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Crop Product Profile

Iron Beans Guatemala



01. Executive Summary

Guatemala has the support of the HarvestPlus Office, which puts its all into working with staple food crops such as iron beans and zinc maize. This represents a progress on nourishment since women and children from the region have shown high deficiency levels of vitamins and minerals.

Beans are one of the most planted crops in Guatemala. Guatemalans have a per capita intake of 8.3 kg/year of beans (Red Sicta-IICA,2013) which is the highest in the region. It is the top prioritized country in LAC for the intervention with iron-zinc biofortified beans. However, it shows a rampant iron and zinc deficiencies, mainly among rural - indigenes population.

In 2017, the first biofortified variety was released, ICTA Chorti has 94 ppm of iron and 35 ppm of zinc. This seed has been distributed through the Platform BioFORT members, mainly World Food Program and some farmers' associations. The wider proportion of seed is expected to be distributed in the second half of the year.

The main challenge for the biofortification of beans in Guatemala is to develop varieties suitable to high lands, over 1,400 meters and some resistance to golden mosaic (Mosaico dorado).

02A. Popular hybids and varieties planted in Guatemala

Line	Туре	Developed by	Year of release	Main characteristics	Yield (ton/ha)
ICTA Huanapú	Bush - type II	ICTA	1996	Intermediate maturity, seed color black, Ascochita and rust tolerant	3.5 - 4
ICTA Altense	Bush - type II	ICTA	1996	Intermediate maturity, seed color black, Ascochita and rust tolerant	3.5 - 4
ICTA Ligero	Bush - type I	ICTA	1998	Early maturity, seed color black, Golden mosaic and rust tolerant	5,3
ICTA Sayaxché	Bush - type l	ICTA	2010	Early maturity, seed color black, Golden mosaic and rust tolerant	5
ICTA Superchiva*	Bush - type I	ІСТА	2011	Intermediate maturity, seed color black, Ascochita and rust tolerant	3,5
ICTA Petén*	Bush - type I	ICTA	2010	Early maturity, seed color black, rust tolerant	5
ICTA Chorti*	Bush - type II	ІСТА	2017	Intermediate maturity, seed color black, Ascochita and rust tolerant	3.5 - 4

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

03. Productive regions:



Figure 1

Traditional beans production across the country

Region of the country	Percentage of contribution to total crop production
Petén Region (A)	27%
South East Region (B)	26,3%
North Region (C)	17%
North West Region (D)	9,2%
North East Region (E)	7,5%
Central Region (F)	5,2%
Metropolitan Region (G)	4,1%
South West Region (H)	3,7%



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

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Sei	me	s	e	r A

Planting Season: April-May

Semester B Planting Season: August-September

Harvest Season: August-September Harvest Season: December-January

Figure 1: Bean production in Guatemala across different regions.

MAGA /Diplan estimates, based on figures from the IV National Agricultural Census and estimates from the Banco de Guatemala –Banguat.

Top agronomic traits for biofortified beans in Guatemala





Early maturity

Relevance for adoption on farmers and producers

A reduction in the number of days to harvest will represent a greater income in a shorter period compared to other materials with late maturity. It also has greater 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, which is 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)



Golden Mosaic Virus (BGYMV)

Relevance for adoption on farmers and producers

BGYMV tolerant varieties will be capable of surviving in the sustained presence of the disease. This characteristic will allow an acceptable grain production under the infestation of the virus.

Trait indicators commonly used for crop improvement:

Selection pressure in segregating populations under infestation of whitefly (Bernisia tabaci - biotype B) as vector of the virus BGYMV for evaluate resistance to the disease

Top agronomic traits for biofortified beans in Guatemala

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Antracnosis

Relevance for adoption on farmers and producers

Antracnosis tolerant varieties will be capable of surviving in the sustained presence of the disease. This characteristic will allow an acceptable grain production under the infestation of the fungi.



Ascochyta

Relevance for adoption on farmers and producers

Ascochyta tolerant varieties will be capable of surviving in the sustained presence of the disease. This characteristic will allow an acceptable grain production under the infestation of the fungi.



Rust

Relevance for adoption on farmers and producers

Rust tolerant varieties will be capable of surviving in the sustained presence of the disease. This characteristic will allow an acceptable grain production under the infestation of the fungi.

Trait indicators commonly used for crop

Selection pressure in segregating populations under infestation of Colletotrichum lindemuthianum for evaluate tolerance and resistance to the disease

Trait indicators commonly used for crop

Selection pressure in segregating populations under infestation of Phoma exigua var diversispora for evaluate tolerance and resistance to the disease

Trait indicators commonly used for crop

Selection pressure in segregating populations under infestation of uromyces phaseoli for evaluate tolerance and resistance to the disease

Top agronomic traits for biofortified beans in Guatemala

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Bean common mosaic virus



Whitefly

Relevance for adoption on farmers and producers

Pest management with different products is recommended to control this type of issue. However, whitefly tolerant varieties will be capable of surviving the completely productive cycle even with a sustained presence of the insect. This characteristic makes the plants less attractive for the insect feeding and it's less probable to cause a consequent death of the plant.

Trait indicators commonly used for crop

Selection pressure in segregating populations under infestation of Bemisia tabaci/Trialeurodes vaporariorum in controlled environments to evaluate tolerance and resistance to the disease



Weevils

Relevance for adoption on farmers and producers

Pest management with different products is recommended to control this type of issue. However, weevils tolerant varieties will be capable of surviving the completely productive cycle even with a sustained presence of the insect. This characteristic makes the plants less attractive for the insect feeding and it's less probable to cause a consequent death of the plant.

Trait indicators commonly used for crop

Selection pressure in segregating populations under infestation of Zabrotes subfasciatus/Acanthoscelides obtectus in controlled environments to evaluate tolerance and resistance to the disease

Relevance for adoption on farmers and producers

Bean common mosaic virus tolerant varieties will be capable of surviving in the sustained presence of the disease. This characteristic will allow an acceptable grain production under the infestation of the virus.

Trait indicators commonly used for crop

Selection pressure in segregating populations under infestation of whitefly (Bernisia tabaci - biotype B) as vector of the virus (BCMNV) for evaluate resistance to the disease

Top post harvest and marketing traits for biofortified beans in Guatemala



Grain/Seed color

Relevance for adoption on farmers and producers

Grain/keed color, together with the size, are the components of which is commonly named 'Market class'. It is the consumer's first approach upon beans, since it relates to acceptance or rejection. It's also a factor that determines the price of the production between farmers, traders and consumers. Beans has a wide variation of colors, white, cream, red, purple, brown, pink, black, yellow, among others.

For Guatemala, the most appreciate color in the country is black, which is commonly used in different local recipes.

Trait indicators commonly used for crop improvement

Seed color of segregating populations could be evaluated using the following methods:

A) Munsell color system (Analitic). B) Scale using the Minolta colorimeter (Lxaxb) or Smartphon app Techkon Color Catcher^{IN} (Analytic) C) Visual scales and comparsions between common market class (Phenotypic)



Grain/seed shape

Relevance for adoption on farmers and producers

Grain/Seed shape, together with the color and size, are the components of which is commonly named "Market class". The physical appearance of the grains defines its price in the market, which is define by length and shape. Variations in size and shape are mainly genetic. Bean grain can have various shapes (round, ova), elongatek, kidney-shaped, among others).

Trait indicators commonly used for crop improvement

A) Visual scales and comparisons between common market class (Phenotypic)

1: round; 2: ovoid; 3: elliptical; 4: small almost square; 5: elongated-ovoid; 6: elongated-ovoid at one end; 7: elongated-almost square; 8: kidney-straight on the side of the thread; 9: kidney-curved on the side of the thread

which is commonly named "Market class". The physical appearance of the grains defines its price in the market, which is define by length and shape. Variations in size and shape are mainly genetic.

Grain/Seed size, together with the color and shape, are the components of

Trait indicators commonly used for crop improvement

Relevance for adoption on farmers and producers

A) 100 seeds weight (Phenotypic) <18gr = Very small 18-25gr = Small 26-40gr = Medium >40 gr = Large

Grain/seed size

B) 100 seeds volume (Phenotypic)

Top post harvest and marketing traits for biofortified beans in Guatemala



Water absorption capacity during soaking (CAA)

Relevance for adoption on farmers and producers

Determines the capacity of the grain to absorb and retain water after and during the cooking process. This characteristic allows the identification of materials that have been affected by wrong post harvesting practices and inappropriate drying of the seed. In the worst case, the most affected seeds can suffer from physiological problems that prevents the seed case (Testa) from absorbing the water necessary to soften its tissues, therefore it will not be eible or even processed for canned bears. This effect is normally described as "Low permiability of coat (testa)" or even "hard coat".

Trait indicators commonly used for crop improvement

Water absorption capacity during (Analytic):

CAA is calculated according to the difference between the weight of the dry material (PMS) and the final weight after soaking (PMR), using the following formula.

Ranks:

>100% - Without problems 70 - 100 - Moderate 40 - 69 - Severe 0 - 39 - Very severe

CAA= PMR - PMS X 100



Cooking time

Relevance for adoption on farmers and producers

Another characteristic of legumes is their ability to increase their volume and weight-one, two or three times the original size-during the cooking process. Therefore, the cooking time represents one of the most important quality parameters in beans. A short cooking time is a characteristic that represents an attribute of culinary quality. The cooking times can be prolonged by two different processes related to the water absorption of the grains: the first process is "low permeability of the seed cat (testa)" and the second is called "difficult to cook" and maintess itself in those grains that absorb enough water, but fail to soften after soaking and, therefore, cooking time is affected.

Trait indicators commonly used for crop improvement

A) Cullinary procedure (phenotypic): Manually clean 50 grams of beans, wash with distilled or deionized water and soak with 4:1 ratio of distilled or deionized water / beans, for 18 hours, at room temperature. Heat 200 mL of distilled or deionized water to boiling in beakers, using the heating plates. Once the boiling point has been reached, add the bean sample previously soaked and drained. At this time start the count.

< 30 minutes -Ideal/Shorter cooking time

> 40 minutes - Long cooking time

B) Mattson cooker equipment: The cooking time by this method is defined as the time required for 80% of the grains to pass through the punches. Heat 1600 mL of distilled or deionized water until they are bolied in the beakers, using the heating plates, until cooking is complete.



Phytate content

Relevance for adoption on farmers and producers

Phytic acid (phytate content) is the main storage form of phosphorus and mineral storage in the bean seed and plant. Absorption of iron and zinc in biofortified crops could be limited by its antinutrient content, such as phytic acid. In the case of beans, common processing techniques (including soaking, boiling, and refrying) have been shown to reduce phytic acid by solubilizing them in the soaking water, while, it can also cause leaching of minerals. In particular, anti-nutritional compounds hamper the potential nutritional impact of consuming plant foods and iron beans, and can generate digestion issues in the consumers.

Trait indicators commonly used for crop improvement

Total Phytic Acid using polyprep prefilled chromatographic columns (Analytic):

After measuring phytic acid, it could be calculated the molar ratio together with the iron content of the sample.

Convention bean: 15 Phytic acid/Fe molar ratio Biofortified bean: 13 phytic acid/fe molar ratio Ipa bean: 1 phytic acid/fe molar ratio.

Quick reference guide

Top marketing traits	of interest for	r beans in Guatemala
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Characteristic	Dry consumption	Canned industry
Grain/seed color	Black	Black, red, white
Grain/seed shape	Round/Ovoid	kidney-straight on the side of the thread/ kidney-curved on the side of the thread
Grain/seed size	Small/Very small	Small/Medium
Water absorption capacity during soaking (CAA).	>100% - Without problems 70 - 100 - Moderate	>100% - Without problems
Cooking time	30 minutes -Ideal/ Shorter cooking time	30 minutes -Ideal/ Shorter cooking time
Phytate content	Low	Low

Contact us:

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

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