Advances in Breeding for Micronutrient – dense Cassava Varieties in Nigeria

C.N. Egesi, B. Olasanmi, I. Ndukwe, E. Okogbenin, B. Maziya-Dixon, P. Ilona, P. Kulakow, D. Njoku, S. Njoku and A.G.O. Dixon

Preamble

Cassava is a critical source of energy in the diet of developing countries but contains insignificant amounts of essential micronutrients, such as vitamin A, compared to other staples. Consumption of large amounts of a staple poor in micro-nutrients has unfavourable health and nutrition effects especially in children under 5 and reproductive women (Maziya-Dixon et al. 2008). Recent plant breeding efforts have yielded improved cassava varieties with 30 times more beta carotene in their storage roots than found in current commercial cultivars (Fig. 1). Beta carotene is the precursor of Vitamin A. In Nigeria, the primary processed cassava product, *gari,* commands a premium price in some regions when it is artificially colored with palm oil yielding a more aesthetic gari (Fig. 2). Yellow gari can be produced from beta carotene biofortified cassava genotypes without the need to use palm oil. We report here advances being made to develop and deliver pro-vitamin A dense cassava varieties to cassava – consuming populations in Nigeria.

Fig 1. Breeding has resulted in the development of pro-vitamin A enriched cassava in Nigeria.

Fig 2. Yellow *gari* (from palm oil) has higher price premium than white by 30-60% in Nigeria! High pro-vitamin A cassava can be used to produce yellow *gari*.

Development of Genetic Stocks

Cassava is a highly heterozygous, perennial, and outcrossing crop that is clonally propogated by stem cuttings making breeding cumbersome. This is further exacerbated by the long 12-month growing season, poor flowering of many desirable clones and a high genetic load. Introduction of partial inbreeding schemes by self pollination have uncovered useful genetic variation. Through this procedure, genetic stocks for high pro-vitamin A cassava have been developed. One such partially inbred population resulted in a population of more than 200 genotypes that would also serve as a QTL mapping population for pro-vitamin A (Fig. 3). Transgressive segregation at the first selfed generation (S1) yielded several genotypes that had up to 20 µg/g of total carotene as against parent values of 6-8 µg/g fresh weight basis were common. Hybridization of partially inbred lines can be useful for determination of heterotic groups in cassava.

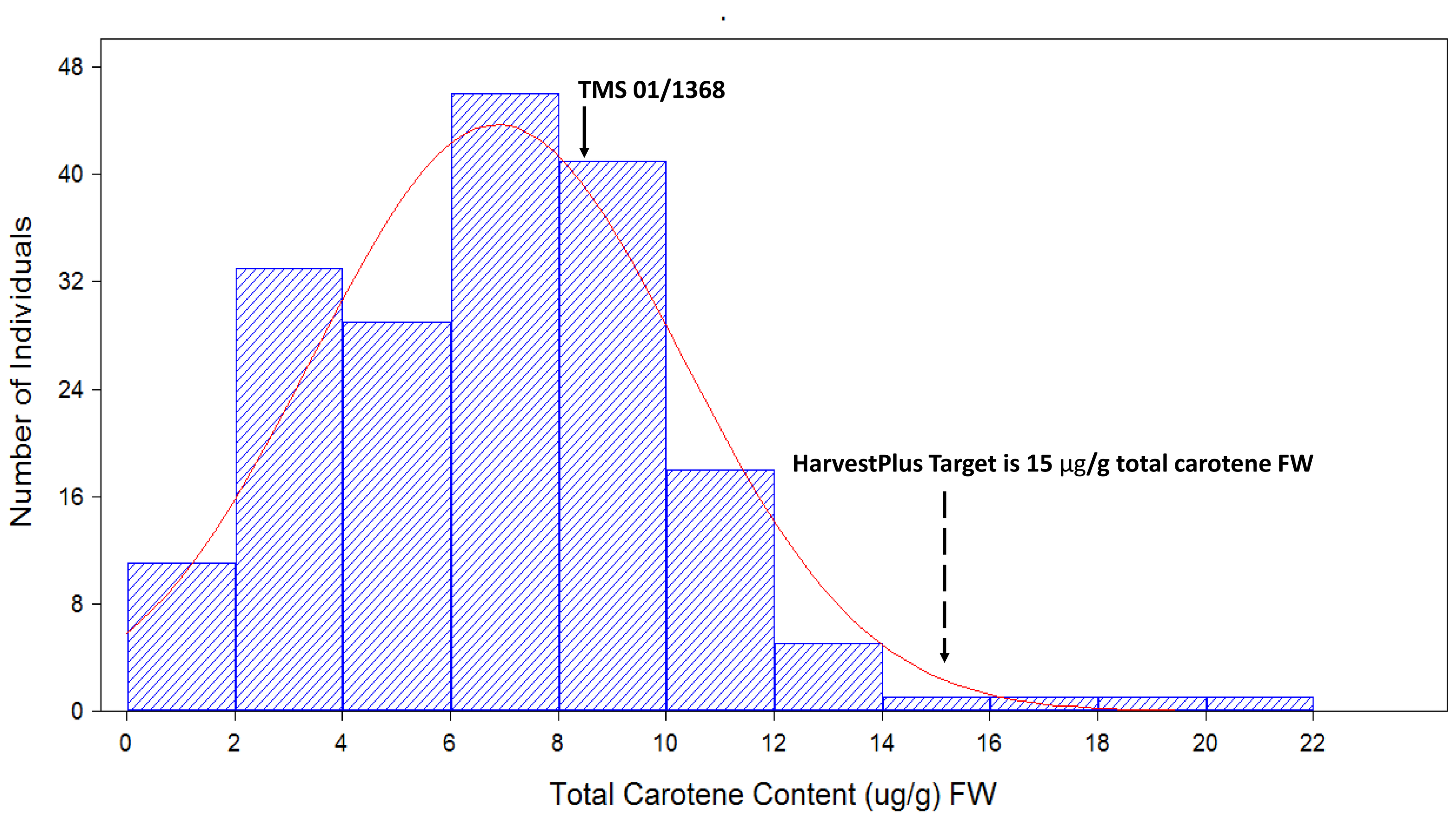

Fig 3. Distribution of total carotene content in cassava from a partially inbred population derived from pro-vitamin A genotype, TMS 01/1368 (n = 209).

Pre-release Trials

Before the release of a cassava variety in Nigeria, it must pass several national trials. First a 2-season national coordinated test of candidate varieties is conducted at 8 – 12 sites across 4 – 5 agroecological zones where cassava is usually grown. Second, one year of on-farm trials is conducted on 8 farms each in 9 – 13 cassava producing states. The 2010 national coordinated trial with three candidate yellow root varieties has been concluded and analysis is ongoing. Determination of total carotene and β-carotene content in the various sites demonstrated consistent performance across locations (Table 1). Variation components showed genotypes contributed 88% of the variation in total carotene (Table 2), while locations and G x E interaction components contributed 4 and 8%, respectively. GGE-biplot analysis further showed no significant variation across locations (Fig. 4). On-farm trials by 104 farmers in 13 states has commenced in 2010.

Table 1. Total carotene content in µg/g fresh weight of 3 biofortified cassava varieties and a check tested at 9 locations in 4 agroecological zones in Nigeria.

Location	TMS 01/1368	TMS 01/1371	TMS 01/1412	TMS 30572
Abakaliki	6.14	8.15	5.58	0.36
Ibadan	4.39	5.88	4.32	0.38
Ikenne	5.57	4.86	6.68	0.56
Minna	---	5.19	6.43	0.39
Nsukka	6.58	10.42	5.96	0.34
Otobi	5.36	5.78	6.72	0.75
Umudike	5.67	6.74	4.31	0.46
Uyo	5.91	4.37	5.00	0.27
Zaria	3.96	3.74	3.34	0.42
Mean	*4.90*	*6.13*	*5.37*	*0.44*
Minimum	*3.96*	*3.74*	*3.34*	*0.27*
Maximum	*6.58*	*10.42*	*6.72*	*0.75*

Table 2. Genotype (G), location (L), and Genotype x Location (GL) variance terms for mean total carotene content of 4 genotypes of cassava grown at nine locations in Nigeria.

Source	df	Sum of Squares	% of total variation
L	8	28.58	4.05
G	3	620.33	87.99
GL	24	56.11	7.96

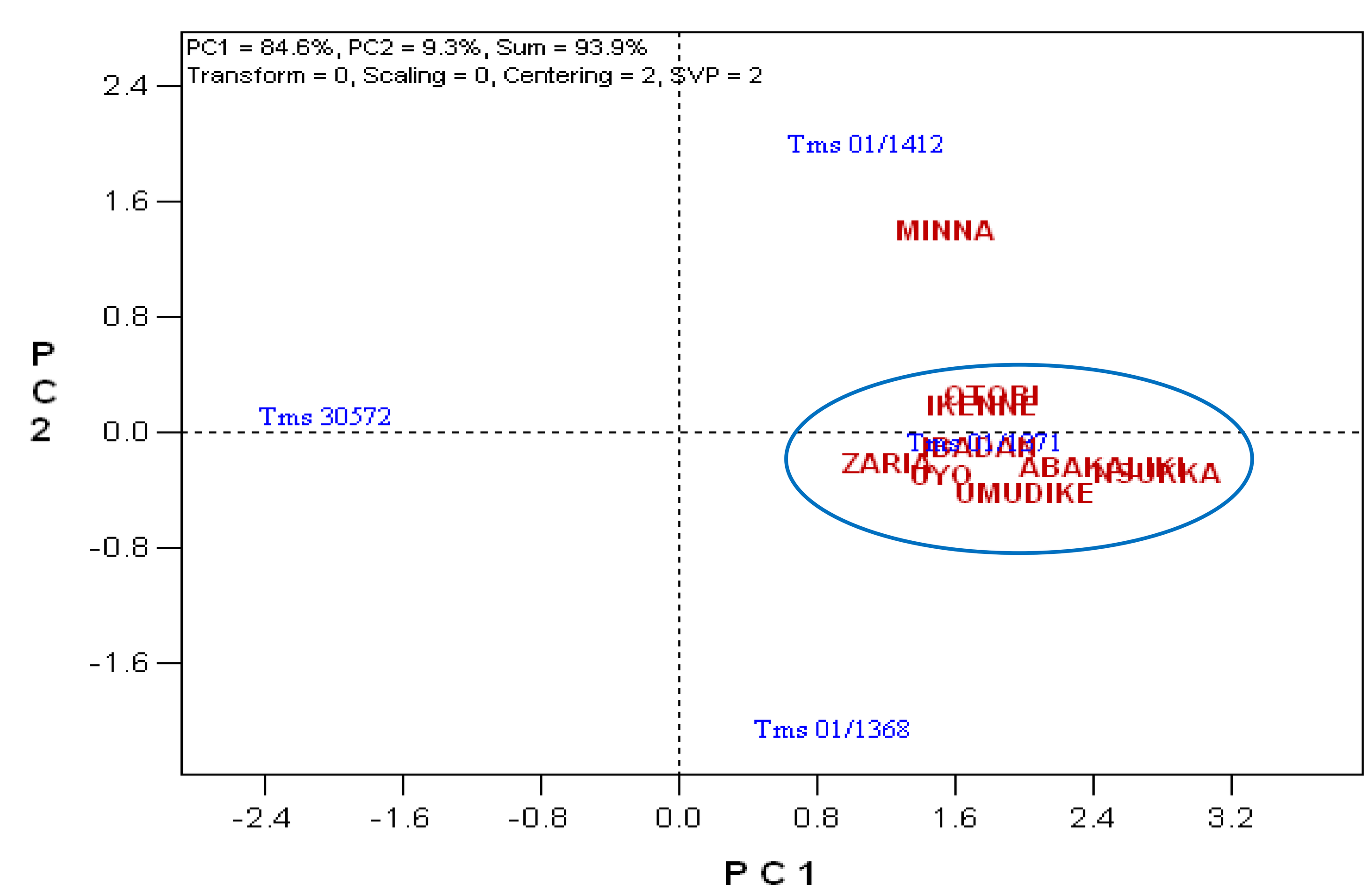

Fig 4. GGE-Biplot analysis of β-carotene of 4 cassava varieties across nine locations in Nigeria.

Perspectives

The next crucial steps are to release these varieties in 2011 and to rapidly multiply seed for targeted distribution to cassava growing areas with the highest incidence of micronutrient deficiency. Further recurrent selection is increasing beta carotene in roots toward target of 15 µg/g fresh weight. Communication strategies to educate producers, processors, marketers and consumers on the potential benefits of new vitamin A enriched cassava will be conducted.

Acknowledgements

This research was supported with funds from HarvestPlus Challenge Programme.

References

Maziya-Dixon, B. A.G.O. Dixon and G. Ssemakula. 2008. Changes in total carotenoid content at different stages of traditional processing of yellow-fleshed cassava genotypes.

National Root Crops Research Institute (NRCRI), Umudike, PMB 7006, Umuahia, Nigeria.
Email: cegesi@yahoo.com

www.nrcri.org