

# Maize Lethal Necrosis (MLN): A Technical Manual for Disease Management



**Editor**  
**B.M. Prasanna**



In collaboration with international and national research  
and development partners

## Chapter 8

# MLN Pathogen-free Commercial Seed Production: Standard Operating Procedures

Lilian Gichuru<sup>1\*</sup>, Samuel Angwenyi<sup>2</sup>, Francis Mwatuni<sup>1,3</sup>,  
L.M. Suresh<sup>4</sup>, and B.M. Prasanna<sup>4</sup>

## 1. Need for MLN/MCMV-free Commercial Seed Production and Deployment

The preceding chapters have shown the extent to which viruses that cause MLN can be transmitted through contaminated maize seeds, thereby contributing to the spread of MLN disease within and across countries. Formal and informal seed movement locally and across borders plays a significant role in the spread of transboundary diseases like MLN. Therefore, diagnostic tests for MLN viruses at various stages during seed production and before shipment of seeds is crucial.

Quality seed production leading to regulator's approval as certified seed is key for effective management of MCMV/MLN. Even if a 0.01% infection in a seed field of about 55,000 plants per hectare is missed, this would mean about 5-6 infected plants, which then become sources for further transmission by insect-vectors. If this infected seed production field is harvested, and the seeds find their way to the farmers' fields, in the presence of vectors like thrips and aphids, not only the entire field but also the village itself will be at the risk of devastation by MLN (especially when the farmers plant MLN-susceptible varieties). Therefore, MLN threshold levels in commercial maize seed production fields during field inspections should be close to zero ( $\leq 1\%$  infection) from the perspective of infected plants. Fields with higher infection levels should NOT be certified for sale of seed to the farmers. At the seed level, the stringency level should be even higher: zero tolerance for any contaminated seed.

Seed producers/growers, therefore, need to maintain high levels of quality crop management during commercial maize seed production, beginning from field practices to processing. This also calls for the importance of harmonization of seed laws across borders, riding on regional platforms such as EAC, COMESA, SADC, etc. to ensure that the threshold/tolerance levels for MLN in seed fields are the same for ensuring free movement of seed without the risks of MLN spread.

During the early years of MLN outbreak in eastern Africa, most of the local/regional seed companies in the MLN-prevalent countries lacked necessary knowledge of the disease and its transmission, as well as protocols to produce MLN pathogen-free clean seed. Recognizing this critical gap, the African Agricultural Technology Foundation (AATF), the Alliance for a Green Revolution in Africa (AGRA) and CIMMYT, under the USAID-funded MLN Diagnostics and Management Project (2015-2019), worked intensively to: (i) support the commercial seed sector in Kenya, Uganda, Tanzania, Rwanda and Ethiopia in the production of MCMV/MLN-free seed throughout the breeder-foundation-certified seed value chain, and (ii) promote the use of certified clean seeds by farmers in respective countries.

## 2. A Harmonized MLN-free Commercial Seed Production Checklist

To ensure MCMV/MLN-free commercial seed production and access to the certified seeds by end users, there was a need of developing country-specific harmonized checklists for MLN control and management (**Annex 1**). We, therefore, focused on the development of harmonized MLN management checklists, with proven standard operating procedures (SOPs) for production of MCMV/MLN-free commercial maize seed by the seed sector in MLN-prevalent countries. The SOPs were adapted from the protocols successfully used by major maize seed companies in the USA which produce large quantities of maize seed in MCMV-prevalent areas, especially Hawaii. These protocols were appropriately refined and customized to suit respective eastern Africa countries', including targeted agro-ecologies, existing seed laws, governance and local agricultural pest management practices. The SOPs are expected to guide breeders and seed producers/growers for production and exchange of MCMV/MLN-free seed.

---

\*Corresponding author ([LGichuru@agra.org](mailto:LGichuru@agra.org))

<sup>1</sup>Alliance for Green Revolution in Africa (AGRA), West End Towers, Muthangari Drive, Nairobi, Kenya;

<sup>2</sup>African Agricultural Technology Foundation (AATF), ILRI Campus, Kilimani Old, Naivasha Rd, Nairobi, Kenya;

<sup>3</sup>Formerly at CIMMYT, Nairobi, Kenya; Presently at AGRA, West End Towers, Muthangari Drive, Nairobi, Kenya;

<sup>4</sup>CIMMYT, ICRAF Campus, UN Avenue, Gigiri, Nairobi, Kenya.

Representatives of key seed stakeholders in respective countries in MLN-prevalent countries in eastern Africa were systematically involved in the formulation of the SOPs. The stakeholders included representatives of seed companies, contract seed producers/growers, breeders, plant pathologists, national seed trade associations, NPPOs and the Ministry of Agriculture comprising Crop Protection, Inspectorate and Plant Health departments. Discussions revolved around assessing the practicability of the SOPs with a view of identifying key practices that were adoptable according to the country seed laws and common practices, how best to popularize the SOPs, and how to mitigate possible challenges that could arise during the implementation of the SOPs. After these consultative meetings, official communiques were prepared as agreed by the participants. Harmonised checklist with SOPs (Annex 1) along with an ODK-based survey questionnaire (Annex 2) were formulated and used in five MLN-affected countries (Ethiopia, Kenya, Rwanda, Tanzania and Uganda).

### **3. Fostering Adoption of Harmonized Checklist and SOPs for MLN-free Commercial Seed Production**

A major strategy that was used to foster adoption of the SOPs was the involvement of key seed stakeholders in respective countries during the development stage. This instilled ownership of the document by the stakeholders especially seed companies and contract growers, and hence quick adoption and use. Buy-in of the National Plant Protection Organizations (NPPOs) in respective countries was also key to include MLN tolerance thresholds in seed certification procedures. Other strategies for the adoption and use of SOPs are listed below.

#### **3.1. Training of Seed Companies and their Contract Growers on SOPs**

A total of 574 participants from NPPOs and NARS institutions, 544 participants from commercial seed companies, and 2313 small-scale contract seed growers in eastern Africa were trained during 2016-2019 on the SOPs for MLN-free seed production. The course content included on-farm MLN diagnostics, disease scouting, leaf and seed sampling, and testing using immunostrips and ELISA.

Most seed companies conduct their seed production using contract growers. It was therefore important to conduct training of not only seed companies but also their contract growers to assist them in understanding and agreeing on the contents of the harmonized checklists for proper implementation. Special focus was given to practices which required hands-on attention; stakeholders were therefore taken to the maize fields for trainings. Some of these trainings included MLN symptoms identification, field scouting and detection using rapid diagnostic kits among others. Rapid MLN diagnostic kits (MCMV immunostrips) were procured and distributed in small quantities as trial kits to the seed companies following individual trainings on their use to facilitate internal quality assurance and early detection of MLN. Seed companies were also encouraged to make private procurement of the kits for their continued MLN surveillance programs.

#### **3.2. Data Collection Tools**

Constant follow-up missions with seed companies and their contract growers are key to ascertain the status of MLN in seed production fields, level of adoption and use of the SOPs, and further gauge the effectiveness of the SOPs to seed production. These follow-ups aid in identifying challenges towards adoption and use of the SOPs as well as for devising mitigative actions to ease the use of these SOPs.

Hence, detailed data collection tools were developed and encrypted into the Open Data Kit (ODK) tool (ODK) for real-time monitoring and data collection. From the analysed data, most effective practices as perceived by stakeholders were: a) observing cropping and disease history before planting; b) timely planting (at the onset of rains); c) crop rotation with legume/non-cereal crops; and d) having maize-free windows (2-3 months) in a year. The most challenging practices, on the other hand, were: a) cleaning vehicles and farm equipment before and after use; b) soil testing (sited as expensive); and c) ensuring that the source of basic seed is MLN-free.

#### **3.3. Engagement with Farming Communities**

The expected output from the MLN-free commercial seed production initiative is to ensure the end-users i.e., farmers have access to clean MLN-free seed for their planting. Farmer education on MLN management practices is important to prevent MLN viruses' re-infection in farmer fields despite having obtained clean seeds. This is also important because informal seed systems are highly prevalent in SSA, even in a crop like maize (McGuire and Sperling, 2016), including includes farmer-saved seeds. Farmer field schools and trainings were held on MLN management practices, with particular emphasis on obtaining and using clean seed, besides

adoption of MLN-tolerant varieties. Where MLN-tolerant varieties were available, small seed packs of these varieties were distributed in farmer forums in partnership with seed companies to achieve rapid adoption through farmer-led demos.

Farmer sensitization was further conducted by the development and dissemination of relevant Information, Education and Communication materials (IECs) on MLN Management (**Annex 3**). The IEC materials were also translated to Swahili (**Annex 4**) and Amharic (**Annex 5**) for better comprehension by stakeholders, including farmers and maize seed growers. Farmer engagements also included visits to extract first-hand testimonies from the farmers on awareness of MLN disease presence, ability to identify MLN symptoms, routine on-farm agronomic management practices, seed sources, etc.

#### **4. Feedback on Relevance, Efficacy and Practicability of the Harmonized SOPs towards MLN-free Commercial Seed Production**

- Some seed growers had a challenge differentiating MLN symptoms from symptoms of nutrient deficiency and moisture stress. This caused a delay in rogueing suspected plants at the early stages of crop growth.
- There were some challenges with the use of MCMV immunostrip kits as they required to be stored under refrigeration for long term use; this limited the use of the kits by some stakeholders who did not have refrigeration facilities.
- SOPs recommend testing of harvested maize seed samples. This was not practiced by many small seed companies (except in Kenya) as the requirement is not enforced and there are no facilities available for its implementation in some countries.
- Adherence to different practices differed; for instance, most seed companies observed timely planting (95%) and management of weeds in seed fields, scouting, rogueing, and destroying of infected plants (90%); while practices such as establishing field history based on last MLN disease records (35%) were less implemented. Some SOPs were not much practiced, such as ensuring healthy seed from the source, seed dressing with systemic insecticides specific for MLN-transmitting vectors, and MLN testing of the harvested seed (with a few exemptions).

#### **5. Summary of Steps towards MLN/MCMV-free Commercial Seed Production and Lessons Learnt**

- A questionnaire for data collection was developed (**Annex 2**), especially targeting seed company personnel and breeders.
- The data collection tool was customized to the ODK app.
- In-country consultants were engaged to individually visit seed companies and/or contract growers to collect information related to MLN disease incidence, severity, production site history, scouting and vector management as well as adoption and use of the MLN management SOPs. The consultants were identified on the basis of understanding the MLN terrain and geographical locations of the seed companies and were engaged in the consultative meetings.
- The field officers were instrumental in identifying the MLN-affected regions in each country, identifying the seed companies/contract growers/breeders etc. operating in each of the targeted countries, and in determining the capacity gaps.
- Rapid diagnostic kits (MCMV immunostrips) were piloted and promoted with selected seed companies and NARS institutions for MLN field testing in order to strengthen internal quality control systems for MLN management. This activity was augmented by on-site training and distribution of 50 MCMV immunostrip testing kits to each of targeted beneficiary institutions.

#### **6. Conclusions**

While detection of MLN-causing viruses on contaminated seed may not necessarily lead to transmission of the disease to the next generation, from the phytosanitary perspective, it is important to evaluate the presence of MCMV and SCMV in commercial seed lots, especially those meant for exportation to countries where MLN/MCMV is not reported. In practice, keeping a commercial seed production field completely free from the MLN-causing viruses in areas where the disease is widely prevalent requires significant efforts and resources,

but is important for protecting the food security, income, and livelihoods of the resource-poor smallholder farmers (Prasanna et al., 2020). More than 30 seed companies are presently implementing the MLN-free seed production checklist on a voluntary basis in Kenya, Uganda, Rwanda, Tanzania and Ethiopia, and there is scope to further scaling up this to ensure that MLN does not spread to other countries in Africa through commercial seed trade.

## 7. References

McGuire S, Sperling L (2016) Seed systems smallholder farmers use. *Food Security* 8: 179–195. <https://doi.org/10.1007/s12571-015-0528-8>

Prasanna BM, Suresh LM, Mwatuni F, Beyene Y, Makumbi D, Gowda M, Olsen M, Hodson D, Worku M, Mezzalama M, Molnar T, Dhugga K, Wangai A, Gichuru L, Angwenyi S, Alemayehu Y, Grønbech-Hansen J, Lassen P (2020) Maize lethal necrosis (MLN): Containing the spread and impact of a devastating transboundary disease in sub-Saharan Africa. *Virus Research* 282: 197943. <https://doi.org/10.1016/j.virusres.2020.197943>

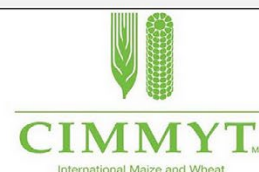
## Annex 1. Harmonized MLN Management Checklist & SOPs (Kenya, as an example).



HARMONIZED MLN MANAGEMENT CHECKLIST & SOPs (KENYA)					
No.	TASK	START DATE	DUE DATE	% COMPLETE	NOTES
1.	Monitor crop disease history of seed production fields to enable adequate control plans				
2.	Maintain adequate levels of soil fertility based on soil tests to ensure healthy crops				
3.	Timely planting to facilitate disease escape and eliminate disease incidence due to late planted crop				
4.	Use of disease free seed stocks in subsequent seed production				
5.	Clean farming equipment to remove contaminated soil debris and minimize spread of disease from one field to another				
6.	Eliminate grasses and other weeds from fields and plot borders to remove vector hosting plants				
7.	Monitor and control insect vector population through tested spraying regimes				
8.	Scout for viral symptoms to ensure early detection and control				
9.	Rogue symptomatic plants and burn/bury to minimize spread of disease				
10.	Sample suspect plants for diagnostic testing within the internal quality control to confirm disease presence				
11.	Post-harvest cob selection and seed testing for MLN causing viruses				
12.	Seed treatment using systemic insecticides to ensure early control of the disease				
13.	Crop rotations with non-cereal crops for 1- 3 seasons depending on disease history				
14.	Closed maize season where appropriate				

Name: ..... Position: .....

Organization: ..... Signature: .....



Ethiopia: [Harmonized MLN Management Checklist & SOPs](#)  
Tanzania: [Harmonized MLN Management Checklist & SOPs](#)  
Uganda & Rwanda: [Harmonized MLN Management Checklist & SOPs](#)

## Annex 2. ODK Survey Questionnaire for Recording MLN Status, Creating Awareness, and Ascertaining Uptake of MLN Management SOPs and Use of Rapid Diagnostic Kit

1. Name and Location of the Seed Company/ Breeder:

Name of respondent:

Country:

2. Have you experienced MLN infection in your production/ breeding fields? (Y/N) *(For those who answer NO here please let them proceed with Q5 to Q7 for those who answer YES they go on with 3 and 4 then proceed from 8)*

3. If [Yes], when was the last time you experienced the MLN pandemic?

Season (Short/Long)	Year

4. Do you have exposure to MLN SOP? (Y/N)

List of SOPs for verification

5. If Q2 is [No], what are your thoughts with regards to the relevance of SOPs in management of MLN *(Alex here please least at SOPs against a relevant and irrelevant checklist)*

6. Which of these SOPs have been included in your quality management system as seed producers? *(Here list all the SOPs against Y/N)*

7. From your knowledge could you pick the top 4 most effective sops in the control of MLN? *(Alex, only allow for 4 responses here for all the SOPs listed)*

8. If Q4 is [Yes], where was your source of SOP?

AATF/AGRA

Self-generated

Ministry of Agriculture

Other source? Specify

9. How severe was the disease (Scale of 1-5)?

\*1 – Not Severe; \*5 – Extremely Severe

10. Did you experience any yield loss caused by the disease? (Y/N)

11. How severe was the yield reduction? (100%, 50%, 30%, 20%, 10%, <10%)

12. Specify the location of the disease (country, County, region, district, location/village)

13. Did the disease cause abandonment of any breeding, testing or seed production sites? [Yes/No]; If [Yes], where \_\_\_\_\_?

14. If Q10 is [Yes], how was the infected material destroyed? [1=Burning, 2=Burying,3=Fed to livestock, 4=used as grain]

15. Do you have any management practice for the disease? (Y/N)

If [Yes]: List them *(Tick against SOPs documented at number 4).*

16. What are your top 4 most effective MLN Management practices?

If [No] in Q15: Why?

17. How often do you monitor your seed production field for MLN symptoms and vectors? *The frequency should be per season (Short and Long seasons)*

18. Have you in the past sampled any suspected MLN plants in your fields for diagnosis? (Y/N)

19. If [Yes], what technique was used to confirm samples for MLN viruses? (PCR, Rapid kits, LAMP, sent to external Lab, I do not know)

20. If Q19 is [sent to external lab] please give the name of the lab?.....
21. Have you used the MLN Rapid Diagnostic Kits? (Y/N)  
If [No] in Q21: Provide a reason:
22. Do you routinely use MLN Rapid Diagnostic Kits? (Y/N)  
If [Yes] in Q20 what is the frequency? (*Number of times per season*)
23. Provide a reason for this rate of frequency:
24. How would you rate efficiency of the RPD kits? (Not effective, Effective, Very effective)  
(Explain)
25. Have you attended a training on MLN diagnostic Kits (Y/N)?  
If [Yes], when and where?  
How many times in the last 5 years?
26. Number of Kits provided by AGRA/AATF
27. How long has your company participated in seed production and commercialization?
28. How long has your company been involved in MLN disease management?
29. Approximately how much is spent on chemicals for controlling MLN insect vector population?
30. What is the total area of land that you use for maize seed production? (in ha)
31. Out of this area what proportion has been affected by MLN disease? (in %)
32. Are your neighbor fields (farmers' fields) infected by MLN disease (Y/N)?  
If [Yes], what measures are used by farmers in controlling it?
33. Do you import any seeds (Y/N)?
34. If q.33 is Yes, where do you import the seeds (maize) from?
35. If q.33 is Yes, what measure do you put in place to ensure you import disease free seed?

# Annex 3. MLN Disease Management in Farmers' Fields.

## IEC Materials - Fliers

### 12 steps for control of MLN disease in farmers' fields

#### What is MLN disease?

- Maize Lethal Necrosis (MLN) disease is a viral disease that affects maize
- MLN disease is caused by the co-infection of Maize Chlorotic Mottle Virus (MCMV) and any of the following viruses: Sugarcane Mosaic Virus (SCMV), Maize Dwarf Mosaic Virus (MDMV) and Wheat streak mosaic virus (WSMV).
- In Africa, the disease was first reported in Kenya in September 2011, and later in Tanzania, Uganda, Rwanda, Democratic Republic of Congo, South Sudan and Ethiopia by 2014.
- MLN disease is a major challenge in maize production and is considered a threat to food security in Africa because it causes yield losses of up to 100 per cent.

#### Symptoms of MLN disease and Transmission Modes

##### MLN disease symptoms include:

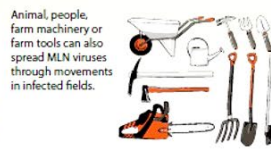
- Severe damage of leaves**  
Severely infected corn leaves may wilt, curl and show yellow patches of discoloration. Scientists refer to this as severe chlorosis and leaf necrosis.
- Sterility of tassels - no pollen production.**
- Poor or no grain filling on cobs.**
- Premature drying of husks**
- Short internodes** (part of a plant where leaves emerge)
- Dead heart symptoms** - withering and drying of central shoot.

##### How is MLN disease transmitted?

Insects can host and transmit MLN virus (Insect Vectors). Some of these insects include thrips, aphids, leaf beetles and rootworms.



MLN disease is also seed-borne (i.e. seed produced from an infected plant may carry the virus).



Animal, people, farm machinery or farm tools can also spread MLN viruses through movements in infected fields.

### How can farmers prevent spread of MLN disease? Farmers can avoid the transmission by following 12-steps

- Find out the cropping or disease history of the field before planting. Practice crop rotation where necessary.
- Make sure the soil in the farm is fertile at all times. This ensures crops are healthy thus can fight disease infections.
- Use certified seed that is free of MLN disease.
- Avoid using grains as seed.
- Clean farm equipment or tools using disinfectants before and after use to eliminate MLN virus contamination.
- Plant early at the onset of rains.
- Maintain a clean farm by removing grasses, weeds and other alternative hosts from fields.
- Monitor the hold every week for presence of insect vector population. A high insect vector population increases chances of attack.
- Remember chemical control of insect vectors can be done using recommended insecticides (Once every 1-2 weeks).
- Try to search weekly for MLN viral symptoms for early detection and control of insect vector.
- Uproot MLN symptomatic plants and destroy them through burning and burying outside the farm to reduce spread of disease. Do not feed infected plants to livestock - animals such as cattle grazing in MLN infected plants can transmit the viruses from infected MLN plots to healthy maize fields.
- Practice crop rotation for at least one season by growing non-cereal crops preferably legumes (beans, soya and peas). Avoid continuous cropping of maize ensuring a closed maize season of at least 2 months where possible.



Alliance for a Green Revolution in Africa (AGRA)  
P.O. Box 66773 Westlands 00800, Nairobi, Kenya  
Phone: +254(0)20 3875 000 | +254 703 033 690

International Maize and Wheat Improvement Center (CIMMYT)  
Dr. Suresh, L.M. | Maize Pathology Lead - sub-Saharan Africa  
Email: l.m.suresh@cgiar.org

African Agricultural Technology Foundation (AATF)  
P.O. Box 30709 - 00100, Nairobi, Kenya  
Phone: +254(0)20-4223790

## Annex 4. MLN Disease Management in Maize Fields (in Swahili)



### Hatua 12 za kuzingatia ili kupata mbegu bora ya mahindi isiyokuwa na Ugonjwa wa Mnyauko (Maize Lethal Necrosis-MLN)

#### Ugonjwa wa Mnyauko (Maize Lethal Necrosis-MLN) ni nini?

Ni Ugonjwa wa mahindi unaosababishwa na virusi. Ugonjwa huu husababishwa na muunganiko wa virusi vya aina mbili: Virusi vya Mabaka na Madoo ya Mahindi-Maize Chlorotic

Mottle Virus (MCMV) na mojawapo kati ya virusi viuatavyo: Virusi vya Batobato ya Miwa-Sugarcane Mosaic Virus (SCMV), Virusi Vidumaza vya Batobato ya Mahindi-Maize Dwarf Mosaic

Virus (MDMV) na Virusi Michirizi vya Batobato ya Ngano-Wheat Streak Mosaic Virus (WSMV)

	<p><b>1</b> Pata historia ya shamba pamoja na ugonjwa katika shamba la kuzalisha mbegu kabla ya kupanda</p>		<p><b>2</b> Hakikisha udongo una rutuba ya kutosha ili kuweza kupata mimea iliyo bora. Inashaurwa kupima rutuba ya udongo kila baada ya kipindi kisichozidi miaka mitatu ili kuweza kutambua aina ya mbolea itakayotumika</p>		<p><b>3</b> Tumia mbegu iliyothibitishwa kutokua na virusi vya ugonjwa wa Mnyauko katika kuzalisha mbegu.</p>
	<p><b>4</b> Safisha zana za kilimo kabla na baada ya kulima ili kuondoa uchafu unaoweza kuwa na virusi vya ugonjwa</p>		<p><b>5</b> Panda mvua zinapozna kunyeshwa ili kuepukana na ugonjwa</p>		<p><b>6</b> Kagua shamba kila wakati ili kuweza kutambua kama kuna dalili za ugonjwa. Ondoa nyasi, magugu na takataka zingine shambani zinazoweza kuhifadhi au kuficha virusi vya ugonjwa wa Mnyauko</p>
	<p><b>7</b> Thibiti wadudu wanaoenea virusi vinavyosababisha Ugonjwa wa Mnyauko kwa kupuliza viuatilifu kwa kutuata utaratibu unaokubalika.</p>		<p><b>8</b> Chunguza dalili za ugonjwa shambani, ng'oa, choma au tukia mimea yote itakayoonekana kuwa na dalili za ugonjwa nje ya shamba.</p>		<p><b>9</b> Chukua sampuli za mimea itakayohisiwa kuwa na virusi, chunguza sampuli hizo kwenye baabara (au kwa kutumia kifaa maalum) ili kuthibitisha kama mimea hiyo ina ugonjwa.</p>
	<p><b>10</b> Baada ya kuvuna chagua magunzi pamoja na punje zenye ugonjwa, viteketeze kwa kuvichoma moto.</p>		<p><b>11</b> Pulizia mbegu viuatilifu vinavyoshauriwa ili kuweza kuepukana na Ugonjwa wa Mnyauko</p>		<p><b>12</b> Tumia kilimo cha mzunguko wa mazao (kwa kupanda mimea aina ya mikundekunde) angalau kila baada ya msimu mmoja</p>

#### Dalili za Ugonjwa wa Mnyauko wa Mahindi

- Madoadoa machache au mengi kwenye jani ambayo huanzia chini ya shina la jani changa na kusambaa kuelekea kwenye ncha yake.
- Majani machanga hukauka kabla ya mmea kuchanua, hali hiyo husababisha dalili inayoitwa 'kifo cha moyo', halimaye kifo cha mmea mzima.
- Jani hukauka kuanzia kwenye kingo zake na kusambaa kuelekea katikali, halimaye jani lote.
- Mmea hudumaa na kukomaa kabla ya wakati wake.
- Wakati mwingine mimea huwa tasa (hakuna utengenezaji wa chumvua).
- Gunzi huwa na mbegu chache zilizohafu au kutokuwa na mbegu kabisa.
- Maganda ya mhindi hukauka kabla hayajakomaa wakati sehemu zingine za mmea zikiwa bado ni mbichi (zikiwa na rangi ya kijani).
- Gunzi huozwa
- Mashambulizi ya kuvu wenye rangi ya kijivu kwenye magunzi yaliyoza hujitokeza kama maambukizi nyemelezi



#### Namna Ugonjwa wa Mnyauko unavyoeneza

Ugonjwa wa Mnyauko hueneza kwa njia zifuatazo:

- Wadudu wa aina mbalimbali, wakiwemo: Vidukari na Vithiripi-hula kwa kufyonza utomvu wa mahindi; minyoo ya mizizi; panzi na mbawa kavu-hushambulia majani.

- Wanyama wa aina mbalimbali, binadamu pamoja na zana za kilimo-katika kuzihamisha kutoka shamba moja hadi jingine (kunaweza kukawa na shamba lenye ugonjwa)
- Huenezwa pia na mbegu ila ni kwa kiasi kidogo



The Alliance for a Green Revolution in Africa (AGRA)  
S.L.P. 66773, Westlands 00800  
Nairobi, Kenya  
Simu: +254 (20)3675 000  
+254 703 033 000  
Tovuti: www.agra.org



International Maize and Wheat Improvement Centre (CIMMYT)  
Barua pepe: l.m.suresh@cigiar.org  
Simu: +254 702 392 664  
Tovuti: cimmyt.org



African Agricultural Technology Foundation (AATF)  
S.L.P. 30709-00100, Nairobi, Kenya  
Simu: +254 (0) 20-4223700  
Barua pepe: aatf@aatf-africa.org  
Tovuti: www.aatf-africa.org



Tanzania Agriculture Research Institute (TARI) Ukiiriguru  
S.L.P. 1433, Mwanza, Tanzania  
Simu: +255(28)2983 104, +255 735 983104  
Barua pepe: cduriguru@tari.go.tz  
Tovuti: www.tari.go.tz

# Annex 5. MLN Disease Management in Maize Fields (in Amharic).

## የኤም ኤል ኤን በሽታን በአርሶ አደሩ ማሳ ላይ ለመቆጣጠር እንዲቻል የሚወስዱ አስራ ሁለቱ እርምጃዎች

### ኤም ኤል ኤን በሽታ ምንድን ነው?

- ኤም ኤል ኤን በሽታ በቆሎን የሚያጠቃ የቫይረስ በሽታ ነው።
- የኤም ኤል ኤን በሽታ መንስኤ የሚሽ ከሎራቲክ ሞታል ቫይረስ ከሌላ ቫይረስ ለምሳሌ ቸ-ገርኬን ሞይድክ ቫይረስ፣ ሚዝ ዲዋርፍ ሞይድክ ቫይረስ፣ ወይንም ከዋት ስትሪክ ሞይድክ ቫይረስ በራራ የሚከሰት በሽታ ነው።
- በአፍሪካ በሽታው ለመጀመሪያ ጊዜ ረፖርት የተደረገው በመስከረም 2011 በኬኔያ ሲሆን ከዚያም በታ-ገዢያ፣ ኡጋንዳ፣ ቀንጭ፣ ትንጌን ዲሞክራቲክ ሪፐብሊክ፣ በደቡብ ሱዳን እና በኢትዮጵያ በ2014 ተከሰቷል።
- የኤም ኤል ኤን በሽታ ለበቆሎ ለመራራት ከፍተኛ ተግዳሮት ያለውና ሙቅ ፕሮሰንት የምርት ብክነትን ስለሚያስተል ለምሳሌ ተፈጻሚ የሚገባ ማስተካከያ ስጦታ ነው።

### የኤም ኤል ኤን በሽታ ምልክቶች እና የመተላለፊያ መንገዶች

#### የኤም ኤል ኤን በሽታ ምልክቶች:

ቅጠሎች በከፍተኛ ሁኔታ መግባት በሽታው የተጠቀሱ ቅጠሎች የኩራሲ ወይንም ኒኮሲስ ሊኖራቸው ይችላሉ

መሳገነት ወይንም የለበሰ ዳቀት አለማመራት

በጣም አና ወይንም ምንም የበቆሎ ፍሬ አለመገኘት

የበቆሎው ልቦስ ያለጊዜ መድረት

ግንዳ(ካጠል የሚወጣበት የተሰኘ ክፍል) ጣኩር ገ ደንክ መሆን

የበቆሎ ፍሬ የመግባት ምልክት (የኒኮሲስ ቅጠሎች፣ ማዕከላዊ ክፍል መመዘኛ መድረት)

#### የኤም ኤል ኤን በሽታ እንዴት ይዘመታ?

ክፍለ-ቅጠሎች (ቅጠሎች ክፍለ-ቅጠሎች) የኤም ኤል ኤን በሽታ ለሌሎች ለሌሎች ይተላለፋሉ። ከአካላዊ መግባታዎች (ትራንስ-ፊደራሽን) እና የቫይረስ ትራንስ-ፊደራሽን ይተላለፋሉ።

ቅርጽ

አፈሪስ

የኤም ኤል ኤን በሽታ ዘር ወላጅም ሊሆን ይችላል (ጣሳትም ከተሰጠ ተከል የተገኘ ዘር በቅጠሎች ላይ ይገኛል።)

ለነገሱት ሰዎች፣ የአርሶ መሳሪያ ማሽኖች፣ ቆሳቆች ከተከለ የአርሶ መራራት ወይንም በአገልግሎት ወጣት ለሌሎች እና የበቆሎ ምንም ሊሆን ይችላሉ።



## የኤም ኤል ኤን በሽታ እንዳይሰራጭ አርሶ አደሮች እንዴት መከላከል ይችላሉ?

አርሶ አደሮች የሚከተሉትን አስራ ሁለት እርምጃዎች በመከተል የበሽታውን ስርጭት ማስቀረት ይችላሉ

1. መራራት የሚከፈሉት በሬት የመራራትን የህክትራራ እና የበሽታ ታሪክ ማጥፋት። አጠቃላይ ሆኖ ከተገኘ ለፈራሽ መራራት።
2. የአርሶ መራራት ላይ ያለው አርሶ ሁለም ለም መሆን ማረጋገጥ። ይህም ለዘርቆት ጠናግን እንዲሆንና የበሽታን እንዲቆሙ ይረዳል።
3. የአርሶ ማረጋገጫ የተሰጠበት ዘር ማጥፋት። ዘርም በተደጋጋሚ አለመጠቀም።
4. አሰለገ እንደ ዘር አለመጠቀም።
5. ማንኛውንም የአርሶ መራራት ከተጠቀሙ በኋላ በጣም የጭንቅ የበሽታው ለምት የአርሶ መራራት ያስቀድሙ።
6. ግንብ መጠቀም ለአርሶ መራራት ተገቢ መሆኑን ማረጋገጥ።
7. ሳር እም ለቫይረስ እንዲሆም ለበሽታ አስተላለፊ ሃይት መደብረት ሊሆን የሚችሉ ለሰላሳት በሌላው በግንብዎቹ የሚከሰት ጭንቅ መጠቀም።

8. የበሽታ ለተሳሳሪ ሃይት በምጣሌ መስጠት ለማድረግ ለሰላሳት ለሰላሳት መስጠት በበሽታው የሚከሰት ለይደልን በኩራት ሁኔታ ይወጡ።

9. የሚጠቀሙ የተለይ ማረጋገጫን በመጠቀም የበሽታ ለምት ሃይትን በኤም ኤል ኤን በሽታ ለማስቀጠር እንዲሆን ያስቀድሙ (በሰላሳት ወይንም በሁለት ሰዎች እንደ ይጠቀሙ)

10. የኤም ኤል ኤን በሽታ ምልክቶችን መጠቀሙ ጭንቅ ሁኔታውን ተገንዝቶ ለማስቀጠል ለማድረግ ይረዳል።

11. የኤም ኤል ኤን በሽታውን የተጠቀሱት የቅጠሎችን ጭንቅ በቆሎ ላይ ወይንም በሌላው ላይ ወይንም ማስቀጠል የበሽታው ስርጭት ለመቀነስ ይረዳል። የኤም ኤል ኤን በሽታውን የተጠቀሱት ሰዎች ለአርሶ መራራት እንዲሆን እንዲጠቀሙ ማረጋገጥ።

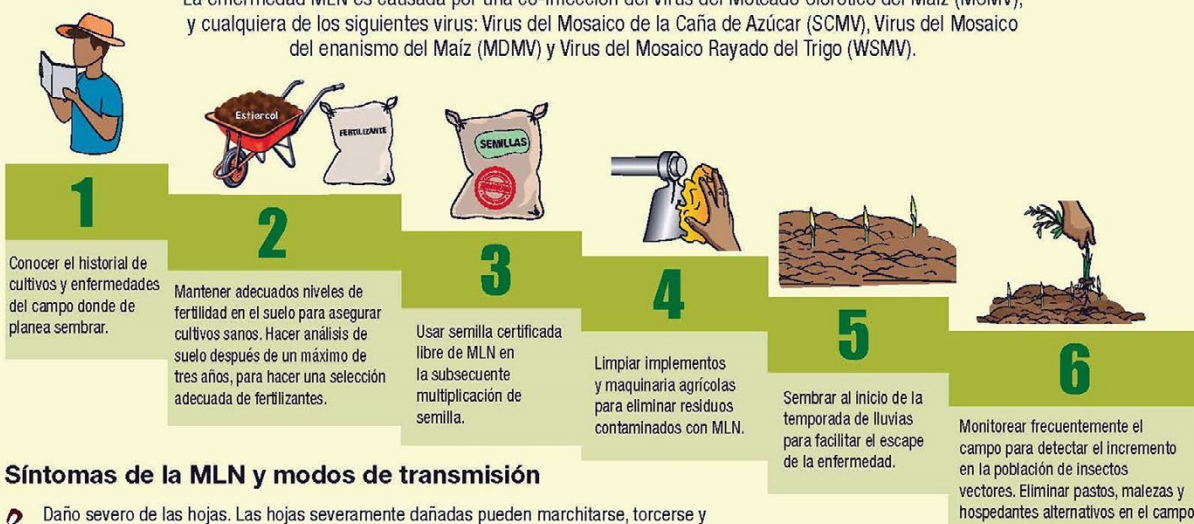
የጥራ ጥራ ሰላሳትን (የቆሎ ላይ አጥር) በማስቀጠል የሚከፈሉትን መራራት፣ የአርሶ መራራትን ለማስቀጠል አሰላሳትን ያስጠቀሙ (ይሁንም ሁለት ወይንም የሚቆዩበትን የአርሶ ሁኔታ ማስቀጠል።)

## Annex 6. Twelve Steps for MLN-free Seed Production (in Spanish).

### Doce pasos para tener semilla libre de MLN

**La Necrosis Letal del Maíz o MLN** (por sus siglas en inglés, Maize Lethal Necrosis) es una enfermedad viral que afecta al maíz.

La enfermedad MLN es causada por una co-infección del Virus del Moteado Clorótico del Maíz (MCMV), y cualquiera de los siguientes virus: Virus del Mosaico de la Caña de Azúcar (SCMV), Virus del Mosaico del enanismo del Maíz (MDMV) y Virus del Mosaico Rayado del Trigo (WSMV).



#### Síntomas de la MLN y modos de transmisión

- Daño severo de las hojas. Las hojas severamente dañadas pueden marchitarse, torcerse y presentar manchas amarillas y un secado prematuro. Los científicos se refieren a esto como clorosis severa y necrosis foliar.
- Espigas estériles. No hay producción de polen.
- Pobre llenado de grano, o no desarrollo de grano en las mazorcas.
- Secado prematuro de las hojas que cubren las mazorcas.
- Entrenudos cortos (los nudos son donde crecen las hojas).
- Síntomas de corazón muerto (marchitez y secado del brote central o cogollo).



#### ¿Cómo se transmite la MLN?

- Los insectos son vectores y transmiten el virus de la MLN; estos vectores incluyen trips, áfidos, escarabajos foliares y gusanos de la raíz.
- La MLN también es transmitida a través de la semilla, es decir, la semilla producida en una planta enferma puede llevar el virus.
- La gente, los animales, la maquinaria e implementos agrícolas, también pueden acarrear el virus a través del movimiento en los campos infectados.