DOMESTICATION OF INDIGENOUS FRUIT AND NUT TREES FOR AGROFORESTRY IN SOLOMON ISLANDS

Thesis submitted by

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I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

I declare also that all research procedures reported in the thesis received the approval of the James Cook University Ethics/Safety Review Committee. Assistance received from others towards this thesis is duly acknowledged.

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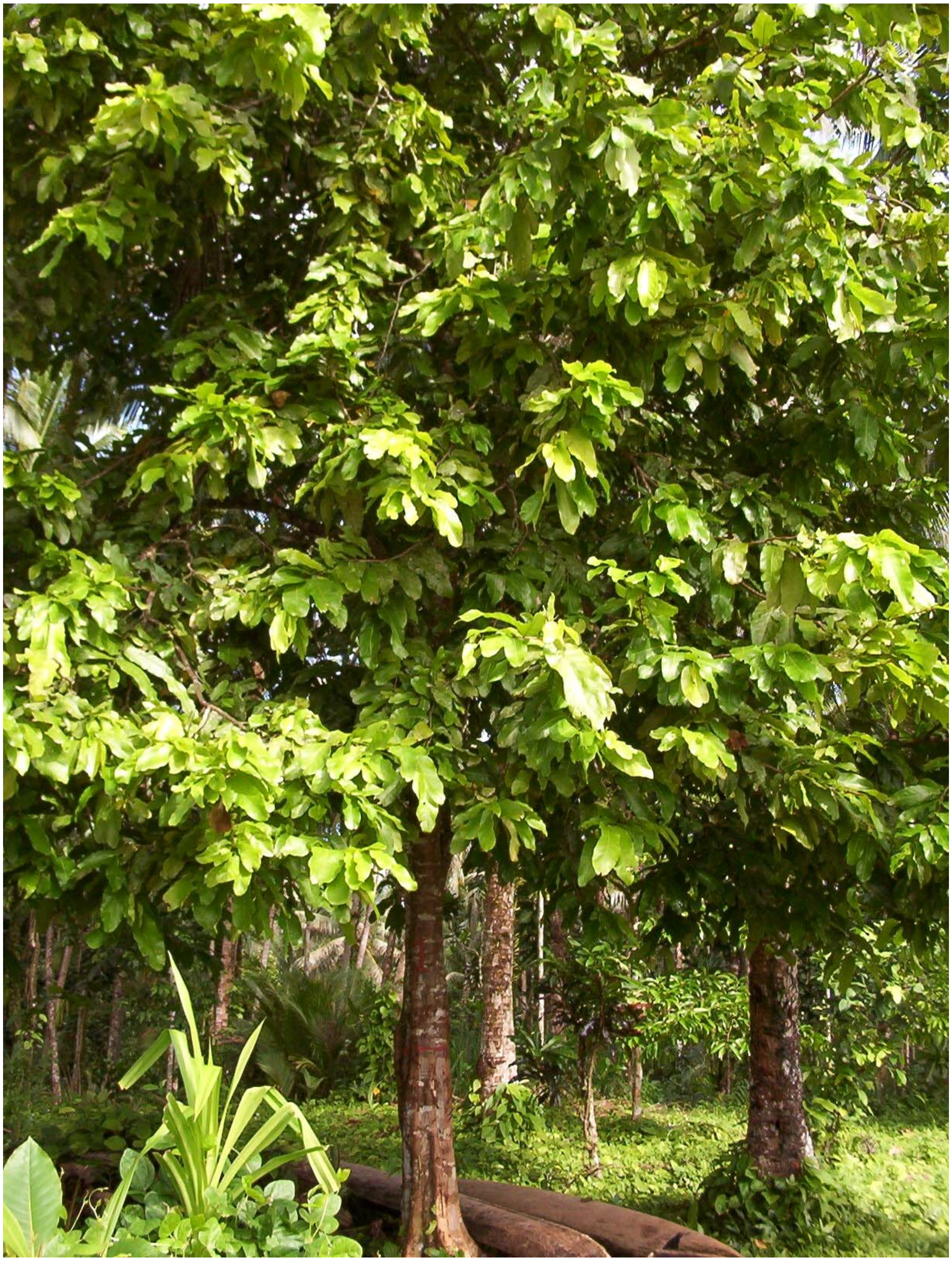
Mature trees of *Barringtonia procera* (Cutnut). Poporo village in Kolombangara, Solomon Islands.



Mature tree of *Inocarpus fagifer* (Tahitian chestnut). Tututi village in Kolombangara, Solomon Islands.

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ABSTRACT

In the Solomon Islands subsistence agriculture, monoculture plantations, new settlements and commercial timber extraction have resulted in indiscriminate deforestation. Agroforestry is an approach to sustainable landuse aimed at reversing these land degradation processes worldwide. In recent years, the domestication of indigenous fruit and nut trees has been added to the package of techniques making agroforestry more effective. By improving the livelihood benefits derived from agroforestry, the domestication of agroforestry trees is becoming a tool for the alleviation of the severe ecological and socio-economic problems of many developing countries.

This thesis describes research to develop techniques for the domestication of indigenous nut tree species in the Solomon Islands. The first step was to determine which species the local communities considered to be their top priorities for domestication. Consequently, participatory surveys were undertaken in 155 households from five villages (Ringi, Seusepe, Rei, Poporo and Hunda) around Kolombangara Island. These surveys identified that *Barringtonia procera* (Cutnut) and *Inocarpus fagifer* (Tahitian chestnut) were the species that were most important as a source of food and income, while also filling in critical niches in the farming systems. A review of the literature found that very little is known about the biology of either species and that no previous studies had been done to domesticate these species. Farmers, however, confirmed that they were growing seeds from trees with desirable nut characters.

The next step was to quantitatively characterise the phenotypic variation in the dry matter partitioning between different components of fruits and nuts from the five target villages. Whenever possible, 24 fruits were collected from each of 119 trees of *B. procera* and separated into their components (pulp, nut and kernel) for measurement. Within each population, highly significant (P= 0.001) and continuous intraspecific variation was found in all the measured traits. However, site-to-site variability was not significant. This quantitative data was also used to:

(i) identify the market-oriented traits which could be combined to describe the 'ideal tree' or 'ideotype', in which 'Harvest Index' is maximised through the partitioning of dry matter to the commercially and domestically important kernel, (ii) identify the elite trees, which could be vegetatively propagated and (iii) ascertain through an anlaysis of the frequency distribution of the data, the degree to which farmers have already from their own actions initiated the domestication process.

This study was complemented by a molecular study of genetic variation in each population. This molecular study found significant genetic diversity within and between the five populations of *Barringtonia procera*. It was also used in parallel with the morphological data, to evaluate: (i) the relatedness of three edible species of *Barringtonia*, and (ii) the relatedness of elite trees within the five populations. The results imply that the field collections failed to accurately distinguish the different species because of overlapping morphological characteristics. There was no conclusive evidence of any hybridisation between these species, it was clear that elite trees were generally unrelated. Further studies are required to elucidate the taxonomy of the three species.

The final section of this thesis examined the factors which affect the rooting ability of both *B. procera* and *I. fagifer* stem cuttings. These results are then used to define the most appropriate material and techniques for the development of robust vegetative propagation protocols for village scale nurseries. Both species were found to be easily propagated by single-node, leafy, stem cuttings. Seventeen experiments tested the main factors known to affect the rooting of tropical tree cuttings. It was found that auxin (indole-3-butyric acid) did not significantly increase the rooting percentage, although there were significant differences in the numbers of roots formed, which in both species were maximal with 0.8% IBA. There were no consistent significant differences between cuttings from different nodes. However, the presence of a leaf was essential for rooting with 100% mortality in leafless cuttings of *I. fagifer* and 79 % mortality in *B. procera*. Both species, regardless of leaf area, leafy cuttings had 77-100% rooting success.

Having identified the optimal treatments for stem cuttings from juvenile trees, the study progressed to an examination of one of the major constraints to developing cultivars from mature trees of any species, namely how to root cuttings taken from the mature (ontogenetically-mature) crown. Three approaches were examined:- (i) a comparison of the rooting ability of juvenile seedlings and shoots from potted mature marcots; (ii) a study of the factors affecting the successfulness of marcotting (air-layering) and (iii) the separation of physiological and ontogenetic ageing in the intact tree crown. In *B. procera*, juvenile cuttings from seedlings rooted better than cuttings from mature potted marcots, because the latter suffered leaf abscission. In *I. fagifer* mature and juvenile cuttings both rooted well. Shading mature stockplants of *B. procera*, however, significantly improved rooting ability of mature cuttings. Marcots of both species rooted 100% and a few factors were found to reduce this, although survival of the marcots declined if they were not harvested within 3-4 months. Attempts to separate ontogenetic and physiological ageing within the mature crown were partially successful, resulting in shoots which were comparable morphologically. However, enhanced rooting percentages were not consistently achieved across all treated shoots. Nevertheless, the number of roots per rooted cutting was significantly increased in the treated mature shoots.

Marcotting resulted in establishment of mature stockplants in the nursery, which can be used in future as the source of mature cuttings for further work to develop cultivars from selected elite individuals.

In conclusion, this study has developed robust and simple techniques which are appropriate for the domestication of *B. procera* and *I. fagifer* in remote communities in the Pacific, like Kolombangara Island. This opens the way for a programme of participatory domestication for these indigenous nuts in the Solomon Islands. This should greatly enhance the opportunities to commercialise indigenous nuts and to use them as a means to enhance income generation and to improve the livelihoods of rural people, as well as to develop more sustainable agricultural production systems based on agroforestry.

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