

Germplasm movement of selected underutilised multipurpose tree species in Sri Lanka

Hillmann, Boris M.^a, Hannah Jaenicke^b and Brigitte L. Maass^a

^a Department of Crop Sciences: Agronomy in the Tropics, Georg-August-University Göttingen, D-37077 Göttingen, Germany

^b International Centre for Underutilised Crops (ICUC), Colombo, Sri Lanka

Abstract

*Multipurpose trees play an important role for the livelihoods of rural and urban people in the tropics. Several species are typical components of homegardens. These species are mainly unimproved landraces. Tree improvement is a slow process because of the long time to flowering and fruiting. The International Centre for Underutilised Crops (ICUC), Colombo, Sri Lanka is studying the value of selected underutilised fruit tree species for income generation of small-scale entrepreneurs. In this study, jackfruit (*Artocarpus heterophyllus* Lam.), bael (*Aegle marmelos* (L.) Correa) and four different *Annona* species were surveyed. Although some improvement research has been done with jackfruit, improved planting material seems still confined to nurseries. No formal improvement activities appear to have been undertaken for either bael or the *Annona* species. Overall, little is known about the provenance and quality of planting material used in farms and whether or how improved lines find their way to the user. This work mainly aims to understand the diversity of sources of planting material found in homegardens and, consequently, describe germplasm flow. For the study, two locations of Sri Lanka were selected where ICUC is active: Kandy and Galle. Semi-structured interviews of 30 farmers and about 10 nursery operators per location were conducted. Differences between locations were established by applying several diversity indices (Sørensen's coefficient, Shannon's and Simpson's indices). The germplasm movement for the selected species seemed to be very weakly developed. Additionally, farmers were not aware of the importance of improved varieties. The results of this study indicate not only the need for research and development in these underutilised multipurpose trees but also for more effective dissemination activities.*

Key words: agroforestry, underutilized crops, genetic resources, multipurpose trees, homegarden, *Artocarpus heterophyllus*, *Aegle marmelos*, *Annona*, germplasm movement, Sri Lanka.

2 Introduction

Small-scale enterprises processing underutilised fruits in Sri Lanka need steady access to quality raw materials which they receive from nearby farming communities (ABEYRATHNE & JAENICKE, in press). In our study we wanted to investigate from where farmers receive planting material for three underutilised fruit tree taxa: *Artocarpus heterophyllus* Lam. (jackfruit), *Aegle marmelos* (L.) Correa (bael) and *Annona* spp. (annona), and whether there is significant use of improved varieties. These taxa are predominantly grown in homegardens or agroforestry systems which provide small-scale farmers with the basic needs for their livelihoods. These systems are very species-rich and includes several fruit tree species which are grown for home consumption or sale of produce (AMARASINGHE ET AL., 1997).

2.1 The species

Jackfruit is one of the most common fruit tree species in Sri Lanka (HITINAYAKE ET AL., 1996; SENARATNE & AMARASHINGE, 1996). Improved jackfruit cultivars have been developed and several varieties and cultivars are now known in Sri Lanka (MEDAGODA & TENNAKOON,

2001). In general, jackfruit growers distinguish two major types, namely firm-fleshed varieties and soft-fleshed varieties, which are called Waraka and Wela, respectively. The tree is grown mainly in homegardens or forest plantations (WATANABE & DASSANAYAKE, 1997) in the humid zone of the island. The main fruiting season is during March to June with a minor season from November to January (DEPARTMENT OF AGRICULTURE, 1997; MEDAGODA & TENNAKON, 2001). Because of its high content in carbohydrates, jackfruit is also called “rice tree” or “poor man’s food”. It is a good substitute staple food in periods of shortness of rice or other main staple crops (NISSANKA & MARAMBE, 1996). Due to its importance as a tree providing food, timber, fuel, fodder, medicinal and industrial products it is highly recommended by ICUC (2003).

Annona cherimola Mill. (cherimoya), *A. muricata* L. (soursop), *A. reticulata* L. (custard apple) and *A. squamosa* L. (sugar apple) are small trees which are grown mainly for their fruits, but for medicinal purposes the trees can be used as well (ICUC, 2002). Different cultivars or botanical forms are known for cherimola, soursop and sugar apple (DE Q. PINTO ET AL., 2005). The major growing area in Sri Lanka for *A. muricata* is the wet and intermediate zone of the island.

Bael, of the Citrus family and originated in India, is mostly grown in agroecological zones with a distinguished dry period, although the plant needs a lot of water during flowering and fruit bearing season (SUNARTO, 1992). In Sri Lanka the tree is found only in cultivation and beside the fruit, which is usually eaten fresh but also processed in form of cream or juice, all parts of the plants are used, mostly for medicinal purposes (DE SILVA, 1992; WATANABE & DASSANAYAKE, 1997). Different types with variation in size and shape of fruit are known (PUSHPAKUMARA, 2004).

2.2 Germplasm sources

The Agricultural Information Centre of the Southern Asian Association for Regional Cooperation (SAARC) lists 11 mostly private suppliers for seeds or planting material in Sri Lanka (ISLAM, 2003), but only one of them, the Seed & Planting Material Development Centre of the Department of Agriculture (DoA) in Peradeniya, offers fruit trees. Since the Sri Lankan government decided to shift production of seeds and planting material in 1999, towards the private sector, i. e. for paddy rice, potato and or vegetables, there exist only few nurseries for fruit crops owned by the DoA. About 200 registered private nurseries are provided with technical assistance to meet the national demand. A limited number of mainstream species, such as mango and rambutan were targeted by the government for this programme. Extension to other species is under consideration (DEPARTMENT OF AGRICULTURE, 1999) and government farms producing planting material of such underutilised species can be found in Bandaragama and Horana.

3 Material and Methods

In the administrative districts of Kandy-Kegalle and Galle, semi-structured interviews (MARTIN, 1995) were conducted with 30 farmers each and 12 and 11 nurseries, respectively. Concerning the main focus on jackfruit, bael and annona, farmers were selected on the basis of whether they grew either bael or annona – whereas jackfruit was assumed to be grown in every homegarden. In order to achieve a broad sampling base, farmers were identified in different locations of the survey area with different connections to main roads and different distances to local nurseries (MARTIN, 1995). Nursermen were interviewed when they offered any fruit trees at all. At the time of interview, data was collected about all other fruit tree species grown in the homesteads to understand better the importance underutilised fruits play in the farmers’ livelihood systems.

Data was analysed by using MS Excel for basic statistics. Diversity was calculated using Simpson's index, Shannon index and Sørensen's coefficient (KREBS, 1999).

4 Results

4.1 Nurseries

Nurseries used more diverse propagation techniques in Kandy-Kegalle than in Galle. However, at both sites budding was the technique most applied for *Artocarpus heterophyllus*. In general all taxa were produced or offered vegetatively propagated. Only few nurseries used seeds for propagation.

Planting material was sourced from the nursery operators' own land. Nursery operators also obtained stock from other nurseries (mainly government nurseries) or sourced propagation material from trees in the surrounding area (Tab. 1). A remarkable difference between the two sites was the use of government nurseries as source for planting material. Whereas in Kandy-Kegalle, only jackfruit was sourced from these nurseries, in Galle, a large number of mostly vegetatively propagated bael was obtained from that source and, in one case, annona. (Tab. 1).

Whereas in Kandy-Kegalle planting material was mainly sourced from own land or up to 10 km distance, a remarkable portion of germplasm in Galle came from over 100 km away (Tab. 2).

Tab. 1. Sources of fruit tree planting materials in nurseries of two locations in Sri Lanka

Site/ Species	No. of nurseries	own nursery/ land % (n)	neighbour/ friend % (n)	other nursery % (n)	surrounding area % (n)	local market % (n)
Kandy-Kegalle						
<i>Aegle marmelos</i>	4	50.0 (2)	0.0 (0)	0.0 (0)	25.0 (1)	25.0 (1)
<i>Annona</i> spp.	3	66.7 (2)	0.0 (0)	0.0 (0)	33.3 (1)	0.0 (0)
<i>Artocarpus heterophyllus</i>	11	45.5 (5)	9.1 (1)	63.6 (7)	27.3 (3)	0.0 (0)
Galle						
<i>Aegle marmelos</i>	5	40.0 (2)	0.0 (0)	60.0 (3)	20.0 (1)	0.0 (0)
<i>Annona</i> spp.	4	50.0 (2)	0.0 (0)	25.0 (1)	50.0 (2)	0.0 (0)
<i>Artocarpus heterophyllus</i>	7	42.9 (3)	0.0 (0)	42.9 (3)	28.6 (1)	0.0 (0)

Tab. 2. Distances of fruit tree planting material sourced by nurseries from two locations in Sri Lanka

Site/ Species	No. of nurseries	own nursery/ land % (n)	< 10km % (n)	> 10-50 km % (n)	> 50-100 km % (n)
Kandy-Kegalle					
<i>Aegle marmelos</i>	4	50.0 (2)	50.0 (2)	0.0 (0)	0.0 (0)
<i>Annona</i> spp.	3	66.7 (2)	33.3 (1)	0.0 (0)	0.0 (0)
<i>Artocarpus heterophyllus</i>	11	45.5 (5)	54.5 (6)	18.2 (2)	18.2 (2)
Galle					

<i>Aegle marmelos</i>	5	40.0 (2)	20.0 (1)	0.0 (0)	60.0 (3)
<i>Annona</i> spp.	4	50.0 (2)	50.0 (2)	0.0 (0)	25.0 (1)
<i>Artocarpus heterophyllus</i>	7	14.3 (2)	28.6 (2)	0.0 (0)	42.9 (3)

4.2 Farmers

Most farmers obtained the planting material in form of seeds or fruits. Outstanding was the high portion (72.6%) of *Aegle marmelos* seedlings that were found in Galle. The relatively high number of farmers that could not give information about the kind of planting material that they received in Kandy-Kegalle was due to the relatively high number of trees that were already on the land when these farmers settled down (Tab. 5).

The sources of planting material for farmers were more diverse than for nurseries (Tab. 1). Whereas in Kandy only annona planting material was generally sourced from neighbours/friends, this was the case for all species in Galle. Family members were more important donors of planting material in Galle (Tab. 6).

In Kandy-Kegalle more trees were already on the land when farmers settled there. For the majority of the farmers in Kandy-Kegalle and Galle the source of planting material was located in the same village (Tab. 6).

Tab. 5. Planting material of fruit trees sourced by farmers from two locations in Sri Lanka

Species	No. of farmers	own land	neighbour/ friend	nursery	surrounding area	local market	family member	naturally grown	unknown
Kandy-Kegalle									
<i>Aegle marmelos</i>	16	12.5 (2)	12.5 (2)	6.3 (1)	0.0 (0)	6.3 (1)	0.0 (0)	0.0 (0)	62.5 (10)
<i>Annona</i> spp.	27	0.0 (0)	48.1 (13)	11.1 (3)	0.0 (0)	14.8 (4)	7.4 (2)	3.7 (1)	14.8 (4)
<i>Artocarpus heterophyllus</i>	28	7.1 (2)	17.9 (5)	7.1 (2)	3.6 (1)	3.6 (1)	10.7 (3)	3.6 (1)	46.4 (13)
Galle									
<i>Aegle marmelos</i>	22	4.5 (1)	31.8 (7)	9.1 (2)	0.0 (0)	18.2 (4)	27.3 (6)	0.0 (0)	9.1 (2)
<i>Annona</i> spp.	28	7.1 (2)	35.7 (10)	10.7 (3)	0.0 (0)	7.1 (2)	17.9 (5)	3.6 (1)	21.4 (6)
<i>Artocarpus heterophyllus</i>	30	10.0 (3)	46.7 (14)	6.7 (2)	3.3 (1)	0.0 (0)	16.7 (5)	0.0 (0)	20.0 (6)

Tab. 6. Distances of fruit tree planting material sourced by farmers from two locations in Sri Lanka

Species	No. of farmers	already on land	own land	same village	< 10 km	< 50 km	< 100 km	unknown
Kandy-Kegalle								
<i>Aegle marmelos</i>	16	62.5 (10)	0.0 (0)	18.8 (3)	6.3 (1)	0.0 (0)	6.3 (1)	6.3 (1)
<i>Annona</i> spp.	27	11.1 (3)	3.7 (1)	59.3 (16)	11.1 (3)	7.4 (2)	3.7 (1)	3.7 (1)
<i>Artocarpus heterophyllus</i>	28	32.1 (9)	7.1 (2)	32.1 (9)	7.1 (2)	0.0 (0)	3.6 (1)	17.9 (1)
Galle								
<i>Aegle marmelos</i>	22	0.0 (0)	4.5 (1)	31.8 (7)	22.7 (5)	9.1 (2)	0.0 (0)	9.1 (2)
<i>Annona</i> spp.	28	0.0 (0)	3.6 (1)	57.1 (16)	10.7 (3)	10.7 (3)	0.0 (0)	10.7 (3)

<i>Artocarpus heterophyllus</i>	30	13.3 (4)	10.0 (3)	63.3 (19)	20.0 (6)	0.0 (0)	0.0 (0)	6.7 (2)
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4.3 Biodiversity

Over 40 fruit tree species were found in the homegardens and only slightly fewer in the nurseries. Comparing data by using both Shannon and Simpson indices, we conclude that the Shannon index is a better measure to show the differences in diversity among the different sites and groups. (Tab. 7).

The species composition between the groups for all species is almost identical, whereas farmers in Galle and Kandy-Kegalle do not share many cultivars of *Artocarpus heterophyllus* (Tab.8).

Tab. 7. Biodiversity in fruit trees and *Artocarpus heterophyllus* assessed in two locations of Sri Lanka

Site	Simpson	Shannon	No. of species/ cultivars
All fruit trees			
F Kandy-Kegalle	0.96	3.46	41
F Galle	0.96	3.44	40
N Kandy-Kegalle	0.96	3.48	38
N Galle	0.96	6.90	37
<i>Artocarpus heterophyllus</i>			
F Kandy-Kegalle	0.53	0.93	4
F Galle	0.64	1.21	6
N Kandy-Kegalle	0.81	1.51	5
N Galle	0.81	1.72	6

F= Farmer, N= Nursery

Tab. 8. Similarity of fruit trees and *Artocarpus heterophyllus* diversity kept by farmers or nurseries between Kandy-Kegalle and Galle, Sri Lanka

Site/ Species	Sørensen
F all species	0.98
F <i>Artocarpus heterophyllus</i>	0.60
N all species	0.88
N <i>Artocarpus heterophyllus</i>	0.73

F= Farmer, N= Nursery

5 Discussion

Although the three taxa studied in this project are so-called underutilised or neglected fruit trees, most of the nurseries offered vegetatively propagated planting material. In most cases, seedlings of jackfruit were not produced in private nurseries but in nurseries run by NGOs or the government (data not shown). Private nurseries in our sample were more orientated towards ornamental plants and major fruit species, such as citrus or mango, where they expected a higher demand. The efforts of the DEPARTMENT OF AGRICULTURE (1999) to provide supply systems with improved planting material most likely is the reason for this result. In Kandy-Kegalle many nurseries received their jackfruit seedlings from the Seed &

Planting Material Development Centre of the Department of Agriculture in Peradeniya (ISLAM, 2003) and, therefore, distances of pathways from this government nursery to other nurseries in the district are not very far (Tab. 2). The fact that farmers and nursery operators travelled far to obtain planting material of jackfruit underlines its local importance (Tab. 2, 6) (NANAYAKKARA, 1991; SENARATNE & AMARASHINGE, 1996). However, in Galle district generally, many nurseries had to source their planting material from very far away (Tab. 3) because no government farms or government nurseries were located here. Much of the planting material offered in nurseries in Galle originated from Horana (data not shown), where several registered farmers and the Fruit Crops Research and Development Centre produce fruit trees (pers. comm. K. D. A. PERERA). As well as sourcing from other nurseries, the majority of the nurseries interviewed and dealing with these taxa sourced the germplasm from their own land or from the surrounding area (Tab. 1), where they usually only used one mother tree. Only for jackfruit, some entrepreneurs used more trees (data not shown). Different from nursery operators, farmers usually obtained planting material as seeds or fresh fruits which were left to germinate.

Only in Galle and mainly for *Aegle marmelos* could we find the use of seedlings rather than seed or fruits as preferred form of planting material in farmers' homegarden, possibly influenced by an increased number of support projects following the 2004 tsunami. The relatively high number of farmers in Kandy-Kegalle who did not know from which form of planting material their trees originated (Tab. 5) was related to the higher proportion of old trees in Kandy-Kegalle and the fact that most trees were already on the land (Tab. 6) when farmers settled there. Only few farmers gathered planting material with the intention to plant a tree (indicated by the small numbers of entries in the "own land" and "nursery" categories in Tab. 5, while all other categories indicate a more opportunistic approach). Very often, farmers received a fruit as a gift from neighbours/friends or family members (Tab. 5), who lived in the same village (Tab. 6). The establishment of fruit trees was then often the result of discarded fruits germinating and the new seedlings being kept and nurtured. The germplasm movement for these species generally took place on a very low level and did not reflect the aims of the DEPARTMENT OF AGRICULTURE (1999). Only two improved cultivars of *Artocarpus heterophyllus* ("18 month variety", "Rosa Kos"), which were also offered in nurseries both in Kandy-Kegalle and Galle, could be found in homegardens in both locations (data not shown).

Although there was no big difference in biodiversity between the two locations (Tab. 7) concerning nurseries and homegardens, a clear difference in the use of jackfruit varieties (Tab. 8), especially the 'Waraka' form, could be detected. In both sites, two cultivars were known that did not appear in the other (data not shown). The total number of fruit tree species found during this survey was consistent with the 41 fruit tree species that were earlier found by HITINAYAKE ET AL. (1996) in Kandy district. The number also indicates a relatively good supply with home-grown fruits for farm families in Sri Lanka.

6 Conclusions

Although most nurseries offered vegetatively propagated or improved planting material of the three taxa investigated, we could not find a link to the trees planted on farms. Only very few farmers sourced planting material with the intention to plant a tree, and even fewer bought planting material from nurseries. The majority of the farmers did not consider these taxa as important, in part due to a (perceived) lack of a market and, consequently, cash income generation possibilities.

Efforts for increased movement of improved germplasm was started by DoA since 1999 with the provision of planting material to nurseries (and farmers) and encouraging the private sector to produce these species. To further these efforts the extension service needs to be strengthened and farmers' awareness for the advantages of improved planting material needs to raise.

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