

## A Decade of Contributing to a Profitable and Sustainable Coffee Industry in Tanzania: The Arabica and Robusta Improvement Programmes

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### ABSTRACT

Coffee berry disease (CBD) and coffee leaf rust (CLR) have threatened the sustainability of the Tanzanian Arabica coffee industry for more than half a century. Coffee wilt disease (CWD) has threatened the sustainability of the Robusta coffee industry since its first report in the country in 1997. The Tanzania coffee stakeholders unanimously agreed that the development and replanting with high yielding Arabica and Robusta varieties that combine durable resistance to these diseases with good beverage quality was the most important strategy for the economic management of these diseases and improve the sustainability of the industry. The Tanzania Coffee Research Institute (TaCRI) has, therefore, been implementing meticulous Arabica and Robusta breeding programmes with the above objectives since 2001 with strong support from the European Commission. Achievements are impressive. We have officially released 15 improved tall and four compact Arabica varieties and four Robusta varieties that meet the above objectives and several more are in the pipeline for official release. This paper gives highlights of the Tanzania Arabica and Robusta coffee improvement programmes, results and the future directions of the programmes to meet the expectations of our stakeholders.

**Key words:** Coffee, breeding, sustainability, Tanzania

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### INTRODUCTION

Comprehensive research work contributing to a profitable and sustainable coffee improvement programme in Tanzania has been documented (Teri *et al.*, 2011). Arabica coffee breeding have

been implemented to develop, evaluate and propagate high yielding coffee berry disease (CBD) and coffee leaf rust (CLR) resistant varieties of *Coffea arabica* with good bean size and cup quality. Coffee Research Improvement Programme managed a 3-phased programme to develop Arabica hybrid varieties with similar properties of disease resistance, yield and quality. The first and second programmes were concentrated to develop tall Arabica hybrids, while the third focused on compact growth habit to address issues of increasing productivity. These efforts lead to official release of 15 improved tall and four (4) compact Arabica varieties. Coffee wilt disease (CWD) continue to be a threat to Robusta coffee industry, however the programme has been making good progress in identifying lines of *Coffea canephora* resistant to the disease. The selected four (4) lines were approved for official release in 2011. This is considered to be a major milestone of historic importance in Tanzania in official release of 19 Arabica coffee hybrid varieties and four Robusta clones which are disease resistant, high yielding and have bold beans and excellent beverage quality. The report highlights progress, results and future strategies to meet expectations of coffee stakeholders in Tanzania,

## MATERIALS AND METHODS

### Selection of Arabica elite breeding lines

Simple and complex crosses established in Field 23, 27 and Compact Variety Trial 3; were selected on basis of performance (yield, resistance to CBD and CLR, and beverage quality). The plants of the crosses originated from rooted cuttings (Fernie, 1962). Collection of *Colletotrichum kahawae* strains and screening resistance to CBD procedures have been extensively documented (Kilambo *et al.*, 1999). For CLR resistance determination, description by Eskes and Tomabragini (1981) were followed. Breeding lines confirmed to have combined disease resistance, higher yield than N39 and KP423, and quality of higher than or equal to commercial cultivars were advanced to the multilocal and on-farm trials accordingly. Assessments of CBD and CLR, yield recording and samples for beverage have been described by Teri *et al.* (2004).

### Selection for CWD resistance Robusta clones

Search for disease resistant clones was initiated in 2004, using 875 breeding lines established at TaCRI Maruku. Assessment included individual tree selection on yield, resistance to CWD and quality in terms of bean sizes and cup taste. Methods developed by Hakiza *et al.* (2004), were used in collection and preparations of *Gibberella xylarioides*, artificial inoculation of clones and assessment of the reaction. Robusta breeding lines that were found to combine genes for CWD resistance, of higher yield and excellent quality, were advanced and established in multilocal and on-farm trials of disease hot spot areas, for adaptation and adoption tests.

## RESULTS AND DISCUSSION

The major characteristics of these varieties are being summarized in Table 1.

**Table 1: Characteristics of 19 improved Arabica and 4 coffee wilt disease resistant Robusta varieties**

Name of the variety	Yield (Kg/ha) Clean coffee	Cup taste	Bean sizes (AA + As)	Class	Description	Type
First generation Arabica tall hybrids officially released in September 2005						
N39-1	2,058	Clean cup	77	4++	Good acidity, body, flavour & aroma	Bourbon
N39-2	2,708	Clean cup	77	4++	Good acidity, body, flavour & aroma	Bourbon
N39-3	2,763	Clean cup	74	5+	Good acidity, body, flavour & aroma	Bourbon
N39-4	1,961	Clean cup	80	4+	Good acidity, body, flavour & aroma	Bourbon
N39-5	2,633	Clean cup	62	5+	Good acidity, body, flavour & aroma	Bourbon
N39-6	2,891	Clean cup	72	4+	Good acidity, body, flavour & aroma	Bourbon
N39-7	2,526	Clean cup	72	5+	Good acidity, body, flavour & aroma	Bourbon
KP423-1	2,225	Clean cup	80	4++	Good acidity, body, flavour & aroma	Kent
KP423-3	1,578	Clean cup	77	5+	Good acidity, body, flavour & aroma	Kent
First generation Arabica tall hybrids officially released in January 2011						
KP423-2	1,851	Clean cup	68	5+	Good acidity, body, flavour & aroma	Kent
Coffee Wilt Disease resistant Robusta varieties officially released in January 2011						
Maruku2	3,900	Clean cup	90	4	Nice aroma like mild Arabica	Robusta
Bukoba1	780	Clean cup	91	5	Natural Robusta coffee	Robusta
Maruku1	2,400	Neutral cup	98	5	Typical natural Robusta coffee	Robusta
Muleba1	2,400	Clean cup	94	6	Typical natural Robusta coffee	Robusta
Second generation Arabica tall hybrids officially released in January 2012						
N39-8	2,000	Clean cup	76	4+	Good acidity, body, flavour & aroma	Bourbon
N39-9	2,700	Clean cup	68	4+	Good acidity, body, flavour & aroma	Bourbon
N39-10	2,400	Clean cup	71	4	Good acidity, body, flavour & aroma	Bourbon
N39-11	2,700	Clean cup	68	4+	Good acidity, body, flavour & aroma	Bourbon
N39-12	2,400	Clean cup	79	4	Good acidity, body, flavour & aroma	Bourbon
Compact hybrids Arabica varieties officially released in December 2013						
TaCRI1F	6,000	Clean cup	69	4+	Sweet and pleasant aroma	Bourbon
TaCRI3F	5,050	Clean cup	64	4+	Sweet aroma	Bourbon
TaCRI4F	4,800	Clean cup	74	4+	Fruity aroma, dark chocolate, honey	Bourbon
TaCRI6F	6,000	Clean cup	68	5	Pleasant aroma	Bourbon
N39	1,000	Clean cup	57	4+	Pleasant aroma	Bourbon

Key: Bean sizes; >50% (AA + A) = excellent quality; Cup taste: Fine, 1=Good to Fine; 2=Good; 3=Fair to Good; 4=Fully Fair; 5=Fair Average Quality; 6=About Fair; 7=Poor to FAIR; 8=Poor.

Worldwide, there are around 40 known physiological races of *H. vastatrix* causative agent for coffee leaf rust (CLR); of which seven were recorded to exist in Tanzania (Rodrigues Jr. *et al.*, 1975). These were races I, II, III, XVII, XXIV, XI and XX. Coffee rust disease surveys carried out from 2006 to 2007 recorded new rust pathogen races XXII and XXXIV (CIFC, 2007). Two years later, five new coffee leaf rust pathogen races were recorded (TaCRI, 2009). These were races XXIII, XXIV, XXV, XXVIII and XXXI. Recently additional seven races: XLI, XLII, XV, XXX, XXXIII, XXXIV and XXXIX; were detected from all coffee growing regions in Tanzania (Kilambo *et al.*, 2013). Despite variability of 21 CLR races in Tanzania, officially released improved coffee varieties continue to maintain resistance. With regards to *C. kahawae* strains,

previous studies indicated variability in pathogenicity of the pathogen in coffee growing areas (Kilambo *et al.*, 2008), but there are no reports of breaking of CBD resistance. Nature of resistance of Arabica hybrids have been confirmed (Kilambo *et al.*, 2013). TaCRI has been keen in implementing Arabica and Robusta breeding programme (van der Vossen, 2005). The institute has officially released 15 improved tall and four compact Arabica varieties that combine high yielding, durable resistance to CBD and CLR, and four CWD resistant Robusta clones combining high yields with good beverage quality. The challenge now is to make planting materials available to coffee growers. Tanzania is practicing several options for availability of disease resistant hybrid cultivars to coffee growers. The options includes clonal multiplication and grafting which are familiar methods to most of our coffee growers, hand-pollination and use of somatic embryogenesis which have also proved to be effective methods for the multiplication of coffee cultivars.

## CONCLUSION AND WAY FORWARD

TaCRI has selected top Arabica hybrid and Robusta varieties. No doubt they are amongst the best varieties in the world. To face the challenge of availability of planting materials to coffee growers, TaCRI prepared a roadmap for optimization of mass multiplication methods. They entails: documentation of protocols on horticultural methods (clonal multiplication and grafting), controlled pollination, tissue culture and male sterility to hasten availability of planting materials. In the meantime, additional coffee breeding lines are in pipeline for official release. Looking back twelve years ago, it was a decade of successful contribution to a profitable and sustainable coffee industry in Tanzania.

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