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MAIZE LETHAL NECROSIS (MLN) DISEASE

By

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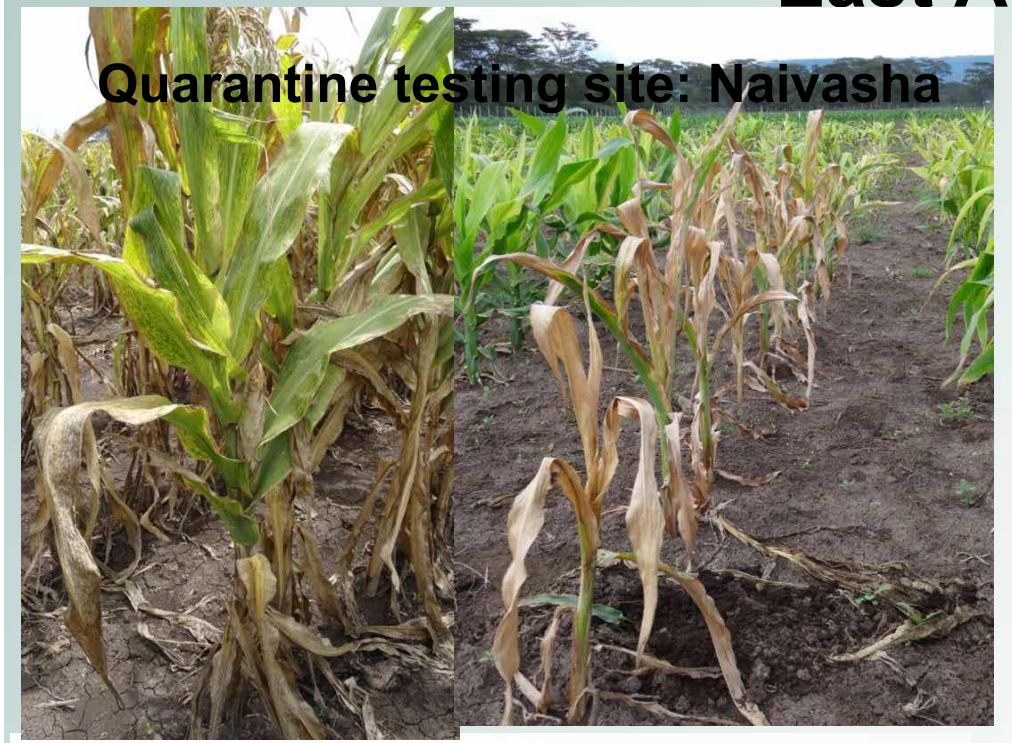
Presentation to ARC's Executive Management Committee, 4 May 2015

MAIZE LETHAL NECROSIS (MLN) DISEASE in East Africa

Quarantine testing site: Naivasha

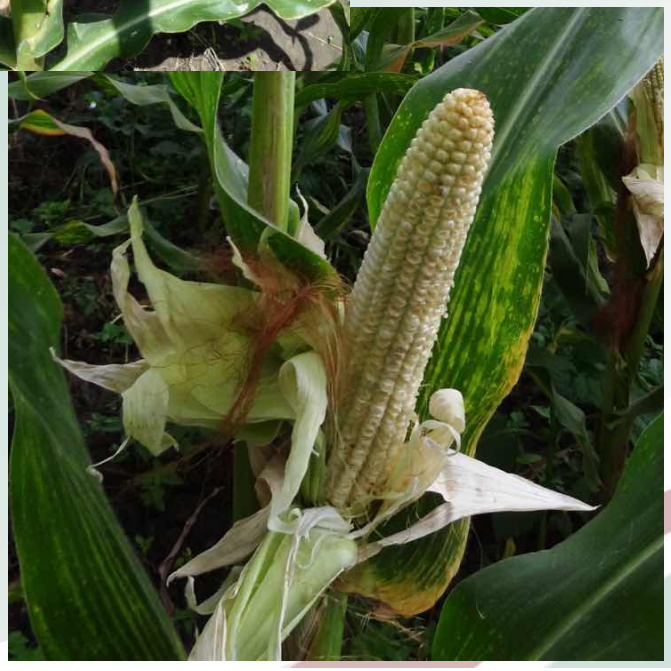


Farmer's field: Kenya

Farmer's field: Kenya

Farmer's field: Tanzania

MLN Disease



Seed production: 100% loss
Because the male inbred line parent died

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Maize Lethal Necrosis (MLN)

Symptoms: Severe mottling of leaves, dead heart, stunted growth (shortened internode distance), leaf necrosis and barren ears.

Poor seed set and shrivelled ears

Shortened Internodes

Early leaf necrosis

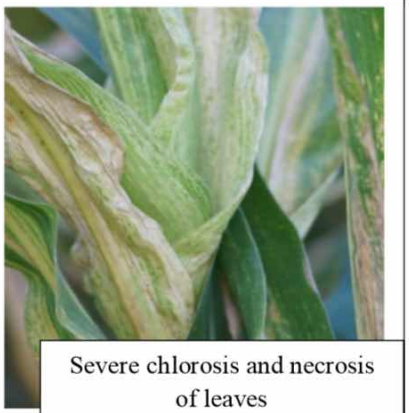
MLN Symptoms

- Mottling symptoms on leaves, usually starting from base of young leaves in the whorl and extending outwards
- Stunting and shortened internodes
- Dead heart and necrosis
- Sterility, poor seed set, shrivelled seeds

Severe Chlorosis on new leaves

Severe chlorotic mottle on the leaves

Necrosis of leaf margins



Severe chlorosis and necrosis of leaves

Dead Heart symptoms

Water soaked lesions Dead heart

Symptoms on flowering parts and ears

Tassel blasting and sterility (No pollen produced)

- Premature drying of cobs, and mosaic symptoms on ear husks
- Poorly filled cobs or no grain filling

No pollen production

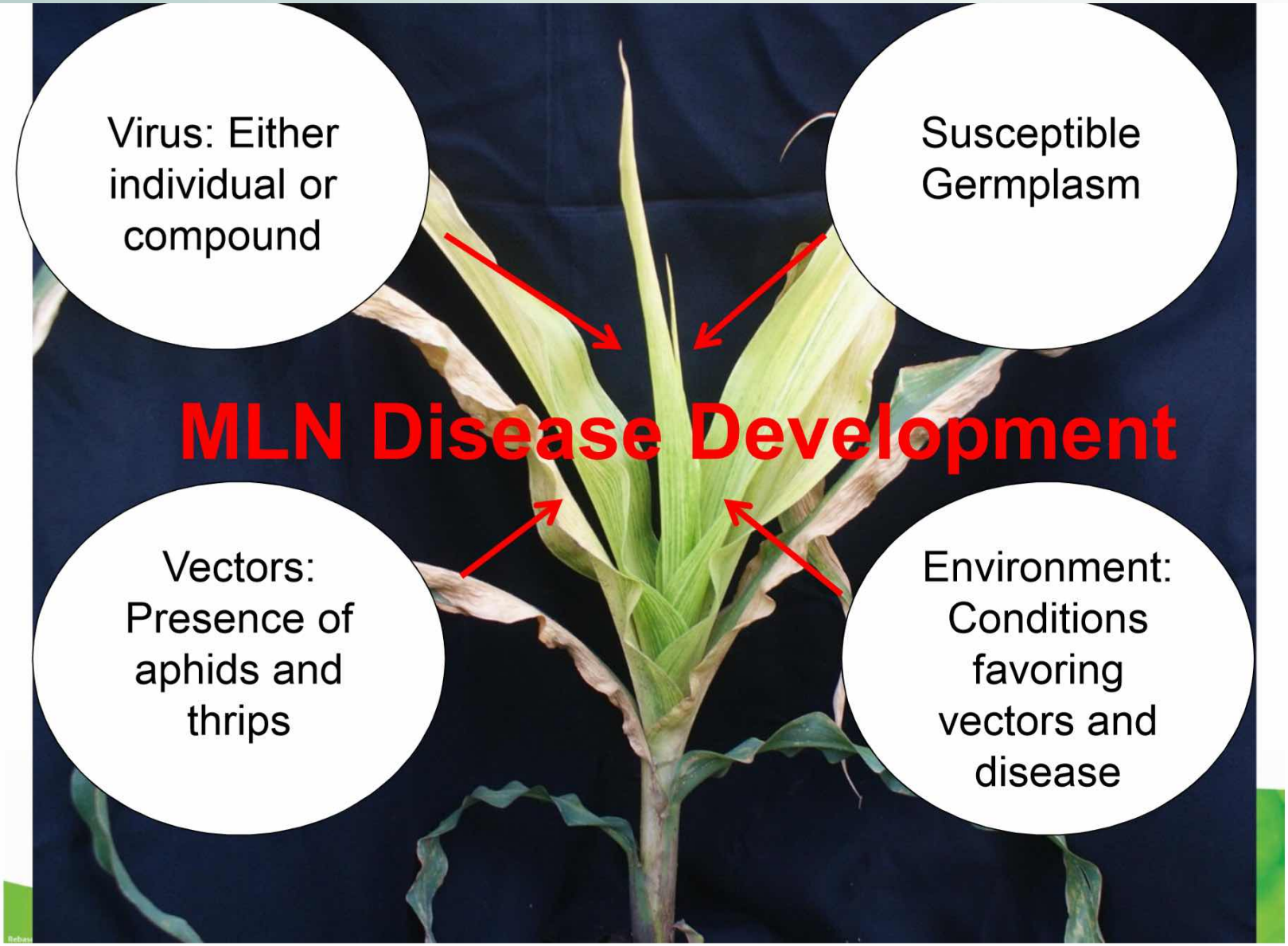
Premature drying of cobs

Premature drying of cobs

No grain filling

Poorly filled cob

Poorly filled cob


Virus: Either individual or compound
Susceptible Germplasm
MLN Disease Development
Vectors: Presence of aphids and thrips
Environment: Conditions favoring vectors and disease

What is Maize Lethal Necrosis (MLN)?

MCMV + **Potyvirus** = **MLN**

SCMV

MDMV

WSMV

→

Individual infection with each virus can also cause disease

Typically, infection with one virus results in milder symptoms than MLN but reaction depends on germplasm and viral strain

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MCMV + **SCMV**
MDMV
WSMV
MMV
= **MLN**




- **Individual infection with each virus can also cause disease**
- Typically, infection with one virus results in milder symptoms than MLN but reaction depends on germplasm and viral strain.

What is Maize Lethal Necrosis

MCMV + **Potyvirus**
SCMV
MDMV
WSMV
= **MLN**

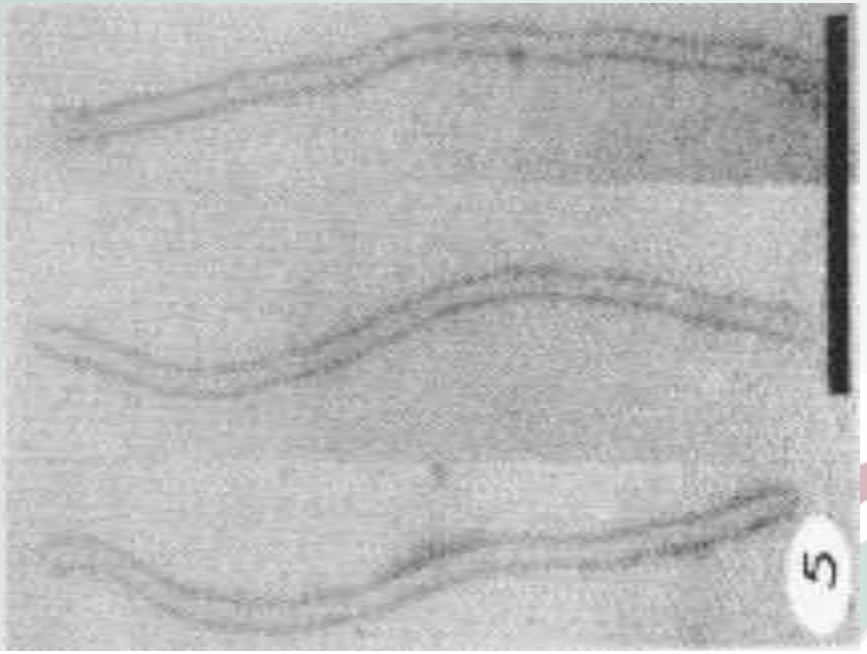



- **Individual infection with each virus can also cause disease**
- Typically, infection with one virus results in milder symptoms than MLN but reaction depends on germplasm and viral strain.

MLN Viruses

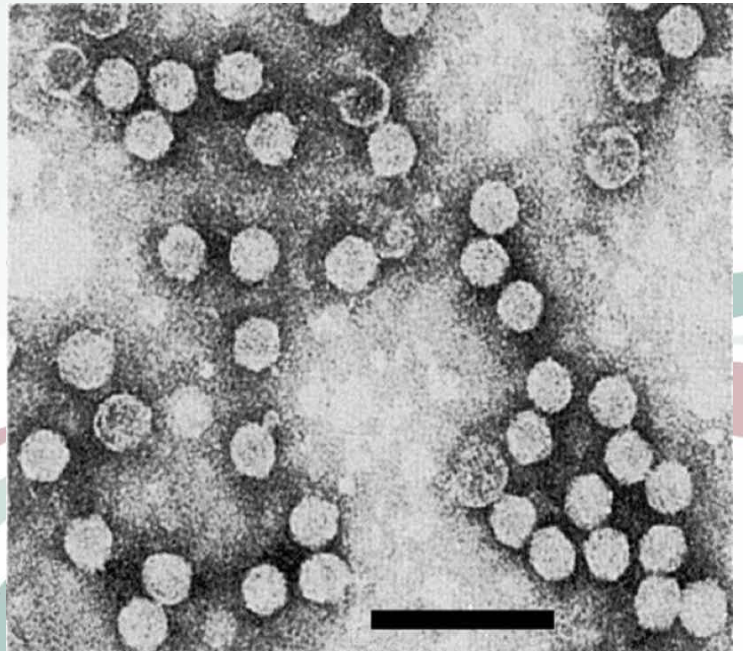
Sugarcane mosaic virus (SCMV)

Family: Potyviridae
Genus: *Potyvirus*
Species: *Sugarcane mosaic virus*
Acronym: SCMV



Maize chlorotic mottle virus(MCMV)

Family: Tombusviridae
Genus: *Machlomovirus*
Species: *Maize chlorotic mottle virus*
Acronym: MCMV



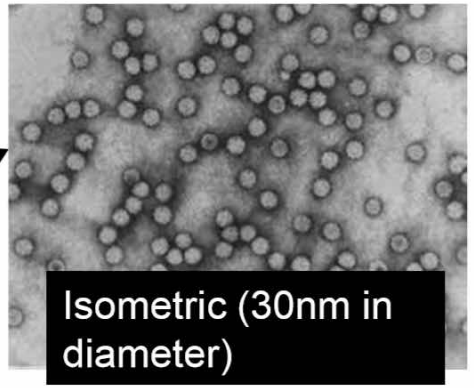
What is MLN?

Viral Disease of Maize caused by double infection of:

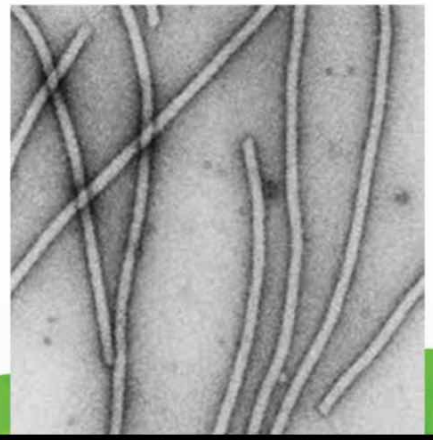
- **Maize chlorotic mottle virus (MCMV)**, Tombusviridae family
- Cereal virus in Potyviridae family:
  - **Sugarcane Mosaic Virus (SCMV)**
  - Maize Dwarf Mosaic Virus (MDMV)
  - Wheat Streak Mosaic Virus (WSMV)

Prior to 1989 (Shukla et al., 1989), MDMV was considered to be a strain of SCMV and the two names were used interchangeably.

- Maize Mosaic Virus (MMV), Rhabdovirus family. Causes corn stunt and is spread by leafhoppers.



Isometric (30nm in diameter)



Filamentous (700nm long, 15nm in diameter)

MCMV Symptoms

- Dependent on time germplasm, environment, stage of infection.
- Chlorotic specking resulting in longitudinal streaks that coalesce resulting in chlorotic mottling and then leaf necrosis.
- Plant stunting, tassel abnormality, small ears with poor seed set.

Symptoms in artificially inoculated maize plants in screen house

MLN Development

Virus:
Either individual or compound

Vectors:
Presence of aphids, thrips, other insects

Susceptible Germplasm

Environment:
Conditions favouring vectors and disease

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How is MLN Spread

Seed transmission rates: very low

- MCMV = 17/42 000 plants (0.04%)
- MDMV = 21/72 897 plants (0.03%)

Insects

- Corn thrips (*Frankliniella williamsi*)
- Corn flea beetle (*Chaetocnema pulicaria*)
- Southern corn rootworm (*Diabrotica undecimpunctata*)
- Northern corn rootworm (*D. lonicornis*)
- Western corn rootworm (*D. virgifera*)
- Flea beetle (*Systena frontalis*)
- Cereal leaf beetle (*Oulema melanopa*

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Global Occurrence of MCMV / MLN

Country	MCMV/MLN	YEAR
Peru	MLN	1973
USA	CLN	1976
Argentina	CLN	1982
Mexico	MCMV/MLN	1987
Thailand	MCMV	1983
Brazil	MCMV	1983
China	MLN	2011
Kenya	MLN	2011
Tanzania	MLN	2012
Uganda	MLN	2012
Rwanda	MCMV	2014
DRC	MCMV	2014
Ethiopia	MLN	2014
South Sudan	MLN	2014

Facts about MLN

- MLN is a viral disease
- MLN is caused by 2 viruses
- MLN is transmitted by insect vectors
- Seed transmission of MLN is possible
- Mechanically transmitted
- Can be transmitted through infested soil (maize residue)
- MLN transmission vectors can be aided by wind

1 = no MLN symptoms
2 = fine chlorotic streaks on lower leaves
3 = chlorotic mottling throughout plant
4 = excessive chlorotic mottling and dead heart
5 = complete plant necrosis

CIMMYT

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Some NPT hybrids, Naivasha 2014

No complete resistance, but there is difference in degree of tolerance

MMYT

What is ARC doing about MLN

1. More than 1000 ARC lines screened → all susceptible to MLN

- MLN screening facility established through KALRO-CIMMYT partnership for the benefit of Kenya and sub-Saharan Africa

ARC MAIZE HYBRIDS SCREENED FOR RESISTANCE TO MLN AT NAIVASHA, KENYA

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What is ARC doing about MLN …..

2. **Resistance breeding**

- Developing resistant DH lines in collaboration with CIMMYT under WEMA project
- CIMMYT converting 20 elite ARC lines using 10 sources of resistance/tolerance
- ARC x CIMMYT followed by DH line development and then screening for MLN tolerance → all work done in Kenya to avoid bringing disease to RSA; DH resistant lines will then be passed on to ARC via quarantine
- Sources of resistance identified by CIMMYT
- Marker development now at advanced stage

What is ARC doing about MLN …..

3. ARC-GCI to conduct **survey of maize viruses and vectors** along RSA-Mozambique and RSA-Zimbabwe border areas (US$44 300 obtained from AATF, under WEMA), in collaboration with researchers in Mozambique and Tanzania

MLN: Conclusions

- MLN is a new devastating maize disease that threatens food security in Africa
- Concerted efforts among stakeholders and countries are needed to effectively control MLN in Africa
- Awareness creation / capacity building / information dissemination among stakeholders is crucial to limiting spread of MLN

- NB: Currently no seed received from CIMMYT-Kenya

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MONSANTO MAIZE HYBRIDS SCREENED FOR RESISTANCE TO MLN AT NAIVASHA, KENYA

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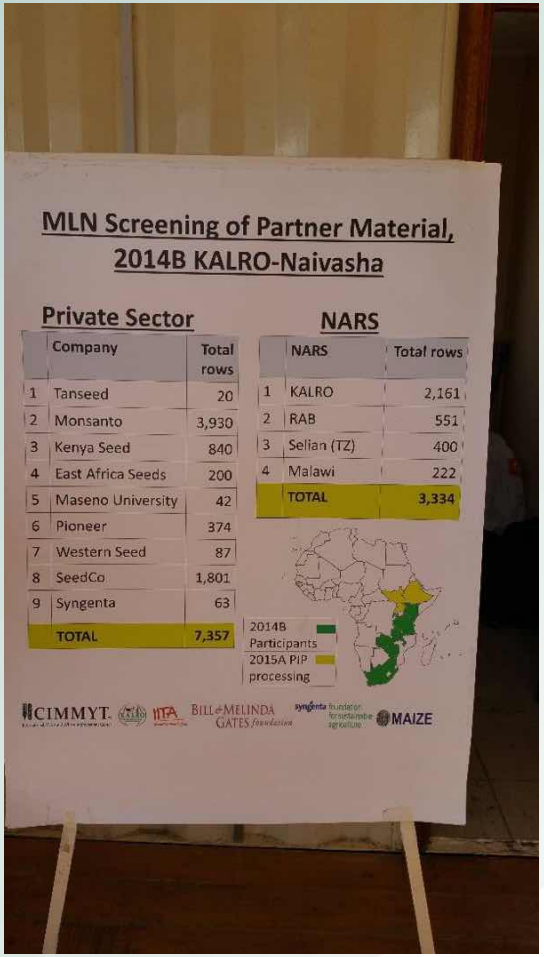


MLN Screening of Partner Material, 2014B KALRO-Naivasha

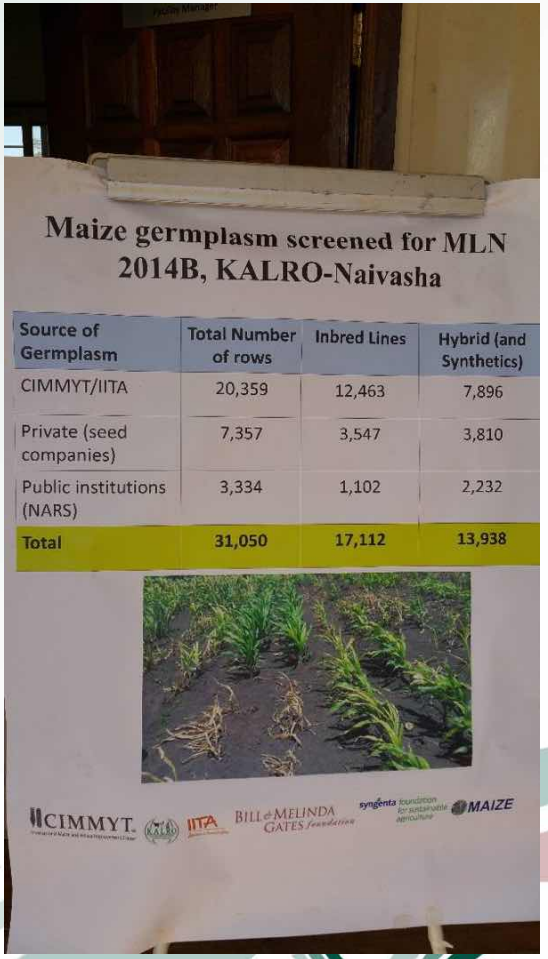
Private Sector

	Company	Total rows
1	Tanseed	20
2	Monsanto	3,930
3	Kenya Seed	840
4	East Africa Seeds	200
5	Maseno University	42
6	Pioneer	374
7	Western Seed	87
8	SeedCo	1,801
9	Syngenta	63
	TOTAL	7,357

NARS

	NARS	Total rows
1	KALRO	2,161
2	RAB	551
3	Selian (TZ)	400
4	Malawi	222
	TOTAL	3,334

CIMMYT. KALRO IITA BILL & MELINDA GATES foundation syngenta foundation for sustainable agriculture MAIZE



Maize germplasm screened for MLN 2014B, KALRO-Naivasha

Source of Germplasm	Total Number of rows	Inbred Lines	Hybrid (and Synthetics)
CIMMYT/IITA	20,359	12,463	7,896
Private (seed companies)	7,357	3,547	3,810
Public institutions (NARS)	3,334	1,102	2,232
Total	**31,050**	**17,112**	**13,938**

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