WEMA PDT 2016: Status, Progress and Achievements

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On behalf of WEMA PDT

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New drought-tolerant white maize hybrids
Protection for a better harvest

Outline

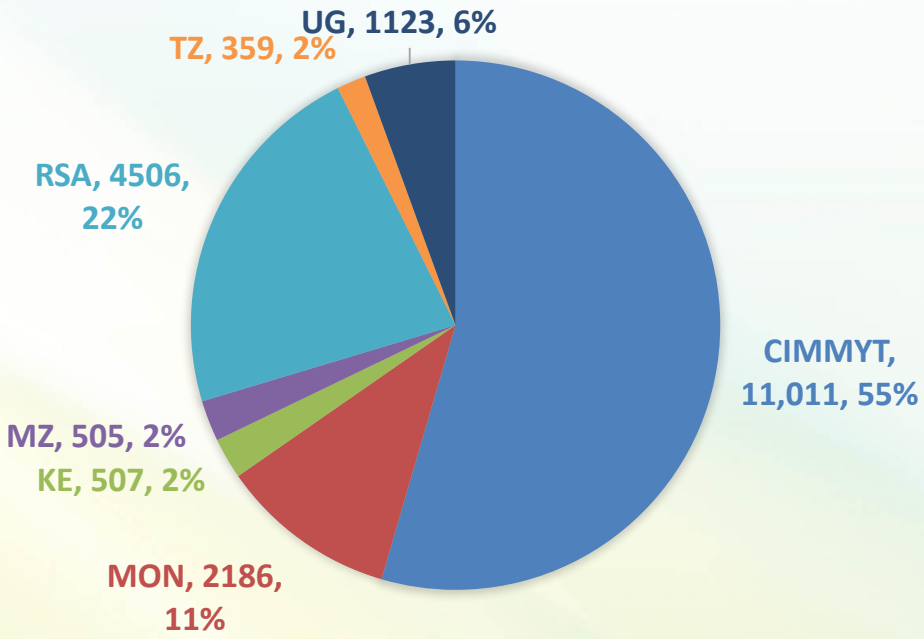
- **Conventional breeding**
  - Breeding matrix and variety release
  - Progress in identification of MLN tolerant hybrids
- **Molecular breeding**
  - NAMP for DT and MLN
- **Biotechnology**
  - Status of Bt and Stack in different countries
- **Conclusions**
- **Way Forward**

WEMA PDT Team

WEMA Product Concept

- **White hybrids (SC or 3-way)**
- **25% yield improvement compared to 2008 hybrids under moderate drought conditions**
  - Target 15% from breeding over 10 years
  - Additional 8-10% from DT transgene
  - Insect protection from *Bt* transgene
- **General Product Requirements**
  - Drought tolerance
  - Maturity 125-135 days
  - Disease resistance: GLS, NLB, MSV and **MLN**
  - Resistance to postharvest insect pests
  - Agronomic traits: root lodging, prolificacy, maturity, husk cover
- **Consumer requirements**
  - Maintain required milling quality
  - Maintain meal yield
  - Grain Texture : flint to flinty-dent

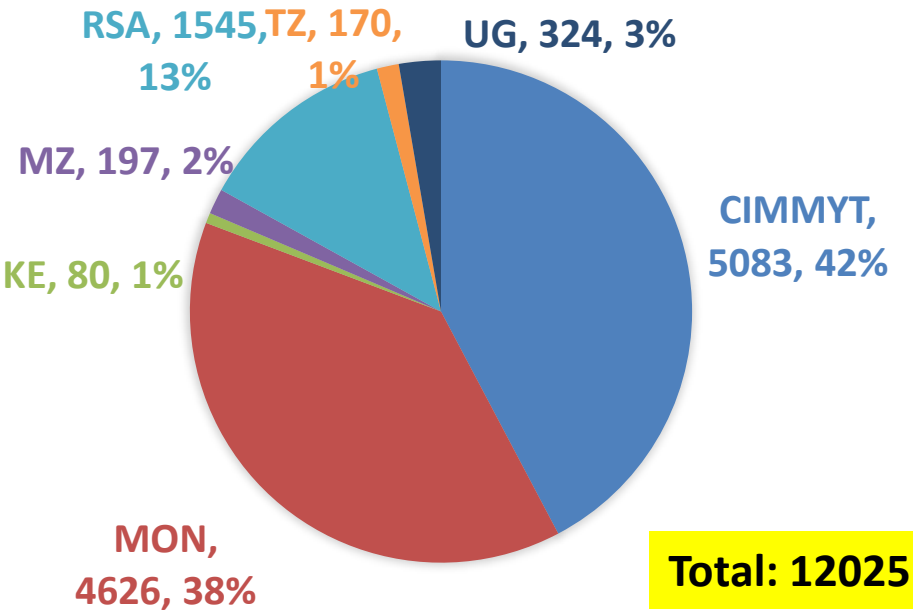
Lines Evaluated in 2016 by WEMA partners



Total: 20,197

67% of them are DH lines

Hybrids Evaluated in 2016 by WEMA Partners



Total: 12025

Elite lines for CML release

CKLTI0028

CKLMARS1C3S5I0293

WEMA -Monsanto Lines for Making Hybrid Makeup

Inbred	Year Released
WMA1202	2013
WMA2001	2013
WMA2003	2013
WMA8827	2013
WMA8828	2013
WMB4002	2013
WMB4413	2013
WMB8804	2013
WMA1002	2014
WMB4807	2014
WMB4810	2014
WMB4871	2014
WMA2101	2015
WMA3104	2015
WMA8812	2015
WMB3307	2015
WMB5803	2015
WMB5806	2015
WMC5510	2015
WMC5516	2015
WMC5812	2015
WMB4840	2016
WMB3001	2016

Elite lines for CML release

CKLTI0368

CKDHL0186

CKDHL120773

Development New SC female

Entry	Pedigree	GY (t/ha)	Rank	Anthesis date	Silking date	Plant height	Ear position
36	CKDHL089/CML543	9.6	1	74	74	283	0.5
4	CKDHL0089/CML395	9.3	2	70	71	284	0.5
6	CKDHL0221/CML442	8.9	3	69	70	260	0.5
22	CML395/CML444	8.7	4	70	70	265	0.6
14	CML202/CML395	8.4	5	69	70	272	0.5
28	CML539/CML442	8.3	7	68	68	237	0.4
37	CKDHL120312/CML312	8.2	9	66	65	263	0.4
16	CML395/CML312	8.2	11	68	69	269	0.4
Mean		7.28		70.0	70.5	255.7	0.48
LSD (0.05)		2.77		2.1	1.8	22.7	0.06
MSe		1.31		1.0	0.7	126.2	0.00
CV		18.48		1.5	1.2	4.4	6.32

Naivasha under AI MLN

Naivasha without MLN

Kiboko-Optimum

Performance of Coded × Coded Hybrids

- 14 CIMMYT elite lines crossed with 8 Monsanto coded lines
- Planted male and female same day
- A total of 66 single- cross hybrids
- Evaluated across 5 locations and showed good heterosis

Entry	Pedigree	GY	% Increase over CC	AD	pSL	pBHC	Eturc	MOI	BLUE_PH
26	CKDHL0106/WMB4002	9.7	58.4	69.5	1.2	8.2	2.5	20.7	254.3
6	CKDHL0323/WMA1202	8.7	42.9	69.2	1.8	0.9	1.6	24.3	251.3
11	CKDHL0470/WMA2001	8.6	40.8	69.1	0.3	24.5	2.5	20.1	250.1
7	CKDHL0323/WMA2003	8.4	37.0	70.0	2.7	55.2	1.4	22.1	245.1
13	CKDHL0470/WMA2003	8.4	37.0	70.9	1.3	24.3	1.7	22.6	238.1
25	CKDHL0106/WMB4413	8.3	36.8	70.0	0.2	35.6	1.9	22.5	241.5
41	CKDHL0467/WMB4002	8.2	33.9	71.1	1.5	21.3	2.9	22.1	249.4
14	CKDHL0470/WMB4002	8.1	32.8	72.8	0.2	9.9	2.0	22.3	246.1
2	CKDHL0089/WMA1202	8.1	32.6	70.9	0.1	7.0	1.7	25.1	244.4
39	CKDHL0411/WMA2003	8.1	32.4	69.0	3.5	36.3	1.7	22.2	237.9
68	Duma 43	5.8		62.8	1.4	14.0	2.5	20.4	244.6
69	DK 8031	5.9		65.9	2.1	4.4	1.7	19.5	238.2
70	Pioneer 3253	6.1		69.9	6.2	2.8	1.7	20.6	236.8
	Mean of commercial checks (CC)	6.0		66.2	3.2	7.1	2.0	20.2	239.9
	Heritability	0.8		0.9	0.1	0.7	0.5	0.6	0.9
	CV	8.8		1.2	131.5	41.5	15.7	6.3	1.7
	n Locations	5		5	2	3	2	5	4

CIMMYT Coded × Monsanto Coded SC Hybrids

CKDHL0323/WMA1202

CKDHL0470/WMB4002

2016 WWT Trial Composition and Checks

- Objective is to identify hybrids for NPT
- Both sets packed for 70 locations

Source	Medium maturity set	Early maturity set
CIMMYT	**36**	**43**
Monsanto	**17**	**7**
Commercial check	**3**	**4**
Internal check	**3 (DTMA, IMAS, WEMA)**	**0**
Local checks	**1**	**1**
Total	**60**	**55**

Locations for 2016 WWT trials

- The medium and early sets were evaluated in Kenya, Tanzania and Uganda in 2016
  - **Random stress**: 05 locations
  - **Optimum**: 29-30 locations
  - **Analysis done**: Single site and combined analysis
  - Only combined analysis across three countries is presented, but we have also done analysis within each country to identify hybrids adapted to a specific country

Results of Medium-maturity WWT Evaluated at 29 Optimum Locations in Eastern Africa in 2016

Entry	Name	Grain Yield (t/ha)	% Increase over Mean of 7 Checks	50% Anthesis (days)	Root Lodging (#)	Stem Lodging (#)	Bad Husk Cover (%)	Ear Aspect (1-5)	TLB (1-5)	Grain Mois (%)	Plant Height (cm)	GLS (1-5)	Female SC Yield (t/ha)	Nicking Difference (days)
46	CKH160066	7.90	27.8	72.6	2.7	5.4	2.6	2.0	1.8	20.6	229.0	1.4	6.36	-4.88
30	CKH160050	7.68	24.2	69.8	2.7	1.5	1.9	2.3	1.8	19.4	224.5	1.5	8.70	-0.59
37	CKH160057	7.65	23.7	69.6	4.6	2.3	4.3	2.4	1.7	20.8	247.6	1.2	8.03	2.38
36	CKH160056	7.61	23.1	70.2	1.2	3.5	3.4	2.6	1.7	20.5	241.9	1.3	6.36	1.99
41	CKH160061	7.56	22.2	70.2	2.9	2.7	5.7	2.1	1.8	20.3	228.3	1.5	9.27	-0.13
45	CKH160065	7.49	21.2	72.9	6.5	5.0	1.7	1.9	1.7	20.0	227.6	1.5	8.03	-4.27
34	CKH160054	7.46	20.7	69.8	2.9	1.2	2.6	2.2	1.7	20.5	222.2	1.2	6.36	3.06
38	CKH160058	7.41	19.9	70.3	1.7	2.8	7.6	2.3	1.8	20.0	236.8	1.4	7.25	2.51
42	CKH160062	7.36	19.1	71.4	2.4	3.5	7.2	2.5	1.9	20.5	219.2	1.3	7.18	-6.57
23	CKH160043	7.31	18.2	69.5	0.4	1.3	17.9	2.4	1.8	19.3	222.4	1.5	8.03	2.66
54	WE1101	5.85		69.3	1.1	2.1	8.9	2.0	1.9	19.4	217.7	1.6		
55	CKH12600	6.25		68.3	1.0	2.2	4.0	2.2	2.2	18.6	212.6	2.6		
56	CKH10717	6.71		72.4	1.1	5.2	4.1	2.3	1.8	20.1	223.5	1.8		
57	H516	5.69		70.5	1.9	8.9	7.6	2.5	2.0	18.9	236.8	2.1		
58	WH505	7.18		73.4	2.3	2.4	2.0	2.0	1.7	20.3	241.4	1.6		
59	Pioneer 30G19	5.98		70.1	5.3	6.3	2.5	2.7	2.1	18.2	227.5	2.5		
60	Local Check	5.60		72.4	3.8	6.4	4.5	2.3	1.9	18.7	223.2	1.7		
	Heritability	0.90		0.97	0.70	0.84	0.89	0.88	0.72	0.89	0.97	0.89		
	Grand Mean	6.73		69.8	2.5	3.3	9.2	2.3	1.9	19.3	218.9	1.7		
	LSD	0.438		0.66	2.99	2.31	3.68	0.22	0.19	0.63	5.67	0.24		
	CV	3.3		0.5	60.5	35.4	20.5	4.7	5.1	1.7	1.3	6.9		
	n Replicates	2		2	2	2	2	2	2	2	2	2		
	n Locations	29		25	9	18	17	19	11	23	22	14		

Results of Medium-maturity Trials WWT Evaluated at 5 Random Stress Locations in Eastern Africa in 2016

Entry	Name	Grain Yield (t/ha)	% Increase over Mean of 7 Checks	50% Anthesis (days)	Ears per Plant (#)	Root Lodging (#)	Stem Lodging (#)	Bad Husk Cover (%)	Grain Moisture (%)	Plant Height (cm)	Rust (1-5)	Female SC Yield (t/ha)	Nicking Difference (Days)
14	WM4429	3.92	53.57	59.3	0.9	1.0	8.6	13.2	16.2	138.8	1.2		
6	WM4129	3.81	49.49	60.3	0.9	1.9	2.7	10.6	16.4	138.3	1.4		
5	WM4424	3.80	48.94	58.8	1.0	1.0	4.0	7.5	16.2	152.3	1.4		
18	CKH160038	3.70	45.18	63.2	0.9	2.8	8.9	5.8	16.1	147.8	1.4	8.22	-4.0
9	WM4345	3.62	41.76	59.9	0.9	2.8	6.0	7.6	17.1	136.3	1.6		
3	WM3319	3.60	41.33	57.9	0.8	0.0	5.3	9.2	16.6	149.9	1.7		
1	WM4271	3.56	39.76	59.5	0.8	0.4	3.1	4.9	15.9	160.3	1.6		
4	WM4435	3.56	39.49	58.6	0.8	0.0	6.8	7.6	16.4	137.1	1.3		
12	WM4257	3.53	38.59	60.6	0.9	2.4	6.6	12.6	17.1	139.1	1.5		
10	WM4184	3.53	38.51	60.2	1.0	0.5	5.6	19.5	16.8	131.6	1.4		
54	WE1101	2.47		60.2	0.7	3.8	9.2	4.1	18.3	159.0	1.4		
55	CKH12600	3.25		60.3	0.8	1.8	5.6	12.4	16.4	146.1	1.4		
56	CKH10717	2.92		62.1	0.8	3.0	4.2	9.3	18.2	153.4	1.4		
57	H516	1.97		62.1	0.7	2.4	7.0	3.3	16.0	165.7	1.0		
58	WH505	2.96		63.1	0.7	2.1	3.2	10.5	16.9	161.8	1.2		
59	Pioneer 30G19	1.90		62.8	0.7	3.7	5.2	2.8	15.3	153.6	1.5		
60	Local Check	2.36		62.2	0.8	3.3	7.8	6.2	16.9	151.1	1.0		
	Heritability	0.62		0.83	0.31	0.27	0.32	0.08	0.00	0.69	0.11		
	Grand Mean	3.04		60.9	0.8	2.5	6.5	7.8	16.6	153.1	1.3		
	LSD	0.71		1.73	0.16	3.47	4.77	8.95	1.40	13.60	0.51		
	CV	12		1	9	69	37	58	4	5	19		
	n Replicates	2		2	2	2	2	2	2	2	2		
	n Locations	5		4	4	3	4	2	5	4	2		

CKH160051

CKH160004

Results of Early-maturity WWT Evaluated at 30 Optimum Locations in Eastern Africa in 2016

Entry	Name	Grain Yield (t/ha)	% Increase over Mean of Checks	Days to 50% Anthesis (days)	Root Lodging (#)	Stem Lodging (#)	Bad Husk Cover (%)	Turcicum Blight (1-5)	Grain Moisture (%)	Plant Height (cm)	GLS (1-5)	Female SC Yield (t/ha)	Nicking Difference (days)
19	CKH160012	**8.09**	51.9	**69.7**	3.6	6.5	1.3	1.6	20.4	233.2	1.5	8.03	-0.9
23	CKH160016	**7.87**	47.9	**69.2**	3.0	7.1	2.3	1.6	20.6	229.7	1.5	8.70	-3.5
21	CKH160014	**7.76**	45.8	**69.2**	2.9	2.2	1.9	1.6	20.9	229.9	1.5	9.27	-2.4
20	CKH160013	**7.74**	45.4	**69.7**	0.7	6.8	3.5	1.7	20.8	229.4	1.3	7.25	-0.8
18	CKH160011	**7.73**	45.1	**69.5**	0.4	5.4	2.8	1.6	21.5	224.2	1.8	6.36	-1.3
22	CKH160015	**7.62**	43.1	**68.6**	0.7	11.2	2.8	1.8	20.1	219.2	1.6	6.66	-2.9
9	CKH160002	**7.55**	41.7	**70.3**	4.0	6.3	1.9	1.9	19.3	233.2	1.8	7.95	-5.1
24	CKH160017	**7.46**	40.1	**69.2**	1.5	4.0	3.3	1.8	20.4	224.3	1.7	6.73	-1.6
25	CKH160018	**7.41**	39.2	**70.0**	2.2	4.4	1.1	1.7	19.7	236.2	1.6	8.03	-1.7
51	DH04	**5.10**		**66.9**	2.5	7.3	6.5	2.3	18.3	218.4	2.2		
52	Duma 43	**5.38**		**63.7**	2.8	4.4	16.0	2.0	17.3	219.7	1.9		
53	DK 8031	**5.50**		**65.7**	1.4	7.1	15.9	1.8	16.5	221.2	1.6		
54	PAN4M-19	**5.46**		**64.5**	4.4	6.3	7.9	2.3	16.6	202.3	2.3		
55	Local Check	**5.19**		**68.7**	2.7	10.1	5.8	1.9	19.7	227.5	1.6		
	Heritability	**0.95**		**0.98**	0.54	0.74	0.87	0.78	0.93	0.97	0.87		
	Grand Mean	**6.49**		**66.7**	2.4	5.3	7.5	1.9	18.7	214.9	1.8		
	LSD	**0.39**		**0.75**	2.92	3.02	2.85	0.19	0.78	6.23	0.29		
	CV	**3**		**1**	62	29	19	5	2	1	8		
	n Replicates	**2**		**2**	2	2	2	2	2	2	2		
	n Locations	**30**		**25**	11	18	17	13	21	20	12		

Results of Early-Maturity WWT Evaluated at 5 Random Stress Locations in Eastern Africa in 2016

Entry	Name	Grain Yield (t/ha)	% Increase over Mean of Checks	Days to 50% Anthesis (days)	Ears per Plant (#)	Root Lodging (#)	Stem Lodging (#)	Bad Husk Cover (%)	Turcicum Blight (1-5)	Grain Moisture (%)	Plant Height (cm)	ASI (days)	Female SC Yield (t/ha)	Nicking Difference (days)
3	WM4197	3.66	42.22	58.1	0.9	8.8	17.9	11.6	1.5	17.4	157.2	2.3		
1	WM4266	3.60	40.19	56.7	0.9	3.4	4.5	3.8	1.7	17.1	142.5	2.6		
2	WM4418	3.52	36.77	58.3	0.9	8.9	6.8	4.3	1.4	18.2	154.1	1.9		
7	WM4158	3.43	33.50	58.9	1.0	4.4	3.0	4.3	1.2	18.5	148.1	2.0		
25	CKH160018	3.38	31.60	60.5	0.9	0.8	5.1	3.8	1.4	17.9	177.1	2.0	8.03	-1.7
43	CKH160036	3.35	30.19	55.3	0.9	3.5	2.5	6.2	1.5	17.4	161.9	2.4	8.23	-3.3
44	CKH160037	3.33	29.38	57.0	0.9	9.2	6.5	8.2	1.6	17.6	158.9	1.5	5.45	-1.7
6	WM4262	3.30	28.48	57.8	0.9	6.9	2.9	4.6	1.7	17.8	155.6	1.8		
46	CKH150293	3.30	28.25	59.4	0.9	5.7	1.8	7.1	1.3	17.4	175.0	2.0	7.95	1.3
50	CKH150033	3.24	26.03	60.0	0.8	5.6	9.9	4.1	1.3	18.3	146.4	2.2	7.95	1.5
51	DH04	2.72		58.9	0.8	7.5	8.9	8.0	1.7	17.9	164.2	2.8		
52	Duma 43	2.38		57.0	0.9	4.5	6.4	11.3	1.5	17.7	168.7	2.9		
53	DK 8031	2.34		58.9	0.8	2.5	4.5	7.1	1.4	16.3	161.1	2.5		
54	PAN4M-19	3.08		58.4	0.8	1.9	4.3	11.2	1.3	16.2	159.1	2.4		
55	Local Check	2.31		61.9	0.8	1.5	7.3	3.9	1.8	17.8	170.9	2.0		
	Heritability	0.23		0.84	0.30	0.00	0.38	0.02	0.05	0.35	0.83	0.10		
	Grand Mean	2.90		59.4	0.8	6.1	7.0	5.1	1.5	18.0	160.5	2.2		
	LSD	0.79		1.51	0.13	6.80	6.12	4.67	0.55	1.27	11.23	1.22		
	CV	14		1	8	56	44	46	18	4	4	27		
	n Replicates	2		2	2	2	2	2	2	2	2	2		
	n Locations	5		5	5	2	3	3	3	6	6	2		

Performance of WEMA Hybrids in Kenya NPT

		YIELD(t/ha)								
						DISEASES			MATURITY (DAYS)	
EXP_NAME	NPT YRS	MEAN	% ABOVE BEST CHECK	% ABOVE MEAN OF CHECKS	CON TRAST	BLT	GLS	RST	DPS	SLK
WE6106	1	9.86	32.29	46.74	0.00	1.75	1.94	1.78	68.06	71.67
WE6103	1	8.92	19.63	32.69	0.00	2.08	2.06	1.89	71.44	74.67
WE6205	1	8.88	19.06	32.07	0.00	1.58	2.06	2.11	65.17	67.83
WE6105	1	8.54	14.61	27.12	0.00	1.92	2.44	1.78	69.22	72.56
WE6107	1	8.48	13.72	26.14	0.00	2.00	1.83	1.44	69.78	58.94
WE6203	1	8.22	10.28	22.32	0.00	1.83	1.72	1.78	66.61	69.39
WE6204	1	8.08	8.37	20.20	0.01	2.33	1.83	2.22	64.78	68.17
H513	2	7.45				2.00	1.72	2.11	66.22	69.94
WH403	2	6.63				2.08	2.33	2.06	72.50	76.50
PHB3253	2	6.08				2.17	1.94	2.06	69.06	72.33
MEAN		6.79				1.48	1.56	1.55	69.96	72.92
P-VALUE		0.00				0.19	0.81	0.40	0.00	0.00
CV(%)		12.29				18.69	24.75	23.29	3.59	9.15
R2		0.76				0.77	0.59	0.59	0.95	0.74
LSD(5%)		1.17				0.40	0.55	0.51	3.51	9.33

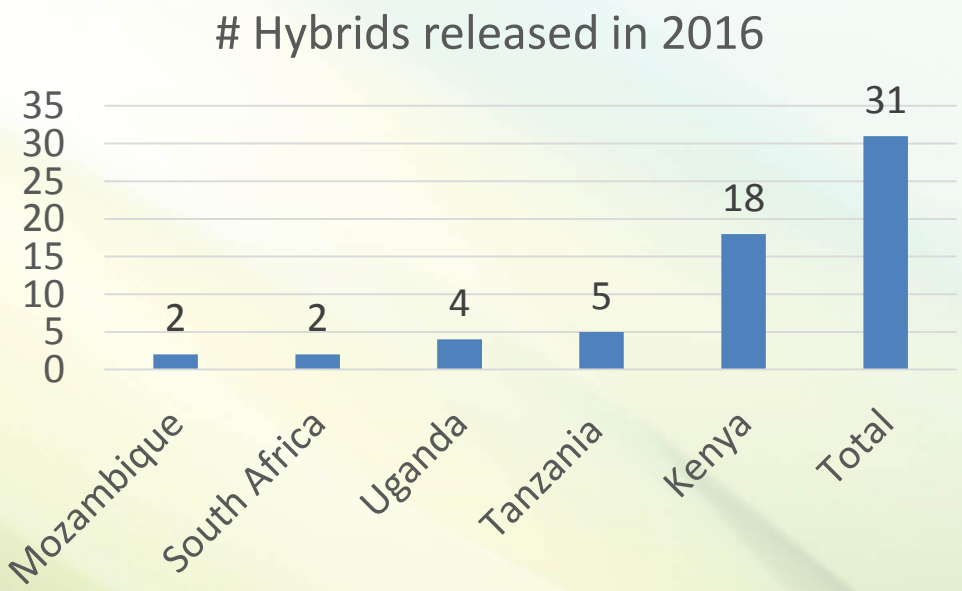
Results of NPT1 in Uganda in 2016

- **Evaluated in 8 sites,**
- **Harvested in 6 sites,**
- **2 sites were significant**
- **NPT 1- 36 entries (6x6)**
  - 12 WEMA Materials
  - 10 DTMA Materials
  - 11 NARS Materials
  - 01 WEMA Commercial Checks
  - 02 Local Commercial Checks

Combined results across six location

Name	Genotype	BLUP_GY	Anthesis Date	ASI
WE6103	**12**	**8.44**	**63.25**	**1.46**
WE6106	**17**	**7.84**	**60.71**	**1.61**
PEX406	1	7.57	61.30	2.05
SS-81-4	**33**	**7.56**	**62.17**	**1.63**
WE2115	**36**	**7.45**	**62.66**	**2.04**
PEX7701	7	7.44	64.61	1.50
PEX703	9	7.33	65.20	1.50
PEX501	6	7.01	63.34	1.44
CKHRM1212	26	6.93	63.54	1.68
CKHRM1231	27	6.79	63.15	1.63
CKHRM1202	32	6.59	64.61	1.69
PEX504	23	6.57	61.88	1.55
CKHRM1203	24	6.48	65.39	1.61
PEX404	8	6.38	64.22	1.34
CKHRM1219	28	6.37	63.54	1.57
WE5136	19	6.24	66.81	1.77
WE6114	16	6.18	64.61	1.45
WE6108	22	5.92	62.81	1.63
WE6113	15	5.86	63.39	1.20
WE6104	13	5.63	64.45	1.39
WE5139	20	5.34	62.54	1.53
Bazooka	34	5.11	67.24	1.81
Heritability		**0.88**	**0.78**	**0.37**
Grand Mean		**5.74**	**63.50**	**1.55**
LSD		**1.89**	**2.75**	**0.95**
CV		**35.17**	**4.13**	**50.70**

Hybrids Released in 2016 in different WEMA Countries



Breeding Maize for MLN Tolerance

List of trials evaluated at Naivasha AI in 2016

No	SEED PREPS	No of Entries	No of Reps	Total # Rows per site
1	WET16A-LET-01	75	2	300
2	WET16A-LET-02	92	2	368
3	WET16A-MLN-EVALSC-01	55	2	220
4	WET16A-MLN-EVALTWC-01	36	2	144
5	WET16A-MLN-EVALTWC-02	55	2	220
6	WWT-EARLYKIT-2016	55	2	220
7	WWT-MEDIUMKIT-2016	60	2	240
8	WET16A-EVALSC-03	70	2	140
9	WET16A-EVALSC-04	102	2	204
10	WET16A-EVALSC-05	84	2	168
11	WET16A-EVALSC-06	30	2	60
12	WET16A-YLOSS-01	48	3	288
13	WET16A-MLN-DHLINES-01	105	2	210
14	WET16A-MLN-DHLINES-02	110	2	220
15	WET16A-MLN-DHLINES-03	112	2	224
16	WET16A-MLN-DHLINES-04	110	2	220
17	WET16A-MLN-DHLINES-05	104	2	208
18	WET15A-DIALLEL-01	88	2	176
19	WET15A-DIALLEL-02	344	2	688
20	WET15B-MLN-LXT-01	138	2	552
21	WET15B-MLN-LXT-02	72	2	288
22	WET15B-MLN-LXT-03	70	2	280
23	WET15B-MLN-LXT-04	60	2	240
24	WET16A-MLN-LET-01	52	2	208
	Total	2127		6086

New Promising MLN Tolerant Lines

Name		BLUP_MLNI2
CKLMLN140185		1.4
CKDHL143064		1.4
CKDHL142833		1.5
CKDHL142767		1.7
CKDHL142806		1.8
CKDHL142763		1.7
CKLMLN140375		1.8
CKDHL143062		1.8
CKDHL140510		2.1
CKDHL120312	Resistant check	2.2
KS23-6-B	Resistant check	1.5
CLYN261	Resistant check	2.1
CLRCY034-B	Resistant check	2.5
CLRCY039-B	Resistant check	2.1
CKLMLN140538	Resistant check	1.8
CKDHL120918	Resistant check	2.1
CML312	Susceptible check	3.2
CML442	Susceptible check	3.7
CML395	Susceptible check	2.9
CML494	Susceptible check	2.8
CML539	Susceptible check	2.8
Heritability		0.8
LSD		1.0
CV		17.5
n Replicates		2

Identification of MLN -Tolerant Lines

Susceptible Resistant

Susceptible Resistant

New MLN Tolerant SC Hybrids

Entry	Cross	GY(t/ha) at Kiboko	MLN (1-5) at Naivasha	AD Kibokoo
1	CKDHL120918/CLRCY034	4.4	1.5	59.5
2	CKLTI0138/CKLMARSI0022	8.5	1.5	59.1
3	CKSBL10060/CKDHL120312	8.2	1.5	49.0
4	CML464/CKDHL120312	5.8	2.0	53.3
5	CKLTI0137/CKLTI0330	7.0	2.0	59.2
6	CKLMARSI0037/CKLTI0139	5.5	2.0	58.7
7	CKSBL10060/DTPYC9-F46-1-2-1-2-B	6.6	2.0	49.2
8	CKLTI0227/CKLMARSI0022	7.1	2.0	57.7
9	CKLMARSI0037/CKLTI0139	4.9	2.0	57.6
10	CKLTI0138/CKLMARSI0022	7.3	2.0	59.0
9	Pioneer 3253	7.9	4.0	59.3
51	WH505	10.2	4.0	58.8
52	WE1101	9.1	4.0	53.8
53	H516	5.3	4.0	58.5
54	Duma 43	7.3	4.0	50.7
55	DK8031	7.2	4.0	53.0
	Heritability	0.7	0.9	1.0
	LSD	2.7	0.8	1.7

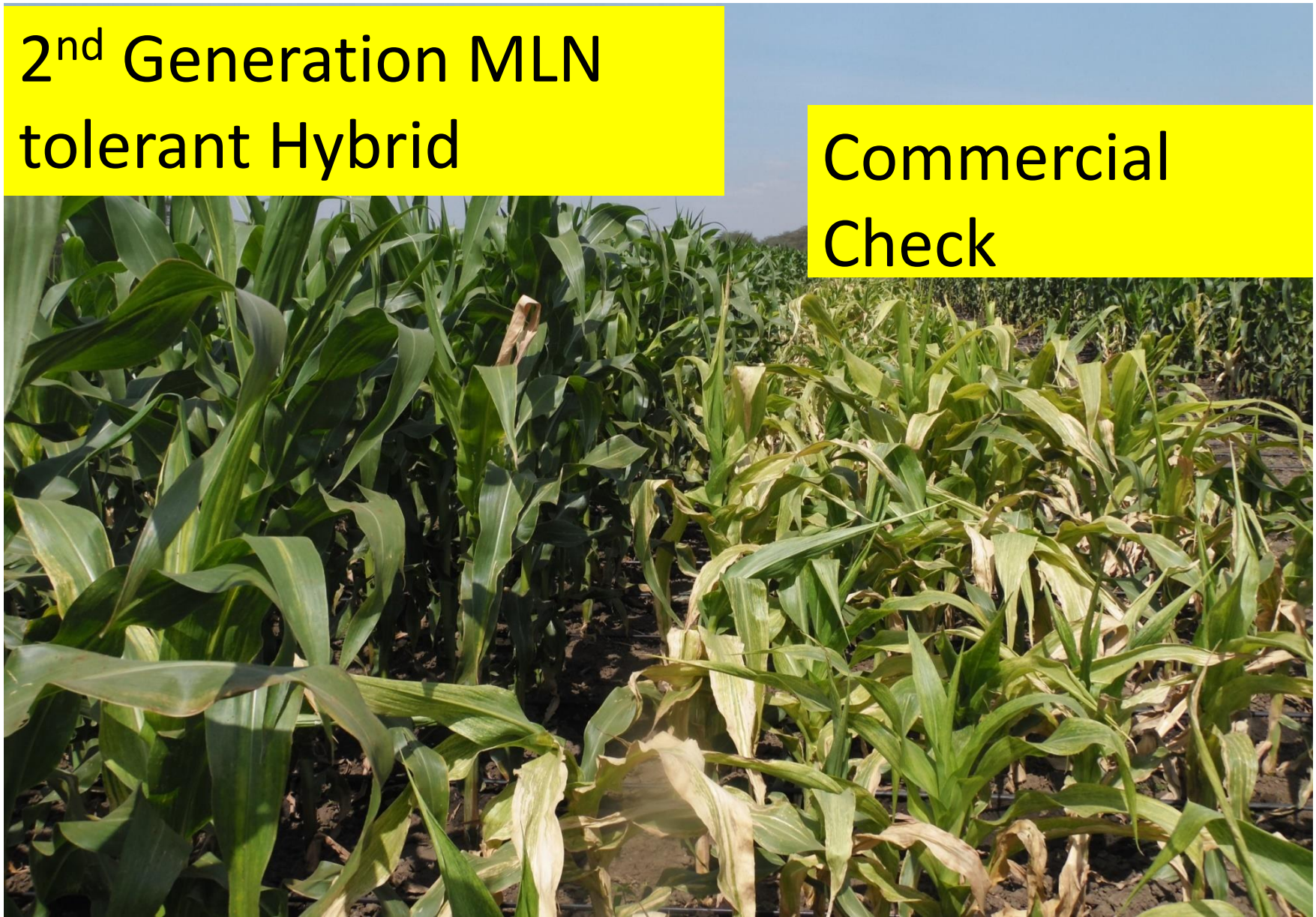
Susceptible commercial checks

MLN tolerant experimental hybrid

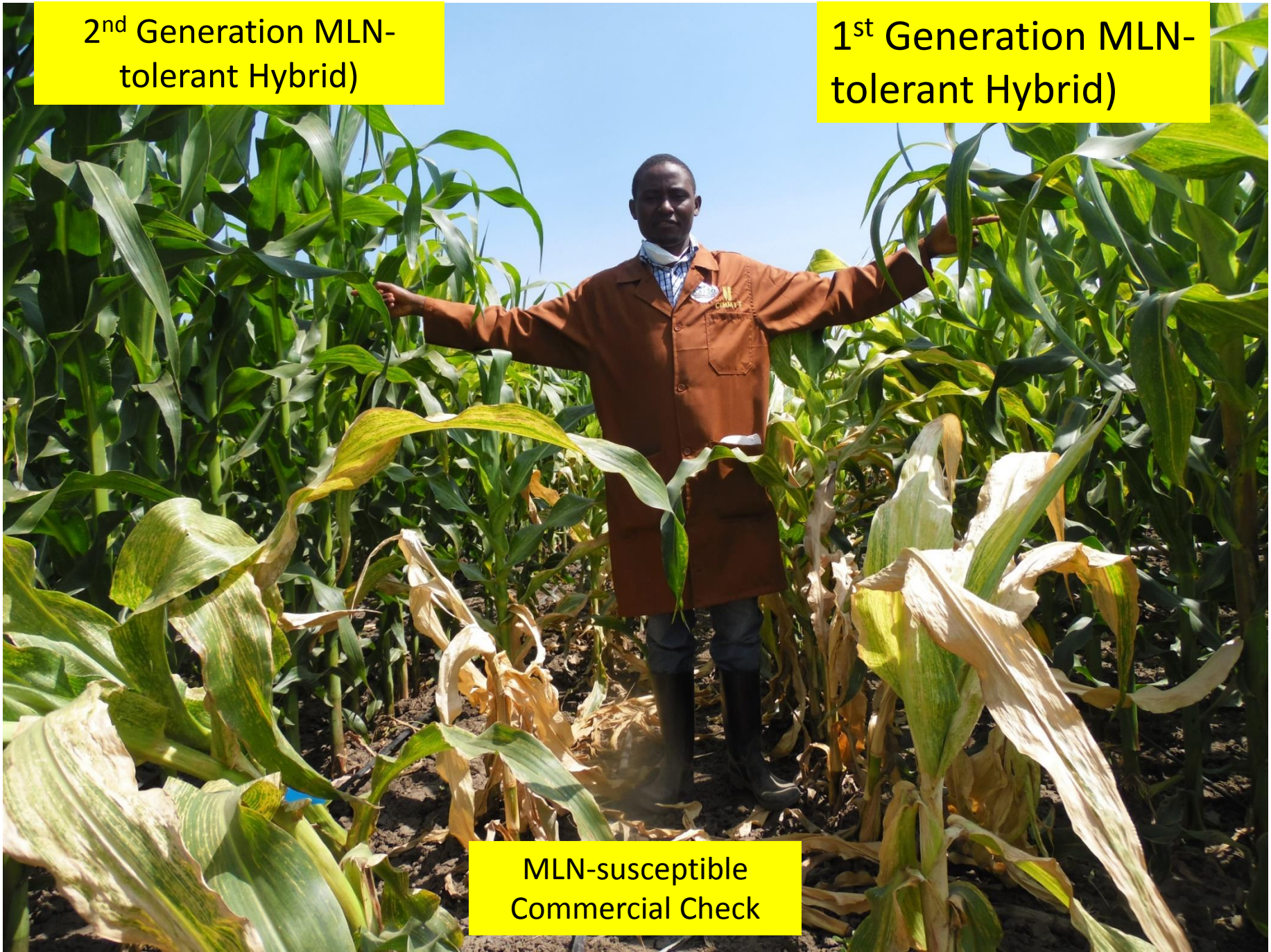
Cobs of MLN tolerant experimental hybrid at maturity

Need to evaluate across optimum and drought condition for grain yield and others major leave diseases

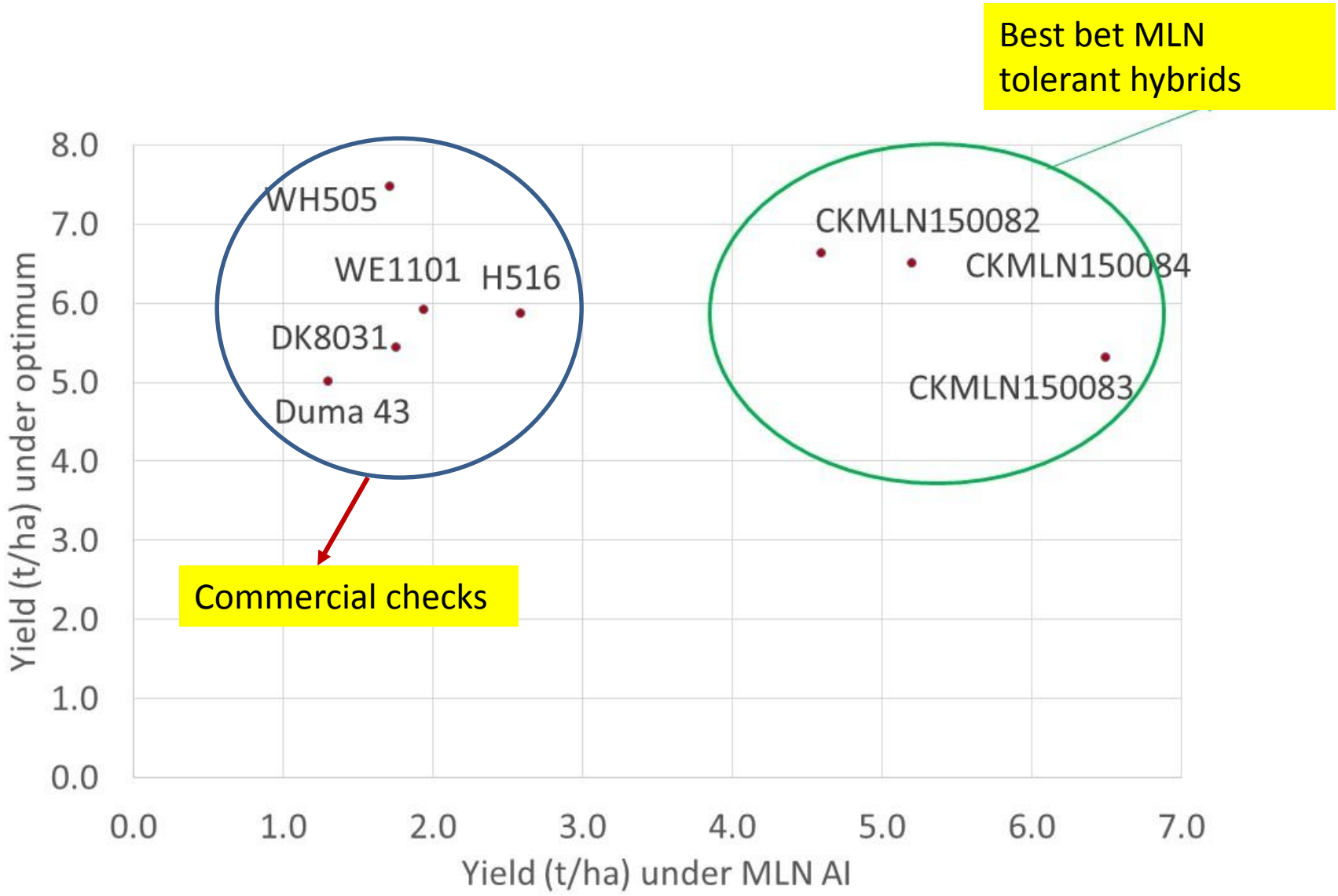
Performance of 2nd Generation MLN-tolerant Hybrid Vs. Comm. Check



Performance of 2nd Generation Vs. 1st Generation MLN-tolerance Hybrids



Yield comparison under optimum across locations and artificial MLN inoculation in Naivasha between MLN tolerant hybrids and commercial checks



Performance of MLN-tolerant & Comm. Check Under AI MLN; Without MLN; & Optimum Condition

CKHMLN1500084

Naivasha under AI MLN

Naivasha without MLN

Kiboko-Optimum

DK8031

MLN Tolerant at Kiru in Babati under Natural Disease Pressure

No	Name	Yield (t/ha)	MLN Score (1-5)
1	CKMLN150081	9.1	1.3
2	CKMLN150088	7.1	2.2
3	CKMLN150082	6.2	2.2
4	CKMLN150079	6.1	2.3
5	CKMLN150158	6.3	2.3
6	CKMLN150075	5.8	2.3
7	CKMLN150083	6.1	2.4
8	CKMLN150077	6.1	2.4
9	CKMLN150084	5.9	2.5
10	CKMLN150201	5.6	2.8
11	Duma 43	0.9	3.3
12	WE1101	0.9	3.8
	LSD (5%)	2.6	0.9
	G.Mean	4.27	2.68
	CV %	30.5	15.9

MLN evaluation at Babati under natural MLN pressure

Hosting Partners at Naivasha

Dr. Lawrence, November 16, 2016

MLN demo plot

KEPHIS NPTC members field visit at Naivasha , 22 November 2016

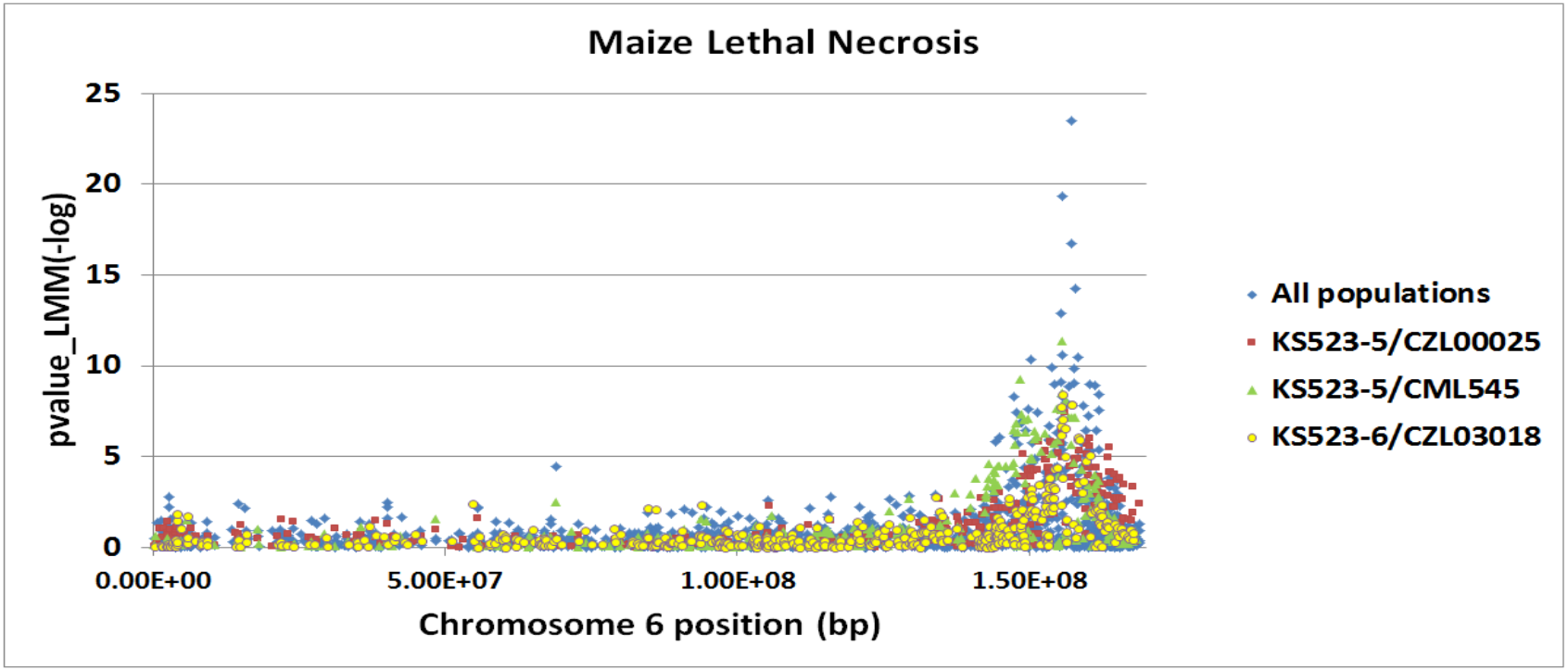
WEMA Project Manger

PDT joint site visit at Naivasha , August 8-12

WE5135: Recommended for release in Kenya and NPT1 in Uganda and Tanzania

WE5135 at Naivasha under MLN AI compared to commercial check

WEMA is Collaborating with other CIMMYT Projects for Conversion of Elite Lines for tolerance to MLN through MABC



Cohort 2:

New Set of lines with high-yield & agronomic performance in hybrid combinations; include: CML567, CML568, CML539, CML540, CML442, CML537, CML548, CML572, CKDHL0186, CKDHL0106, CKDHL0323, CML444, CML511, CML547, CML566, CML569, and CML570.

Each of these lines crossed to Heterotic Group A Donors – **KS23-5 and KS23-6**

Drought TEGO™

WEMA

Molecular Breeding

New drought-tolerant white maize hybrids

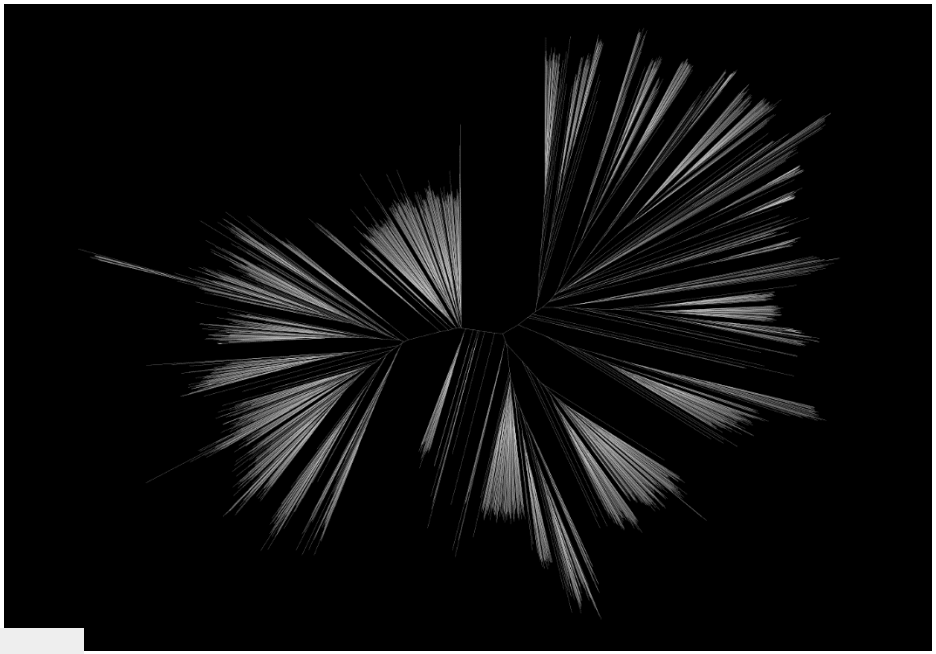
Protection for a better harvest

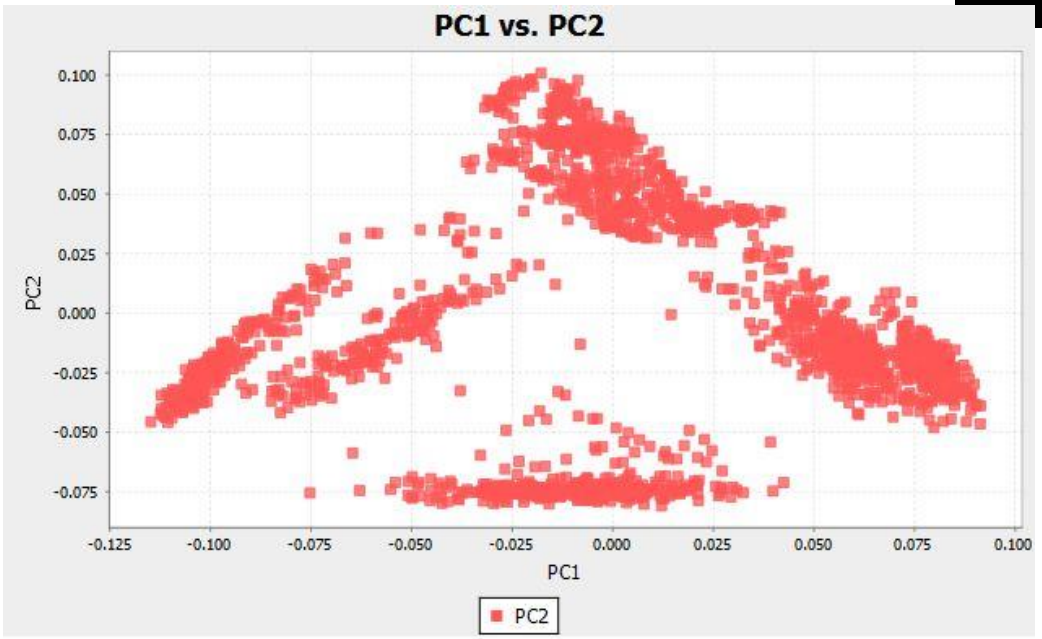
Performance of Hybrids Developed Through Molecular Markers

Entry	GY (t/ha)	% incerase over the mean of check	AD	MOI	PH	EH
(CML395/CML444)//CKLMARS1C3S50140	8.5	24.3	73.4	21.1	237.4	99.7
(CKDHL0159/CKDHL0282)//CKLMARS1C3S50140	8.3	21.4	70.9	20.4	233.8	96.0
(CKDHL0089/CKDHL0333)//CKLMARS1C3S50140	8.3	21.2	72.4	21.6	232.4	94.9
(CML395/CML444)//CKLMARS1C3S50113	8.3	21.1	72.8	21.3	219.9	99.2
WH505	7.0		78.2	21.2	235.9	110.1
Duma 43	6.7		69.2	19.4	218.8	95.2
DK 8031	7.0		71.3	18.7	204.1	93.5
H516	7.0		74.9	20.8	227.4	106.7
Pioneer 3253	6.6		73.4	19.3	217.8	101.4
Heritability	0.7		0.8	0.5	0.9	0.7
Grand Mean	7.6		72.8	20.5	214.2	95.5
LSD	1.2		1.8	1.8	12.2	8.7
CV	14.1		2.4	8.8	4.8	8.1
n Locations	3		4	4	4	4

Genetic Diversity among 2000 DH lines

Stat Type	Value
Number of DH lines	1989
Number of SNP	955690
Proportion Missing	0.2
Proportion Heterozygous	0.0

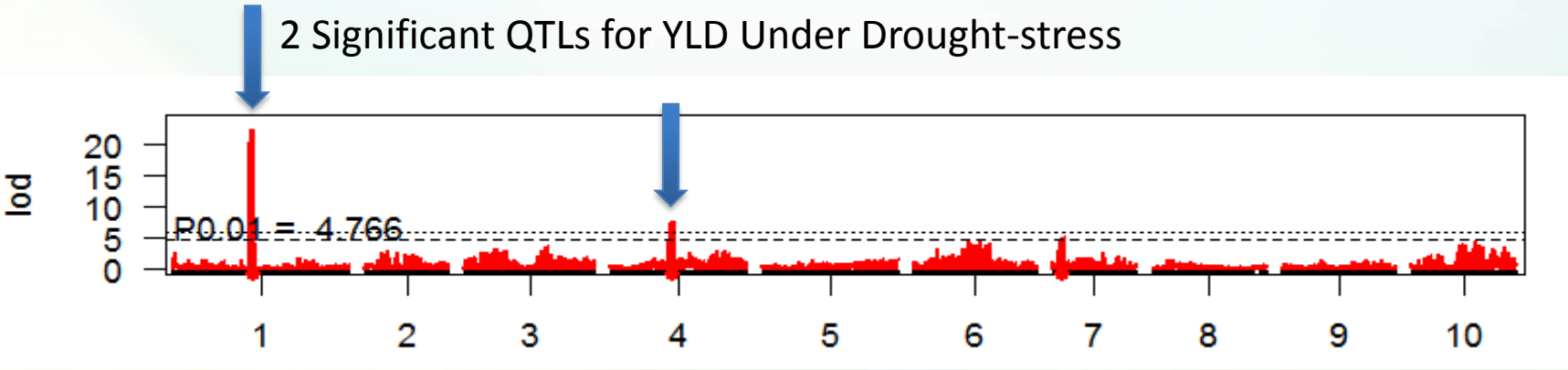




- Will help us in selecting parents to make new pedigree starts
- Discard/purify contaminated lines

NAM1 Results

Joint Linkage Mapping / Composite Interval Mapping



- **Early validation trials**
- **Introgression commenced in anticipation of a positive outcome**
- **CIMMYT & Monsanto Germplasm**

Chromosome	Interval	Effect	Variation explained
1	6 cM	1.2 t/ha	**17.5%**
4	5 cM	1.0 t/ha	**6.1%**

Efficacy Test of Drought QTL Introgressed Lines

- **Wave1**:
  - 6 Finished Monsanto Lines into which QTL1 was introgressed
  - One more line about to be finished
  - Testing to commence from 2017/18
- **Wave2**:
  - 25 Lines being introgressed with the 2 Drought QTLs
  - 19 Lines from MON and
  - 6 from CIMMYT: CKDHL0231, CKDHL0333, CKDHL0374, CKDHL0411, CML539, CML566
  - Testing to commence from 2019/20 season

Molecular Breeding to Improve MLN Tolerance

Entry	Pedigree	Purpose	% White Kernels
1	(CML494*/OFP105)-2-1-2-1-2-B-B/CKDHL120918	MARS	
2	CKDHL120918/CML543	MARS	
3	CML543/CML494	MARS	
4	CKDHL120918/CML494	MARS	
5	CML539/KS23-6	Forward Breeding	32
6	CKDHL0186/KS23-6	Forward Breeding	25
7	CKDHL0221/KS23-6	Forward Breeding	31
8	CML442/KS23-6	Forward Breeding	32
9	CML537/KS523-5	Forward Breeding	28
10	CML312/KS23-6	Forward Breeding	30
11	CKDHL0089/CKDHL120918	QTL Mapping	
12	CKDHL0221/CKDHL120312	QTL Mapping	
13	CKDHL0089/CML494	QTL Mapping	

F_3 planted in Dec 2016 at Naivasha for MLN evaluation; and leaf samples were taken for genotyping

Submitted for DH induction In Kiboko

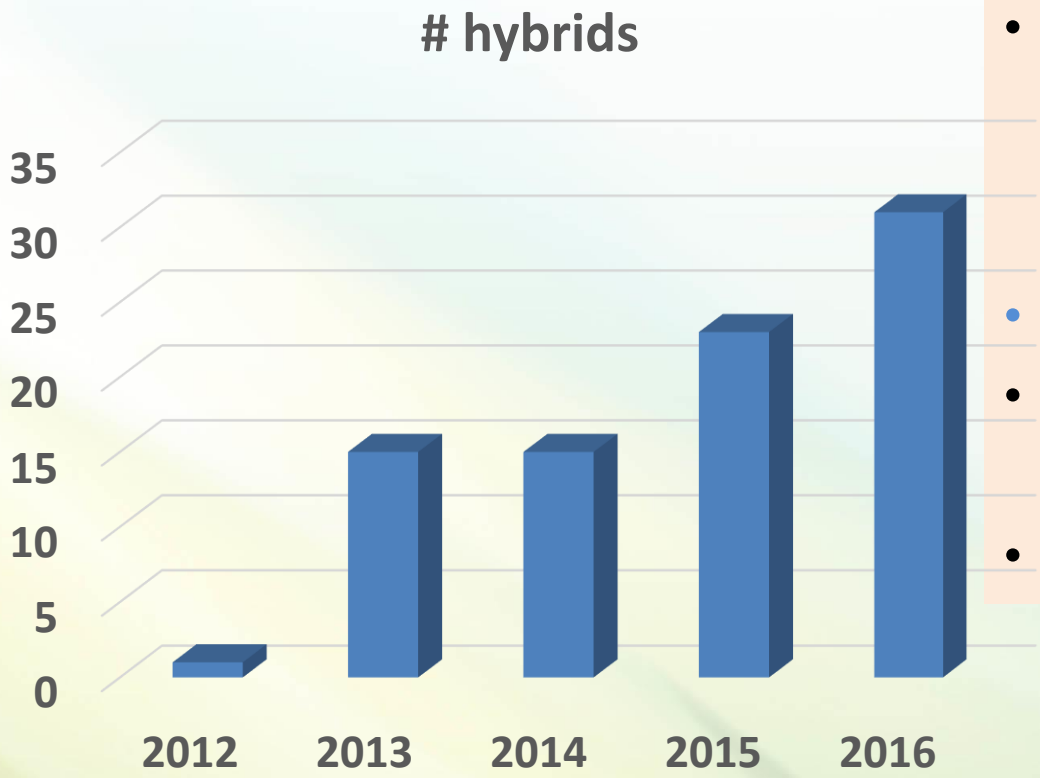
- **Recombination, Line extraction and Hybrid evaluation proposed for WEMA Phase III**

NAM Populations for Detection of QTL for MLN

- Developed MLN NAM populations: A cross between MLN-tolerant line and seven founder parents
- F_1s were sent for DH induction at Kiboko in 2015
- D1 seed were received in 2016A & increased at Kiboko
- Planted at Kiboko under MLN AI and genotyping in 2017
- Introgressing of QTL to drought-tolerant elite lines in 2018/19
- Testing in 2020/21

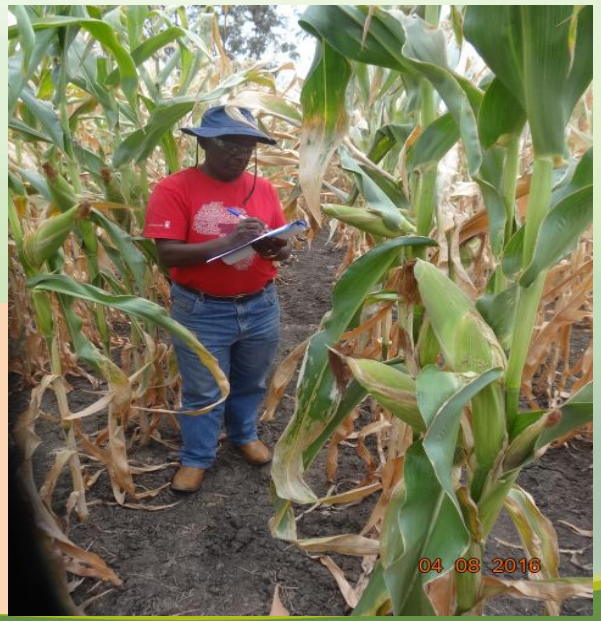
S/N	Pedigree of cross	# DH per cross
1	CKDHL120312/CML567	150
2	CKDHL120312/CML568	179
3	CKDHL120312/CML536	337
4	CKDHL120312/CKDHL121167	103
5	CKDHL120312/CKDHL0221	84
6	CKDHL120312/CKDHL120143	83
7	CKDHL120312/CKDHL120184	125
	Total	1061

WEMA Breeding Achievements



- A total of 85 *DroughtTEGO®* hybrids released in All WEMA countries
  - ❖ Three hybrids from NARS (ARC) breeding program
- 5 *TELA™* hybrids on initial sales, RSA
- 31 Seed Companies licensed *DroughtTEGO®* & *TELA™*
- 14 hybrids are in market place

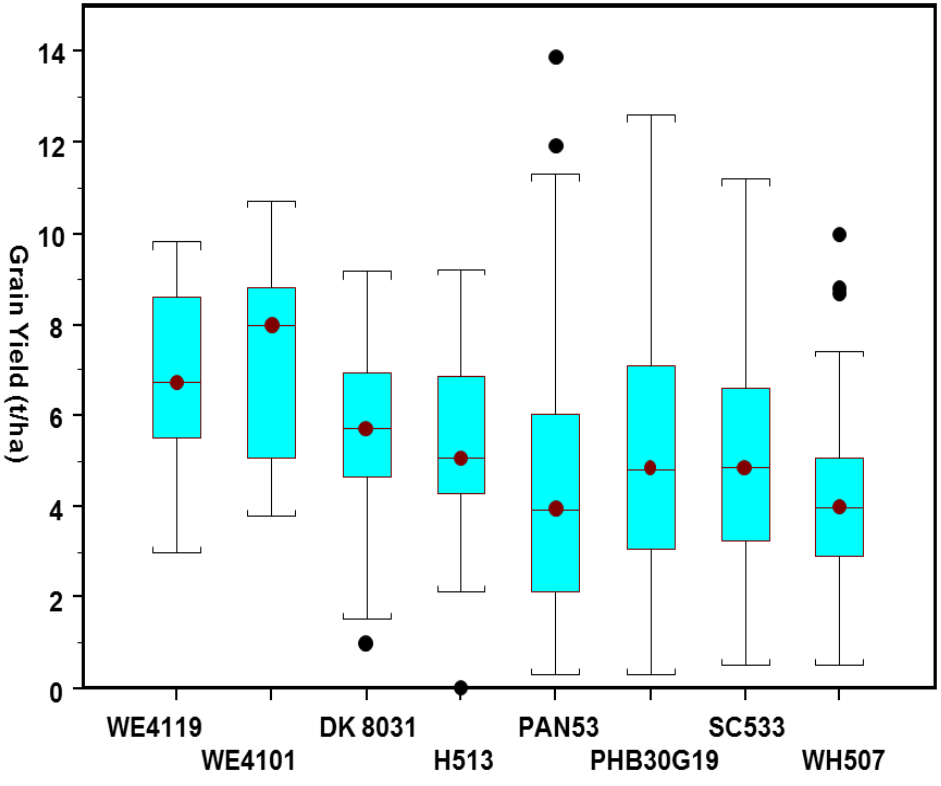
Ears of WE4120 released in Kenya



WE4141 Planted at Kangundo by a Seed Company

WEMA Hybrids vs. Commercial Hybrids in ESA

Head-to-Head Comparison



- **Best 10-15 hybrids from different maturity groups** (extra-early, early, intermediate, late) vs. corresponding checks from each of DTMA, WEMA and IMAS nodes in ESA
- **7073 comparisons** across different maturity groups.
- Results of combined analyses across Optimum-moisture & N-application; Managed-drought; & Low-N Environments.
- Identified best products cutting across environments vis-à-vis popular commercial hybrids

- ❖ Recently released WEMA hybrids are more superior to popular commercial hybrids
- ❖ The parents of these hybrids will be sent for TI with DT and *Bt* transgenes

Drought TEGO™

WEMA

BIOTECHNOLOGY

MON87460

MON810

New drought-tolerant white maize hybrids

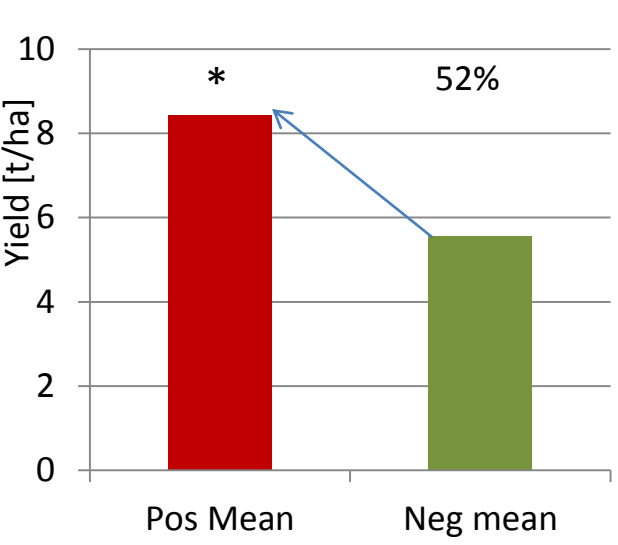
Protection for a better harvest

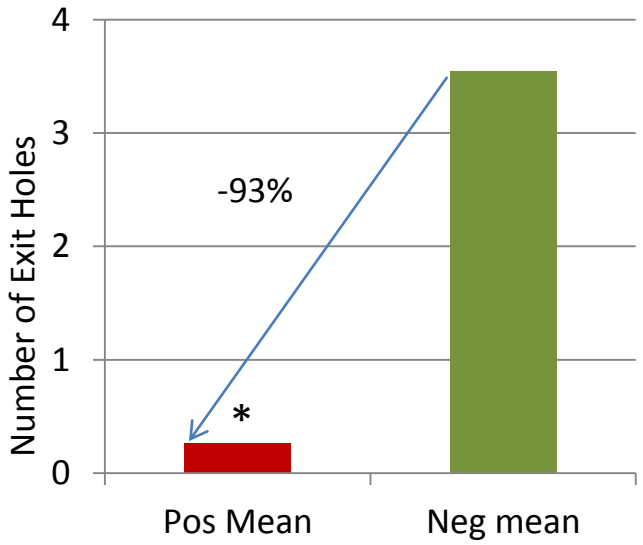
Uganda and Kenya MON810 data
Executive summary

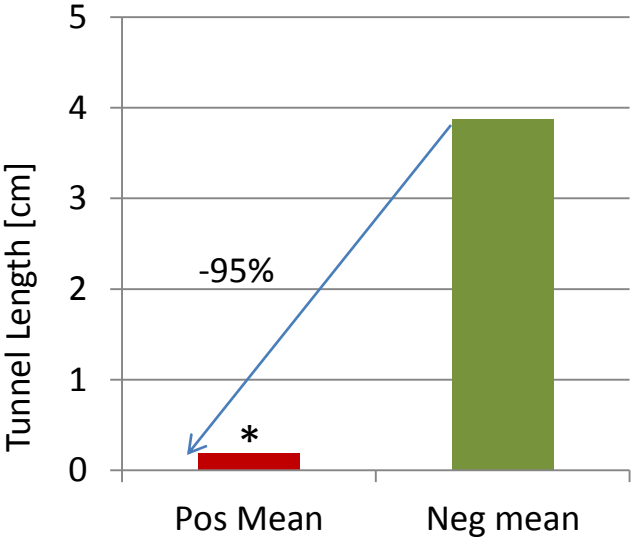
The gene has a positive and significant effect on yield across germplasm and trials. The yield increase was 52% on average.

The gene significantly reduced numbers of exit holes and tunnel length across germplasm and trials.

Trait	Pos Mean	Neg Mean	Delta	PERC	P-value
Yield [t/ha]	8.4	5.5	2.9	52	0.00
Exit holes [number]	0.3	3.5	-3.3	-93	0.00
Tunnel length [cm]	0.2	3.9	-3.7	-95	0.00







RSA MON89 Products

Entry#	Product Name	Yield [t/ha]	MST [%]	Root lodging %	Stalk lodging %	P50D	S50D	EHT [cm]	PHT [cm]	Diplodia Ear Rot
36	WE6211B	8.5	19.4	0.0	1.6	83	83	85	225	Tolerant
69	Commercial check2	8.2	18.6	4.7	5.5	83	83	130	235	Medium
72	Commercial check5	7.9	21.5	0.3	7.9	84	85	115	235	Medium
52	WE6212B	7.9	19.6	0.0	1.3	82	82	120	250	Medium
32	WE6215B	7.7	21.3	0.0	0.4	87	87	135	245	Medium
70	Commercial check3	7.5	18.3	0.1	8.2	85	85	110	235	Tolerant
67	WE6213B	7.5	20.1	0.4	4.7	84	84	115	225	Tolerant
68	Commercial check1	7.5	21.4	0.3	8.9	85	84	95	225	Medium
64	WE6214B	7.4	21.9	0.3	1.7	82	82	150	250	Tolerant
38	WE6210B	7.2	19.8	1.1	1.2	83	83	95	245	Tolerant
57	WE6208B	7.2	23.3	1.1	0.7	85	84	140	250	Tolerant
71	Commercial check4	7.1	19.1	1.8	5.6	87	87	110	230	Tolerant
2	WE6206B	7.0	19.7	1.0	5.8	83	83	85	240	Tolerant
39	WE6207B	6.7	19.8	0.4	1.7	84	84	85	215	Tolerant
62	WE6209B	6.0	22.1	0.7	2.5			105	250	Medium
	Overall mean	6.8	20.2	0.8	4.8	84.7	85.2	107.7	234.4	
	Check mean	7.7	19.7	1.4	7.2	84.8	84.8	112.0	232.0	

- Highlighted hybrids available for commercial release. Demo seed already available.
- Remaining hybrids in retest for potential commercialization in 2017.

Visits to Bt and stacked trials sites in Kenya

Visits at Kiboko

Training at Kiboko

Visits at Kitale

Scientific Publications in 2016

1. **Beyene et al. (2016)** Euphytica : 208:285–297
2. **Tadele et al (2016)** Crop Protection 89: 202-208
3. **Tadele et al (2016)** Food Security 8: 211-220
4. **Beyene et al. (2016)** Crop Sci. 56:1–10
5. **Regasa et al (2016)** Euphytica DOI 10.1007/s10681-016-1758-3
6. **Wallace et al (2016**) Crop Sci. 56:1–14
7. **Beyene et al (2016)** *Harnessing agricultural biotechnology for resilience to climate change: A lesson from water efficient maize for Africa project*, FAO International Symposium in Rome on 15-17 February 2016. (http://www.fao.org/about/meetings/agribiotechs-symposium/en/).
8. **Beyene et al (2016**) Progress in Developing Maize Hybrids Resistant to Maize Lethal Necrosis (MLN) in Eastern Africa Poster presented to 7th Africa Agriculture Science Conference Week (AASW) and FARA General Assembly13-16 June 2016, Kigali, Rwanda.
9. **Beyene et al (2016)** The Development of Drought Tolerant Maize Germplasm in sub-Saharan Africa using Marker-Assisted Recurrent Selection and Genomic Selection. Oral presentation to at the 7th International Crop Science Congress 14–19 August 2016 Beijing, China

Conclusions

- **A total of 31** hybrids released in in Kenya, Tanzania, Uganda, Mozambique and Uganda in 2016
- Actively engaged in identifying sources of resistance to MLN, and trait being incorporated into the breeding program
- Combined analysis of MON810 in Kenya and Uganda indicated positive and significant effects on grain yield under artificial infestation

Way Forward

- Development and deployments of second and third generation MLN tolerant hybrids
- Trait integration into parents of recent released WEMA hybrids MLN tolerant inbred lines
- Use of coded by code cross to identify superior hybrids

MLN Field-day at Naivasha, 20 January 2016

Thank You