified at the arboretum are sound and in a good condition. No severe pests and diseases attack parent trees, poles, saplings and seedlings of kulim in the stand. This indicates that the sustainability of the stand will be maintained in the future provided that no natural circumstances or human intervention inhibit natural regeneration of the trees.

3.2.7. The Origin of Seeds
The development of the Arboretum of PT Arara Abadi, Minas-Rasau Kuning District was aimed to conserve a native species of Kulim, which is naturally grown in the area. No enrichment planting has been recorded to carry out in the area. Hence, origin of the kulim trees in the area were solely from natural regenerations. Clarity of tree origin in a seed source largely determines the genetic quality of seeds produced from the seed source, and concerns about genetic mixing between populations can be eliminated.

3.2.8. Isolation
Isolation paths are needed to avoid pollen from outside the stands pollinating the trees in the seed source stands that potentially reduce the genetic quality of the seeds produced. However, referring to the Regulation of the Minister of Forestry No P.01/Menhut-II/2009 that has been revised to P.72/Menhut-II/2009 concerning the Implementation of Forest Seed and the Regulation of the Director General of Land Rehabilitation and Social Forestry No: P05/V-SET/2010 concerning Guidelines for Implementing Standard of Seed Source, no isolation paths is required for a seed source classified as an Identified Seed Stand. In addition, the absence of kulim tress in the vicinity of the seed source that potentially pollinate the parent trees in the seed stands indicate that the purity of the seeds produced from the seed source will be maintained.

3.3. Arboretum as *in situ* conservation
Since the number of kulim trees in the arboretum is still relatively large and well managed, despite facing difficulties in natural regeneration, this stand can be designated as an identified seed stand as well as *in situ* conservation stand of the species. An enrichment planting with materials originated from this particular population is therefore required to ensure its sustainability. Besides providing material for planting program, the stand presents research opportunities in population biology, mating systems, seed production, seed distribution, natural regeneration and genetics.

4. Conclusions
The arboretum is accessible, relatively safe from interference, has sufficient number of parent trees to produce good quality seeds, has fruits, seedlings and saplings on its forest floor and has no pests nor diseases. The stand is appropriate to be designated as Identified Seed Stand of Kulim. This stand can also be reserved as an *in situ* conservation area of Kulim.
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### Appendix 1. Daily rainfall at Distrik Minas-Rasau Kuning, PT Arara Abadi 2018

| Date | Amount of rainfall (mm) | Total | Average |
|------|-------------------------|-------|---------|
|      | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |     |
| 1    | 30  | 5   | 5   | 99  | 13  | 16  | 70  | 238 | 34,0 |  |     |
| 2    | 39  | 24  | 65  | 56  | 184 | 46,0 |     |
| 3    | 23  | 17  | 80  | 73  | 54  | 7   | 44  | 298 | 42,6 |  |     |
| 4    | 88  | 19  | 125 | 78  | 310 | 77,5 |     |
| 5    | 6   |     |     |     | 31  | 37  | 18,5 |     |
| 6    |     | 34  | 144 | 68  | 246 | 82,0 |     |
| 7    |     | 4   |     |     |     | 4   | 4,0 |     |
| 8    | 8   |     |     | 43  | 10  | 61  | 20,3 |     |
| 9    | 17  | 40  |     |     | 53  | 5   | 115 | 28,8 |     |
| 10   | 56  | 8   |     |     | 33  | 5   | 102 | 25,5 |     |
| 11   | 3   | 10  |     |     | 15  | 17  | 37  | 14  | 96  | 16,0 |     |
| 12   | 10  | 18  |     |     | 25  | 55  | 176 | 25  | 309 | 51,5 |     |
| 13   | 3   |     |     |     | 42  | 75  | 120 | 40,0 |     |
| 14   | 87  | 8   |     |     | 14  | 109 | 36,3 |     |
| 15   | 5   |     |     |     | 96  | 24  | 125 | 41,7 |     |
| 16   | 10  | 20  | 14  |     | 8   |     |     | 52  | 13,0 |     |
| 17   | 43  |     | 31  | 27  | 45  |     |     | 146 | 36,5 |     |
| 18   | 10  | 10  |     |     | 80  | 68  | 168 | 42,0 |     |
| 19   | 11  | 26  |     |     | 48  | 110 | 94  | 19  | 308 | 51,3 |     |
| 20   | 20  | 21  |     |     | 29  | 10  | 23  |     | 103 | 20,6 |     |
| 21   | 2   | 37  |     |     | 27  | 81  | 175 | 9   | 331 | 55,2 |     |
| 22   |     | 38  | 6   |     | 13  | 57  | 19,0 |     |
| 23   | 9   | 80  | 26  | 10  | 47  | 23  | 180 | 34  | 409 | 51,1 |     |
| 24   | 80  | 5   | 57  |     | 11  | 153 | 38,3 |     |
| 25   |     | 147 | 120 |     | 14  |     | 281 | 93,7 |     |
| 26   | 30  |     |     |     | 6   |     | 36  | 18,0 |     |
| 27   | 9   | 110 |     | 118 | 0   | 11  | 5   | 39  | 292 | 48,7 |     |
| 28   | 3   |     |     |     |     |     |     |     | 24  | 12,0 |     |
| 29   | 5   | 96  |     | 68  |     | 40  | 11  | 220 | 44,0 |     |
| 30   | 67  | 5   | 57,0| 36  | 10  | 175 | 35,0 |     |
| 31   | 11  | 23  |     |     | 34  | 34  | 17,0 |     |
| Total| 118 | 169 | 503 | 388 | 183 | 679 | 401 | 93 | 396 | 808 | 936 | 469 | 5143 | 428,6 |
| Number of rain days | 11  | 5   | 13  | 12  | 7   | 9   | 9   | 5   | 10  | 16  | 18  | 14  | 129  | 11   |
Appendix 2. Monthly rainfall at Distrik Minas-Rasau Kuning, PT Arara Abadi 2018

| Month     | Amount (mm) | Number of rain day |
|-----------|-------------|--------------------|
| January   | 118         | 11                 |
| February  | 169         | 5                  |
| March     | 503         | 13                 |
| April     | 388         | 12                 |
| May       | 183         | 7                  |
| June      | 679         | 9                  |
| July      | 401         | 9                  |
| August    | 93          | 5                  |
| September | 396         | 10                 |
| October   | 808         | 16                 |
| November  | 936         | 18                 |
| December  | 469         | 14                 |
| Total     | 5,143       | 129                |

Appendix 3. Air temperature and relative humidity at Rasau Kuning District of PT Arara Abadi 2018

| No. | Month     | Temperature (°C) | Relative Humidity (%) |
|-----|-----------|------------------|-----------------------|
|     |           | Min | Max | Average | Min | Max | Average |
| 1.  | January   | 30.16 | 31.71 | 30.94 | 56.42 | 78.48 | 67.45 |
| 2.  | February  | 30.46 | 31.93 | 31.20 | 55.07 | 76.93 | 66.00 |
| 3.  | March     | 27.84 | 32.39 | 30.12 | 60.10 | 86.03 | 73.06 |
| 4.  | April     | 30.47 | 32.23 | 31.35 | 54.50 | 77.47 | 65.98 |
| 5.  | May       | 30.42 | 32.39 | 31.40 | 50.39 | 77.42 | 63.90 |
| 6.  | June      | 30.37 | 33.23 | 31.80 | 48.67 | 77.27 | 62.97 |
| 7.  | July      | 30.02 | 36.00 | 33.01 | 22.60 | 80.10 | 51.35 |
| 8.  | August    | 30.00 | 35.00 | 32.50 | 23.46 | 80.16 | 51.81 |
| 9.  | September | 20.38 | 33.96 | 27.17 | 40.44 | 80.03 | 60.24 |
| 10. | October   | 22.10 | 34.83 | 28.46 | 40.85 | 80.08 | 60.47 |
| 11. | November  | 20.06 | 32.04 | 26.05 | 59.14 | 79.78 | 69.46 |
| 12. | December  | 22.09 | 31.97 | 27.03 | 30.86 | 78.91 | 54.91 |