
Undamaged maize plant


Stem borer damaged maize plant

POLICY BRIEF

IMPROVED FOOD SECURITY THROUGH STEM BORER PEST RESISTANT MAIZE HYBRIDS

Policy Issues

- The average yield of hybrid maize in Kenya is low at 1.5t/ha (7 bags/acre) compared to the global average of about 5t/ha (22 bags/acre); huge yield difference.
- Stem borers cause about 13.5% maize losses annually which translate to 400,000 tonnes.
- Recommended cultural and chemical control methods have not been effective.
- Farmers have opportunities to choose from various varieties but are not aware of the varieties that have high levels of resistance to the stem borers.
- Stem borer resistant hybrid maize seeds are effective in controlling the pest and can easily be sourced by farmers.
- The correct choice of hybrid maize to plant will lead to less losses the pest, higher yields, thus improved food security.

Policy Recommendations

- Create awareness on the maize stem borer resistant hybrids
- Promote adoption of maize hybrids that are resistant to stem borers for improved yields and enhanced food security.
- Support and encourage the development of maize hybrids that are resistant to stem borer pests.

How do Maize Stem Borer Pests Affect Grain Yield?

Maize stem borers affect plant growth and specifically cob development in the following ways:

- The adult moth lays its eggs on young maize leaves and once hatched the stem borer larva feeds on young leaves, producing holes.
- As the maize plant continues to grow, the larva feeds and bores into the heart of the plant, and consequently into the stem pith where it feeds and transforms into a worm.
- The worm finds its way into young milky cobs and continues to destroy the grains.

The spotted stem borer destructive larva

Maize stem borer cob damage

Why Reduce Stem Borer Losses in Maize?

Food insecurity remains a major challenge in Kenya and is escalated by rising agricultural input prices, changing seasons due to negative climate change effects, pests and diseases attacks among other constraints. Kenya's per capita maize consumption is estimated at 103 kg/person/year and one of the top five in Africa.

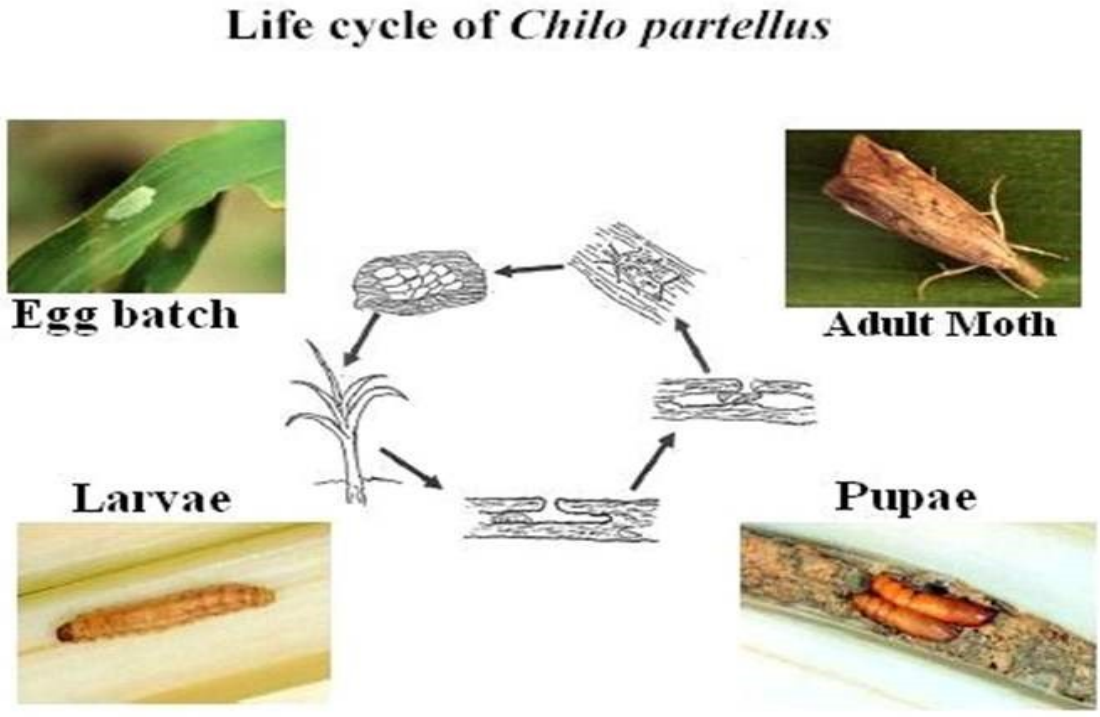
An analysis of yield gains between 1980 and 2013 indicated that Kenya's average yield has shown a slight decline of about 1kg/ha/year [1], thus in spite of its huge importance for food security and economic wellbeing of the country, the productivity and production have not shown significant improvements over the years. In Kenya, maize is grown in 1.6 million hectares mainly by smallholders who are 75% of maize producers.

It strongly contributes to the country's economy and national food security with 68% of daily per capita cereal consumption, 35% of total dietary energy consumption, and 32% of total protein consumption [2]. Food insecurity and poverty affect 43 and 46% of Kenya's population, respectively. Small scale producers mainly grow the crop for subsistence, retaining up to 58% of their total output for household consumption [3].

In spite of these major roles played by maize as an inevitable crop, stem borers are detrimental pests estimated to be responsible for annual yield losses of about 13.5% in Kenya, which translate to 400,000 tonnes, an equivalent figure to the normal yearly amount the country imports [4]. These insect pests essentially 'steal' from farmers' fields, reduce their profits and make it harder for households to put enough food on their table.

Among the major stem borer types in Kenya, the spotted stem borer is the most widespread and most damaging field pest second only to the recently introduced fall army worm (FAW) pest. Control through the recommended methods has been challenging, not efficient, and so far not successful. Use of pesticides has also not been effective partly due to prohibitive costs and because during its destructive stage, the destructive larvae are well hidden within the maize stem and, therefore, not reachable by regular recommended chemical control measures [5, 6].

Partly due to these limitations, maize yields remain low especially in smallholder farms which are responsible for about 75 % of the country's production [7, 1]. Such smallholder's farms suffer severe losses from maize production due to their low input usage including none or very limited stem borer pest control initiatives.



The life cycle of spotted stem borer (*Chilo partellus*)

Pest damages and losses are more severe on weak poorly managed crops which are unfortunately a common scenario in most poor rural farm holdings.

Further, these rural poor populations are normally the very first and most highly affected by lack of food whenever yields are poor and maize shortages occur since maize forms a major part of the daily dietary intake in most families.

Any threat, therefore, to maize production endangers the lives of majority of Kenyans and derails the achievement of one of the government's big four agenda of achieving food security for all.

The reduction of stem borer damage and losses could improve maize yields, increase farmers' on-farm income, and strengthen Kenya's food security, thus reducing regular famines, malnutrition and saving on the foreign exchange used on maize imports regularly [4, 7, 1].

Why Host Plant Resistance in Managing Stem Borer Pests is Crucial

Host plant resistance which is 'packaged' in a seed represents the most suitable pest management solution and is beneficial to the farmer as it can easily be adopted.

It eliminates the environmental risks associated with pesticides, is compatible with all other pest control methods, is economically feasible and confers many other advantages.

Because stem borer host plant resistance has been proven to work, Kenyan farmers can reap multiple benefits by opting to use resistant varieties to reduce maize yield losses, increase productivity and thus improve livelihoods [5, 6].

Tolerance is an integral part of host plant resistance since it indicates the increased ability of a plant to survive or recover from a pest damage leading to none or minimal grain yield penalty.

The knowledge on the available maize hybrids carrying appreciable levels of resistance to the stem borer pest will assist farmers in wisely choosing the varieties of maize seeds to plant for better yields amidst the stem borer pest.

This will consequently impact positively on the socio-economic status of Kenyan rural poor and their food security.

(a)

(b)

Maize leaf damage:
(a) A resistant variety; undamaged leaves two weeks after pest infestation
(b) A susceptible variety; damaged leaves two weeks after pest infestation

(a) **(b)**

Stem damage at harvest showing split maize stems:
(a) Susceptible variety
(b) Resistant variety

The actual stem borer damage levels and yield losses in maize depend on the choice of variety planted since each has its own inherent protective potential against the stem borer pest. This has been scientifically proven as adequate to manage damage effects to appreciable levels [5].

In the current research, Kenyan commercial hybrids were sourced from local seed retailers and tested for host plant resistance to the spotted stem borer, and several highly resistant or tolerant varieties were identified and documented for most maize production zones [8].

Challenges to Stem Borer Control

A major challenge to effective control of maize stem borer pest is the high cost of chemical pesticides for the majority resource-poor smallholder farmers. Further, the recommended cultural control methods are not always effective, with most requiring the farmers to have specialized skills and added labor costs in order to apply them effectively.

For effective control, the insecticides must be applied with precision and timeliness which usually doesn't happen and is extremely hard to achieve. This leaves many farmers wasting money attempting to control an already well established and hidden insect which by this time is already inside the stems destroying essential vessels that channel food to the developing maize cob.

Farmers only come to terms with its enormous damage on encountering the aftermath of its losses on cob grains. Since host plant resistance innovation comes packaged within a hybrid seed, it bears no extra cost, thus it is highly economical and does not need any added management skills from the farmer [9].

Commercial Maize Hybrids Resistant to Spotted Stem Borer Pest in Kenya

Eighty five commercial Kenyan maize varieties were tested against newly released and confirmed insect resistant varieties under artificial insect infestation. Top most superior commercial hybrids established to be highly resistant to the pest were; DHO1, PH1, DHO2, PH4, PH3253, DK8053 and WH403 (Table 1).

These hybrids are ecologically recommended for production in low to dry moist transitional zones and showed lowest damage levels under pest infestation. In this group, the lowest yielding was DH02 at 3.12 t/ha (14 bags/acre) under heavily infested conditions, and it yielded 3.56 t/ha (16 bags/acre) under no infestation, and thus only a two bags/acre difference in yield.

These two bags/acre difference was quite low and insignificant, which demonstrated that such a hybrid can give reasonably normal yields even under the pest's infestation. The rest of the varieties were higher yielding than DH02 and showed much lower and insignificant yield penalties under the pest's infestation.

This group of hybrids is recommended for low to dry mid transition zones which are also areas with greatest threat to yield loss owing to the ecological preference by the spotted stem borer pest. Maize hybrids recommended for the mid to high altitude zones that showed high resistance levels included H629, H6210, H628, H6213, H626, 611D, and 531A.

Among this group, H629 gave the highest yield under both infestation at 9.44 t/ha (42 bags/acre) and protected conditions at 10.03 t/ha(46 bag/acre). This group of varieties is suited for adopting in the moist transitional to high altitude zones where they are well adapted.

It was noted that majority of the highly resistant hybrids were mostly those adapted to the low altitudes zones i.e. PH1 and PH4; dry to mid-altitude and transitional ecological zones including DH01, DH02, PH3253, WH403 and DKC8053.

Stem borer yield losses are highest in these areas [4], thus adoption of these varieties should be highly encouraged. Due to overlaps within production zones, several varieties can be produced across zones thus farmers have a wide group of good varieties to choose from depending on individual preferences.

A healthy maize crop

Conclusion

Yield in the commercial varieties in Kenya could be enhanced through farmers being made aware of the availability of locally available resistant maize varieties. The good news was that resistant hybrids to the spotted stem borer were identified for all agro-ecological zones among commercial varieties screened.

Farmers should, therefore, be encouraged to be intentional in choosing to plant stem borer resistant maize hybrids available in the market. Promoting the use of such maize will contribute to increased grain yield and lead to improved food security and household incomes.

Table 1 List of some commercially available maize hybrids with high resistance levels to the spotted stem borer pest

	Hybrid Name	Suitable Ecological Zones
	Resistant Hybrids	
1	DH01	Dry-altitude
2	PH1	Lowland tropics
3	PH3253	Dry mid to dry transitional
4	DH02	Dry-mid altitude
5	PH4	Lowland to dry-mid altitude
6	DKC8053	Dry to moist transitional
7	WH403	Dry to moist transitional
8	H6210	Highlands
9	H629	Highlands
10	H628	Highlands
11	H6213	Highlands
12	H626	Highlands
13	611D	Highlands
14	531A	Dry to moist transitional

Acknowledgement

Preparation of this policy brief was supported by the AgriFose2030 program and the International Livestock Research Institute (ILRI) with financial support from the Swedish International Development Agency (SIDA). Actual field research was supported by CIMMYT-Kenya, IRMA III Project. I thank Eunice Githae for technical input in the brief preparation.

References

1. Food Security (2015) 7:965-981; DOI 10.1007/s12571-015-0488-z. DT Maize; A Quarterly Bulletin of the Drought Tolerant Maize for Africa Project. Vol. 4 No. 3.

2. Schroeder C., K'Oloo T. O., Ranabhat N. B., Jick N. A., Parzies H. K. and Gemenet D.C. 2013. Potentials of hybrid maize varieties for small-holder farmers in Kenya: A review based on Swot analysis. African Journal of Food, Agriculture, Nutrition and Development 13(2).

3. Kenya National Bureau of Statistics. 2014. Economic Survey, 2014; Production of maize ('000' MT) in Kenya (1972 - 2008) Data source: Republic of Kenya. Economic Surveys (various issues). Nairobi: Government Printer.

4. De Groote, H. 2002. 'Maize yield losses from stem borers in Kenya.' Insect Science and its Application 22: 89–96.

5. Mugo, S., De Groote, H., Bergvinson, D., Mulaa,. M., Songa, J. and Gichuki, S. 2005. Developing Bt maize for resource-poor farmers - Recent advances in the IRMA project. African Journal of Biotechnology 4:1490-1504.

6. M'mboyi F., Mugo S., Mwimali M. and Ambani L. 2010. Maize production and improvement in sub-Saharan Africa. African Biotechnology Stakeholders Forum (ABSF), Nairobi, Kenya.

7. Mugo S. N. 2014. Leveraging Agriculture for Food and Nutrition Security: Maize Technology Development, Dissemination and Production in SSA and Kenya. Agriculture for Food and Nutrition Security Session of Enhancing Innovation for Sustainable Dev. in the 21st Century, an Int. Conf. at Chuka University, 29-31 Oct. 2014.

8. Munyiri S.W. and Mugo S.N. 2014. Resistance to spotted stem borer in commercial maize hybrids and open pollinated varieties in Kenya. Agricultural Innovations for Sustainable Development: Contributions from the 3rd Africa-Wide Women and Young Professionals in Science Competitions. Agricultural Innovations for Sustainable Development. CTA and FARA; Vol 4 Issue 3.

9. Mugo, S., Tefera, T. and Beyene Y. Stem Borer Pest Resistant Maize: An Update from Africa. 2012. Presented to the SI 4 Stress tolerant maize for the poorest (Session M1 – Group 1) During the Global Launch of the MAIZE and WHEAT CGIAR Research Programs, Mexico City, 16-20 Jan 2012.

CONTACT ADDRESS:
Shelmith Munyiri, Chuka University
Email: smunyiri@chuka.ac.ke
munyirishelmith@gmail.com

CHUKA UNIVERSITY

AgriFoSe2030
Agriculture for Food Security 2030
- Translating science into policy and practice

SLU · Lund University · SEI · University of Gothenburg

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE