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Tea Genetic Resources in Sri Lanka: 1. Genetic Resources Originating from Estate Selections

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ABSTRACT

As a first step towards more systematic handling of plant genetic resources in tea breeding and related disciplines, this document collates the scattered information on estate selections made from the 1930s. Passport and collecting descriptors are compiled in order to arrive at international standards in documenting genetic resources by adopting Tea Descriptors developed by the International Plant Genetic Resource Institute. Accessions were stratified by agro-ecological regions and presented according to the estate from which they were selected, in order to enable accessing the information in a usable form. According to the information compiled in this document, a total of 688 tea accessions have been originated from old seedling populations, existing in various estates covering ten agro-ecological regions.

Key words: genetic resources, tea, core collection, passport and collecting descriptors, *Camellia sinensis*

INTRODUCTION

The need for the conservation of tea genetic resources deserves the strongest emphasis, especially because its importance and urgency are not yet fully recognized. As genetic erosion makes the preservation of local germplasm collections indispensable, the organized conservation of tea genetic resources is a prerequisite in breeding and crop improvement programs. For running efficient and effective crop improvement programs, plant breeders should have a collection of all possible genetic resources whether they are commercially productive or not. Scientists in other disciplines need to have access to a wide array of genetic material, in order to study the underlying phenomena of resistance for major biotic and abiotic stresses which affect the tea plant. As a first step towards more systematic handling of tea genetic resources in plant breeding and related disciplines, the present document is intended to collate the scattered information on estate selections made from the 1930s onwards, based on the sites or estates where they were originally selected.

The Estate Cultivar Selection Program

Owing to free hybridization and the indiscriminate introduction of seeds from several sources in the early years, seed populations in every part of the county were extremely heterogeneous. Utilizing this variability, programs for selection of tea cultivars from existing seedling tea, dating back to 1905, were initiated. Since then many cultivars have been selected from seedling populations on various estates. The main objective in the early days was selection for the type of tea, or "jat", and establishing the plantations with seedling plants from different sources imported from China and India.

The second phase of selection work commenced around 1920, when it was felt that selections could be made for yield. Yield surveys carried out on seedling tea revealed that the majority of the tea bushes were low-yielding, and that about 70% of the yield was contributed by only about 20-30% of the bushes in a population (Richards, 1978). Whilst some of the variability was probably due to environmental causes, it was felt that a large proportion must be due to inherent factors (Tubbs, 1932, 1939).

This set the pace for increased selection work, using existing seedling fields located over diverse agro-ecological regions in Sri Lanka. Selection programs were carried out with the involvement of Tea Research Institute scientists, in collaboration with various estates.

Research on vegetative propagation methods commenced in 1932. Initially, there were some set backs due to the unavailability of proper methods to raise clonal populations through vegetative propagation. However, with the availability of a perfected system of vegetative propagation through single nodal cuttings, in the late 1950s, selection programs were accelerated, and numerous selections from various parts of the island, covering different agro-ecological zones, were the result.

Untapped Potential

In the early years, during the period of evaluating selections in respect to various characters, the accessions selected were subjected initially to yield testing, and low-yielding accessions were eliminated from the evaluation program, without studying the other important traits such as resistance to pests and diseases. Hence most of the estate selections came to be discarded halfway without an analysis of their other properties being carried out. However, there would have been valuable genetic material among those estate selections, although the possibility of making use of them in future programs was not recognized fully. As a result, most of the information on these estate selections is scanty, and has not been systematically documented.

Planning a Core Collection of Germplasm

In many surveys of the distribution of genetic variability within a species, the most obvious pattern that emerges is the variability associated with broad ecological regions (Aston and Bradshaw, 1966; Bennett, 1970; Nevo, 1978).

In Sri Lanka, tea-growing regions fall into four broad categories owing to differences in climatic and edaphic factors. Genetic variation in adaptation was shown to be present and has been described in detail in a study on genotype x environment interactions in tea (Wickramaratne, 1981 a). The effect of climatic factors on plant growth in tea has also been discussed (Devanathan, 1975). Hence, it is evident that tea cultivars show specific adaptability to soil and climatic factors prevailing in a particular tea-growing region, and cultivars evolved through selections may also show variability in terms of various important characteristics which are necessary to withstand conditions in the different regions. The suggestion is that genes, contributing to environmental or climatic adaptability, depend on the germplasm from which they have evolved.

It is generally accepted that a description of the extent, and of the distribution of variation or diversity, of a species is an essential prerequisite for determining what to conserve, when planning a core collection to represent wide variability using a minimum number of accessions. Analysis of the data from characterization studies on accessions, along with ecological variability including the information on observed variation, will greatly help in this aspect.

The variations between some cultivars of Assam and China hybrids, and other types (for example, cultivars selected from Balangoda Estate), have been discussed in relation to variations present in some leaf characteristics (Wickramaratne, 1981 b). The presence of a strong resemblance between the morphology of the accessions, selected from the same estates or sites, was evident. Hence, in order to preserve the maximum amount of variability, it is essential to sample geographical variability on the broadest scale possible which would facilitate the rational selection of accessions to develop a core collection.

The Importance of Documentation

When allocating priorities for germplasm activities, often not enough time or resources are assigned to documenting genetic resources and their descriptions. This will inevitably lead to an ineffective utilization of genetic resources in meeting the demands of the present time. The accessibility of collections depends largely on the information available concerning them, and a systematic, descriptive documentation of a collection is the key to its utilization. Hence any accumulated information enhances the value of the material. It is also important to conserve the information to make sure that information relating to collections is adequately recorded, safeguarded and made

available. Often the relatively limited use, which has been made of large existing collections, seems to be mainly due to unavailability of the required information.

Accurate passport and characterization data are the first requirements for documentation, but users of plant genetic resources, particularly plant breeders, have also emphasized the need for improved evaluation of accessions. However, to date, no proper assemblage of information, on the accessions originating from estate selections, is available. Hence, passport and collecting descriptors are compiled in the present document in order to arrive at international standards in documenting genetic resources. This had been done by adopting Tea Descriptors developed by the International Plant Genetic Resource Institute (Anon, 1997).

An accession descriptor serves as a unique identifier for accession. This is assigned during selection, and also serves as a collecting descriptor, which normally consists of the acronym of the estate, followed by an identification number.

The present compilation illustrates the grouping of estate selections into categories, based on agro-ecological regions, which allows accessing of the information in a usable form (Figures 1-4 and Tables 1-10). It has to be mentioned that, in order to give prominence only to cultivars and accessions developed through estate selections, other cultivars with the designation 'TRI', which have been developed through planned breeding and introductions, are not included in this document.

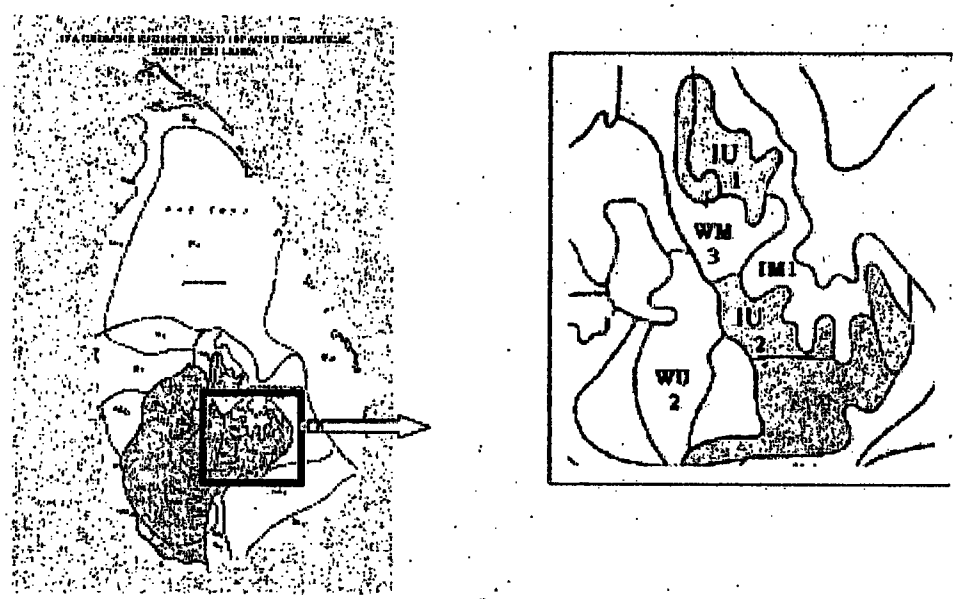

Figure 1: Tea growing region – Up country intermediate zone (IU)

Table 1: Agro-ecological area – Up country Intermediate zone (*IU 2)*

Planting District: Udapussellawa

Selection Code	Estate	Selection Identity
HUGO	Hugoland	3/13, 3/32, 4/51, HUGO
B	Ragala	B275 (Rg.B275)
LLF	Luckyland	LLF14/2
PO	Pindenioya	PO5
Rg	Ragala	Rg.A55, Rg.A199, Rg.A228, Rg.A238, Rg.B158 ,Rg.B275 (B275) Rg.HO49, Rg.HO81, Rg.HO94, Rg.HO136, Rg.HO142
SM	St. Margarets	SM401, SM404

Table 2: Agro-ecological area –Up country Intermediate zone (*IU 3)*

Planting District: Badulla

Selection Code	Estate	Selection Identity
—	El-Teb	7, 9, 30
AL	Aislaby	AL10/24, AL3/4
AMA	Ampittiakande	AMA5/60
AMAH	Ampittiakande	AMAH3/12
AMDCA	Ampittiakande	AMDCA12/2, AMDCA9/16
ANDCA	Ampittiakande	ANDCA9/6
CR	Craig	CR4
CV	Cannavarella	CV4/B1, CV5/B1
DA	Dambatenna	DA434, DA1408
DW(DOW)	Downside	DW, DW1, DW3, DW5, DW12, DW16, DW19, DW26, DW29, DW32, DW73, DW73, DW304, DW317
GMT	Gonamotawa	GMT9
GN	Glenanore	GN10/1, GN3D
GOW	Gowerakelle	GOW15/25, GO15/13, GOW15/30, GOW20/1
H	Haputale	H1, H2
LD	Gonakelle	LD9
MG	Cannavarella	MG, MG3/B1, MG3/81
MPA	Passara	MPA1
N	Nayabedda	N3
NAY	Nayabedda	NAY1, NAY3
NK	Cannavarella	NK3/B1, NK4/B29
NL	Neluwa	NL3/1, NL4/2, NL8/3
PA	Passara	PA2, PA3 PA5, PA22, PA23, PA24, PA29
PCG	Poonagala	PCG2
PD	Gonakelle	PD14, PD22
PING	Pingarawa	PING2/1
PLLG	Poonagala	PLLG1, PLLG2
PUH	Poonagala	PUH1, PUH5,
PULG	Poonagala	PULG1
QT	Queenstown	QT1/5, QT1/3, QT1/6, QT2/3, QT2/5, QT3/3, QT3/4, QT4/4, QT7/1, QT7/4
SJ	St. James	SJ2, SJ2/28, SJ2/30, SJ76
SS/P	Passara	SS/P
T	Thotulagala	T2/2, T5/2, T5/3, T5/35
UH	Uva Highlands	UH3/7, UH3/4, UH9/3
W	Wellimada	W1/1

Total number of accessions selected from Up Country Intermediate Zone = 109

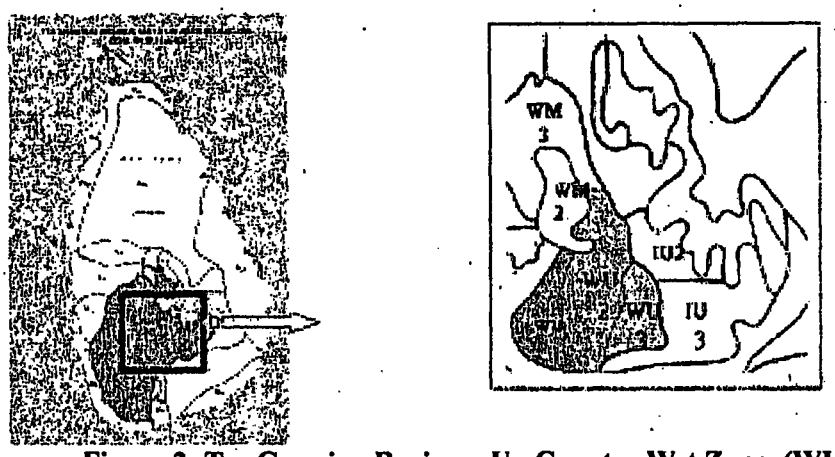

Figure 2: Tea Growing Region – Up Country Wet Zone (WU)

Table 3: Agro-ecological Area – Up country Wet zone (*WU1*)

Planting District: Kotagala, Maskelliya

Selection Code	Estate	Selection Identity
—	St. Heliers	11
A	Carolina	A2/18, A7/3, A7/10, A1042
B	Bogawana	B11/69, B77, B85, B95
B	Gartmore	B2, B3, B5, B7, B8, B15, B18, B35
BNO	Bogawana	BNO8
BW	Brunswick	BW1B2, BW.CB1B2(CB1B2), BW.CB2A1(CB2A1), BW.CB3B3(CB3B3), BW.DT1-56(DT1-56), BW.DT1-47(DT1-47), BW.DT1-56(DT1-56), BW.EM9(EM9)
C	Chapelton	C7, C12, C21, C33, C33A, C38, C40, C41, C56, C58, C68, C103, C113, C171
CW	Coombewood	CW12, CW21
CY	Tangakelle	CY9
DK	Diyanillakelle	DK1, DK2, DK3, DK8, DK9, DK11, DK13, DK16, DK17, DK19, DK24, DK26, DK48, DK69
DT	Drayton	DT1, DT3, DT95, DT150, DT1001, DT1/47
E	Tangakelle	E727
EELD (K.EELD)	Kirkoswald	EELD163 (K.EELD163)
EEUD (K.EEUD)	Kirkoswald	EEUD20(K.EEUD20), EEUD65(K.EEUD65)
EM	Brunswick	EM9(BW.EM9)
EY	Tangakelle	EY/27
GLEN	Glentilt	GLEN3/1, GLEN3/2, GLEN3/5, GLEN3/33, GLEN6/3, GLEN7/1, GLEN9/1, GLEN9/2, GLEN9/3
GT	Glentilt	GT7/1(GLEN7/1), GT7/4, GT4/4
GV	Gouravilla	GV35, GV95
K	Kirkoswald	K136, K145, K150
KATABOOL	Kataboola	KATABOOL
KEW	Kew	KEW4A/2, KEW4A/4, KEW14/1, KEW/HRW
M	Moray	M, MB, ME, MH, MG, MV, MX,M3,M6, M19, M21, M23, M25, M222, M242
ML	Mincing Lane	ML7
N	Norwood	N2, N4NY
NEM	St.Coombs	NEM7, NEM9
OK	Ouvahkelle	OK1, OK2, OK3, OK4
RG	Robgill	RG41
TK	Talankanda	TK2, TK8, TK13, TK34, TK42, TK43, TK45, TK48, TK53, TK56, TK68, TK69, TK70, TK76,
TKL	Talankanda	TKL13
TLA	Talankanda	TLA1, TLA4/10
V	Moray	VA, VE, VD
VK	Ouvahkelle	VK1, VK2, VK4, VK9, VK11, VK12
WY	Tangakelle	WY (Wallaha Yellow or Wallaha)
Y	Yapame	Y2/3
YF	Yoxford	YF6

Table 4: Agro-ecological area - Up country Wet zone (*WU2)*

Planting District: Pussellawa, Pundaloya, Dimbula, Dickoya

Selection Code	Estate	Selection Identity
—	Ardlaw	5, 11, 23, 25
—	Attabage	23, 24
—	Balapokuna	40, 170
—	Chrystler's Farm	1, 26, 60, 61, 63, 66
—	Dayagama	A-H, J-N, P
—	Mount Jean	1, 3, 7/10
—	Oonoogaloya	1, 2, 8, 16, 23, 24, 25,
—	Tyspane	1, 2, 3
—	Sanquhar	BPM4, NP1, SQBP
—	Wattegoda	154, 537, 557
—	Weddemulle	CN/D, RB/5, WM/2
A/O (AO)	Agra Ouvah	A/O4(AO4), A/O14(AO14), A/O42
ABB	Abbotsleigh	ABB-AL2/33
ABB (B)	Albion	ABB3B2(3B2), ABB3B5(3B5)
C	Carolina	C6/3
CAR	Carolina	CAR2/10, CAR2/18, CAR6/3, CAR7/10A, CAR7/10B, CAR7/10, CAR7/4, CAR12/18, CAR7/3
CLEA	Craigie Lea	CLEA6
D	Dayagama	D, D32, D95, D2049, D2050, DG
D/S	Delta	D/S/10, D/S/11, D/S/37, D/S/51
DE	Delma	DE10/2, DE10/27
DEL	Delta	DEL10, DEL11, DEL23, DEL25, DEL37, DEL40, DEL51, DEL231
DUN	Dunsinane	DUN, DUN7, DUN3A1
E	Sommerset	E7/7, E7/27
EH	Eildon Hall	EH8/15
F	Fernlanda	F4, F8
GL	Glassaugh	GL6, GL48
GW	Grate Western	GW19
H	Hellbodde	H13/4, H16/13, H16/14, H16/19, H6A/1, H6A/2, H6A/3
HR	Harrow	HR1/3, HR4/11, HR11/4, HR18
HV	Hauteville	HV(H/V)
K	Kanapediwatta	K2039
K	Kotiyagalla	K62, K65
KK	Talawakelle	KK41, KK43, KK46, KK63, KK66, KK72, KK73
KPW	Kanapediwatta	KPW
LP	Sheen	LP5/3
MK	Mattakelle	MK2, MK5,
MV	Ferham	MV120, MV125
N	Dayagama	N(DN)
OT	Ottery	OT1B3, OT5/7, OT5/8, OT5/18, OT5/30, OT6A35
TC	Tillicoultry	TC9, TC10,TC16
TLK	Talawakelle	TLK13
VO	Vellai Oya	VO4/1, VO33/3, VO45/12, VO45/46
UR	Uda Radella	UR1, UR12
W	Waltrim	W23F2, W24F2, W24F3, W30F3, W34F2
WT	Waltrim	WT26, WT36, WT37, WT23/F2, WT24/F2, WT30/F3, WT34/F3
W	Wooton	W3, W14, W2.125, W23, W43, W45, W86

Table 5: Agro-ecological area - Up country Wet zone *(WU3)*

Planting District: Nuwara Eliya

Selection Code	Estate	Selection Identity
CC	Concordia	CC34, CC72, CC/CL30, CC/CL35, CC/CL64
CL	Court Lodge	CL14, CL18NY, CL19, CL22, CL25, CL26, CL31, CL32, CL72
DON	Marigold	DON3NI, DONANI
GF	Goat Fell	GF5/01, GF7/6
HS	Hethersett	HS10/A
PD	Pedro	PD1/5, PD13/7, PD14
PK	Park	PK2, PK1703, PK2202

Total number of accessions selected from Upcountry Wet Zone = 320

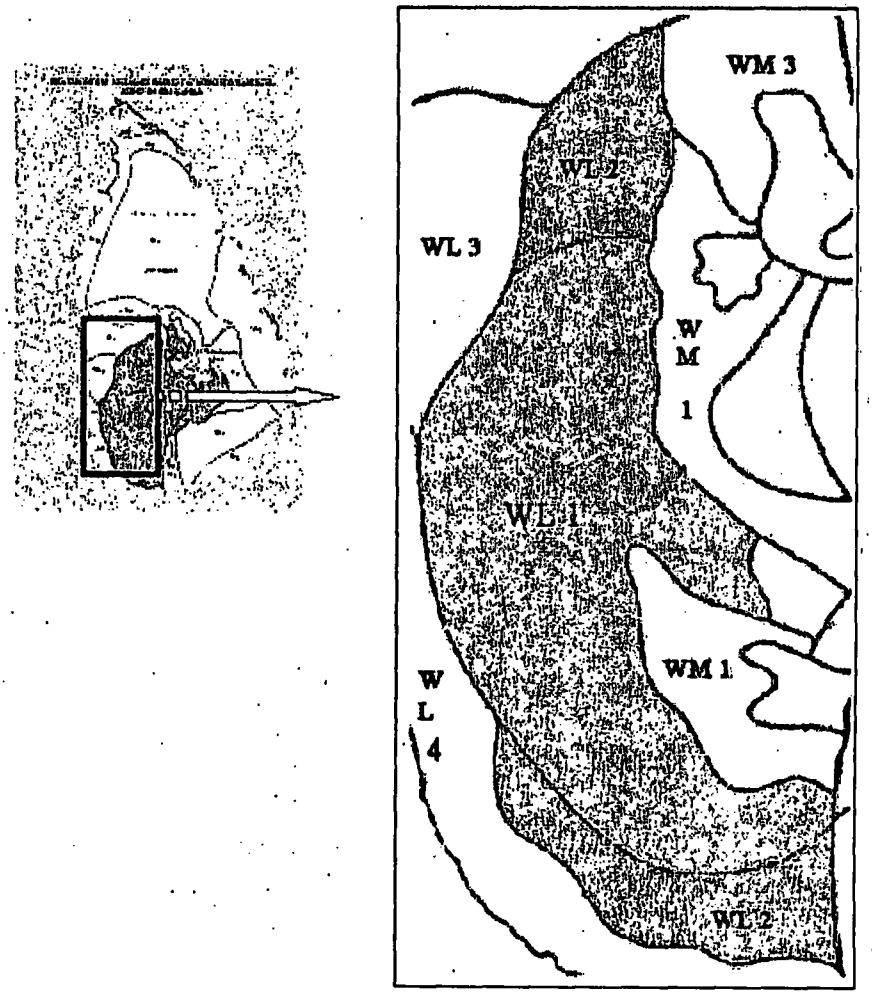

Figure 3 : Tea Growing Region – Low Country Wet Zone (WL)

Table 6: Agro-ecological area – Low country Wet zone (*WL1)*

Planting District: Ratnapura, Kalutara, Kellany Valley, Galle

Selection Code	Estate	Selection Identity
—	Ederapolla	61/14A21
A	Alupola	61/14A/2, A13, A15, A17, A19
ADK	Alupola	ADK2, ADK20, ADK29,
B	Niriella	1B7, 1B21, 3B22, 3B30
ED	Ederapolla	ED22, ED24, ED31, ED40, ED41, ED42, ED43, ED45, ED46, ED53, ED56, ED73, ED95, ED97, ED116, ED117, ED128, ED129, ED134, ED145, ED151, ED177, ED180, ED184, ED188, ED199, ED350, ED379, ED397,
G	Galathura	G13, G14, G15, G16, G18, G19,
GIKI	Geekiyanakanda	GIKA13
GK		GK518
H	Hulandawa	H1/58
HAL	Halwatura	HAL8, HAL9
KP	Palmgarden	KP2, KP3, KP4, KP9, KP204, KP518,
MB	Maliboda	MB33
NIL	Nilagama	NIL2, NIL4, NIL7, NIL12, NIL15, NIL28, NIL30, NIL53, NIL63, NIL72, NIL89, NIL203, NIL208, NIL211, NIL212, NIL228, NIL235, NIL246, NIL256, NIL262, NIL263, NIL274, NIL275, NIL285, NIL345, NIL355, NIL395, NIL425, NIL435, NIL475, NIL525, NIL575, NIL766, NIL806, NIL925, NIL945, NIL955
NP	Petteigala	NP1/3, NP3/3
P	Panawatta	P13,
PBG	Pabegama	PBG1
PM	Strathdon	PM1, PM2, PM3, PM7, PM8, PM9, PM10
PTG	Pettigala	PTG14/5
PW	Panawatta	PW14, PW39, PW40, PW44, PW46, PW55, PW58
R	Rayigama	R5, R12 (RGM12)
RGM	Rayigama	RGA12 (R12)
S	Sirikandura	S106, S123, S126, S173, S220, S255, S261, S265

Table 7: Agro-ecological area – Low country Wet zone (*WL2)*

Planting District: Kegalle, Ratnapura, Galle

Selection Code	Estate	Selection Identity
—	Karadupona	1,4
OP	Opatha	OP35, OP66, OP110, OP117, OP177, OP308
WEL	Wellandura	WEL1B7, WEL2, WEL34, WEL35

Total number of accessions selected from Low Country Wet Zone = 139

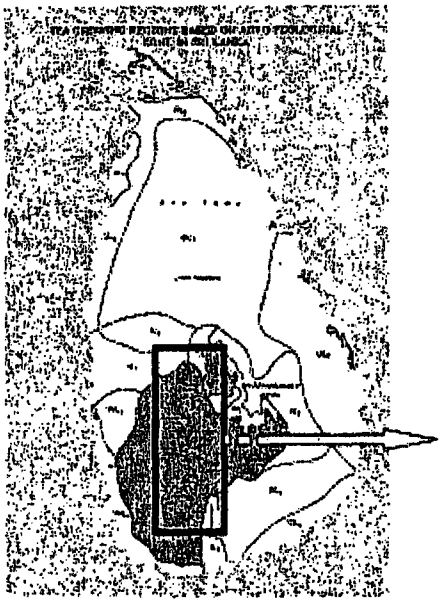

Figure 3: Tea Growing Region – Mid Country Wet Zone (WM)

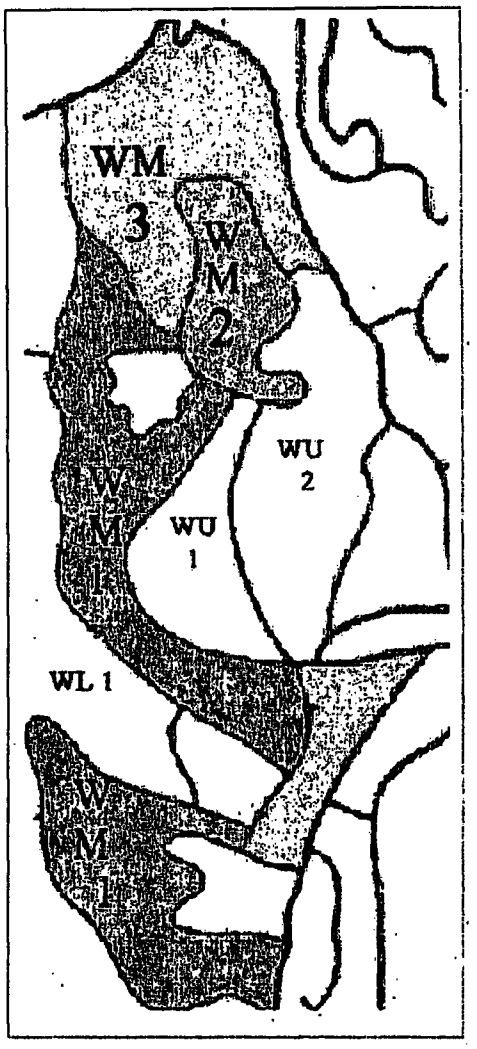

Table 8: Agro-ecological area – Mid country Wet zone (*WM1*)

Planting District : Morawak Korale, Ratnapura

Selection Code	Estate	Selection Identity
—	Dankoluwa	19, 34, 36, 50, 58,
HUN	Hunuwella	HUN, HUN1, HUN2, HUN5D, HUNROW
HW	Hunuwella	HW154, HW167, HW-ROW, HWSDL
KEN	Kenilworth	KEN13/3, KEN15/2, KEN15/7, KEN15/8, KEN15/12, KEN15/13, KEN15/15, KEN16/3, KEN22/1, KEN31/7, KEN31/11, KEN4A4
P	Poronuwa	P62, P63, P98, P101, P104, P105

Table 9: Agro-ecological area – Mid country Wet zone (*WM2)*

Planting District: Dolosbage

Selection Code	Estate	Selection Identity
—	Rutland	6, 11, 26, 57
B/R	Downside	B/R1
CG	Le vallon	CG1/2, CG1/3
CH	Craighead	CH13, CH2A1, CH33, CH38, CH56
D/S	Downside	D/S73 (DS73), D/S317(DS317)
HM	Le vallon	HM8/11
L/C	Loolcondera	L/C1, L/C50, L/C80, L/C85
M	Mooloya	M20, M21, M116, M208, M209, M241
MO	Mooloya	MO16, MO20, MO21, MO33, MO110, MO114, MO116, MO134, MO146, MO208, MO209, MO220, MO241, MO246
R	Rutland	R80, RA, RB, RD, RE
RL	Rutland	RL2, RL/A, RL/B, RL/D, RL/E
SS	Somerset	SS/1

Table 10 : Agro-ecological area – Mid Country Wet zone (*WM3)*

Planting District: Kandy, Balangoda, Rakwana

Selection Code	Estate	Selection Identity
—	Hunnasgeria	1, 5
DG	Balangoda	DG, DG3, DG7, DG16, DG32, DG39, DG43, DG52, DG54, DG66
E (EN)	Endane	E 31(EN31)
HOPE	Hope	HOPE7
KM	Kirimetiya	KM247
MT	Balangoda	MT/BG, MT4, MT5, MT11, MT12, MT13, MT15, MT16, MT17, MT18, MT20, MT26, MT31, MT35, MT54
PET	Pettigala	PET1A/1, PET2A/1, PET2A/3, PET11/4, PET14/4, PET13B/1, PETNP5N,

Total number of accessions selected from Mid Country Wet Zone =120

CONCLUSIONS

According to the information compiled in this document, based on the records at our disposal, a total of 688 tea accessions have originated from old seedling populations existing in various estates and covering 10 agro-ecological regions. Accessions were stratified by agro-ecological regions, and presented according to the estate from which they were selected, in order to access the information in a usable form. Among the accessions, nearly 45% have already been secured for future use, by conserving them in field gene banks at the Tea Research Institute's regional stations, at four different locations.

Most of the research and development efforts, expended in the plant breeding programs, focused on the identification and incorporation of resistant traits. The enormous collection originating from old seedling tea populations, mentioned in this article, may contain resistant genes which are not incorporated into the new improved cultivars or breeding lines. In situations where there is evidence that the pool of available variation for biotic and abiotic stress-resistant genes within commercial breeding lines is limited, the search for novel sources of resistance is required. In such a situation, a wide range of breeding lines or acquisitions must be examined to find adequate levels of resistance to major diseases and pests.

In the search for resistance to various biotc and abiotic stresses, it is important to evaluate these genetic resources. It is worthwhile exploring the possibility of using the resources in future breeding programs, after a proper evaluation of their characteristics. Therefore, this document will be followed by another compilation, based on the characteristics evaluated in those accessions which aim at a better utilization of genetic resources in tea breeding and related activities.

ACKNOWLEDGEMENT

Scientists, who made efforts in the past to select valuable tea genetic resources, and to make information available in various forms, including personal notebooks, for the benefit of future generations of tea breeders at the Institute, are gratefully acknowledged.

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