HarvestPlus
Better Crops • Better Nutrition

Crop Product Profile

Zinc Maize Guatemala

01. Executive Summary

According to the FAO, the Guatemalan population has presented an undernourishment prevalence of 15.4% between 2017 and 2019, this means that a total of 2.7 million people were affected by this problem. These data estimate that by 2030, this problem could be close to 15.2%, showing a total of 2.92 million people affected by it, which is a positive scenario within this problem.

Biofortified zinc maize crops are grown in Guatemala with the support of the HarvestPlus Office, which puts its all into working with staple food crops such as iron beans and zinc maize. This maize is used to prepare typical consumer products. This represents a progress on nourishment since women and children from the region have shown high deficiency levels of vitamins and minerals.

Guatemalan maize represents more than 864 thousand harvested hectares, with a production of 1.8 million tonnes a year, reaching a national yield of 2.1 t/ha a year.

02. Popular hybrids and varieties in Guatemala

Line	Type	Developed by	Year of release	Main characteristics	Yield (ton/ha)
ICTA HB-18ACP+Zn (Fortaleza F3)*	Hybrid	CIMMYT, ICTA & Semilla Nueva	2018	Higher adaptability across diferent regions, high levels of Zinc content (31 ppm)	13
ICTA B-15ACP+Zn*	OPV	CIMMYT & ICTA	2018	Higher adaptability across diferent regions, high levels of Zinc content (30 ppm)	11
Cerato	Hybrid	Syngenta Guatemala	2019	White, good yield potential, medium Maturing, tolerance to foliar diseases, semi-dente, excellent texture for milling and fresh consumption.	9
Tiburón	Hybrid	Syngenta Guatemala	2018	White, Higher adaptability across diferent tropical regions, tolerance to foliar diseases, intermidieta maturiting	15
Sorento	Hybrid	Syngenta Guatemala	2015	higher plant vigor, good cob and seed size	7,8
ICTA B-7	OPV	ICA	2017	Drougth and lodging tolerant	7,35
DK-390	Hybrid	BAYER	2020	White, good yield potential, tolerance to foliar and cob diseases excellent texture for milling and fresh consumption.	N/A
DK-410	Hybrid	BAYER	2020	White, good yield potential, tolerance to foliar and cob diseases excellent texture for milling and fresh consumption.	N/A

Yield values correspond to the average of the sites where the line is commercialized.
***Green materials were developed and release funded by HarvestPlus**

03.
Productive regions:

Figure 1

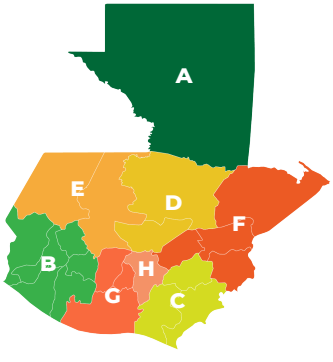

Figure 1
Traditional maize production across the country

Region of the country	Percentage of contribution to total crop production
Petén Region (A)	21%
South West Region (B)	20%
South East Region (C)	16%
North Region (D)	13%
North West Region (E)	10%
North East Region (F)	10%
Central Region (G)	9%
Metropolitan Region (H)	2%

Figure 1: Maize production in Guatemala across different regions.
MAGA estimates, based on the IV National Agricultural Census from Banco de Guatemala –BANGUAT (2018)

04.
Preferred planting and harvesting seasons for the crop in the country

Semester A

Sowing season:
April-May

Harvesting season:
August-September

Semester B

Sowing season:
August-September

Harvesting season:
December-January

Top agronomic traits for biofortified maize in Guatemala

Early maturity

Relevance for adoption on farmers and producers

Reduction in the number of days to harvest will represent a greater income in a shorter period compared to other materials with late maturity and permits better chances to sell the production with a better price. Early maturity will let varieties enter the market when prices are still high and increase crop profitability.

Trait indicators commonly used for crop improvement:

Days to anthesis (Phenotypic)
Days to maturity (Phenotypic)
Heading seeding interval (Phenotypic)

Drought tolerance

Relevance for adoption on farmers and producers

Drought-tolerant varieties will develop acceptable grain yield even under stress conditions. This characteristic will allow incomes based on the commercialization of the production achieved in challenging environments.

Trait indicators commonly used for crop improvement:

Segregating populations under drought environment to evaluate:
a) Nutrient acquisition/Uptake efficiency (Analytic)
b) Water use efficiency Photosynthesis (Analytic)
c) Radiation use efficiency (Analytic)
d) Deep Root development (Phenotypic)
e) Grain number maintenance (Phenotypic)
f) Grain fill duration and rate. (Phenotypic)

Tolerance to low soil nitrogen (N)

Relevance for adoption on farmers and producers

Low soil nitrogen (N) tolerant varieties will develop acceptable grain yield even under deficient N soils. This characteristic will allow incomes based in the commercialization of the production achieved in nutrient deficient soils.

Trait indicators commonly used for crop improvement:

Segregating populations under deficient N soils to evaluate:
a) No. kernels/ear (Phenotypic)
b) Dry matter yield of stems and roots (Phenotypic)
c) Grain yield (Phenotypic)
d) N-uptake efficiency (Analytic)
e) Utilization efficiency of N (Analytic)

Top agronomic traits for biofortified maize in Guatemala

Grey leaf spot (GLS)

Relevance for adoption on farmers and producers

GLS tolerant varieties will be capable of surviving in the sustained presence of the weed. This characteristic will allow an acceptable grain production under the infestated weed.

Trait indicators commonly used for crop improvement:

Selection pressure in segregating populations under infestation of Cercospora zeae-maydis

Ear and Stalk rot

Relevance for adoption on farmers and producers

Ear and stalk tolerant varieties will be capable of surviving even with the sustained presence of the disease lowering the risk of molds in grains which may develop production of toxic aflatoxins.

Trait indicators commonly used for crop improvement:

Selection pressure in segregating populations under infestation of Fusarium sp, Diplodia sp, Penicilum sp, and Aspergilus sp to evaluate tolerance and resistance to the disease.

Top agronomic traits for biofortified maize in Guatemala

Maize streak virus tolerance (MSV)

Relevance for adoption on farmers and producers

MSV tolerant varieties will be capable of surviving the productive cycle even with the sustained presence of the disease. This characteristic will allow an acceptable production of the crop. In general, virus diseases are capable of severely affect any crop. Tolerance to this type of issues are mandatory.

Trait indicators commonly used for crop improvement:

Selection pressure in segregating populations under infestation of green leafhoppers (C. mbila Naudé and C. storeyi.) feed with infested plants with the virus MSC in controlled environments to evaluate tolerance and resistance to the disease.

Army worm tolerance (Spodoptera frugiperda)

Relevance for adoption on farmers and producers

Pest management with different products is recommended to control this type of issue. However army worm tolerant varieties will be capable of surviving the completely productive cycle even with the sustained presence of the insect. This characteristic makes the plants less attractive for the insect feeding and helps to prevent a consequent death of the plant.

Trait indicators commonly used for crop improvement:

Selection pressure in segregating populations under infestation of Spodoptera frugiperda in controlled environments to evaluate tolerance and resistance to the disease

Top post harvest and marketing traits for biofortified maize in Guatemala

Kernel length/ Kernel shape

Relevance for adoption on farmers and producers

The flour industry for bread and snacks requires medium to small sized maize, which hydrates more easily than the large ones; favoring the performance of the products made with flour. However, larger seeds are often preferred for fresh consumption of cob.

Dent corn is often used as livestock feed, industrial products, or processed food preparations. Flint corn is used for similar purposes as dent corn, however has hard outer shell, which make it more attractive for millers and retailers. Popcorn, a type of flint corn, has a soft starchy center surrounded by a very hard exterior shell.

Trait indicators commonly used for crop improvement:

The physical appearance of the kernels defines its price in the market, which is define by length and shape. Variations in size and shape are mainly genetic.
Kernel length - Phenotypic
Weight of 100 seeds (Phenotypic):<33gr = Small
33-38gr= Medium
>38 gr= Large
Kernel shape (Phenotypic)
Visual Rank (Phenotypic)
Flint(Phenotypic)
SemiFlint (Phenotypic)
Semi dent (Phenotypic)
Dent (Phenotypic))

Hardness of the Kernel

Relevance for adoption on farmers and producers

Determines the capacity of the grain to absorb and retain water during the different stages of the cooking process. For boiled consumption, usually soft or very soft grains are required. The dry milling industry requires hard or very hard kernels, to obtain good milling performance. The popcorn industry requires hard kernels. The flour industry prefers intermediate and soft grains, which is related to adequate cooking time of kernels at the time of making flour.

Trait indicators commonly used for crop improvement:

Flotation index of Kernels in sodium nitrate or sugar solution (Analytic):

Ranks: Very hard (0-12 FG), Hard (13-37 FG), Intermediate (38-62 FG), Soft (63 - 87 FG) and very soft (88-100 FG)

Hectolitic weight in 1 liter of H2O (Analytic):
Hard (>75 kg), Intermediate (74-75 kg), soft (<74 kg)

Color of the Kernel

Relevance for adoption on farmers and producers

The consumer's first approach to raw materials and processed foods based upon maize is because of its color, since it relates to acceptance or rejection. For maize, the most appreciate colors in the country are white which is related to flour industry which is associated with fresh consumption, animal feed and some minor cases of flour industry.

Trait indicators commonly used for crop improvement:

Scale using the Minolta colorimeter (Lxaxb) or Smartphon app Techkon Color Catcher™ (Analytic)

L: Low intensity (black colors> Values closer to zero), High Intensity (White colors > Values closer to 100).
a: Negative values, green color (Low intensity closer to 0, high intensity closer to -100), Positive values, red color (Low intensity closer to 0, high intensity closer to 100).
b: Negative values, blue color (Low intensity closer to 0, high intensity closer to -100), Positive values, yellow colors (Low intensity closer to 0, high intensity closer to 100).

Top post harvest and marketing traits for biofortified maize in Guatemala

Milling performance ratio

Relevance for adoption on farmers and producers

It is a Key characteristic that contributes to give maize mechanical resistance during the post-harvest activities, which determines the integrity of the kernel during the harvesting, pre-cleaning and milling of the seed maize. For retailers, processors and flour industry, it's the most relevant trait for commercialization.

Scale of measurements

A) Ratio of milled dry maize (Analytics)
Pre cleaning of dry maize and moisture content below 14% are needed for this test. Milled dry maize remove the pericarp and part of endosperm layers. Weight of entire kernel, which remains after the milling and compare against the weight before milling expressed in milling ratio (%).

Weight of kernel after milling / weight before milling (Analytics)
Ranks: High milling performance ratio (>70%), Intermediate (70% - 60%), Low (<60%)

Aflatoxins

Relevance for adoption on farmers and producers

Aflatoxins (mycotoxins) awareness in maize has grown due to their high influence in massive food; they are produced by fungi species (Fusarium sp, Diplodia sp, Penicilum sp, and Aspergilus sp). On the field they have more incidence in tropical climate with close ranges of 80 to 90% relative humidity and temperatures of 30 to 35°C. To reduce its incidence under storage, the raw material needs to be stored in dry and cold places to have longer shelf life. This issue can generate epidemiological effects in a short time (acute), as well as it could manifest in months or years (chronic).

Scale of measurements

Ranks:
High > 5 ug/kg for dry maize

Quick reference guide

Characteristic	Fresh consumption	Flour industry	Popcorn industry
Kernel lenght	Large	Medium - Small	Small
Kernel shape	Flint	Semiflint - Dent	Flint
Hardness	Soft - intermediate	Very hard - Hard	Hard
Color	White - yellow	White - yellow	White - yellow
Miling performance ratio	Not relevant	High - Intermediate	High - Intermediate
Aflaxotins	X < 5	X < 5	X < 5

Contact us:

If you have any questions or want to access to our germplasm, please contact our breeders:

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