16 Propagation and pruning techniques of *Garcinia atroviridis* (asam gelugor) in Bukit Gantang, Perak, Malaysia

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GPD 'passport'

GPD code:	08
Focus area:	Propagation and planting materials Production and crop management
Character:	Technique and practices
Species and varieties involved:	*G. atroviridis*, locally known as asam gelugor
Name of location:	Bukit Gantang, Perak, Malaysia
GIS reference of location:	N 04°45′83″; E 100°45′86″ Elevation: 40 masl
Name of farmers:	Mr Zainal Abidin Ramli, Mr Abdul Wahab Bin Ahmad, Mr Mazlan Bin Mohd Nor, Mr Mustafa Kamal and Mr Zaki

Introduction

Garcinia atroviridis l. (asam gelugor) is a large perennial fruit tree that can grow up to 30 m high and has drooping branches. The species is endemic to Peninsular Malaysia, although the tree grows throughout a large part of south-east Asia where it is valued for its culinary and medical uses. Seven of the 50

Garcinia species that exist in Peninsular Malaysia (Corner, 1988) can be found in the home gardens and orchards in the six sites chosen as part of the TFTGR project[1] (Salma *et al.*, 2012): *G. mangostana*, *G. atroviridis*, G. *forbesii*, *G. cowa*, *G. dulcis*, *G. hombroniana*, *G. prainiana* and *G. bancana*. Of these, *G. mangostana* (Manggis, mangosteen) is the most commonly cultivated species, while *G. atroviridis* (asam gelugor) is ranked the second most important species among the sites. It is also widely grown in India, Indonesia and Thailand. In the Malaysian and Indonesian tradition, the rinds of the unripe fruit are cut into pieces and dried in the sun. The dried sliced fruit is locally known as 'asam keping'. It is sold in markets or bazaars for use as a sour relish in curries in place of tamarind or for dressing fish (Plate 38). Asam gelugor is rich in vitamin C and also contains hydroxycitric acid (HCA), which can be used for reducing weight and excess fat (Khairunnisa, 2005). This has led to a growing demand for this fruit. In addition, the young leaves of asam gelugor are traditionally eaten as a salad, while lately the matured leaves have been used for making tea. The dried fruit have also been used as a dye for silk, when combined with alum as a fixative. Studies have now confirmed that the acidic nature of the fruit has anti-fungal, anti-microbial and weight-reducing properties. In traditional medicine, dried asam gelugor is soaked in hot water and then drunk to reduce high blood pressure. This range of traditional and modern uses has increased interest in this underutilized species over the last 10–15 years.

Asam gelugor trees are mostly raised from seeds planted in home gardens and orchards. These seedlings are grown from seeds selected by the farmers themselves or the seedlings are bought from private nurseries. Despite the increasing interest in the species, its cultivation and especially its propagation has been challenging for farmers. First, asam gelugor, like other *Garcinia* species, is dioecious and produces male and female trees. The farmers interviewed noted that trees raised from seedlings produce about 70 per cent male trees, which are not wanted as they do not bear fruits. Normally the farmers cut down the male trees after 6 to 10 years when the female trees should have started producing their first fruits. It would be useful for farmers not to wait so long and to be able to select female seedlings from the outset. Second, the seedling tree can grow up to 30 m tall and thus can be difficult to harvest. In addition, the species is plagiotropic; the branches grow obliquely or at an almost horizontal angle from the trunk. When new plants are produced by taking cuttings from these branches, the new sapling does not assume a normal vertical tree shape but continues to grow like a horizontal branch. This makes it difficult to propagate the species vegetatively. A few farmers from Bukit Gantang have developed some particular methods to be able to induce female trees from saplings. As well as this they have perfected some propagation and pruning techniques to keep the trees small and thus easier to harvest.

Context

Bukit Gantang is a small town located in the centre of Larut-Matang Selama District, in the state of Perak, Peninsular Malaysia. The town and its periphery

cover an area of about 68,160 ha. The topography of the area is hilly in the interior western part, sloping towards the coast in the east. The area receives an average rainfall of 3,045 mm a year, with December being the wettest month while February to April is drier. The average temperature is 28°C. A few perennial rivers pass through the area including Sungai Larut, Sungai Jaha, Sungai Limau, Sungai Sepetang and Sungai Punggor. Bukit Gantang is surrounded by thick forest and the livelihoods and culture of the people are closely associated with the forest. Agriculture and horticulture are the main land use systems in the area. The main crops planted are oil palm (83 per cent), fruit trees (9 per cent), rubber (4 per cent) and vegetable crops (4 per cent). Palm oil and rubber are cultivated in large-scale estates owned by private companies, but also in small plots by farm households. In addition, farmers grow a range of fruit trees in home gardens and mixed orchards including *G. atroviridis* (Table 16.1).

Major fruit tree species grown in home gardens and mixed orchards are mango, durian, mangosteen and rambutan. Fruit trees are grown in home gardens, mixed fruit orchards or in agroforestry systems where rubber trees are used as anchor crops. Some wild fruit species such as *Parkia speciosa* (a legume fruit tree) are planted in the orchards. *Garcinia atroviridis* is planted in home gardens, mixed fruit orchards, agroforestry systems and also small-scale

Table 16.1 Comparative species richness, evenness and diversity indices of tropical fruit tree diversity in Bukit Gantang in Malaysia

System	*Richness*	*Evenness*	*Diversity Indices*
Home garden	8	0.65	0.57
Orchards	7	0.72	0.62
Forest	NA	NA	NA

Source: Baseline survey data, 2010; see Nazmi *et al.* (2013).

Table 16.2 Comparative richness, evenness and diversity indices of *Garcinia mangostana* and *Garcinia atroviridis* in Bukit Gantang in Malaysia

Diversity parameters⋆	*Home garden*	*Orchards*
Total number of trees	968	1245
Average number of trees per household	18.62	23.94
Community richness	2	2
Average richness per household	1.67	1.63
Average household evenness (Simpson Index)	0.21	0.21
Community evenness (Simpson Index)	0.32	0.44
Divergence community	0.34	0.53
Number of households	52	52

⋆ Refer to Jarvis *et al.* (2008) for definition of various parameters.
Source: Baseline survey data, 2010; see Nazmi *et al.* (2013).

monocropping. Comparative on-farm *Garcinia* diversity indices of Bukit Gantang are summarized in Table 16.2. Some community members who enjoy going to the forest, also collect fruit from the adjacent forest, such as wild mango and fruits from several *Garcinia* species and *Parkia* species among others (diversity data from forest are not available).

Table 16.2 shows that the number of *G. atroviridis* and *G. mangostana* trees are higher in orchards, suggesting farmers' interest in commercialization of these species. The project focused on farmers growing fruit trees, so those involved in oil palm activities are not included in this analysis. Among these farmers, the average monthly household income is RM750 (US$250), which is mostly derived from agricultural activities such as rubber tapping, fishing and selling of agricultural produce. The community receives strong support from government agencies such as the Department of Agriculture (DOA), the Department of Irrigation and Drainage (DID), Department of Forestry (DOF) and government-supported Farmer Associations. All the agencies play a role in developing the community infrastructure, economic development programmes, marketing and social development.

Method used for data collection and problem statement

A research team from the Malaysian Agriculture Research and Development Institute (MARDI) and officers from the Perak Horticulture Division, DOA and DOA District of Larut Matang Selama, Perak, interacted with farmers to identify, understand, evaluate and document the propagation and management of *G. atroviridis*. A semi-structured questionnaire was used, followed by a farm walk and focus group discussion with heads of households (mostly male) to understand the practice. The farming and propagation practices and other details were documented in the form of pictures, audio and video recordings and written notes.

Farmers in Bukit Gantang who cultivate asam gelugur were facing two problems: (i) having too many male trees in their home gardens and (ii) having trees that were too tall to harvest. The difficulty of obtaining female trees and the drudgery of harvesting prevented farmers from growing the species at a larger scale or in higher numbers in their home gardens and orchards. These drawbacks kept the species underutilized despite its multiple uses and increasing market value. Also, over the last three to four decades, many farmers have been steadily losing interest more generally in the diverse species grown in home gardens or mixed orchards or that are found in forests, as profits have been comparatively low and not keeping up with the high profits made in palm oil and rubber. Many farm households have kept their home gardens or mixed orchards out of tradition or merely for home use or surplus sales as maintenance costs are relatively low. As nowadays most of the younger generation have jobs outside farming and are moving to the cities, it is expected that many orchards or home gardens will be discontinued or abandoned in the near future.

The research did, however, find cases that bucked this trend: farmers who had developed techniques for inducing female trees and pruning techniques to make harvesting easier.

Description of GPD: propagation techniques and pruning practices of asam gelugor

This chapter describes four practices that could help to popularize this underutilized species:

- Inducing the growth of female trees by bending and stressing the taproot of saplings
- Traditional marcotting technique through root cuttings to multiply female trees from the forest (Plate 41)
- Patch and cleft grafting techniques to multiply female trees (Plates 39 and 40)
- Top working and pruning of trees to train tree height and reduce drudgery of harvesting (Plates 38a and 38b).

These practices have been developed and perfected by a few dedicated farmers in Bukit Gantang, who have innovated and adopted those techniques based on traditional knowledge in combination with information and workshops provided by the DOA.

Inducing the growth of female trees through root stress

Mr Mazlan Bin Mohd Nor has been growing asam gelugor for a long time and has developed in his home garden an innovative method to obtain female trees. He obtained the knowledge of how to raise female asam gelugor seedlings from the older farmers in the village. They told him to stress the taproot of the young sapling when transplanting from the seedbed into the orchard or home garden. This is done by bending the taproot several times before transplantation and placing a plank or board just below the taproot to force the taproot to grow sideward. This practice is traditionally proven to induce the growth of a female tree. Mr Zaki, another farmer, has now tested this method with 100 saplings of which about 10 seedling trees have started to bear fruits.

Traditional grafting technique by root cuttings (marcotting)

Propagation by cuttings (i.e. marcots) is the oldest known method for propagation and considered by farmers the cheapest and most convenient method to create new saplings of a preferred tree. First, one selects a female tree with good characteristics such as a tree known to produce big and good-quality fruits. In the root cutting technique, the root from this female tree is

dug up, raised to the surface and a small cut is made to the root. The exposure to the air will induce the formation of a new shoot at the location of the cut and subsequently additional roots (Plate 41). This method is considered by farmers the simplest method to produce a clone from a preferred female tree.

Cleft grafting and patch budding

In cleft grafting, a shoot (i.e. scion) of the desired female tree is joined with the stem of a young seedling (stock or rootstock) of different genetic origin (Plate 39). This technique has been developed by scientists and is commonly used for popular commercial species such as mango (*Mangifera indica*) and rambutan (*Nepheleum lappaceum*), although it has proven to be more complicated for lesser known species such as asam gelugor. Mr Abdul Wahab Bin Ahmad from Bukit Gantang, however, has experimented and perfected the technique specific for asam gelugor. He is considered the most skilled farmer in the village and obtains a high survival rate (about 90 per cent) of his grafted asam gelugor plants. Another related grafting method is patch budding, where a patch of bark including a bud is carefully cut and taken from the desired female tree and placed on the stem of a rootstock where the bark has been removed. As soon as the bud starts to grow a new shoot, the stem of the rootstock above the bud is removed (Plate 40). For patch budding and cleft grafting, Mr Abdul Wahab Bin Ahmad prepares the rootstock by sowing the seed in 15 cm x 22.5 cm polybags. When the seedlings in the polybags are four to six months old they are budded or grafted using the scions selected from healthy female tree branches. Mr Abdul Wahab Bin Ahmad has been practising cleft grafting for more than 10 years in Bukit Gantang. All grafted trees planted survived according to Mr Abdul Wahab Bin Ahmad, but he prefers patch budding. He has planted in his home garden 60 healthy trees over the last 10 years using patch budding, with a survival rate of 90 per cent. Mr Mustafa Kamal learned the technique during a training course and now he has 20 new saplings of about nine months old. Patch budding develops a strong tree structure that can avoid falling and breakage in the strong winds that are common in this region. Neither grafting method is practised widely in Bukit Gantang, or Malaysia in general, as they require experience and specific skills to be successful and to obtain a high survival rate of grafts for asam gelugor.

Top working and pruning to reduce size of trees

Mr Abdul Wahab Bin Ahmad was interested in the management of asam gelugor trees to reduce their height and to optimize the tree structure to improve the quality of fruits and to make harvesting easier. He decided to carry out top working of the tree, which means cutting the trunk of a tree aged 2 to 2.5 years at 2–3 m height, maintaining three strong, healthy branches at the trunk base to form a much lower but wider canopy by regular pruning so that harvesting the fruits is easier (Plates 38a–38b). Pruning is necessary to

maintain a good canopy and healthy growth. Mr Abdul Wahab Bin Ahmad has experimented and applied this technique, which is more common in mango, to asam gelugor and this has now become a popular practice in Bukit Gantang as well in neighbouring villages, especially since the Department of Agriculture has been supporting and promoting this technique as part of the TFTGR project. Farmers have shown interest in applying the technique to new trees, but often do not want to apply it to already fully grown trees as they are afraid of reducing yield potential and damaging the tree.

Benefits to farmers

A team of researchers from the DOA, along with the above mentioned innovative custodian farmers, examined the techniques closely to understand and demonstrate their use and evaluate the potential to spread the techniques to other farmers and areas with similar conditions. Which particular method of propagation to be used in a particular situation is often dependent on the experience of the farmer and the purpose of growing asam gelugor. Farmers tend to prefer traditional propagation techniques when growing the trees in home gardens on a smaller scale, but prefer the grafting techniques and top working when growing them for commercial purposes. Among the four propagation techniques that were tried and evaluated within the TFTGR project, patch budding was found to be the most suitable and practical when growing for commercial scale. The propagation and pruning practices were demonstrated and validated from 2010 up to 2014 as part of the TFTGR project. Additionally, training was provided by the Department of Agriculture in collaboration with the identified farmers, and vegetatively propagated planting materials have been supplied to other farmers in the district. The patch budding technique has now been adopted by a few innovative farmers to improve the commercialization of asam gelugor for sales to generate income. Two training courses on vegetative propagation of *G. atroviridis* were conducted for 25 men farmers, two of whom established community nurseries. When combining patch budding with top working of trees, farmers get the following benefits:

- Farmers obtain only female trees with good yields as buds have been selected from heavily fruit bearing trees with high-quality fruits
- A tree can be productive within 3–4 years compared with 10 years from a seedling raised tree
- It is easy to harvest the fruit from the dwarf trees and this therefore reduces labour costs
- The dwarf trees allow the fruit to be harvested at the right stage and ripeness to ensure the quality of the finished product
- The risk of trees falling down due to strong winds and pest damage is reduced
- The techniques are simple and inexpensive and can be practised by farmers.

Impact on intraspecific and interspecific biodiversity

These propagation and management practices have helped farmers to continue growing *G. atroviridis*, thus maintaining its diversity in home gardens and orchards. Previously in Bukit Gantang, *G. atroviridis* was mainly grown for home consumption only, but with the introduction of the vegetatively propagated female seedlings, it has become a source of income for the farmers through the sale of its products. The production of female saplings combined with the top working technique creates more interest among farmers to plant this species for commercial purposes. It has increased the population size (number of trees planted) in the area. A total of 189 new *G. atroviridis* seedlings were planted in home gardens and orchards by the farmers in the study area during the period 2010 to 2014. Through the training of farmers on the use of grafting techniques such as patch budding, cleft grafting or the use of root cuttings, farmers make better use of the available intraspecific variability of *G. atroviridis* in Bukit Gantang as they select their scions or buds from a range of source trees. Besides, the growing interest in the species asam gelugor has increased the interest in home gardens and the mixed orchard system in general, as sources of promising species that can be commercialized.

Economic impact on livelihoods

Through the adoption of the techniques described above, combined with increasing market interest and demand, growing asam gelugor has become a livelihood activity that generates income. In the study site, an average home garden has about seven trees of asam gelugor from which each household obtains an extra income of RM300–600 (US$100–200) a month through selling fresh fruit or processed asam gelugor. In addition to this, the vegetatively propagated female saplings fetch a substantially higher price compared with undefined seedlings and thus provide additional income for those farmers who have obtained the skills to graft and multiply their most productive and high-quality female trees. The combination of specific propagation techniques and pruning methods makes it possible to grow asam gelugor on a larger scale within their home gardens and mixed orchards. From 2010 to 2014, 301 grafted seedlings were produced and sold at RM15.00 (US$5) per sapling. In addition, a total of 3,120 seedlings were produced directly from seed and were sold at RM10.00 (US$ 3.3) per seedling.

Scaling up and dissemination

Based on its special advantages, cultivation of asam gelugor should be maintained and enhanced to provide an additional source of income to the households in the community while it ensures the on-farm and *in situ* conservation of this species in the country. Propagation and production practices should be combined with the improved processing and marketing of

the processed product, asam keping. A set of farmer-friendly good marketing practices might include: (i) hands-on training on propagation and post-harvest techniques; (ii) specialized equipment such as a mechanized fruit slicer; (iii) good hygiene; and (iv) an all-weather drying structure that can help to improve the quality of asam keping (see Chapter 21 for more details). This good practice will be extended to other farmers in this area and also to other asam gelugor growing areas in Malaysia by introducing this technique using a 'peer to peer' group method and extension officers through a training programme organized by the DOA. The training will be on patch budding, topping, pruning and other aspects of on-farm management and good cultivation practices.

Conclusion

The difficulties in harvesting and in obtaining female trees had limited the potential of asam gelugor to become a popular, commonly grown tree species. However, the growing market demand for traditional local recipes and cuisine in Malaysia, the new application of dried gelugor as an ingredient for weight-loss products and other health-related products, combined with the successful use of improved propagation methods to multiply female trees, have increased the interest of farmers in its commercial cultivation. Farmers have found the following sets of propagation and pruning techniques useful to popularize this underutilized species:

- Inducing the growth of female trees by bending and stressing the taproot of saplings
- Patch budding and cleft grafting techniques to multiply female trees
- Traditional marcotting technique through root cuttings to multiply female trees from the forest
- Top working and pruning of trees to train tree height and reduce drudgery of harvesting.

The case of asam gelugor describes how market incentives can lead to new innovations in propagation and the continued cultivation of an underutilized species. However, to popularize a neglected species such as asam gelugor requires the concerted efforts of all stakeholders within the value chain, from farmers to retailers, including service providers such as researchers. In conclusion, this set of techniques has significant potential as it could be scaled out in other similar contexts in which this simple technique might contribute to farmers' livelihoods, food culture and income.

References

Corner, E.J.H. (1988) 'Wayside trees of Malaya', *Malayan Nature Society*, vol 1, pp. 351–359

Jarvis, D.I., Brown, A.H.D., Cuong, P.H., Collado-Panduro, L., Latourniere-Moreno, L., Gyawali, S., Tanto, T., Sawadogo, M., Mar, I., Sadiki, M., Hue, N.T.H., Arias-

Reyes, L., Balma, D., Bajracharya, J., Castillo, F., Rijal, D., Belqadi, L., Rana, R., Saidi, S., Ouedraogo, J., Zangre, R., Keltoum, R.O., Chavez, J.L., Schoen, D., Sthapit, B.R., Santis, P.D., Fadda, C., and Hodgkin, T. (2008) 'A global perspective of the richness and evenness of traditional crop genetic diversity maintained by farming communities', *Proceedings of the National Academy of Sciences PNAS (USA)*, vol 105, no 14, pp. 5326–5331; www.pnas.org/cgi/doi/10.1073/pnas.0800607105

Khairunnisa, S. (2005) 'Asam gelugor', *Berita Harian*, 27 June, pp. 8–9

Nazmi, M.S., Lamers, H.A.H., and Salma, I. (2013) *Baseline Report Malaysia for the UNEP-GEF Project Entitled: Conservation and Sustainable Use of Cultivated and Wild Tropical Fruit Diversity: Promoting Sustainable livelihoods, Food Security and Ecosystem Services*, GEF, UNEP, Bioversity and MARDI, Malaysia

Salma, I., Mohd. Shauqi, N., Shariah, U., Pearlycia, B., Wong, W.W.W., and Abd. Rahim, B. (2012) 'Distribution and diversity of *Garcinia* species on farm in six selected sites in Malaysia', poster presented during 1st Regional Conference on Agrobiodiversity Conservation and Sustainable Utilization (RAC-1), 25–27 September, Langkawi, Kedah, Malaysia

Note

1 From 2009 to 2014, Bioversity International coordinated a research-for-development project supported by the Global Environment Facility (GEF) with implementation support from the United Nations Environment Programme (UNEP) – 'Conservation and sustainable use of cultivated and wild tropical fruit tree diversity: sustainable livelihoods, food security and ecosystem services', abbreviated as 'the TFTGR Project'. This project, implemented in India, Indonesia, Malaysia and Thailand, focused on livelihood and environment benefits that people could derive from the conservation of species and varietal diversity of *Citrus*, *Garcinia*, *Mangifera* and *Nephelium*.