Progress on breeding - East & Central Africa Sweetpotato Support Platform

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SWEETPOTATO ACTION FOR SECURITY AND HEALTH IN AFRICA

Outline

- Milestones for the East and Central Africa breeding platform/ SASHA
- Summary of on-going breeding trials
- Progress on the milestones
- Workplan
- Way forward

Four Milestones

(1) MS1.1.1. Studies demonstrating that significant **genetic gain** (2% per year in yield) can be achieved in 2 years in early generations and 4 years for selected varieties;

(2) MS1.1.3. At least 14 African **sweetpotato breeders breed using the latest knowledge and efficient methods**;

(3) MS1.2.1. At least 250,000 seeds with **increased frequencies of resistance to SPVD** (2–10%) disseminated to at least 10 NARS partners; and

(4) MS1.2.3. Selected hybrid progeny demonstrating **yield jumps** of 10–20% from populations with SPVD resistance.

Table 1. Summary of breeding trials, January - April 2018, SASHA II breeding objectives for East and Central Africa

Trial type	Description	Location/AEZ	Comments
Crossing block	**Two crossing blocks:** 80 parents (population Uganda B); 50 parents (pop Ug A) for generating populations for: national program seed needs, studies e.g. SPVD resistance, genomics, and heterosis	Namulonge (warm, moist, tall grassland, high SPVD pressure zone)	Data: Crosses Seed set Seed distribution Seed germination
	Evaluating performance of parents, population Uganda A (50) and B (80): RCBD, 3 reps	Namulonge Serere and Kachwekano **Seasons:** 2016A, 2016B,2017A & 2017B	Data: Agronomic performance Root quality attributes Completed

Crossing

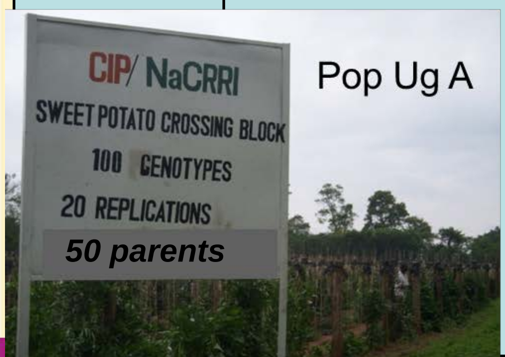

Table 1. Summary of breeding trials, May 2018, SASHA II breeding objectives for East and Central Africa

Trial type	Description	Location/AEZ	Comments
Observation trials	SPVD resistance cross test: Evaluating the response of 10,600 entries obtained from 80B x 50A crosses to SPVD: comprise 987 families; 6-16 genotypes/family Eliminating bad SPVD resistance parents. Experimental design: Westcott	Namulonge Season: 2018A Planted 6 April 2018	Data: Response to SPVD Agronomic performance
	Determining genotypic frequency for SPVD resistance Evaluating 2,149 genotypes (4B x 4B 8 SPVD resistant parents): increase SPVD frequency/ resistant clones; Westcott design	Namulonge Season 2018A Planted 11/4/2018	Data: Response to SPVD Agronomic performance

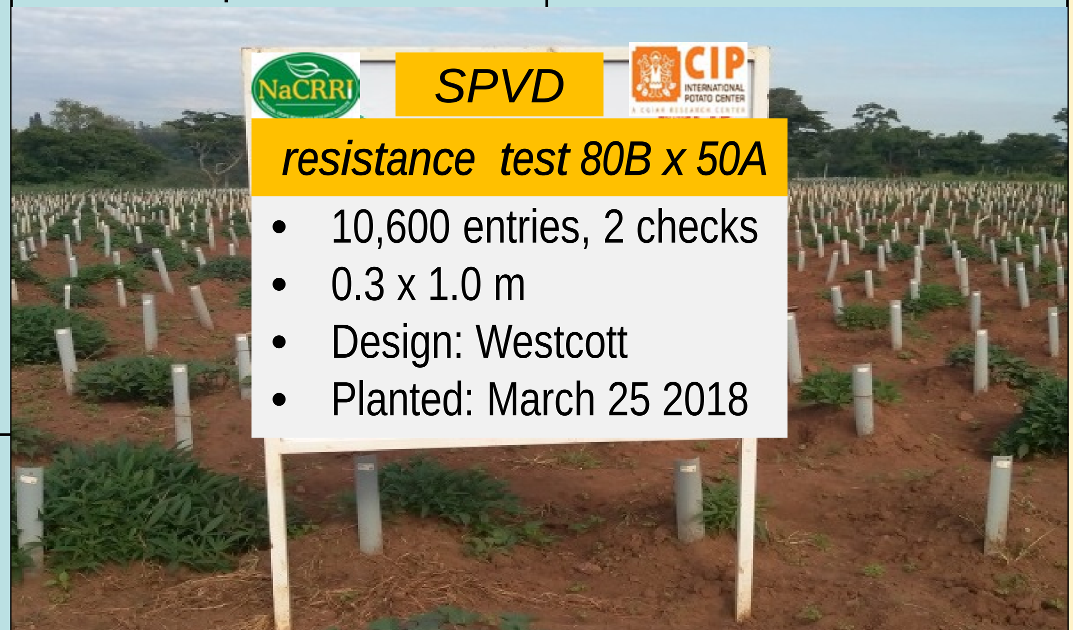

Table 1. Summary of breeding trials, January - April 2018, SASHA II breeding objectives for East and Central Africa

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Trial type	Description	Location/AEZ	Comments
Preliminary trials	Continuous root formation and bulking 30 clones selected for continuous root formation and bulking. **Experimental design:** RCBD, 4 reps	Namulonge (Planted 3rd week of April 2018) Kachwekano (Planted 4th week of April 2018)	Data: Agronomic performance Pest/disease response Root quality attributes
Advanced yield trial	Advanced yield trial for 8 OFSP entries Experimental design: RCBD Seasons: 2017B and 2018A	Namulonge, Kachwekano (Planted in April 2018)	Data: Agronomic performance Pest/disease response Root quality attributes Harvested 2017B trials at Namulonge and Serere

Polycross seed generated from crossing blocks at Namulonge, 2017

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Parent	Name	Total No. of seeds	Parent	Name	Total No. of seeds
B1	RESISTO	1517	B41	WAGABOLIGE	1917
B2	ARA209	1105	B42	LIR258	2091
B3	HMA496	1424	B43	PAL148	541
B4	MSD380	819	B44	RAK865	1409
B5	LUW1230	1704	B45	MPG1122	2148
_	_	_	_	_	_
_	_	_	_	_	_
B37	BSH741	167	B77	TIS9265	843
B38	BND145L	2412	B78	CIP199062.1	2479
B39	SRT41	2815	B79	SANTA AMARO	1202
B40	SRT01	1117	B80	HUARMAYANO	1641
				Total	**113,047**

Controlled cross seed generated from crossing blocks at Namulonge, 2017

Pop B (Female)	Name	No. of families with Pop A parents	Total No. seeds	Pop B (Female)	Name	No. of families with Pop A parents	Total No. seeds
B1	RESISTO	12	210	B41	WAGABOLIGE	19	273
B2	ARA209	23	822	B42	LIR258	20	354
B3	HMA496	27	926	B43	PAL148	14	117
B4	MSD380	9	29	B44	RAK865	40	1294
–	–	–	–	–	–	–	–
B37	BSH741	32	766	B78	CIP199062.1	21	192
B38	BND145L	20	298	B79	SANTA AMARO	5	16
B39	SRT41	29	649	B80	HUARMEYANO	19	357
B40	SRT01	15	188		Total	1,533	34,231

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MS1.2.1. At least 250,000 seeds with increased frequencies of resistance to SPVD (2–10%) disseminated to at least 10 NARS partners;

Country (recipient/ organization)	No. of seeds	No. of families	Purpose	Year
Burkina Faso (INERA)	20,195	91	Screening trials for new variety development	2014
Kenya-NARS-KALRO)	28,000	14	Screening for high altitude adapted dual purpose genotypes	
Kenya-J.K. University	500	10	For sweetpotato weevil resistance trial	
Kenya (CIP) BecA	3548	63	Populations for sweetpotato genomics project	
S. Africa/ARC)	2,530	15	Screening for new variety development	
Uganda (NaCRRI)	107,000	13	Screening for SPVD resistance and other traits	
Malawi (Bvumbwe)	34,000	10	Screening for SPVD resistance and other traits	2015
Kenya (CIP) BecA	797	13	Populations for aweetpotato genomics project	2016
Kenya (CIP) BecA	897	14	Populations for aweetpotato genomics project	
Burundi (ISABU)	66,197	21	Screening for SPVD resistance and other traits	
Kenya (CIP) BecA	763	39	Populations for Sweetpotato genomics project	2017
CIP Ghana	38,620	17	Comparing perfomance of progenies obtained from breeding support platforms	2018
Total	303,047	320		

MS1.1.1. Studies demonstrating that significant genetic gain (2% per year in yield) can be achieved in 2 years in early generations and 4 years for selected varieties.

Storage root yield, dry matter content of sweetpotato cultivars released in Uganda at 3 sites (Namulonge, Serere and Kachwekano) – Kawogo collected in 1987

Variety	Release year	Storage root yield (t/ha)	% Storage root yield increment over Kawogo	Biomass yield (t/ha)	% Biomass increment over Kawogo	Dry matter storage root yield (t/ha)	% Dry matter root yield increment over Kawogo
Kawogo	1987	22.3	-	66.7	-	6.9	-
NASPOT 1	1999	39	74.9	74.4	11.5	12.8	85.7
NASPOT 8	2007	39.8	78.5	66.3	-0.6	13.3	92.9
NASPOT 9 O	2007	27	21.1	43.7	-34.5	8.1	17.6
NASPOT 10 O	2007	25.5	14.3	48.7	-27	8.6	25.5
NASPOT 11	2010	39.7	78	73.4	10	13.3	93
NASPOT 12 O	2013	46.1	106.7	77.4	16	14	102.7
NASPOT 13 O	2013	27.8	24.7	69.5	4.2	9.1	31.9

21%-106.7% storage root yield increment over Kawogo [Data: 2 seasons 2015B/2016A, 5 plants/row, 3 rows/plot, 3 reps, RCBD]

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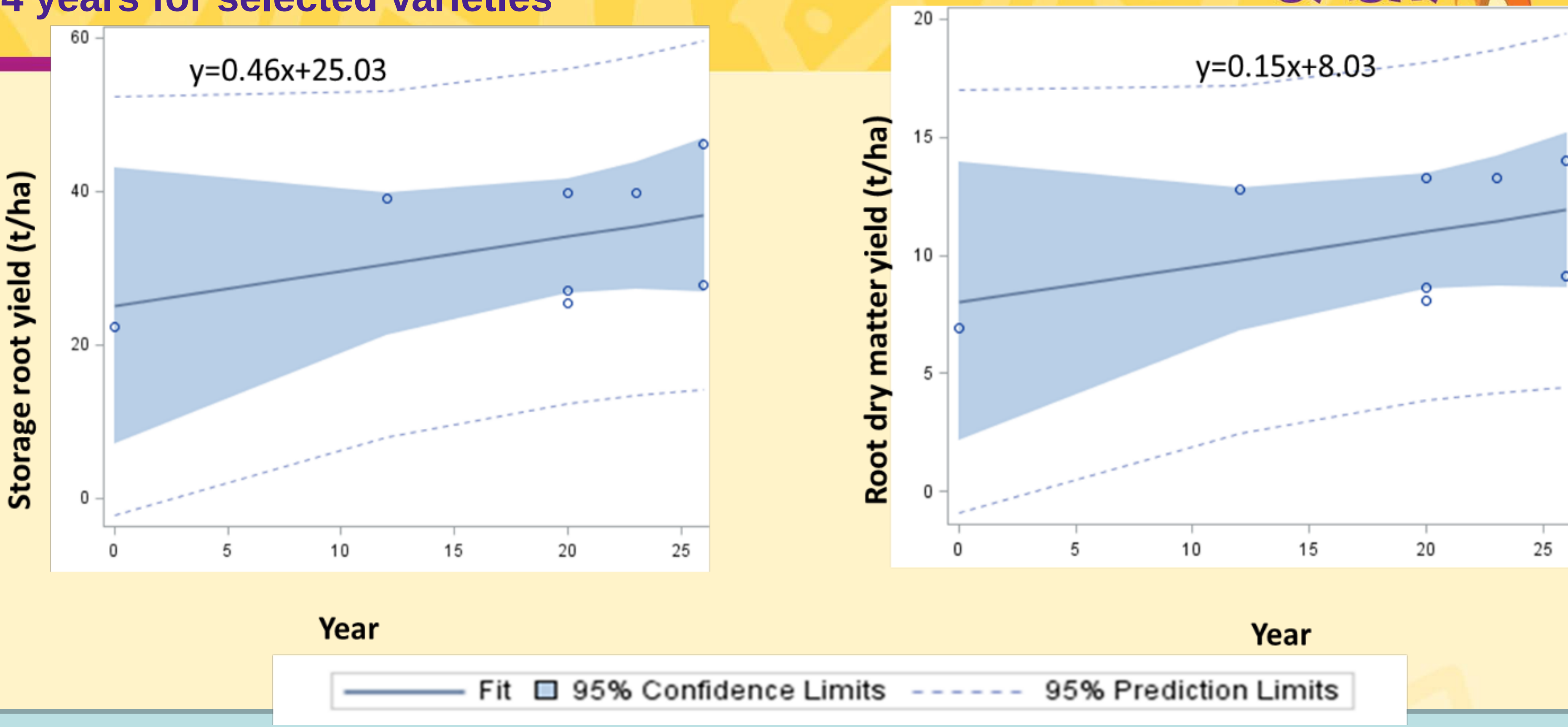

Fig. 1. Storage root yield (A) and Storage root dry matter yield (B) of sweetpotato varieties against years of release since 1987 (storage root yield increment was 0.46 t/ha per year)[Data: 2 seasons 2015B/2016A, 5 plants/row, 3 rows/plot, 3 reps, RCBD)

Performance of parents at Namulonge, Serere and Kachwekano (2016A, 2016B and 2017)

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Trait	N	Mean	Std Dev	Minimum	Maximum
SPVD	2077	2.4	0.9	1.0	7.0
Alternaria blight	2077	1.6	0.3	1.0	6.0
Weevil damage	1800	1.7	1.0	1.0	6.0
Root flesh color	1805	6.2	7.0	1.0	30.0
Storage root yield (t/ha)	1662	9.4	8.6	0.0	40.3
Biomass	1662	41.3	35.7	0.0	285.0
Foliage yield (t/ha)	2044	30.8	27.7	0.0	173.3
Commercial Root yield (t/ha)	1906	9.2	8.4	0.0	40.0
Percentage of marketable roots	1538	76.3	21.5	0.0	100.0
Harvest Index (%)	1659	27.3	19.6	0.0	95.5
Number of roots per plant	1659	2.3	2.0	0.0	21.0
Yield per plant (Kgs)	1659	0.4	0.5	0.0	4.2
Establishment index (%)	2153	58.8	29.6	0.0	100.0

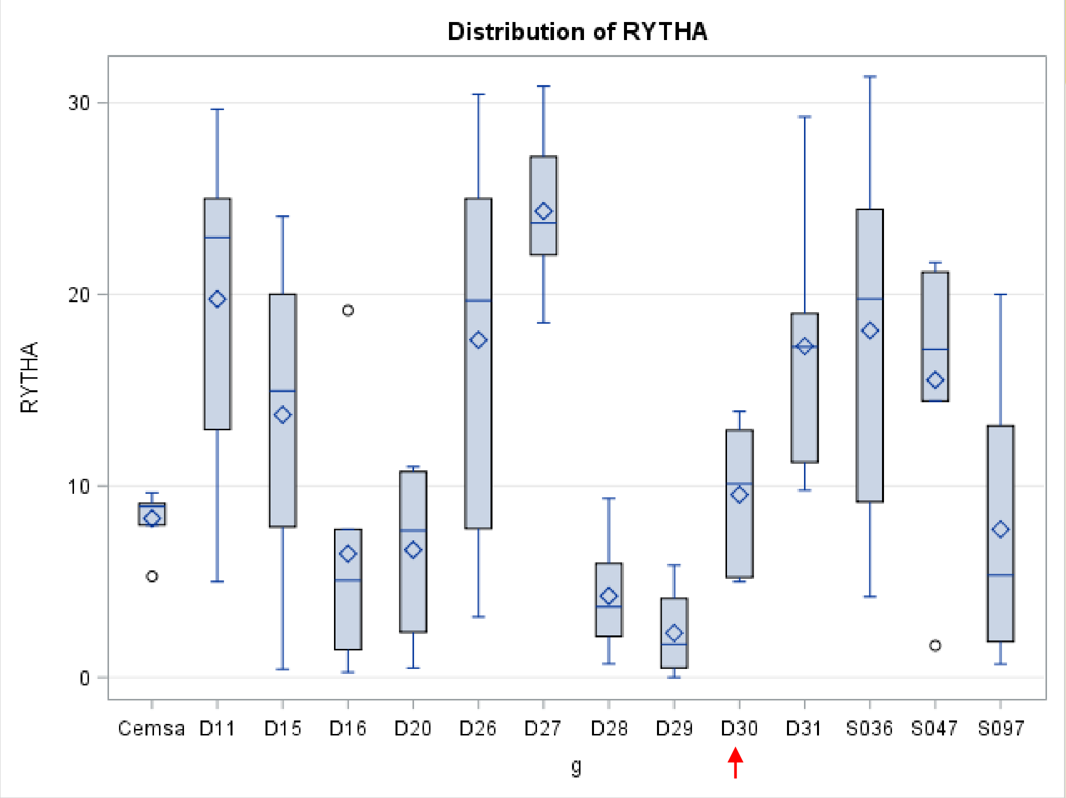
Genetic correlation coefficients of traits among the parents

	RYTHA	FYTHA	CYTHA	BIOM	HI	NOCRPL	BCE	SPVD	AB	wed	CI	NRPP
FYTHA	0.231											
CYTHA	0.989	0.217										
BIOM	0.461	0.962	0.451									
HI	0.603	-0.37	0.591	-0.176								
NOCRPL	0.669	0.048	0.637	0.233	0.521							
BCE	-0.083	-0.156	-0.066	-0.171	0.06	0.032						
SPVD	-0.136	-0.216	-0.131	-0.2	-0.032	-0.102	0.114					
AB	-0.039	-0.12	-0.07	-0.171	0.048	0.004	-0.015	0.14				
wed	0.144	0.122	0.141	-0.033	0.161	0.189	0.084	0.017	-0.003			
CI	0.33	0.053	0.368	0.128	0.239	0.402	-0.068	-0.004	-0.035	0.065		
NRPP	0.581	0.049	0.563	0.189	0.482	0.872	0.012	-0.09	0.061	0.16	0.019	
YPP	0.881	-0.088	0.875	0.333	0.618	0.768	-0.072	-0.117	0.007	0.14	0.31	0.708

RYTHA= root yield; FYTHA= Foliage yield; BCE = beta-carotene AB= Alternaria blight; Wed= weevil damage; CI= commercial index

MS1.2.3. Selected hybrid progeny demonstrating **yield jumps** of 10–20% from populations with SPVD resistance.

Clone	Pedigree
D26	Huarmeyano x NASPOT 10 O
S047	Resisto x Magabali
D11	Huarmeyano x Ejumula
D30	NASPOT 10 O x
D15	NASPOT 5/58 x NK259L
S097	NASPOT 11 x SPK004
S010	NASPOT 7 x
S036	Mugande x Ejumula



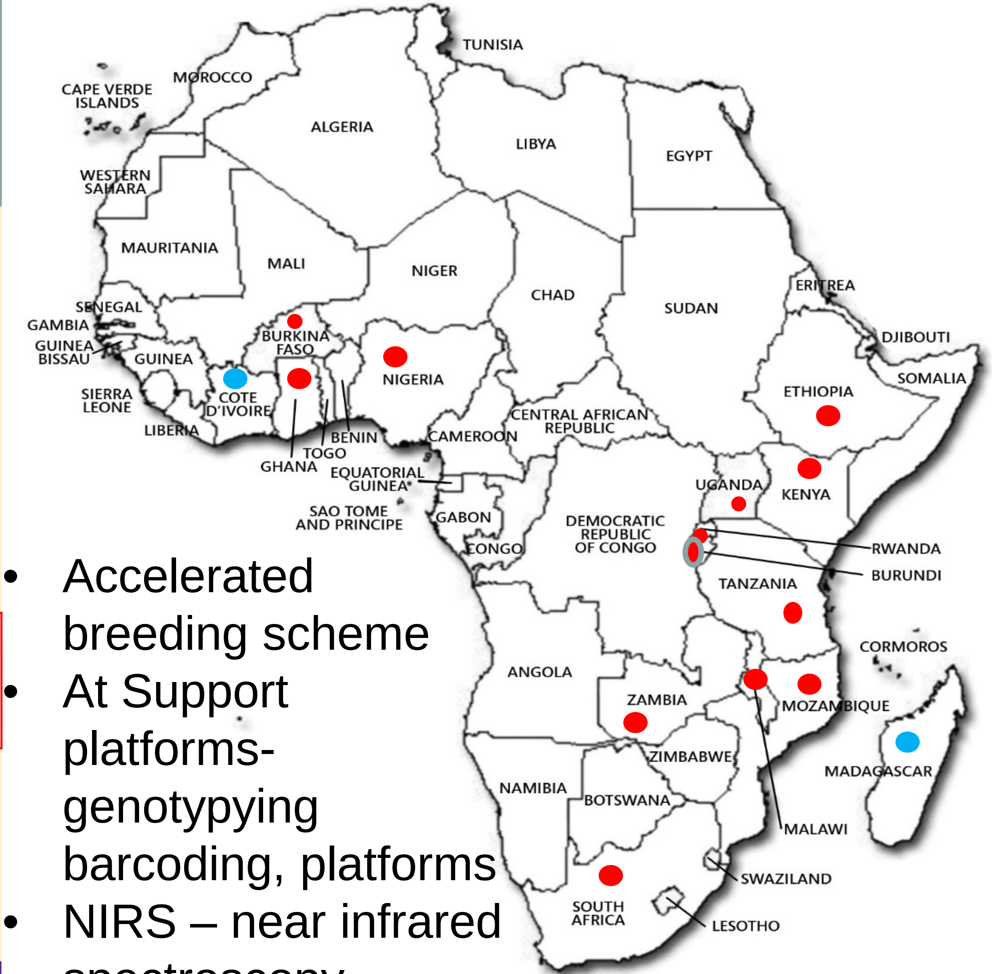
MS1.1.3. At least 14 African sweetpotato breeders breed **using the latest knowledge and efficient methods.**

10 PhDs, 3 MScs Sweetpotato breeders trained 2009-2017

Since 2009, 10 countries have released 84 superior varieties (of them 42 orange-fleshed; 22 drought tolerant; 2 purple-fleshed)

● 13 Countries with crossing blocks/breeding

● 2 Countries with sweetpotato evaluation/ selection activities



- Accelerated breeding scheme
- At Support platforms- genotyping barcoding, platforms
- NIRS – near infrared spectroscopy

Variety releases 2017/2018

Country	Name of variety	Flesh color	Status/Introduction=I; B=bred; S=selection	Year of release
Burundi	Cacearpedo	Orange	I (CIP-Kenya)	2017
	97062	Orange	I (CIP-Kenya)	2017
Ethiopia	Hawassa 09	White	I (IITA)	2017
Ghana	CRI-GAVANA	Dark yellow	B	2017
	CRI-Mbofara	Cream	Landrace	2017
	SARI-NAN	Orange	Landrace	2018
	SARI-Numingre	White	Landrace	2018
	SARI-Diedi	Purple	I (Tuskegee - USA)	2018
Kenya	Shock5	Cream	S (Uganda)	2018
	Kyebandula13	Cream	S (Uganda)	2018
	Kyebandula6	Cream	S (Uganda)	2018
	Silkow6	Orange	S (Uganda)	2018
	New Kawogo14	Cream	S (Uganda)	2018
	NASPOT 12 O	Orange	I (Uganda)	2018
	Irine	Orange	I (Mozambique)	2018
	Sumaia	Orange	I (Mozambique)	2018

Variety releases 2017/2018 Cont'd

Country	Name of variety	Flesh color	Status	Year of release
Madagascar	Delvia	Orange	I (Mozambique)	2017
	Jane	Orange	I (Mozambique)	2017
	Lourdes	Orange	I (Mozambique)	2017
	Irene	Orange	I (Mozambique)	2017
	Erica	Orange	I (Mozambique)	2017
Malawi				
	BV11/131	Orange	S (Uganda)	2018
	BV11/106	Orange	S (Uganda)	2018
	BV11/150A	Orange	S (Uganda)	2018
Uganda	NAROSPOT1 (New Dimbuka)	Cream	B	2017
	NAROSPOT 2	Cream	B	2017
	NAROSPOT 3	Cream	B	2017
	NAROSPOT 4	Cream	B	2017
	NAROSPOT 5	Cream	B	2017

Bred = B ; Seedling selection (+ country from which seed was introduced) = S. Kenya released five cold tolerant varieties: Shocks5, Kybandula13, Silklow6, Kyebandula6, New awogo14

48% OFSP of total released (16/31). 50% OFSP of new releases (bred/selected, 4/8)

Publications

Published 2017 (Excludes publications on Genomics Project)

1.Mwanga R.O.M., M.I. Andrade, E.E. Carey, J.W. Low, G.C. Yencho, and W.J. Grüneberg. 2017. Sweetpotato (*Ipomoea batatas* L.). In H. Campos and P.D.S. Caligari (ed.) Genetic Improvement of Tropical Crops. Springer International Publishing AG, Gewerbestrasse, Cham, Switzerland, Pages 181-218. DOI 10.1007/978-3-319-59819-2.

2. Asindu M., G. Elepu, E. Ouma, G. Kyalo, P. Lule and D. Naziri 2017: Sweet potato wastes in major pig producing districts in Uganda: an opportunity for investment in silage technologies. Livestock Research for Rural Development. Volume 29, Article #216. Retrieved November 13, 2017, from http://www.lrrd.org/lrrd29/11/asim29216.html

3.Mwanga R.O.M., M.I. Andrade, E.E. Carey, J.W. Low, G.C. Yencho, and W.J. Grüneberg. 2017. Sweetpotato (Ipomoea batatas L.). In H. Campos and P.D.S. Caligari (ed.) Genetic Improvement of Tropical Crops. Springer International Publishing AG, Gewerbestrasse, Cham, Switzerland, Pages 181-218. DOI 10.1007/978-3-319-59819-2.

4.Lowa, J.W., R.O.M. Mwanga, M. Andrade, E. Carey and A. Ball. 2017. Tackling vitamin A deficiency with biofortified sweetpotato in sub-Saharan Africa. Global Food Security, 14:23-30. https://doi.org/10.1016/j.gfs.2017.01.004.

Publications

Published 2017 (Excludes publications on Genomics Project)

5. Low J., A. Ball, S. Magezi, J. Njoku, R. Mwanga, M. Andrade, K. Tomlins, R. Dove, and T. van Mourik. 2017. Sweet potato development and delivery in sub-Saharan Africa. 2017. African Journal of Food, Agriculture, Nutrition and development 17(2):11955-11972.

6. Ramírez, D.A., C. Gaviléna, C. Barreda, B. Condori d, G. Rossel, R.O.M. Mwanga, M. Andrade, P. Monneveux, N.L. Anglin, D. Ellis, and R. Quiroz. 2017. Characterizing the diversity of sweetpotato through growth parameters and leaf traits: Precocity and light use efficiency as important ordination factors. 2017. South African Journal of Botany 113:192-199.

7. Kabirizi J,M., P. Lule, G. Kyalo, S. Mayanja, J. F. Ojakol, D. Mutetikka, D. Naziri and B. Lukuyu, 2017. Sweetpotato Silage Manual for Smallholder Farmers, CIP/NARO, 2nd Edition, Kampala.

Workplan

(1) MS1.1.1., MS1.1.3, MS1.2.1 (genetic gain, increasing SPVD frequency, demonstrating yield jumps)

a) Produce populations (seed) from crossing blocks for population improvement (population Uganda A and Pop Uganda to NARS for selection.

b) Evaluate populations for increased SPVD resistance from the parent-offspring analysis, i.e. 2149 progenies from nine SPVD resistant parents (8 parents: 4A X 5B)

c) Eliminating bad SPVD resistance parents i.e. using 1,600 families from the 80 x 50 parents (8,728 genotypes); each family has at least 16 genotypes.

(2) Capacity building:

- Isaac Bagaga (MSc, Makerere University), Thesis topic: *A mathematical model for the dynamics and optimal control strategy of sweetpotato virus disease in Uganda*
- Scovia Adikini (Makerere University), Thesis title: Contribution of sweetpotato viruses to cultivar decline in Uganda (waiting to defend, submitted PhD thesis)
- Astère Bararyenya, thesis title Continuous root bulking experiments field/BecA – PhD research Scovia
- **Backstop: Burundi, Ethiopia, Rwanda, Kenya, Tanzania, :** Follow up on field protocols and data processing

Way forward

Focus on Product Development: East & Central Africa, high virus pressure agroecologies

Must have:

<u>High SPVD resistance</u> combined with orange flesh (high beta-carotene) color, 120 days to maturity, High dry content matter (above 29%), preferred table quality.

Desirable traits:

- Wide adaptation across Lake Victoria zone, EA highlands (Alternaria resistance),
- Northern EA (drought tolerance)
- Processing quality
- High upper biomass production for animal feed
- Purple flesh (anti-oxidants)?

Approach: Exploit heterosis and offspring – parent analysis to increase SPVD resistance for the East & Central breeding platform based in Uganda

- High throughput NIR for quality in fresh root samples (dry matter, b-carotene, sugars)
- Link with genomics project; develop fast throughput molecular markers for SPVD resistance

Thank you for your attention