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Assessment and Selection of Superior Genotypes among Elite Cassava Genotypes by Farmers and Scientists in Southern Tanzania.

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Abstract
A participatory genotype/variety selection involving farmers in three agro ecological zones in Southern Tanzania and scientists from Naliendele Agricultural Research Institute (NARI) and Sokoine University of Agriculture (SUA) to select superior cassava genotypes is described. Initial situation analyses of the communities indicated that cassava is increasing in importance both as a food and a cash crop. Most farmers utilized landraces of cassava; improved varieties were scarcely mentioned. Nine newly improved cassava genotypes obtained from advanced yield trial at NARI were planted in each agro ecological in a randomized complete block design. During cropping season (2011/2012) the genotypes selected by farmers were almost the same as those selected by scientists after analysis. This selection process has identified four superior genotypes from amongst nine elite genotypes; namely Kiroba, NDL 2006/487, NDL 2006/438 and Naliendele. Farmers were relatively consistent in their selection from different stages of crop growth, and their selections corresponded with their stated selection criteria. Official variety release requires additional multilocational and inspection trials and postharvest assays but otherwise seems harmonious with a participatory breeding approach; involvement of farmers in this stage may facilitate early variety release, an important factor in cost-effectiveness. Adoption of a participatory approach, with farmers and scientists taking on new roles and decentralization of activities, implies a concomitant transfer of influence and resources.
Keywords: Participatory Variety Selection, Farmer selection criteria, Variety release.

1.0 Introduction

Participatory Crop Improvement (PCI) is a new approach in genetic improvement. The approach aims at fully integrating farmers and their stakeholders of the production chain into the process of variety development. It aims at ensuring the needs of small farmers living in poor and marginal areas for which conventional breeding cannot offer suitable varieties (Trouche, 2004).

Participatory crop improvement and or genotype/variety selection is based on the principal of sufficient knowledge of farmers' specific production needs and of the advantages and disadvantages of the local varieties they use (Trouche, 2004). The approach involves farmers in different stages of selection and evaluation of future varieties. This can be done either through "Mother" trial where researchers test advanced lines on-farm and on-station, in which groups of farmers rank cassava lines or through "Baby trial" where farmers test lines on their fields using their level of management and rate the performance (Singh *et al.*, 2002).

Cassava (*Manihot esculenta* Crantz) is from the family *Euphobeaceae*. It is among the most important root crops worldwide and provides food for one billion people (Bokanga, 2001; Nuwamanya *et al.,* 2009). It is an important food crop in developing countries, and it is the fourth source of calories, after rice, sugar cane and maize worldwide (Akinwale *et al.,* 2010). The edible roots supply energy for more than 500 million people worldwide (Ceballos *et al.,* 2006). It is a perennial crop, native to America and grown in agro ecologies which differ in rainfall, temperature regimes and soil types (Olsen and Schaal, 2001). Cassava constitutes an essential part of the diet of most tropical countries of the world (Calle *et al.,* 2005). In Africa the crop is the most important staple food grown and plays a major role in the effort to alleviate food crisis (Hahn and Keyer, 1985).

Tanzania is the fifth producer of cassava in Africa and eighth cassava producer in the world, with about 670 000 hectares of land under cassava cultivation with estimated annual production of 7 000 000 tons of fresh root (FAOSTAT, 2008). Cassava is among the most important food security crops in the country and is the most important in the Lake zone(mid altitude warm sub-humid, highland cool humid and mid altitude warm sub-humid) and in the coastal lowlands (Lowland warm sub-humid) (Kapinga *et al.,* 1997). In Tanzania it is the second most important food crop after maize in terms of volume and capita consumption (Kavishe, 1993).

Cassava varieties have been released in Tanzania since 1990s; varieties developed by Tanzania Roots and Tuber Crops National Program. These varieties had been selected largely on the basis of their root yield and their resistance to pests and diseases, particularly cassava mosaic disease and cassava brown streak disease (Kundy *et al.,* 2014). Despite this, cassava landraces remain predominant in Tanzania. Participatory Plant Breeding has focused

mainly on crops which farmers usually propagate by seed such as rice, maize and beans. Tropical root crops such as cassava and sweet potato are, by contrast, usually propagated vegetatively and African farmers use their seedlings (de Waal *et al*., 1997) only rarely (Gibson *et al*., 2000; Manu-Aduening *et al*., 2005) prefer.ring the more certain option of vegetative propagation from known cultivars. In root crops breeding programmersmes farmers are usually involved in the final sift and verification of clones and, even in programmes in which farmer involvement has been promoted, they have been involved only at harvesting stage. Here we report a cassava breeding activity in which farmers and scientists worked together from planting, data collection and harvesting.

2.0 Materials and Methods

2.1 Description of Study Area

The study was conducted in three locations of Southern Tanzania at Naliendele (Coastal low land plains), Mtopwa(Makonde plateau) and Nachingwea(Masasi-Nachinwea plains), during the 2011 – 2012 cropping season under rain fed conditions.Naliendele is located at 10° 22'S and 40° 10'E, 120m above sea level and receives mean annual rainfall of 950mm with monthly mean temperature of 27°C and average relative humidity of 86%. Nachingwea is located at 10° 20′S and 38°46'E, 465 m above sea level has a mean annual rainfall of 850mm, mean monthly temperature of 25°C and annual mean relative humidity of 78%. Mtopwa is located at 10° 41'S and 39° 23'E, 760m above sea level receives a mean annual rainfall of 1133mm with monthly mean temperature of 23°C and mean relative humidity of 75%. All the three sites experience a mono-modal type of rainfall. These data are according to the report by the Planning Commission Dar es Salaam and Regional Commissioner's Office Mtwara, Tanzania (2008).

2.2 Situational Analysis

The study involved surveys of cassava farmers belonging to three agro ecological zones in Southern Tanzania. A group of farmers at Naliendele was selected to represent the coastal low land, while groups of farmers from Mtopwa and Nachingwea were selected to represent Makonde Plateau and Masasi-Nachingwea agro ecological zones respectively. Information on the communities was obtained using participatory rural appraisal (PRA) as a needs assessment exercise and to engage with each community. Groups of women and men farmers and village elders provided information on the historical and current production and uses of cassava in each study area.

2.2 Identification of farmers' criteria for cassava acceptability

The scientists described to farmers in each location what was involved in this study and the potential benefits new genotypes could bring to the communities. An invitation was given to all cassava farmers in the three communities to collaborate as a group with us. A group of farmers between 10 – 20 in each location were involved in this study. Before harvesting, farmers were urged to mention/describe the cassava criteria they use in selecting cassava varieties/genotypes. These criteria were then ranked according to the farmers' prioritization. By using "seed ranking method", criteria-wise, farmers made selection among the harvested cassava genotypes. Then genotypes were compared using 'pair-wise ranking" method.

2.3 Statistical Analysis

Genstat version 14 statistical software were used for analysis. Means of treatments were compared using Duncan's Multiple Range Test at 0.001 and 0.05 levels of significance.

3.0 Results

3.1 Farmers Participation

3.1.1 Farmers' criteria for selecting cassava genotypes/varieties

During harvesting, farmers were given a chance of selecting cassava genotypes/varieties according to their fore discussed criteria. Twelve farmers were involved at Naliendele site whereas fifteen farmers were involved at both Mtopwa and Nachingwea sites. The criteria used by farmers in selecting cassava genotypes/varieties were almost the same at all the trial sites. Table 1 shows the criteria used by farmers and their respective ranking in order of importance. At Naliendele site, yield ranked the first while root hardness ranked fourth in order of importance. At Mtopwa yield ranked the third whereas diseases ranked first and root hardness was fourth. On the other hand, at Nachingwea yield ranked first while root taste rank was fourth in order of importance.

Table 1: Farmers criteria for selecting cassava varieties/genotypes at the trial sites

	Rank		
Criteria	**Naliendele**	**Mtopwa**	**Nachingwea**
Yield	1	3	1
Disease	2	1	2
Taste	3	2	4
Hardness	4	4	3
Cookability	5	7	7
Planting material	6	8	6
Storability	7	9	10
Architecture	8	10	9
Fibreousness	9	-	-
Flesh colour	10	11	10
Maturity	-	6	-
Vegetables	-	5	8
Drought	-	-	5

- = Not ranked in top ten

From table 1, at Naliendele flesh colour as a criterion of selecting genotypes was of the least importance. Root fibrousness ranked second from the last followed by plant architecture. However, at Mtopwa the least criterion (storability) in order of importance differed from the least one at Naliendele site. Storability ranked the last, followed by cookability, whereas planting material was the third from the bottom. At Nachingwea, storability ranked the last in order of importance, followed by plant architecture and vegetables production (cassava plant leaves).

The above mentioned criteria are used by farmers depending on the prevailing need(s) at a given period of time. However, according to them, they mostly use the top four ranked criteria. In this study only two major and important criteria were used for selection of genotypes. The criteria used are root yield and cassava diseases. -

3.1.2 Farmers' genotypes selection based on root yield and diseases – "Seed ranking method"

3.1.2.1Root Yield

Results for farmers' genotypes selection based on yield and diseases are shown in Table 2. The highest yielder selected by farmers at Naliendele site was NDL 438 (32 points), followed by NDL 2006/487(31 points) and NDL 2006/283 (29 points), while Albert, NDL 200/741 and variety Naliendele were found to be inferior with score points of 14, 18 and 19 respectively. At Mtopwa the highest yielders were NDL 2006/487 (27 points) followed by NDL 2006/438 (25 points) and variety Naliendele (24 points). The least yielders were found to be NDL 2006/840, NDL 2006/741 and NDL 2006/283 with score points of 15, 16 and 17 respectively. At Nachingwea site, Kiroba, Naliendele variety and NDL 2006/487 were observed to have higher score points of 33, 31 and 30 respectively. The lower score points were found on NDL 2006/741(17 points), NDL 2006/840 (19 points) and Albert (20 points).

3.1.2.2 Diseases

At Naliendele no or minor signs of diseases were observed on genotypes NDL 2006/487 (27 points), NDL 2006/738 (26 points) and NDL 2006/840 (24 points), while most disease symptoms were observed on Albert (12 points), variety Naliendele (13 points) and NDL 2006/283 (14 points) (Table 2). Genotypes NDL 200/438, NDL 2006/850 and NDL 2006/030 were assigned the highest score points of 34, 33 and 31 respectively at Mtopwa, while genotypes NDL 2006/741(15 points), Albert (15 points) and variety Naliendele (17) were found to have clear disease symptoms. At Nachingwea, NDL 2006/487(38 points), NDL 2006/738 (35 points) and Kiroba (34 points) were observed as most tolerant genotypes, while the most susceptible ones were NDL 2006/741 (16 points), Albert (17 points) and Naliendele (17 points).

Table 2: Farmers' genotypes selection based on yield and diseases

	Naliendele				Mtopwa				Nachingwea			
Geno	Y	**Rank**	D	**Rank**	Y	**Rank**	D	**Rank**	Y	**Rank**	D	**Rank**
1	14	**12**	12	**12**	18	**9**	15	**11.5**	20	**10**	17	**11.5**
2	21	**9**	22	**4**	19	**7.5**	30	**4.5**	33	**1**	34	**3**
3	19	**10**	13	**11**	24	**3**	17	**10**	31	**2**	17	**11.5**
4	24	**8**	21	**5**	20	**6**	31	**3**	23	**7**	20	**9**
5	28	**5**	18	**7**	21	**5**	30	**4.5**	21	**9**	25	**7**
6	29	**3.5**	14	**10**	17	**10**	19	**9**	22	**8**	23	**8**
7	32	**1**	20	**6**	25	**2**	34	**1**	25	**6**	33	**4**
8	31	**2**	27	**1**	27	**1**	29	**6**	30	**3**	38	**1**
9	25	**6.5**	26	**2**	19	**7.5**	28	**7**	27	**4**	35	**2**
10	18	**11**	16	**8**	16	**11**	15	**11.5**	17	**12**	19	**10**
11	25	**6.5**	24	**3**	15	**12**	25	**8**	19	**11**	31	**5**
12	29	**3.5**	15	**9**	22	**4**	33	**2**	26	**5**	29	**6**

N.B: 1. The higher the number of the variables, the better the genotype
2. Yield and disease assessed by visual observation

KEY:
Y = Yield, D = Disease
1 = Albert, 2 = Kiroba, 3 = Naliendele, 4 = NDL 2006/030, 5 = NDL 2006/104, 6 =NDL 2006/283, 7 = NDL 2006/438, 8 = NDL 2006/487, 9 = NDL 2006/738, 10 = NDL 2006/741, 11 = NDL 2006/840, 12 =NDL 2006/850.

3.1.3 Farmers pair wise matrix selection of the studied genotypes based on yield

3.1.3.1 Naliendele site

At Naliendele site, twelve farmers participated in the assessment of genotypes based on yield, the results are presented in (Table 28). Genotype NDL 2006/438 was the highest yielder (11 score) followed by NDL 2006/850 and NDL 2006/283, whereas Albert was the least yielder (0 score) among the varieties and genotypes assessed.

Table 3: Pair wise ranking based on yield for Naliendele site

Genotype	1	2	3	4	5	6	7	8	9	10	11	12	Score	Rank
ALBERT													0	12
KIROBA	2												4	8
NALIENDELE	3	2											3	9
NDL 2006/030	4	4	4										5	7
NDL 2006/104	5	5	5	5									7	5.5
NDL 2006/283	6	6	6	6	6								9	2.5
NDL 2006/438	7	7	7	7	7	7							11	1
NDL 2006/487	8	8	8	8	8	6	7						8	4
NDL 2006/738	9	9	9	9	5	6	7	8					7	5.5
NDL 2006/741	10	2	3	4	5	6	7	8	9				2	10
NDL 2006/840	11	2	3	4	5	6	7	8	9	10			1	11
NDL 2006/850	12	12	12	12	12	12	7	12	9	12	12		9	2.5

KEY:
1 = Albert, 2 = Kiroba, 3 = Naliendele, 4 = NDL 2006/030, 5 = NDL 2006/104, 6 =NDL 2006/283, 7 = NDL 2006/438, 8 = NDL 2006/487, 9 = NDL 2006/738, 10 = NDL 2006/741, 11 = NDL 2006/840, 12 = NDL 2006/850.

3.1.3.2 Mtopwa site

At Mtopwa site, fifteen farmers participated for the comparison of genotypes based on yield. Based on yield at Mtopwa, genotype NDL 2006/438 (11 scores) was superior followed by NDL 2006/487 (10 score) and Kiroba (9 scores), while genotype NDL 2006/741 was the least (0 score) (Table 4).

Table 4: Pair wise ranking based on yield for Mtopwa site

Genotype	1	2	3	4	5	6	7	8	9	10	11	12	Score	Rank
ALBERT													2	10
KIROBA	2												9	3
NALIENDELE	3	2											8	4
NDL 2006/030	4	2	3										3	9
NDL 2006/104	5	2	3	4									4	8
NDL 2006/283	6	2	3	6	6								7	5
NDL 2006/438	7	7	7	7	7	7							11	1
NDL 2006/487	8	8	8	8	8	8	7						5	2
NDL 2006/738	9	2	3	9	9	6	7	8					10	7
NDL 2006/741	1	2	3	4	5	6	7	8	9				0	12
NDL 2006/840	1	2	3	4	5	6	7	8	9	11			1	11
NDL 2006/850	12	2	3	12	12	6	7	8	12	12	12		6	6

KEY:
1 = Albert, 2 = Kiroba, 3 = Naliendele, 4 = NDL 2006/030, 5 = NDL 2006/104, 6 =NDL 2006/283, 7 = NDL 2006/438, 8 = NDL 2006/487, 9 = NDL 2006/738, 10 = NDL 2006/741, 11 = NDL 2006/840, 12 = NDL 2006/850.

3.1.3.3 Nachingwea site

At Nachingwea site, fifteen farmers participated for the comparison of genotypes based on yield. Based on yield at Nachingwea, Kiroba with 11 score, outperformed other genotypes followed by NDL 2006/487 (10 score) and Naliendele (9 score). Genotype NDL 2006/741 was the least genotype in terms of yield, it scored (0) (Table 5).

Table 5: Pair wise ranking for Nachingwea site.

Genotype	1	2	3	4	5	6	7	8	9	10	11	12	Score	Rank
ALBERT													0	12
KIROBA	2												11	1
NALIENDELE	3	2											9	3
NDL 2006/030	4	2	3										5	7
NDL 2006/104	5	2	3	4									3	9
NDL 2006/283	6	2	3	6	6								7	5
NDL 2006/438	7	2	3	7	7	7							8	4
NDL 2006/487	8	2	8	8	8	8	8						10	2
NDL 2006/738	9	2	3	4	9	6	7	8					4	8
NDL 2006/741	10	2	3	4	5	6	7	8	9				1	11
NDL 2006/840	11	2	3	4	5	6	7	8	9	11			2	10
NDL 2006/850	12	2	3	12	12	6	7	8	12	12	12		6	6

KEY:
1 = Albert, 2 = Kiroba, 3 = Naliendele, 4 = NDL 2006/030, 5 = NDL 2006/104, 6 =NDL 2006/283, 7 = NDL 2006/438, 8 = NDL 2006/487, 9 = NDL 2006/738, 10 = NDL 2006/741, 11 = NDL 2006/840, 12 = NDL 2006/850.

3.2 Scientists' Evaluation

The evaluations were done at 3, 6 and 9 months after planting. The most important data was those of 9 months after planting (harvesting data) as are the ones used for selection. Those data of 3 and 6 months after planting were used just to have a trend of growing characteristics of the studied genotypes.

3.2.1 Root yield

Table 6 presents the means for cassava root yield at Naliendele, Mtopwa and Nachingwea. Significant variations ($P \leq 0.05$) were observed among genotypes. Genotype NDL 2006/487 had the highest mean root yield of 19.02 t ha^{-1} at Naliendele, while the lowest mean root yield (4.71 t ha^{-1}) was recorded on NDL 2006/840 which was not significantly different from Albert (5.00 t ha^{-1}). At Mtopwa, the genotype NDL 2006/487 also recorded the highest mean root yield (14.02 t ha^{-1}), while landrace Albert had the lowest root yield of 4.71 t ha^{-1} which did not significantly differ from genotype NDL 2006/030 (5.17 t ha^{-1}), variety Naliendele (5.33 t ha^{-1}) and genotype NDL 2006/850 (5.55 t ha^{-1}). On the other hand, the adapted variety, Kiroba, showed superiority over the rest of the genotypes by producing the highest root yield of 40.48 t ha^{-1} at Nachingwea, while at that site genotype NDL 2006/030 gave the lowest root yield of 8.97 t ha^{-1}. However this genotype (NDL 2006/030) did not differ significantly from genotype NDL 2006/104 (9.06 t ha^{-1}). The highest overall mean root yield (18.18 t ha^{-1}) was obtained at Nachingwea, while Mtopwa site gave the lowest overall mean root yield (8.1t ha^{-1}). On the other hand, Naliendele site gave an overall mean root yield of 11.62 t ha^{-1} (Table 6).

Table 1: Means for root yield in cassava genotypes at Naliendele, Mtopwa and Nachingwea locations

Genotype	Naliendele	Mtopwa	Nachingwea
ALBERT	5.00^{h}	4.71^{f}	12.23^{efg}
KIROBA	**14.11^{dc}**	**10.56^{c}**	**40.48^{a}**
NALIENDELE	**16.00^{b}**	5.33^{f}	12.87^{ef}
NDL 2006/030	12.72^{ed}	5.17^{f}	8.97^{g}
NDL 2006/104	11.22^{fe}	5.83^{ef}	9.06^{g}
NDL 2006/283	11.42^{e}	8.02^{d}	13.20^{e}
NDL 2006/438	**14.40^{c}**	**12.83^{b}**	14.61^{e}
NDL 2006/487	**19.02^{a}**	**14.02^{a}**	**19.45^{d}**
NDL 2006/738	9.77^{gf}	**10.15^{c}**	**20.50^{d}**
NDL 2006/741	8.92^{g}	8.22^{d}	9.63^{fg}
NDL 2006/840	4.71^{h}	6.78^{e}	12.33^{efg}
NDL 2006/850	12.17^{e}	5.55^{f}	**24.80^{c}**
Overall mean	**11.62**	**8.10**	**18.18**
s.e	1.32	0.98	0.91
c.v. (%)	11.40	12.10	5.00

Means with the same superscript letter(s) in the same column are not significantly different ($P \leq 0.05$) following separation by Duncan's Multiple Range Test.

3.2.2 Diseases

The results for CBSD, CMD and root necrosis across the locations are presented in (Table 7). Significant variabilities ($P \leq 0.05$) were observed on the means for cassava brown streak disease incidence among genotypes. Across the locations variety Albert recorded the highest mean cassava brown streak disease incidence (96.67%) followed by Naliendele (11.68%). The overall mean disease incidence was 11.55%. Genotype NDL 2006/487 showed least disease symptoms across the locations, whereas the lowest CBSD incidence (0.06%) was recorded on NDL 2006/840. With exception of treatments Albert, Kiroba and Naliendele the rest of the treatments had no significant differences among them.

Significant variations ($P \leq 0.05$) were observed on the mean cassava brown streak disease severity of the studied genotypes. Variety Albert recorded the highest mean cassava brown streak disease severity (2.99) followed by Naliendele (1.28), while NDL 2006/487 did not show any disease symptoms. The overall mean disease severity was 1.26 (Table 6). There were no significant differences observed among treatments Kiroba, NDL 2006/030, NDL 2006/104, NDL 2006/438, NDL 2006/487, NDL 2006/741, NDL 2006/840 and NDL 2006/850.

The results on CMD incidences revealed presence of significant variations ($P \leq 0.05$) among the genotypes. The highest mean values for CMD incidence (92.11%) was observed on the genotype NDL 2006/741 followed by Naliendele (38.62%), which was significantly different from the rest of the treatments. Kiroba showed no any CMD incidence. However the treatment (Kiroba) was not significantly different from treatments Albert, NDL 2006/104, NDL 2006/283, NDL 2006/438, NDL 2006/487 and NDL 2006/ 850. The overall mean disease incidence was 13.82.

There were significant variations ($P \leq 0.05$) on mean cassava mosaic disease severity among genotypes across the locations. The highest mean value for CMD severity (2.97) was observed on the genotype NDL 2006/741 followed by variety Naliendele which had CMD severity of 1.82. The overall mean disease severity was 1.3. Kiroba was not affected by CMD but revealed no significant differences with treatments Albert, NDL 2006/030, NDL, 2006/840 and NDL 2006/850.

The means for cassava root necrosis varied significantly ($P \leq 0.05$) across the locations (Table 19). Albert showed the highest root necrosis score of 3.17 and had significant differences with the rest of the treatments. Naliendele recorded 2.33 root necrosis. On the other hand, genotypes NDL 2006/840 and NDL 2006/850 had no any symptoms of root necrosis i.e. had a root necrosis score of 1.00. Although the two genotypes had no root necrosis symptoms, they were not significantly different from the treatments Kiroba, NDL 2006/487, NDL 2006/438, NDL 2006/741 and NDL 2006/738. The overall mean root necrosis in all sites was 1.47.

Treatment Albert had consistently highest CDSDI (96.67%), CDSDS (2.96) and root necrosis (3.17) across the locations, while it had lowest scores for CMDI (0.56) and CMDS (1.01). On the other hand, treatment NDL 2006/487 showed consistently lowest mean value sores of the diseases, CDSDI (1.39), CDSDS (1.00) and root necrosis (1.11), while with regard to CMD, NDL 2006/487 had not showed disease incidence (0.00) and severity(1.00) (Table 19).

Table 2: Means for CBSD, CMD and root necrosis in cassava genotypes under combined analysis

Genotype	CBSDI	CBSDS	CMDI	CMDS	Root necrosis
ALBERT	96.67[a]	2.96[a]	0.56[d]	1.01[d]	3.17[a]
KIROBA	1.53[b]	1.00[c]	0.00[d]	1.00[d]	1.54[c]
NALIENDELE	11.68[b]	1.28[b]	38.62[b]	1.82[b]	2.33[b]
NDL 2006/030	5.56[c]	1.06[c]	8.77[c]	1.17[c]	1.50[cd]
NDL 2006/104	4.17[c]	1.06[c]	2.52[d]	1.19[cd]	1.44[cde]
NDL 2006/283	2.78[c]	1.32[b]	0.79[d]	1.12[cd]	1.24[def]
NDL 2006/438	2.50[c]	1.11[c]	1.43[d]	1.10[cd]	1.22[ef]
NDL 2006/487	1.39[c]	1.00[c]	0.00[d]	1.00[cd]	1.11[f]
NDL 2006/738	1.39[c]	1.14[c]	10.55[c]	1.05[cd]	1.06[f]
NDL 2006/741	1.39[c]	1.06[c]	92.11[a]	2.97[a]	1.06[f]
NDL 2006/840	0.06[c]	1.08[c]	8.03[c]	1.00[d]	1.00[f]
NDL 2006/850	0.00[c]	1.08[c]	2.50[d]	1.00[d]	1.00[f]
Overall mean	**11.55**	**1.26**	**13.82**	**1.30**	**1.47**
s.e	8.34	0.26	4.35	0.19	0.38
c.v.(%)	28.80	16.20	31.40	14.80	25.70

Means with the same superscript letter(s) in the same column are not significantly different ($P \leq 0.05$) following separation by Duncan's Multiple Range Test.

Key: CBSDI% = Percentage cassava brown streak disease incidence, CBSDS = Cassava brown streak disease severity, CMDI% = Percentage cassava mosaic disease incidence and CMDS = Cassava mosaic disease severity.

4.0 Discussion

4.1 Farmers' Criteria for genotype/variety selection

Table 1 outlined the most criteria used by farmers to select cassava genotypes/varieties in the study areas.

4.1.1 Cassava root yield

Root yield ranked first both at Naliendele and Nachingwea , while at Mtopwa yield criterion ranked the third. At Naliendele and Nachingwea locations farmers gave root yield great importance as cassava crop comparatively performs better in these areas. Furthermore, in these two sites farmers depend very much on cassava as a source of food (Naliendele site) and as a source of income (Nachingwea) by selling of "Makopa" (dried peeled cassava roots). At Mtopwa yield ranked third after taste and diseases. This is because the weather conditions at Mtopwa are not in favour of cassava crop.

4. 1. 2 Planting material

At Mtopwa cassava planting material is not a big deal since the weather condition at this site provides high viability of the planting materials without special care. On the other hand at Naliendele and Nachingwea where the temperatures are high during harvesting of the crop, planting material was given moderate importance. Planting materials has been valued because there is a time lag (dry spell) between harvesting time and the next season planting time in these two locations, hence most of the planting materials do lose their viability. Therefore, genotypes/varieties with large amount of planting materials are preferred as not all can be lost due to dry weather with good conservation of the planting materials.

4.1.3 Plant architecture

At Naliendele and Nachingwea plant architecture is of less importance criterion as farmers in these sites used to grow sole crops because of the nature of soils in the area (poor sand soils). At Mtopwa archtexrture was given moderate importance as farmers do intercrop cassava with other crops.

4.1.4 Root flesh colour

This criterion has neither been mentioned at Mtopwa nor at Nachingwea. This is not by chance but it is because farmers in this location are used only to one root flesh colour (white) varieties. Contrary to farmers at Naliendele, as they are nearby to NARI, they had come across with "Yellow Fleshed Varieties" which are tested at NARI. Farmers do not prefer yellow fleshed varieties, as the ones at Naliendele have bitter taste.

4.1.5 Diseases

Criterion disease at Mtopwa, ranked the first as most of farmers in this location do leave cassava crop in the field for two or more cropping seasons before harvesting in order for the crop to attain optimum growth and/or yield. For such extended period to maturity, if a variety is diseased, then at the end of growing season farmers will harvest nothing. For Naliendele and Nachingwea, diseases are of importance but because of short growing period (6 – 12 months) these sites are advantaged as compared to Mtopwa.

4.2 Farmers/Scientists Genotypes Selection

From the results of both farmers and scientists, selection was done based on root yield and diseases (Table 2) on

the studied cassava genotypes. This was so because these two criteria were the most important for both farmers (Table 1) and scientists (aim of scientists in this context is to breed for varieties which are high yielding and disease resistant/tolerant). Also according to farmers, their major hindrances in cassava industry are varieties with low yields and susceptible to diseases.

4.2.1 Root Yield

Farmers' selection based on root yield was done in two ways; one by using seed ranking method and the other was by pairwise matrix selection. On the other hand, scientists' selection was done based on scientific data analysis of the harvested root yield. In the two groups of selection only the top four genotypes were put into consideration as best genotypes and suitable for farmers. At Naliendele, farmers selected genotypes NDL 2006/438, NDL 2006/487, NDL 2006/283 and NDL 2006/850 (Table 3) while scientists selected genotypes NDL 2006/487, Naliendele variety, NDL 2006/438 and Kiroba (Table 6). At Mtopwa, among four top genotypes selected, farmers and scientists selected same two genotypes which are NDL 2006/487 and NDL 438. Selections made at Nachingwea were very close among the two groups as in the top four genotypes selected, only one diferred. The common selected genotypes/varieties at Nachingwea were Kiroba, NDL 2006/487 and NDL 2006/738. From this, it is evident that farmers' selection is also important in plant breeding as they have 'hidden/natural" knowledge in the same.

4.2.2 Diseases

Selection of genotypes based on diseases focused on the resistance or tolerance of different genotypes/varieties against major two cassava diseases (Cassava Brown Streak Disease [CBSD]/Root necrosis and Cassava Mosaic Disease [CMD]). Farmers assessed the genotypes by visual observation before harvesting for severity and incidence and after harvest for root necrosis. Genotypes selected by farmers which are resistant/tolerant to CBSD and or CMD across the locations are NDL 2006/487 and Kiroba (Table 2), which are the same as those selected by scientists via scientific analysis (Table 7) . This implies that, farmers' knowledge in agriculture is worth in many areas and it has not to be taken for granted as where scientific evidences cannot apply, farmers knowledge can take over and succeed.

5.0 Conclusion/Recommendations

Famers, criteria for variety/genotype selection were not so different from those of researchers. This is because the best four criteria for farmers in all locations included root yield and diseases, which are the characters that researchers are trying to work on. Furthermore, farmers' genotype/variety selection is very good and can be employed in genotypes selection where scientific methods are not available. This is justified by the results obtained from researchers and farmers during harvesting. Farmers observed that, genotypes NDL 2006/487, NDL 2006/438, Kiroba, and Naliendele were good root yielders at one or more locations; the same as results from the researchers. On the other hand, farmers assessed treatments Albert, NDL 2006/741 and NDL 2006/840 as poorer yielders, the same as recorded in researcher's results. Also farmers found out that, genotypes NDL 2006/487 and variety Kiroba were the resistant/tolerant across the three locations; as it has been shown by scientists' findings.

It is important that, in any research or project/experiment planned for improvement of crops, farmers have to be involved from the start. This is because not only farmers have the "hidden/natural" research knowledge, but also farmers are the target group of agricultural research as the findings/outcomes of most of agricultural researches are for farmers.

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