VARIATION IN WOOD DENSITY AND FIBRE LENGTH AMONG GREVILLEA ROBUSTA (A. CUNN EX R.BR.) FAMILIES GROWN IN WESTERN KENYA

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Abstract:
This paper reports on the variation of specific gravity and fibre length among *G. robusta* families grown at Kodera Forest in Western Kenya. It also states the correlation between these properties and the environmental and growth factors.

Grevillea robusta is a high priority farm forestry tree of economic importance in East and Central Africa. It provides a variety of wood products with little interference to the adjacent crops. The wood properties of *Grevillea robusta* in general and specific gravity and fibre length in particular are not much studied. Reported information on variation of specific gravity and fibre length among *G. robusta* families is also scanty.

Wood samples for the study were taken from a half-sib progeny trial of *G. robusta*, planted at Kodera in 1991. The 3.5 years old trial had stands representing 36 families from 14 provenances of natural stands of Australian families and 12 Kenyan families. An incomplete block design, with accessions replicated in different plots had been used in the experiment. Linear plots, each of ten trees and an initial spacing of 2 m x 2 m were used.

Three trees per family were sampled at random for the determination of the wood properties. Samples for the wood properties were obtained at the intersection of the Magnetic North Direction (MN) and Breast Height points. The specific gravity was determined using the water displacement method (Browning, 1967) while a loupe graticule was used to measure lengths of fibres obtained using Franklins' method of maceration. The growth factors for each tree sampled were assessed as well.

Significant variations in the wood properties among the families were revealed. Families from Australia have higher specific gravity than the Kenyan selections, however the latter have longer fibres than the former. Specific gravity had significant correlation with environmental and growth factors while fibre length had significant association with growth factors only.

It is concluded that, at 3.5 years, *G. robusta* can be selected for specific gravity and fibre length and can be thinned for firewood, aerial biomass and possibly for pulp production for wrapping and packaging purposes. It is recommended the provenances from high altitudes in Queensland be considered for dense wood and the Kenyan selections for long fibre production in future genetic improvement programmes.

Key words: *Grevillea robusta,* specific gravity, fibre length and provenance/family variation, Kenya and Australia.

Introduction

Grevillea robusta A. Cunn. ex R. Br. is one of the high priority species for Agroforestry development in the highlands of East and Central Africa (ICRAF, 1994). It was introduced in the region early the parts of the 20th century as a shade tree in coffee and tea plantations. Local populations of *G. robusta* in Kenya are from a few natural provenances in Australia (Harwood et al. 1992).

Currently, *G. robusta,* is a farm forestry tree of economic importance. It is grown on farm boundaries and in woodlots, providing sawn timber, veneer, cabinet and joinery timber, poles, firewood and leaf mulch while interfering relatively little with adjacent cash and food crops (Harwood and Owino, 1992). *G. robusta* also produces pulp of good quality (Harwood, 1989). For example, it has been shown that paper made from 100% unbleached *G. robusta* pulp is ideal for ordinary wrapping and packaging purposes. However, for the manufacture of higher-grade paper, the use of an admixture of some long-fibre pulp is recommended to improve on its low tear factor (Ghosh, 1972).

Very limited studies have been conducted on the wood properties of *Grevillea robusta* in general and specific gravity and fibre length in particular. Specific gravity is the most important determinant of the strength properties of wood (Panshin and Carl de Zeeuw, 1980). It is also a critical determinant of wood working properties (Bamber, 1978). In general, species with high specific gravity have correspondingly high strength values.

In contrast to specific gravity, fibre length has not been shown to influence wood properties in hardwoods. However, it is an important characteristic determining paper strength and therefore of importance in plantation forestry (Metcalfe et al., 1983; Bhat et al. 1990). Unfortunately much of the research on hardwoods in this subject is confined to a few tree genera such as *Eucalyptus, Populus, Gmelina, Fagus, Betula, Albizia and, Acacia*, (Giertz, 1995 & Singh *et al*. 1991). Very few studies have been done on fibre length of *G. robusta.* Istas *et al*. (1954) reported a mean of 1.62 mm for mature trees of *G. robusta* and Kalinganire (1992), a range of 1.18 mm to 1.46 mm for 2.5-year-old trees.

Reported information on variation of specific gravity and fibre length among *G. robusta* families is scanty. However, for a fair tree improvement programme, information on the variation of wood properties among provenances and families is crucial. There was therefore need to fully evaluate the extent of variation in wood properties for the existing genetic resources of this species.

This paper reports the results of a study on the wood quality of *G. robusta* families grown at Kodera Forest in Western Kenya. A family in this context means the offspring of a single tree after open pollination. The objectives of the study were:

1. To determine the specific gravity and fibre length of 12 families from Kenyan landraces selections and 36 families from Australian natural stands: and their variation among families.
2. To establish the correlation between environmental factors at the places of origin and growth parameters and wood properties of the 36 families of *Grevillea robusta* from Australia grown at Kodera (Western Kenya).

Materials and methods

Study area

Wood samples were taken from a half-sib progeny trial of *G. robusta,* planted at Kodera Forest in September-October 1991. Kodera Forest is situated about five kilometres from Oyugis Township in Homa Bay District, in Nyanza province. The Kodera site (0°40'S, 34 ° 45'E; 1600 m a.s.l) slopes gently (less than 5%) and has a southwesterly aspect. The mean annual precipitation is 1600 mm, with a bimodal distribution (February-May and September-December). The mean annual temperature is about 18°C. According to Matungulu (1995; personal communication) the soils are classified as fine-silty, mixed, isohyperthermic plinthic eutrustox (Soil Survey Staff, 1992) with a pH of 5.5. Soils are deep and well drained.

Plant materials

The trial incorporated stands representing 36 families from 14 provenances of natural stands of Australian families and 12 Kenyan families (Appendix 1). The Tree Seed Centre of the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Canberra supplied the Australian material. The Multipurpose Tree Improvement and Management Programme (MPT) of the International Centre for Research in Agroforestry (ICRAF), Nairobi collected the Kenyan families.

Experimental design

The experiment conformed to incomplete block design, accessions represented in different replicates. However, only families represented in three consecutive replicates were retained for wood samples. Blocks were aligned along contours. Linear plots each consisting of ten trees and an initial spacing of 2 m x 2 m were used.

Management of the experiment

The site was prepared by manual clearance and then cultivated by hoes before planting. The area was a clear felled first rotation plantation of *Cupressus lusitanica*. Cypress stumps were dug out prior to planting. Complete weeding was carried out in January and July annually. A firebreak cleared at every weeding provided protection against fire.

Wood sampling and analysis

Wood sampling was done in April 1995. Total height, diameter at breast height, crown diameter (crown width) and branch density were assessed as well.

For wood properties one tree per replicate per family was sampled at random (i.e. 36 Australian and 12 Kenyan families) from the 3 replicates. Before felling the sampled trees, Magnetic North Direction (MN) and Breast Height (BH) (at 1.3 m) points were marked on the standing trees using a sharp knife.

Wood billets 20 cm long extending 10 cm above and below breast height were taken from the stems of the sampled and felled trees. These were labeled on the two cut surfaces using permanent ink, clearly indicating family, tree and replicate numbers, before being transported to Kenya Forestry Research Institute (KEFRI)'s forest products laboratories at Karura, Nairobi for analyses. Two discs each of 1 cm thickness were obtained from each section at breast height point (BH), one for the specific gravity determination and the other for the fibre length.

Specific gravity.

Wedge shaped samples each of 1 cm thickness were obtained from a quarter of the disc at the intersection of the MN and BH points. Sampling positions were similar in all samples.

The water displacement method (Browning, 1967) was used to determine specific gravity. The specific gravity was then calculated as follows:

SG = D/V
Where:
SG is the specific gravity,
D is the oven dry weight of wood in grams and
V is the weight of water in grams displaced by the specimen

Fibre length.

Strips of about 4 mm x 4-mm dimensions cut from the intersection of MN and BH points were used for fibre length measurements. Maceration of the samples was done with a 1:1 mixture of analar glacial acetic acid and 20-volume hydrogen peroxide solution in labelled test tubes, heated in a water bath for four hours until samples became whitish in colour. After washing with distilled water a small portion of each sample was shaken in different test tubes to give a suspension of single fibres. The fibres were then stained with safranin solution before placing a drop on a microscopic slide for measurement.

Each fibre was measured to the nearest 0.01 mm using a scale loupe graticule at 15X magnification. A total of 30 unbroken fibres were measured from each sample. Only those fibres lying parallel to the graticule were measured minimizing observer bias.

Statistical analysis

Plot means were calculated and used in the analysis of variance (ANOVA) without any transformation. The data was subjected to analyses of variance of treatments (specific gravity and fibre length) mean values. The model was of the form:
(Observation) = (overall mean) + (replicate effect) + (family effect) + (residual) or symbolically

$y_{ij} = \mu + p_i + t_j + \sum_{ij}$ (Williams and Matheson, 1994).

Where: y_{ij} are means of j^{th} replicate of the i^{th} treatment, μ is the overall mean, pi is the replicate effect of the ith treatment, r_j are observations for the j^{th} replicate and the $\sum_{ij}$ are the residuals in the model.

The relationship between environmental factors at the places of origin in Australia (altitude, latitude, longitude, rainfall and temperature), growth parameters (total height, diameter at breast height, crown diameter and branch density) and the wood properties were established by regression/correlation analysis.

Results and discussion

Specific gravity

The minimum, the maximum and the mean specific gravity values were 0.42, 0.60 and 0.51 respectively for. These results indicate that at 3.5 years, *G. robusta* has attained a reasonable specific gravity almost the same as that of mature trees from the same species. At mature age, *G. robusta* has specific gravity values ranging from 0.54 to 0.66 (Chichignoud and Sales, 1981; Webb *et al*. 1984) while younger trees (2.5 years old) have specific gravity values ranging from 0.39 to 0.47 (Kalinganire, 1992).

There were significant differences ($P<0.001$) in the specific gravity between the progenies. The progenies with the highest and lowest mean specific gravity values are given in Table 1. The families with highest specific gravity values were from Porters Gap provenance in Queensland (0.59.0.57 and 0.56) and Duck Creek in New South Wales (0.56). The progenies with the lowest specific gravity values were from: Gatuatine Meru (0.48), *Grevillea* NSW (0.47), Nkubu Meru (0.47), *Grevillea* NSW (0.46) and Mann River NSW (0.46).

The correlation between environmental factors and Specific gravity.

There was linear association between specific gravity of the Australian families and factors of the environment (altitude, latitude and longitude) at the place of origins (Table 2). The higher specific gravity for the four families from Porters Gap provenance could be linked to the higher altitude and the influence of latitude and longitude parameters. However, the predictive value of their equations were low, the coefficient of determination in percentage being below 40%.

The correlation between growth parameters and specific gravity.

Growth parameters (height, diameter at breast height and crown width) were also positively correlated with specific gravity, (Table 2). However, the predictive values of their equations were also low.

Table 1: The progenies with highest and lowest mean specific gravity values out of the 48 *Grevillea robusta* families grown at Kodera (Western Kenya).

Family code	Provenance/family details	Specific gravity
Highest Five Families		
17694 T9	Porters Gap, Queensland	0.59
17694 T4	Porters Gap, Queensland	0.57

17694 T8	Porters Gap, Queensland	0.57
17694 T1	Porters Gap, Queensland	0.56
17614 CEH 29	Duck Creek, New South Wales	0.56
Lowest Five Families		
K8G039	Gatuatine, Meru, Kenya	0.48
17613 CEH 23	Grevillea, New South Wales	0.47
K8G045	Nkubu, Meru, Kenya	0.47
17613 CEH 24	Grevillea, New South Wales	0.46
17620 GJM 989	Mann River, New South Wales	0.46
Mean of families (n = 48)		0.51
Standard error of differences		0.03
Coefficient of variation (%)		6.7
F-ratio of families		2.14
Significance level		***

Table 2. Correlation coefficients (r) of environmental and growth factors and wood properties of *Grevillea robusta families* from Australia grown at Kodera.

Variables	Specific gravity (r values)	Fibre length (r values)
Altitude	0.33*	0.14
Latitude	0.57**	0.26
Longitude	0.49**	0.20
Total height	0.47**	0.59**
Diameter at breast height	0.53**	0.62**
Crown width	0.32*	0.36*
Branch density	0.07	0.10

n = 36
* Indicates significance at 0.05 probability
** Indicates significance at 0.01 probability

Fibre length

The minimum, the maximum and the mean fibre lengths for all the families were 1.4 mm, 1.89 mm and 1.64 mm respectively. The results indicate that at 3.5 years, *G. robusta* has a mean fibre length (1.64 mm) similar to that in mature trees (1.62 mm) (Istas *et al*. 1954) and higher than that of 2.5 years old ones (1.18 mm to 1.46 mm) of the same species (Kalinganire, 1992). A mean fibre length of 1.64 mm is also higher than that for most mature hardwoods (1.0 –1.5 mm) except for a few, for example, *Bischofia javonica* (1.82 mm), *Buclandia poplunea* (1.84 mm), Birch (1.85 mm), Red gum (1.70 mm), *B. buonopozense* (1.76 mm), *C. pentandra* (1.83 mm) and *S. rhinopetala* (2.07 mm) (Singh *et al*. 1991, Isenberg, 1951, & Darkwa, N.A, 1996)

The mean fibre lengths were significantly different among the families (P<0.001). A summary of progenies with the longest and shortest fibres is given in Table 3. The four progenies with longest fibres are all from the Kenyan selections namely Nkubu Meru (1.85 mm), Karolina Meru (1.81 mm), Kaelo Meru (1.80 mm) and Chuka Meru (1.80 mm). The progeny from Boyd River NSW (1.75 mm) has the longest fibres among the families from Australia. The families with the shortest fibres were: Grevillea NSW (1.53 mm), Porters Gap QLD (1.49 mm), Porters Gap QLD (1.45 mm), Nimbin NSW (1.41 mm) and Grevillea NSW (1.40 mm).

The correlation of fibre length of *G. robusta* with environmental and growth factors.

A significant linear association was found between fibre length and growth factors (total height, diameter at breast height and crown width) (Table 2). Families with larger crowns tend to have longer fibres. This confirms results reported by Kalinganire (1992) on the same species. However, the predictive values of their equations were low. No correlation was found with factors of the environment at the places of origin in Australia.

Table 3. The top and bottom five progenies (in terms of fibre length), among the 48 *Grevillea robusta* families grown at Kodera.

Family code	Provenance/family details	Fibre length (mm)
Top Five families		
K8G045	Nkubu, Meru, Kenya	1.85
K8G093	Karolina Market, Meru, Kenya	1.81
K8G058	Kaelo Market, Meru, Kenya	1.80
K8G021	Chuka, Meru, Kenya	1.77
17622 GJM 978	Boyd River, New South Wales	1.75
Bottom Five families		
17613 CEH 23	*Grevillea*, New South Wales	1.53
17694 T9	Porters Gap, Queensland	1.49
17694 T1	Porters Gap, Queensland	1.45
17612 GJM 961	Nimbin, New South Wales	1.41
17613 CEH 1	*Grevillea*, New South Wales	1.40
Mean of families (n = 48)		1.64
Standard error of differences		0.07
Coefficient of variation (%)		5.2
F-ratio of families		3.8
Significance level		***

*** Indicates significance at 0.001 level.

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Conclusions and Recommendations

The mean specific gravity of *G. robusta* is 0.51 with a mean range of 0.42-0.60, while the fibre length values are 1.64 and 1.4 - 1.89 mm respectively. There is a significant variation ($p<0.001$) in specific gravity and fibre length among *G. robusta* families. Factors of the environment at the places of origin have an influence on specific gravity but little or no effect on fibre length. Denser families seem to originate from higher altitudes and latitudes in Australia. Families from Queensland tend to have a higher specific gravity than those from New South Wales and the Kenyan landraces. Kenyan landraces have longer fibres than the Queensland and New South Wales families. It is also evident that better growing families have longer fibres. At 3.5 years *G. robusta* can be selected for specific gravity and fibre length and can be thinned for firewood, aerial biomass and possibly for pulp production for wrapping and packaging purposes. For any profitable genetic improvement in the future, first attention should be given to provenances from high altitudes in Queensland for dense wood and to the Kenyan selections for long fibre production.

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References

Bamber, R.K., 1978. Wood properties and selection criteria for the breeding of eucalypts. In Progress and problems of genetic improvement of tropical forest trees, D.G. Nikles, J. Burley and R.D. Barnes eds. Vol. 1 and 2. Proc. IUFRO symposium. Brisbane. (Australia). Commonwealth Forestry Institute, University of Oxford, pp. 197-204.

Bhat, K.M., Bhat, K.V. and Dhamodaran, T.K., 1990. Wood density and fibre length of *Eucalyptus grandis* grown in Kerala, India. Wood and Fibre Science, Vol. 22 (1): 54-61.

Browning, B.L. (1967). Methods of wood chemistry. Interscience Publishers. Sydney.

Chichignoud, M. and Sales, C., 1981. Contribution a l' etude de la qualite des bois de plantation de *Grevillea robusta*, origine Republique du Burundi. Centre Technique Forestier Tropical (CTFT). 46 P.

Darkwa, N.A. The chemical composition of tropical hardwoods and its influence on pulping processes. *In* Kennedy, J. F. , Philips, G. O., and Williams, P. A. eds. The chemistry and processing of wood and plant fibrous materials. Galliard, Great Yarmouth, pp111-117.

Giertz, H. W. 1995. Figures, tables, diagrams and short notes in Pulp and Paper technology to the lectures at the Environmentally balanced pulp production course, Markaryd, Sweden., 103 p

Ghosh, K.L., 1972. Pulping characteristics of silver oak (*Grevillea robusta*): unbleached kraft paper for wrapping and packing purposes. Indian Pulp and Paper 26, 185-193.

Harwood, C.E. (ed.), 1989. *Grevillea robusta:* an annotated bibliography. ICRAF, Nairobi (Kenya). 124 p.

Harwood, C.E. and Owino, F., 1992. Design of genetic improvement programs for *Grevillea robusta*. In *Grevillea robusta* in Agroforestry and Forestry, C.E. Harwood ed. Proc. of an Inter. Workshop, 21-31 August 1990, Nairobi, Kenya. International Centre for Research in Agroforestry, Nairobi, pp. 141-149.

Harwood, C.E., Bell, J.C. and Moran, G.F., 1992. Isozyme studies on breeding system and genetic variation in *Grevillea robusta*. In *Grevillea robusta* in Agroforestry and Forestry, C. E. Harwood ed. Proc. of an Inter. Workshop, 23-31 August 1990, Nairobi, Kenya. International Centre for Research in Agroforestry, Nairobi, pp. 165-176.

ICRAF, 1994. Multipurpose tree improvement and management programme. Research activities at Kenya Forestry Research Institute (KEFRI) International Centre for Research in Agroforestry (ICRAF) and Kenya Agricultural Research Institute (KARI) Agroforestry Research Centre, Maseno.

Isenberg, I. H. The Pulpwoods of the United States and Canada. Second edition. The Institute of Paper Chemistry, Appleton, Wisconsin.

Istas, J.R., Heremans, R. Raekelboom, E.L., 1954. Caracteres gereraux des bois feuillus du Congo Belge. Publications de l' Institut National pour l' Etude Agronomique du Congo Belge, Serie Technique, 43.

Kalinganire, A., 1992. Gene-ecological variation in *Grevillea robusta* with special reference to its silviculture in Rwanda. Mphil. Thesis. University of Wales, United Kingdom. 218 p.

Metacalfe, C.R. and Chalk, L., 1983. Anatomy of the Dicotyledons. 2 ed. Vol.II: Wood structure and conclusion of the general introduction. Calarendon Press. Oxford.

Panshin, A.J. and de Zeeuw, C., 1980. Textbook of wood technology, structure, identification, properties and uses of the commercial trees of the United States and Canada. Fourth edition. McGraw-Hill Book. 722 p.

Singh, S.V. , Rai, A.K. and Dhawan, R.A. Advances in pulp and paper research in India. Indian Forestry Research Institute, ICFRE-15. Dehra Dun, 200 p.

Soil Survey Staff, 1992. Keys to soil taxonomy, 5th edition. SMSS technical monograph no. 19. Blacksburg, Virginia: Pocahontas Press, Inc. 556 p.

Webb, D.E., Wood, P.J., Smith, J. and Sian Henman, P., 1984. A guide to species selection for tropical and subtropical plantations. Oxford, United Kingdom: Oxford University, Commonwealth Forestry Institute, Tropical Forestry Paper 15, 2 ed, revised.

Williams, E.R. and Matheson, A.C. 1994. Experimental design and analysis for use in tree improvement. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia. 174 p.

Appendix 1: Provenance details

NO.	ALT (m)
1. Linville, QLD	140
2. Rudgeveeba, QLD	20
3. Tyalgum, NSW	80
4. Nimbiu, NSW	50
5. Grevillea, NSW	180
6. Duck Greek, NSW	160
7. Paddy Flat, NSW	180
8. Rappville, NSW	40
9. Nonn River, NSW	60
10. Boyd River, NSW	200
11. Bunya Mts, QLD	1000
12. Porters Gap, QLD	650
13. Albert River, QLD	280
14. Woodenbong, QLD	200
15. Kenyan selections	1100-1450

QLD: Queensland
NSW: New South Wales

Appendix 2.

Table 1. Family details for a half-sib progeny trial of *Grevillea robusta* at Kodera (Western Kenya)

Serial No.	Family code	Origin	Alt. (m)	Lat. (°)	Long. (°)
1	15872/2	Linville, QLD	140	26 29	152 16
2	15872/5	Linville, QLD	140	26 29	152 16
3	15872/6	Linville, QLD	140	26 29	152 16
4	17610 CEH 10	Mudgereeba, QLD	20	28 05	153 22
5	17611 CEH 19	Tyalgum, NSW	80	28 22	153 11
6	17611 CEH 20	Tyalgum, NSW	80	28 22	153 11
7	17612 GJM 961	Nimbin, NSW	50	28 38	153 13
8	17613 CEH 1	Grevillea, NSW	180	28 26	152 47
9	17613 CEH 23	Grevillea, NSW	180	28 26	152 47
10	17613 CEH 24	Grevillea, NSW	180	28 26	152 47
11	17614 CEH 26	Duck Creek, NSW	160	28 43	152 33
12	17614 CEH 28	Duck Creek, NSW	160	28 43	152 33
13	17614 CEH 29	Duck Creek, NSW	160	28 43	152 33
14	17616 CEH 36	Paddys Flat, NSW	180	28 44	152 26
15	17618 CEH 68	Pappville, NSW	40	29 07	152 58
16	17620 GJM 987	Mann River, NSW	60	29 24	152 29
17	17620 GJM 989	Mann River, NSW	60	29 24	152 29
18	17622 CEH 88	Boyd River, NSW	200	29 53	152 27
19	17622 CEH 89	Boyd River, NSW	200	29 53	152 27
20	17622 CEH 91	Boyd River, NSW	200	29 53	152 27
21	17622 GJM 976	Boyd River, NSW	200	29 53	152 27
22	17622 GJM 978	Boyd River, NSW	200	29 53	152 27
23	17622 GJM 980	Boyd River, NSW	200	29 53	152 27
24	17693 T1	Bunya Mts, QLD	1000	26 54	151 37
25	17693 T2	Bunya Mts, QLD	1000	26 54	151 37
26	17693 T5	Bunya Mts, QLD	1000	26 54	151 37
27	17693 T6	Bunya Mts, QLD	1000	26 54	151 37
28	17693 T7	Bunya Mts, QLD	1000	26 54	151 37
29	17693 T8	Bunya Mts, QLD	1000	26 54	151 37
30	17694 T1	Porters Gap, QLD	650	26 45	151 30
31	17694 T4	Porters Gap, QLD	650	26 45	151 30
32	17694 T8	Porters Gap, QLD	650	26 45	151 30
33	17694 T9	Porters Gap, QLD	650	26 45	151 30
34	17694 T10	Porters Gap, QLD	650	26 45	151 30
35	17699 PJ 18	Albert River QLD	280	28 16	153 06
36	17185 MRO 135/7	Woodenbong, QLD	200	28 26	152 45
37	K8G013	Chuka, Meru (K)			
38	K8G014	Chuka, Meru (K)			
39	K8G016	Ndubeni, Meru (K)			
40	K8G018	Kibubua, Meru (K)			
41	K8G021	Chuka, Meru (K)			
42	K8G029	Imenti, Meru (K)			
43	K8G039	Gatuatine, Meru (K)			
44	K8G045	Nkubu, Meru (K)			
45	K8G056	Kilindini, Meru (K)			
46	K8G058	Kaelo, Meru (K)			
47	K9G083	Kangarire, Embu (K)			
48	K9G093	Karolina, Meru (K)			

(K) = Kenya

QLD = Queensland (Australia)   NSW = New South Wales (Australia)