

# NOMINATION OF CASSAVA VARIETY, *POUNDABLE (TMEB693)*, FOR REGISTRATION AND RELEASE FOR FRESH ROOTS MARKETS IN NIGERIA

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## Introduction

Cassava is a major staple for more than 500 million Africans and the crop's importance has extended from food security to that of industrial crop. While Nigeria is relatively the most advanced in cassava transformation as well as the largest producer, most of her production (90%) is still used as food. Gari and fufu constitute about 70% of the food while other forms are consumed. Fresh boiled cassava is eaten in many parts of northern Nigeria as well as other African countries. Breeding programs in Nigeria have not particularly paid attention to the boiled product (also poundable types) due to the intricacies of the special culinary qualities demanded by farmers and end-users alike for a mealy (floury feeling in the mouth) as well as low cyanogenic glucosides expected for such a product. In the past, farmers cultivated landraces such as Iwa Panya (grown mostly around the South East and South South regions) and Isunikakiyan or TME117 (grown in the South West and North Central regions) but these have been stopped because they are very susceptible to the major diseases such as cassava mosaic disease (CMD) and cassava bacterial blight (CBB). Thus, farmers have resorted to varieties that are more resistant and productive but unfortunately, they have not been found to be as desirable for the boiled or poundable cassava product.

Boiled/poundable cassava product is a product profile that will be needed as this approach presents an opportunity to be introgressed into biofortified cassava which requires limited processing in order to conserve the micronutrients. IITA and NRCRI have explored and discovered a landrace grown by farmers in Nigeria and other parts of West Africa for a variety, Ankra, (also known by its accession number TMEB693), that is mealy when boiled and loved by farmers for the added value of resistance and high productivity. TMEB693 has been grown by farmers in Nigeria for nearly two decades and is called 'Doya' in some parts of northern Nigeria, meaning 'yam-cassava' due to the mouthfeel similarities. We have tested it across several locations and also in

farmers' fields in Nigeria and present the data for it to be registered, released and marketed as the first 'poundable' cassava. This landrace, TMEB693, is now being used as a recurrent parent in generating populations that combine the desirable eating qualities with higher productivity and resilience traits. In the interim, it serves as a good replacement for Iwa Panya and Isunikakiyan, older and susceptible varieties rarely found in farmers plots. On 23<sup>rd</sup> September 2020, the Cassava Growers Association of Nigeria (CGAN) with its state chapters agreed to give the landrace, TMEB693 among a few others, a brand name for marketing – 'POUNDABLE'. The event was well attended by officials of the Federal Ministry of Agriculture and Rural Development, the National Agricultural Seed Council, the Agricultural Research Council of Nigeria, NRCRI, IITA and NACGRAB as well as cassava farmers, seed producers and cassava processors. Earlier on in August 2019, the Technical Sub-Committee (TSC) appointed a monitoring team that visited the on-farm trials where farmers grew and assessed the variety in several states of Nigeria.

Cassava breeders at NRCRI and IITA developed product profiles for cassava varieties and this includes varieties that address gari and fufu markets, boiled/poundable cassava, biofortified cassava and cassava for industry (Table 1). Our aim is to ensure that varieties were developed to address each of these profiles for appropriate market segments.

The variety presented here for registration and release would serve as a replacement for older poundable or 'boil and eat' varieties, now out of cultivation, but persistently requested for by consumers and growers. We hereby present 'POUNDABLE', suitable for boiling and pounding, for registration and release as a variety to be grown by Nigerian cassava seed producers and farmers.

### ***MULTI-LOCATIONAL TRIALS FOR BOILED/POUNDABLE PRODUCT PROFILE (ON-STATION NCRP TRIALS)***

#### **Materials and methods**

In 2014 to 2016, 12 improved provitamin A cassava varieties were nominated by the breeders at NRCRI, Umudike and IITA, Ibadan, with the inclusion of POUNDABLE (TMEB693) since poundability was going to be part of the parameters being evaluated to address a product profile, for multi-locational trial through the National Coordinated Research Project. The varieties were tested in five on-station locations: Mokwa, Ubiaja, Ikenne, Abuja and Zaria in 2014/2015, 2015/2016 and 2016/2017 cropping seasons. The varieties were IITA-TMS-IBA011368, IITA-TMS-IBA070557, IITA-TMS-IBA070703, IITA-TMS-IBA083724, IITA-TMS-IBA083739, IITA-TMS-IBA090091, IITA-TMS-

IBA30572, NR07/240, NR1S1/059, NR1S1/096, NR1S1/131, NR1S1/200, NR1S1/205, TMEB693. The checks were a national check variety, IITA-TMS-IBA-30572, and a provitamin A variety, IITA-TMS-IBA011368 (UMUCASS 36). However, we decided to step down on proceeding with the provitamin A varieties to on-farm trials since we were not convinced that we had attained the target levels of beta carotene in the entries. We had to proceed to a combined on-farm trials with TMEB693 and a few other new white root varieties (that went through a separate NCRP trial) to complete the process required for nomination to the committee.

## **Results and Discussion**

### ***MULTI-LOCATIONAL TRIALS FOR BOILED/POUNDABLE PRODUCT PROFILE (ON-STATION NCRP TRIALS)***

The mean performance of POUNDABLE relative to the other genotypes evaluated are shown in Tables 2 to 6 and in Fig 1. The mean fresh root yield of 15 t/ha (Table 2) is a reflection of its performance even in marginal conditions as it recorded more than 25 t/ha in some environments. The mean dry matter of 32% is above the threshold of 30% and is suitable for the poundability (Table 3). The mean dry yield of 5 t/ha (Table 4) is a good value for commercial production. Biplot analysis (Fig 1) indicated that POUNDABLE stood out for high yields, dry matter and starch contents in the locations tested relative to the other genotypes. The very low scores for cassava mosaic disease (CMD) as shown in Table 5 is indicative of a disease resistant cultivar.

The poundability score of 2.96 on a scale of 0 to 3 indicates its suitability for boil and eat or poundable type, cassava variety (Table 6). This variety if registered would enable seed producers market it for people who prefer to consume cassava as a boiled vegetable or to pound it as they would yam. It has been opined that pectin walls are responsible for root mealiness of cassava and pectin degradability during cooking of root is associated with the level of mealiness achievable by each variety (Bechoff *et al.* 2019). This presents a new vista for breeding of mealy, poundable cassava varieties.

### ***ONFARM TRIALS***

#### **Materials and methods**

The genotypes NR060394, NR060333, IITA-TMS-IBA090506, IITA-TMS-IBA090521, NR060117, POUNDABLE, TME419 and a local check at each location were nominated for on-farm trials in 12 states in 2018 (Table 7). Five farmers per state were used for the trials and each farmer was

considered a replicate in each state while the state constituted a trial site. The varieties were evaluated along with the local best in each location for yield and for food qualities. In August 2019, representatives of the Technical Sub-Committee of the National Varieties Release Committee visited a selected number of farmers in some states where the trials were being conducted.

## **Results**

The variety POUNDABLE showed a moderate yield level and ranked among the preferred ones (Table 8). Biplot analysis (Fig 2) showed a stable fresh root yield and a distinctive characteristic for poundability by POUNDABLE. It was also outstanding for its swelling ability and poundability (Table 9) and as such should be so registered and released in Nigeria for commercial purposes. Many people often share the nostalgia of cassava varieties they could simply boil and eat or pound. The variety POUNDABLE is more resilient to diseases and pests than the earlier grown cultivars with similar characteristics. On this basis, we can encourage burgeoning cassava seed companies and community seed producers to grow and sell certified seeds of POUNDABLE as a variety that could be pounded. We recommend the naming, registration and release of POUNDABLE as a boiled or poundable variety.

## **References**

Bechoff, A., K. Tomlins, G. Fliedel, L.A. Becerra Lopez-Lavalle, A. Westby, C. Hershey and D. Dufour. 2018. Cassava traits and end-user preference: Relating traits to consumer liking, sensory perception and genetics. *Critical Reviews in Food Science and Nutrition* 58 (4): 547-567. [doi.org/10.1080/10408398.2016.1202888](https://doi.org/10.1080/10408398.2016.1202888)

Table 1. Cassava product profiles

<b>SN</b>	<b>Product</b>	<b>Key Trait</b>	<b>Required Trait</b>	<b>Target Level</b>
1	Gari and Fufu (granulated and paste products)	Yield, high dry matter & processed product quality (colour and texture)	CMD, CBDSD and whitefly resistance, flexible time of harvest	Dry matter content >35% with high processed product yield
2	Cassava for Fresh Markets	Yield, root mealiness, poundable, end-user preference	CMD, CBDSD and whitefly resistance, drought tolerance, low CNP potential	Mealiness score 3 all seasons
3	Biofortified cassava for enhanced nutrition	Yield, $\beta$ -carotene, suitability for gari and fufu	CMD, CBDSD and whitefly resistance, low CNP potential	$\beta$ -carotene content >15ppm fresh weight, Dry mater content >30%
4	Cassava for industry	Yield, high starch and flour content	CMD, CBDSD and whitefly resistance, suitability for mechanization	Starch content >25%

Table 2. Mean fresh root yield (t/ha) of varieties including landrace, TMEB693, from multilocational trials across three seasons.

Genotype	ABJ14	IKN14	MOK14	UBJ14	ZAR14	IKN15	MOK15	UBJ15	ZAR15	ABJ16	IKN16	MOK16	UBJ16	ZAR16	Mean	SE
IITA-TMS-IBA070557	23.83	11.25	13.94	21.81	1.94	11.25	13.94	21.81	1.94	33.17	16.25	14.72	6.39	14.33	15.36	2.21
IITA-TMS-IBA070703	18.67	11.39	3.22	6.67	2.61	11.39	3.22	6.67	2.61	26.33	14.86	1.11	1.81	7.00	9.08	1.96
IITA-TMS-IBA083724	15.28	17.22	16.72	29.31	4.87	17.22	16.72	29.31	4.87	26.72	21.94	22.36	12.36	10.28	17.36	1.97
IITA-TMS-IBA083739	27.11	16.67	20.89	28.75	7.56	16.67	20.89	28.75	7.56	44.17	24.58	26.25	13.75	12.78	21.56	2.48
IITA-TMS-IBA090091	32.39	10.56	14.11	7.05	2.89	10.56	14.11	7.05	2.89	24.72	22.22	20.28	6.94	9.17	14.49	2.52
NR07/240	13.78	15.49	21.83	25.14	6.35	15.39	21.83	25.14	6.35	30.50	20.83	13.75	5.56	9.00	16.31	1.98
NR1S1/059	1.72	1.12	4.11	8.33	0.61	1.53	4.11	8.33	0.61	29.72	27.22	11.81	7.08	11.06	7.78	2.40
NR1S1/096	4.00	7.62	14.39	6.81	0.44	5.86	14.39	6.81	0.44	41.94	44.58	26.94	5.56	12.28	12.95	3.63
NR1S1/131	2.61	3.75	2.06	5.42		3.75	2.06	5.42		24.00	6.39	4.72	8.19	9.66	6.20	1.62
NR1S1/200	1.39	3.33	1.70	10.69		3.33	1.70	10.69		25.83	24.58	3.19	4.31	3.28	7.34	2.36
NR1S1/205	3.64	2.50	2.28	13.19		2.55	2.28	13.19		18.06	7.78	6.81	5.42	9.16	6.96	1.42
<b>TMEB693</b>	<b>16.33</b>	<b>7.64</b>	<b>17.83</b>	<b>21.81</b>	<b>0.97</b>	<b>7.64</b>	<b>17.83</b>	<b>21.81</b>	<b>0.97</b>	<b>37.61</b>	<b>25.83</b>	<b>25.28</b>	<b>8.75</b>	<b>8.61</b>	<b>15.68</b>	<b>2.60</b>
IITA-TMS-IBA011368	11.11	11.11	7.22	30.97	1.61	11.11	7.22	30.97	1.61	30.28	20.00	10.42	11.67	12.89	13.95	2.52
IITA-TMS-IBA30572	30.28	16.25	31.33	28.75	4.67	16.25	31.33	28.75	4.67	39.17	25.00	26.39	12.92	20.06	23.07	2.64
Mean	14.44	9.71	12.26	17.48	2.95	9.61	12.26	17.48	2.95	30.87	21.58	15.29	7.91	10.68		
SE	2.92	1.48	2.44	2.68	0.80	1.48	2.44	2.68	0.80	2.01	2.47	2.48	0.95	1.03		

ABJ=ABUJA, IKN=IKENNE, MOK=MOKWA, UBJ=UBIAJA, ZAR=ZARIA

Table 3. Mean dry matter content (%) of varieties including landrace, TMEB693, from multilocational trials across three seasons.

Genotype	ABJ14	IKN14	MOK14	UBJ14	ZAR14	IKN15	MOK15	UBJ15	ZAR15	ABJ16	IKN16	MOK16	UBJ16	ZAR16	Mean	SE
IITA-TMS-IBA070557	32.47	25.93	25.57	33.43	29.73	25.93	25.57	33.43	29.73	29.70	40.00	16.47	29.03	29.63	29.27	1.35
IITA-TMS-IBA070703	20.73	26.30	18.69	25.63	23.50	26.30	18.69	25.63	23.50	23.10	26.67		15.51	20.57	22.54	0.93
IITA-TMS-IBA083724	28.23	33.50	26.33	33.83	24.93	33.50	26.33	33.83	24.93	34.00	35.83	17.03	35.87	31.26	29.84	1.37
IITA-TMS-IBA083739	31.87	29.20	23.13	31.03	27.20	29.20	23.13	31.03	27.20	29.87	30.03	15.70	34.53	32.05	28.47	1.22
IITA-TMS-IBA090091	28.23	31.13	27.10	28.61	27.30	31.13	27.10	28.61	27.30	29.73	33.13	18.57	28.77	26.70	28.11	0.83
NR07/240	19.63	20.30	15.13	22.60	20.86	20.30	15.13	22.60	20.86	23.40	21.40	14.07	26.60	22.91	20.36	0.88
NR1S1/059	22.93	23.69	10.60	25.50		23.69	10.60	25.50		25.57	29.47	11.63	25.00	25.44	21.73	1.77
NR1S1/096	27.20	30.05	11.97	26.30	19.33	30.05	11.97	26.30	19.33	23.90	23.07	16.57	27.30	25.30	23.06	1.53
NR1S1/131	29.07	28.50	18.50	30.98	23.46	28.50	18.50	30.98	23.46	24.30	33.63	12.52	27.71	29.80	25.93	1.49
NR1S1/200	24.93	30.19	16.57	33.86	38.94	30.19	16.57	33.86	38.94	27.80	30.77	18.86	32.43	26.11	28.33	1.84
NR1S1/205	25.23	28.40	15.59	31.73	28.70	28.40	15.59	31.73	28.70	26.43	28.33	10.58	27.10	25.13	25.13	1.61
<b>TMEB693</b>	<b>33.37</b>	<b>35.20</b>	<b>27.33</b>	<b>32.40</b>	<b>28.00</b>	<b>35.20</b>	<b>27.33</b>	<b>32.40</b>	<b>28.00</b>	<b>34.47</b>	<b>35.57</b>	<b>16.70</b>	<b>34.41</b>	<b>36.64</b>	<b>31.36</b>	<b>1.33</b>
IITA-TMS-IBA011368	28.83	22.80	20.30	26.53	21.18	22.80	20.30	26.53	21.18	23.20	27.87	13.40	29.13	25.04	23.86	1.11
IITA-TMS-IBA30572	27.40	34.80	24.17	28.87	29.82	34.80	24.17	28.87	29.82	33.53	26.90	16.57	31.47	29.16	28.52	1.20
Mean	27.15	28.57	20.07	29.38	26.38	28.57	20.07	29.38	26.38	27.79	30.19	15.28	28.92	27.55		
SE	1.10	1.19	1.51	0.97	1.42	1.19	1.51	0.97	1.42	1.11	1.36	0.72	1.36	1.11		

ABJ=ABUJA, IKN=IKENNE, MOK=MOKWA, UBJ=UBIAJA, ZAR=ZARIA

Table 4. Mean dry root yield (t/ha) of varieties including landrace, TMEB693, from multilocational trials across three seasons.

Genotype	ABJ14	IKN14	MOK14	UBJ14	ZAR14	IKN15	MOK15	UBJ15	ZAR15	ABJ16	IKN16	MOK16	UBJ16	ZAR16	Mean	SEM
IITA-TMS-IBA070557	7.72	2.97	3.58	7.28	0.56	2.97	3.58	7.28	0.56	9.90	6.50	2.42	1.90	3.37	4.55	0.75
IITA-TMS-IBA070703	3.83	2.95	0.29	1.74	0.60	2.95	0.50	1.74	0.60	6.11	3.98		0.14	1.28	2.18	0.48
IITA-TMS-IBA083724	4.19	5.86	4.40	9.90	1.27	5.86	4.40	9.90	1.27	9.18	7.92	3.85	4.41	3.90	5.37	0.71
IITA-TMS-IBA083739	8.66	4.81	4.66	8.91	2.06	4.81	4.66	8.91	2.06	13.14	7.36	4.11	4.72	3.74	6.08	0.79
IITA-TMS-IBA090091	9.07	3.24	3.84	2.00	0.76	3.24	3.84	2.00	0.78	7.29	7.36	3.84	2.02	2.21	4.04	0.73
NR07/240	2.95	3.01	3.23	5.68	1.26	2.94	3.23	5.68	1.33	7.16	4.56	1.93	1.47	2.50	3.32	0.45
NR1S1/059	0.42	0.06	0.43	2.12	0.12	0.15	0.43	2.12		7.61	8.02	1.32	1.78	2.03	1.91	0.70
NR1S1/096	1.09	2.03	2.56	1.80	0.05	1.95	2.56	1.80	0.10	10.03	10.22	4.18	1.56	3.53	2.95	0.81
NR1S1/131	0.76	0.84	0.35	3.46		1.56	0.35	3.46		5.68	2.33	1.03	2.31	2.94	1.99	0.44
NR1S1/200	0.34	0.95	0.33	4.09		1.93	0.32	4.09		7.03	7.49	0.43	1.41	0.85	2.28	0.71
NR1S1/205	0.83	0.58	0.23	4.13		1.38	0.40	4.13		4.80	2.18	0.90	1.48	2.24	1.85	0.43
<b>TMEB693</b>	<b>5.44</b>	<b>2.73</b>	<b>4.75</b>	<b>7.04</b>	<b>0.17</b>	<b>2.73</b>	<b>4.75</b>	<b>7.04</b>	<b>0.61</b>	<b>13.00</b>	<b>9.20</b>	<b>4.43</b>	<b>3.14</b>	<b>3.36</b>	<b>4.92</b>	<b>0.84</b>
IITA-TMS-IBA011368	3.31	2.55	1.45	8.23	0.32	2.55	1.45	8.23	0.33	6.98	5.59	1.42	3.38	4.22	3.55	0.68
IITA-TMS-IBA30572	8.26	5.78	7.55	8.30	1.82	5.78	7.55	8.30	1.79	13.13	6.70	4.34	4.05	3.92	6.37	0.76
Mean	4.06	2.74	2.69	5.34	0.79	2.91	2.71	5.34	0.92	8.65	6.39	2.63	2.41	2.86		
SE	0.87	0.49	0.60	0.78	0.22	0.44	0.60	0.78	0.21	0.75	0.64	0.42	0.36	0.28		

ABJ=ABUJA, IKN=IKENNE, MOK=MOKWA, UBJ=UBIAJA, ZAR=ZARIA

Table 5. Mean symptom severity scores for cassava mosaic disease (CMD) of varieties including landrace, TMEB693, from multilocational trials across three seasons.

Genotype	ABJ14	IKN14	MOK14	UBJ14	ZAR14	IKN15	MOK15	UBJ15	ZAR15	ABJ16	IKN16	MOK16	UBJ16	ZAR16	Mean	SE
TMS-IBA011368	2.00	3.00	2.56	2.67	1.67	3.00	2.56	2.67	1.67	2.22	2.89	1.56	2.11	2.00	2.33	0.13
TMS-IBA070557	1.00	1.33	1.00	1.00	1.00	1.33	1.00	1.00	1.00	1.44	1.00	1.44	1.00	1.22	1.13	0.05
TMS-IBA070703	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.56	1.00	1.22	1.00	1.00	1.06	0.04
TMS-IBA083724	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.67	1.00	1.22	1.00	1.00	1.06	0.05
TMS-IBA083739	1.00	1.11	1.11	1.00	1.00	1.11	1.11	1.00	1.00	1.67	1.11	1.11	1.00	1.00	1.10	0.05
TMS-IBA090091	1.00	1.00	1.00	0.93	1.00	1.00	1.00	0.93	1.00	1.56	1.00	1.11	1.00	1.00	1.04	0.04
TMS-IBA30572	1.00	2.33	1.56	1.44	1.00	2.33	1.56	1.44	1.00	1.67	2.56	1.33	1.11	2.33	1.62	0.15
NR07/240	1.00	1.22	1.00	1.44	1.00	1.22	1.00	1.44	1.00	2.22	2.00	1.33	1.56	2.11	1.40	0.12
NR1S1/059	1.00	1.22	1.44	1.00	1.22	1.22	1.44	1.00	1.22	1.44	2.89	1.67	2.00	1.44	1.44	0.13
NR1S1/096	1.11	1.47	1.44	1.78	1.01	1.47	1.44	1.78	1.01	1.67	1.00	1.56	2.22	1.22	1.44	0.09
NR1S1/131	1.56	1.44	1.78	2.22	1.00	1.44	1.78	2.22	1.00	1.89	2.78	1.56	2.00	1.89	1.75	0.13
NR1S1/200	1.22	1.78	1.78	2.56	1.01	1.78	1.78	2.56	1.01	2.22	3.00	1.56	2.78	2.22	1.95	0.17
NR1S1/205	1.33	2.22	2.33	2.22	1.00	2.22	2.33	2.22	1.00	2.22	3.00	2.00	2.89	1.67	2.05	0.16
<b>TMEB693</b>	<b>1.00</b>	<b>1.89</b>	<b>1.78</b>	<b>1.11</b>	<b>1.11</b>	<b>1.89</b>	<b>1.78</b>	<b>1.11</b>	<b>1.11</b>	<b>1.56</b>	<b>1.00</b>	<b>1.67</b>	<b>1.00</b>	<b>1.56</b>	<b>1.40</b>	<b>0.10</b>
Mean	1.16	1.57	1.48	1.53	1.07	1.57	1.48	1.53	1.07	1.79	1.87	1.45	1.62	1.55		
SE	0.08	0.16	0.14	0.17	0.05	0.16	0.14	0.17	0.05	0.08	0.25	0.07	0.19	0.13		

CMD = mean cassava mosaic disease severity score on a scale of 1-5, where 1: no symptom and 5: very severe

ABJ=ABUJA, IKN=IKENNE, MOK=MOKWA, UBJ=UBIAJA, ZAR=ZARIA

Table 6. Mean disease and pest responses for cassava mosaic disease severity (mcmds) and incidence (mcm-di), cassava bacterial blight severity (mcbbs) and incidence (mcbbi), cassava green mite severity (mcgms) and cassava anthracnose disease severity (mcads) and incidence (mcadi) of varieties including landrace, TMEB693, from multilocational trials across three seasons.

Genotype	mcmds	mcm-di	mcbbs	mcbbi	mcgms	mcads	mcadi
IITA-TMS-IBA011368	2.30	0.31	1.69	0.31	2.34	1.17	0.04
IITA-TMS-IBA070557	1.12	0.04	1.47	0.25	1.88	1.17	0.04
IITA-TMS-IBA070703	1.05	0.01	1.70	0.30	2.20	1.13	0.02
IITA-TMS-IBA083724	1.06	0.01	1.67	0.31	1.97	1.19	0.04
IITA-TMS-IBA083739	1.09	0.01	1.69	0.33	2.46	1.29	0.09
IITA-TMS-IBA090091	1.05	0.01	1.76	0.53	2.62	1.01	0.00
IITA-TMS-IBA30572	1.61	0.08	1.78	0.36	2.83	1.22	0.06
NR07/240	1.37	0.06	1.68	0.29	2.43	1.22	0.07
NR1S1/059	1.41	0.12	1.52	0.34	2.30	1.04	0.01
NR1S1/096	1.44	0.15	1.67	0.23	2.54	1.02	0.00
NR1S1/131	1.74	0.21	1.77	0.31	2.50	1.07	0.07
NR1S1/200	1.90	0.39	1.56	0.23	1.96	1.06	0.02
NR1S1/205	2.00	0.34	1.58	0.30	1.99	1.14	0.04
TMEB693	1.33	0.06	1.74	0.30	2.68	1.35	0.08
Mean	1.46	0.13	1.66	0.31	2.34	1.15	0.04
SEM	0.11	0.04	0.03	0.02	0.08	0.03	0.01
CV	0.27	1.05	0.06	0.23	0.13	0.09	0.69

mcmds = mean cassava mosaic disease severity score on a scale of 1-5, where 1: no symptom and 5: very severe

mcm-di = mean cassava mosaic disease incidence which is the proportion of infected plants per plot

mcbbs = mean cassava bacterial blight severity score on a scale of 1-5, where 1: no symptom and 5: very severe

mcbbi = mean cassava bacterial blight incidence which is the proportion of infected plants per plot

mcgms = mean cassava green mite severity score on a scale of 1-5, where 1: no symptom and 5: very severe

mcads = mean cassava anthracnose disease severity score on a scale of 1-5, where 1: no symptom and 5: very severe

mcadi = mean cassava anthracnose disease incidence which is the proportion of infected plants per plot

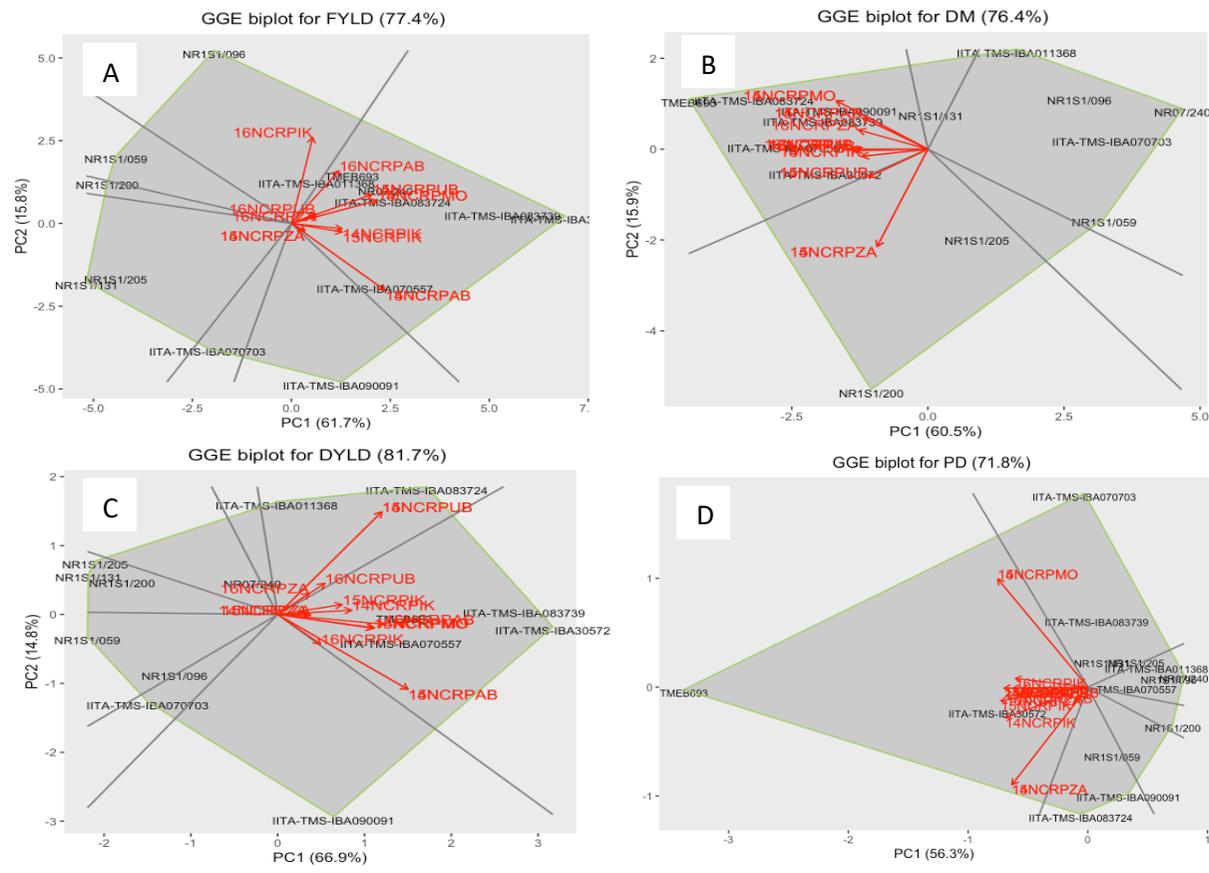


Fig 1. Biplot of “Which-won-where” of the improved cassava genotypes across showing the performance of ‘boil and eat’ or poundable landrace, TMEB693, in testing locations in Nigeria for A: fresh yield, B: dry matter, C: dry yield and D: poundability.

NCRPAB=ABUJA, NCRPIK=IKENNE, NCRPMO=MOKWA, NCRPUB=UBIAJA, NCRPZA=ZARIA

Table 7. Mean poundability scores\* of varieties including landrace, TMEB693, from multilocational trials across three seasons.

Genotype	ABJ14	IKN14	MOK14	UBJ14	ZAR14	IKN15	MOK15	UBJ15	ZAR15	ABJ16	IKN16	UBJ16	ZAR16	Mean	SE
IITA-TMS-IBA070557	0.67	0.16	0.00	0.00	0.33	-0.33	0.00	0.00	0.33	2.00	0.00	0.00	2.67	0.44	0.23
IITA-TMS-IBA070703	0.00	0.33	3.00	0.00	0.00	0.33	3.00	0.00	0.00	0.00	0.00	0.00	1.67	0.60	0.30
IITA-TMS-IBA083724	0.00	0.67	0.00	0.00	2.63	0.67	0.00	0.00	2.63	0.33	0.00	0.00	2.67	0.69	0.29
IITA-TMS-IBA083739	0.00	0.00	1.67	0.00	1.00	0.00	1.67	0.00	1.00	0.33	0.67	0.00	1.61	0.57	0.18
IITA-TMS-IBA090091	0.00	0.00	0.00	0.01	2.48	0.00	0.00	0.01	2.48	0.00	0.00	0.00	1.00	0.43	0.24
NR07/240	0.00	0.10	0.00	0.00	0.22	0.01	0.00	0.00	0.22	1.00	0.00	0.00	0.00	0.11	0.07
NR1S1/059	0.00	2.84	0.00	0.00		1.32	0.00	0.00		0.00	0.00	0.00	0.33	0.37	0.25
NR1S1/096	0.00	1.10	0.00	0.00	0.04	1.01	0.00	0.00	0.04	0.33	0.00	0.00	0.00	0.18	0.10
NR1S1/131	0.00	1.08	1.33	0.00		1.17	1.33	0.00		0.00	0.00	0.00	0.11	0.42	0.17
NR1S1/200	0.00	0.16	0.03	0.01		0.33	0.03	0.01		0.67	0.00	0.00	0.00	0.01	0.07
NR1S1/205	0.00	0.20	1.05	0.00		0.02	1.05	0.00		0.00	0.67	0.00	0.11	0.22	0.13
<b>TMEB693</b>	<b>3.00</b>	<b>3.00</b>	<b>3.00</b>	<b>2.67</b>	<b>3.00</b>	<b>3.00</b>	<b>3.00</b>	<b>2.67</b>	<b>3.00</b>	<b>3.00</b>	<b>2.67</b>	<b>2.33</b>	<b>3.00</b>	<b>2.88</b>	<b>0.06</b>
IITA-TMS-IBA011368	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.00	0.00	0.67	0.26	0.13
IITA-TMS-IBA30572	0.67	1.33	1.67	0.00	2.33	1.33	1.67	0.00	2.33	2.00	0.00	0.00	1.67	1.12	0.24
Mean	0.36	0.71	0.84	0.19	1.20	0.58	0.84	0.19	1.20	0.81	0.29	0.17	1.11		
SE	0.22	0.29	0.30	0.19	0.40	0.25	0.30	0.19	0.40	0.26	0.19	0.17	0.29		

\*Poundability on a score of 0-3, where 0: not poundable and 3: very poundable.

ABJ=ABUJA, IKN=IKENNE, MOK=MOKWA, UBJ=UBIAJA, ZAR=ZARIA

Table 8. List of states used for on-farm trials of improved cassava varieties in Nigeria in 2018/2019.

S/N	State	Agroecological Zone
1	Ogun	Humid Forest
2	Akwa Ibom	Humid Forest
3	Jigawa	Humid Forest
4	Imo	Humid Forest
5	Ondo	Humid Forest
6	Delta	Humid Forest
7	Edo	Humid Forest
8	Kwara	Southern Guinea Savannah
9	Kogi	Southern Guinea Savannah
10	Benue	Southern Guinea Savannah
11	Niger	Southern Guinea Savannah
12	Kaduna	Northern Guinea Savannah

Table 9. Fresh root yield (t/ha) of cassava varieties under on-farm pre-release trial in some states of Nigeria during 2018/2019 cropping season.

State	IBA090506	IBA090521	NR060117	NR060333	NR090394	TMEB419	TMEB693	LOCAL
Edo	13 (5)	16.7 (3)	16.4 (2)	22.5 (2)	18.1 (6)	13.7 (3)	11.3 (5)	12.2 (6)
Jigawa	18.1 (5)	20.7 (3)	21.7 (2)	21.6 (2)	17 (4)	18 (5)	14 (6)	9.7 (7)
Kaduna	31.2 (4)	40.8 (3)	37.1 (3)	39.1 (2)	36.6 (5)	30.4 (4)	31.9 (6)	27.7 (7)
Kogi	32.5 (4)	38.8 (3)	39.4 (4)	43.1 (2)	43.8 (6)	33.5 (2)	26.3	19.4 (6)
Kwara	20 (4)	21.1 (2)	26.6 (3)	28 (2)	20.2 (6)	18.9 (3)	16.3	11.7 (6)
Niger	23.1 (4)	26.1 (3)	29.8 (2)	35.9 (2)	32.7 (4)	24.6 (4)	18 (6)	10.4 (7)
Ogun	23 (4)	8.8 (3)	19.4 (2)	29.3 (3)	17.9 (6)	13 (3)	20	5.7 (6)
Ondo	19.5 (5)	20 (3)	19.1 (2)	25.2 (2)	15.9 (6)	15.5 (4)	11.7 (5)	15.6 (5)
Mean								
(*)	22.6 (4.2)	24.1 (2.9)	26.2 (2.4)	30.6 (2)	25.3 (5.4)	20.9 (3.3)	18.7 (5.5)	23.5 (6)

The figures in parenthesis is the rank on a scale of 1–7; where 1 = most preferred and 7 = least preferred; N.T = Not tested; \* = mean ranking

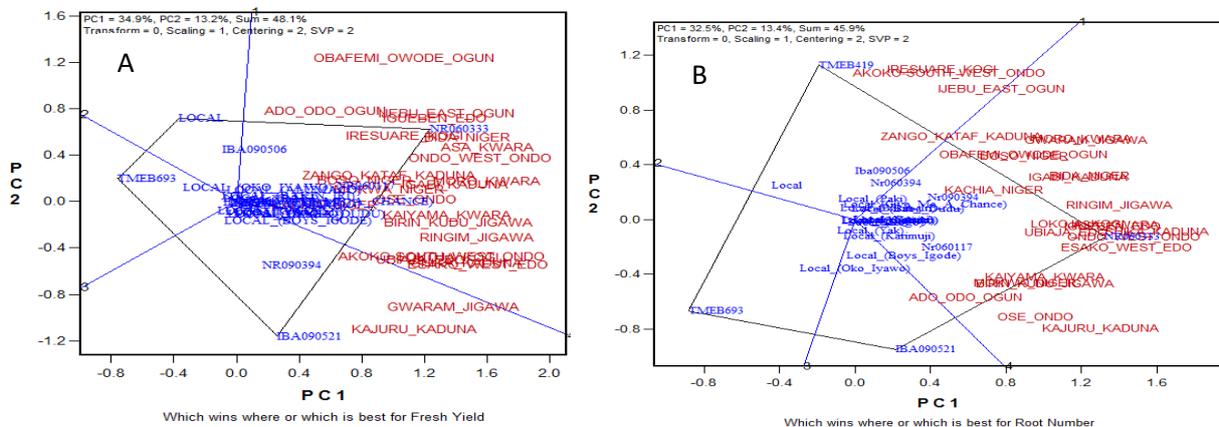


Fig 2. Biplot of “Which-won-where” of the 7 improved cassava genotypes across and local checks in on-farm trials in selected states testing locations in Nigeria in 2018 for A: fresh yield, B: no. of roots/plot.

Table 10. Contingency table of combined frequency of preferred clones by appearance, swelling ability for food quality across the states sampled.

<b>Genotype</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
NR060333				5	132
TMEB419				13	129
NR060117				9	128
IBA090521				14	123
IBA090506				25	107
NR060394		2		43	92
<b>TMEB693</b>				<b>42</b>	<b>90</b>
Local (Oko-Iyawo)				11	14
Local				12	8
Local Rogo			2	12	6
Local (Alumaco)				1	4
Ozigbo				1	4
Local Karimuji				6	4
Local (Give me Chance)				1	4
Local Bakin-Iri				3	2
Local Iri- Doya				3	2
Local (Atiku)				3	2
Local (UNICEF)				3	2
Local (Baba Dudu)				4	1
Local (Sanmi)				4	1
Local (Paki)			1	4	
Local (Yak)			1	6	
Local (Boy's Igode)			1	4	

Rank 5 is considered the best rating in the order of 1-5. Numbers are individuals who preferred each genotype. Food Quality (Appearance, Swelling, Stickiness, Drawability, Gari aroma, Gari color, Fufu aroma, Fufu color, Poundability)

## TSC DESCRIPTORS FORMAT FOR CASSAVA VARIETIES

### GENERAL DESCRIPTORS

1. **Species:** *Manihot esculenta* Crantz.
2. **Name of variety:** UMUCASS 51 (POUNDABLE)
3. **Old name:** TMEB693
4. **Origin/Source of variety:** International Institute of Tropical Agriculture (IITA), Nigeria.
5. **Type of variety:** Landrace
6. **Pedigree:** Unknown
7. **Name and address of developing/releasing organizations:**
  - a.) **Developing organization:** International Institute of Tropical Agriculture (IITA), Nigeria / National Root Crops Research Institute (NRCRI), Umudike, Nigeria
  - b.) **Releasing organization:** National Root Crops Research Institute (NRCRI), Umudike, Nigeria
  - c.) **Breeders:** Alfred Dixon, Chiedozi N. Egesi, Peter Kulakow, Damian Njoku, Ismail Rabbi, Elizabeth Parkes and Charles Amadi, Mercy Diebiru-Ojo
  - d.) **Collaborating scientists:** Maria Okoro, Joseph Onyeka, Busie Maziya-Dixon
8. **Morphological characteristics:** Erect plant with high height of branching
9. **Adaptation:** Rainforest and southern Guinea Savannah
10. **Days to maturity:** 10 – 12 months
11. **Potential root yield:** 26 t/ha
12. **Pest/Disease tolerance:** resistant to cassava anthracnose disease (CAD), cassava mealybug (CM), cassava bacterial blight (CBB), cassava mosaic disease (CMD), cassava green mite (CGM).
13. **Outstanding characteristics:** Poundable, mealy, low cyanogenic potential and high dry matter
14. **Nutrient content:** Dry matter content (39.5%); Starch of dry roots (40.3%)
15. **Year of release:**

### SPECIFIC DESCRIPTORS FOR (UMUCASS 51 - POUNDABLE)

1. **Plant type:** Tall (2.0-3.0 m)
2. **Branching habit:** moderate branching
3. **Height at branching:** (1-1.5 m)
4. **Suitability for mixed cropping:** highly suitable
5. **Colour of unexpanded young leaf:** greenish purple
6. **First fully expanded leaf colour:** green
7. **Pubescence of young leaf:** none
8. **Central leaf lobe shape:** lanceolate
9. **Petiole colour:** reddish purple
10. **Young stem colour:** silver green
11. **Stem colour:** dark brown
12. **Flower:** present
13. **Root neck length:** medium
14. **Outer root skin colour:** brown
15. **Inner root skin colour:** purple
16. **Pulp colour:** white
17. **Cyanogenic potential (CNP):** 4.2 mg HCN eqv. per 100 g
18. **Dry matter of fresh roots (%):** 39.5
19. **Starch of dried roots (%):** 78.2
20. **Gari yield (%):** 25
21. **Proximate composition of dry roots:** Reducing sugar (3.67%), Crude fibre (1.1%), Ash (1.94%), Amylose (23.8%).

**UMUCASS 51 (TMEB693 - POUNDABLE)**

