Table 4. Diameter classes of surviving cuttings

Diameter class	Diameter interval (mm)	Mean diameter (mm)	Percentage
I	5.86–7.61	6.40	22.58
II	7.62–9.37	8.63	45.16
III	9.38–11.13	10.15	22.58
IV	11.14–12.89	11.22	3.23
V	12.90–14.65	13.13	3.23
VI	14.66–16.41	16.25	3.23

Source: Pamungkas et al. (2019).

As seen in Table 4, diameter classes I, II and III, ranging 5.9–11.1 mm, appeared to provide more viability of success. This indicates that diameter could be an additional factor for the viability of stem cutting alone. In addition, diameter classes I, II and III were easier to collect owing to their smaller dimensions.

4. How can the findings benefit farmers' livelihoods and the environment?

The results indicate that domestication of the screw tree is an opportunity to diversify and improve local livelihoods. The technique of screw-tree propagation can be used by farmers to reduce the need to undergo the difficult process of harvesting from trees in their natural habitat.

Mortality or otherwise unsuccessful growth of planting stock that has been propagated vegetatively is a common issue when seeking to grow an adequate number of seedlings. Therefore, farmers should use plenty of cutting material, sufficient to provide enough viable stock.

Figure 3 shows that the propagated screw tree is able to form first flowers within six months. This is possibly quicker flower production than other commodities, such as fruit trees.

In its natural habitat, screw trees are able to grow under shade or full sun. Thus, farmers could plant the species in their homegardens, which would make management and harvesting much easier. Environmentally, planting screw trees increases biodiversity and adds tree cover to bare or unproductive land.

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THREADS OF LIFE

Screw tree (*Helicteres isora* Linn.) Domestication for Local Livelihoods Improvement



1. Why do we do this research?

Screw tree (*Helicteres isora*), or kayu ules in local language, is a medicinal plant that can be found in India and Indonesia. The fruit of this species has been proven to be effective to prevent the increase of blood glucose levels (Venkatesh et al., 2004). Meanwhile, in Indonesia the fruit of the screw tree is an ingredient in traditional medicine, known as 'jamu', which is sold commercially. One location in Indonesia where this species can be found is in Soe, South Timor Tengah District, East Nusa Tenggara Province. The distribution of this species is discontinuous; it naturally grows with other species, such as *Cassia siamea, Psidium guajava, Leucaena leucochepala, Woodfordia fruticose* and *Canarium Oleosum* as a sapling (Umroni et al., 2015).

As a medicinal plant, this species has the potential to be traded because it has an economic value. If it is managed well, it could be a new commodity and increase farmers' incomes. Currently in Soe, screw trees are only available in natural populations, located at about 610 masl. The sites are difficult to access and hence do not encourage management or enrichment planting. To reduce the incidence of this difficult process to obtain the fruit, domestication of the species could be the answer.

The propagation of screw trees has been successful using a vegetative method with stem cuttings. However, seed germination had not performed as well for growth. A trial was undertaken to acquire better understanding of the vegetative propagation of screw trees.

2. How did we do the research?

We obtained stem-cutting material from natural habitats in Soe. The trial used two treatment factors: 1) the type of stem cutting (Figure 1); and 2) application of commercial growth regulators (Table 1). The treatments of the two regulators are presented in Table 2. The survival rate of the stem-cutting samples was classified into diameter classes using a formula described in Hidayat dan Nurohman (2007) (Table 3). The length of the stems used in this trial was 25 cm (Ferdousi et al., 2014).

Figure 1. Three types of stem-cutting material

Note: Soft wood (left); semi-hard wood (middle); and hard wood (right).

Table 1. Profiles of commercial regulators

Atonik	Root-up
a. Natrium para-nitrofenol 3.0 g/l	a. 1-Naftalenaasetamida 0.2%
b. Natrium orto-nitrofenol 2.0 g/l	b. Indole-3-butiric 0.01%
c. Natrium 5 – nitroguaiakol 1.0 g/l	c. Thiram 4%
d. Natrium 2 – 4 dinitrofenol 0.5 g/l	

Table 2. Treatment combinations of growth regulators and stem cutting sources

Stem cutting	Growth regulator
Soft wood	Submerging in water for 30 minutes (control)
	Submerging in Atonik solution for 30 minutes
	Smearing with Root-up paste at bottom of stem
Semi-hard wood	Submerging in water for 30 minutes (control)
	Submerging in Atonik solution for 30 minutes
	Smearing with Root-up paste at bottom of stem
Hard wood	Submerging in water for 30 minutes (control)
	Submerging in Atonik solution for 30 minutes
	Smearing with Root-up paste at bottom of stem

Table 3. The formulas of diameter classes based on the survival rate of stem-cutting

$R = D_2 - D_1$	where,
$BK = 1 + (3.3 \log P)$	R: diameter range of the survivals
$I = R/BK$	D_1: smallest diameter value
	D_2: biggest diameter value
	BK: number of diameter class
	P: number of survivals
	I: interval of diameter class

Source: Pamungkas et al. (2019)

3. What are the findings?

3.1 Cutting stem growth

Each source of stem cutting showed patterns in survival rate after observation for three months. Stem cuttings from hard wood, semi-hard wood and soft wood had similar trends, which were declining, nevertheless, stem cuttings from hard wood showed the highest survival rate. From three different treatments of growth regulator, Atonik appeared to be the most suitable as a growth regulator.

With Atonik, hard wood stem cuttings showed better survival ability compared to the other two types; evolving into new individuals at a rate of 36% by Day 53. The other stem cuttings with Atonik were under 30% by Day 53: 24% (semi-hard wood); and 0% (soft wood) (Pamungkas et al., 2019).

The Root-up and Control trials had much lower survival rates than with Atonik: 1) Root-up: 24% (hard wood); 12% (semi-hard wood); 4% (soft wood); 2) Control: 16% (hard wood); 8% (semi-hard wood); 0% (soft wood) (Figure 2) (Pamungkas et al., 2019).

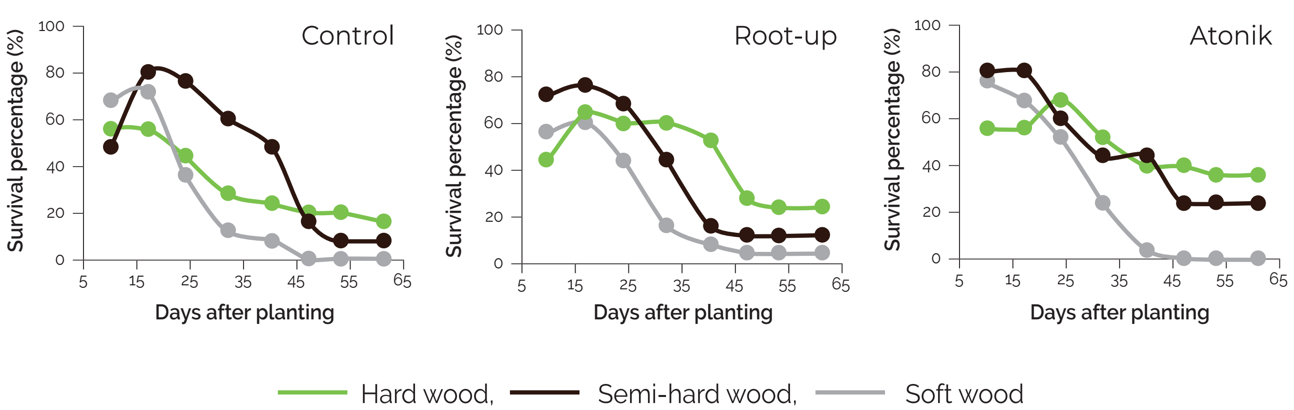

Figure 2. Stem-cutting survival percentages for three different types of cutting and three different treatments

Source: Pamungkas et al. (2019).

Figure 3. A primordial shoot, and successful and unsuccessful stem cuttings (3a–c); root formation at the bottom of a stem cutting; and first flower (3d–f)

Source: Pamungkas et al. (2019).

Figure 3 shows the ability of stem cuttings to produce primordial shoots (3a) and develop into a complete individual with leaves, stem and roots (3b). Some of the stem cuttings were unable to grow well (3c): the young leaves appeared to be not resilient because the root system was not formed or was forming poorly.

The vegetative seedlings that grew well had good root systems, as seen in 3d and 3e: the main roots appeared sturdy with denser root hairs at the bottom of the stem cutting.

After six months, the surviving stem cuttings produced flowers (3f). The first buds appeared with a green and hairy appearance (3f, next to red flower). After a few days, the buds developed into complete flowers with a red crown where a pistil could be seen.

3.2 Diameter classes

Stem cuttings derived from soft wood were clearly not recommended to be used because there was a very low survival rate. From the surviving stem cuttings (regardless of the growth regulators used), we classified the cuttings into diameter classes sourced only from semi-hard and hard wood. Results were six diameter classes with potential to be material for stem-cutting propagation, with intervals of 1.75 mm each. However, only three diameter classes with potential were subsequently used: I (22.58%); II (45.16 %); and III (22.58%) (Table 4) (Pamungkas et al., 2019).