Golden maize varieties (High provitamin A)

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Summary

Maize is the preferred staple food for millions of people in Sub-Saharan Africa, but common varieties grown by farmers have low levels of vitamins and minerals. This situation is contributing to widespread malnutrition and hidden hunger on the continent, with 50% of children between 0.5 to 5 years suffering from vitamin A deficiency according to World Health Organization. Insufficient intake of vitamin A is the leading cause of preventable blindness in children, it compromises the immune system increasing the risk of death from diseases like measles, diarrhea and respiratory infections. Conventional breeding techniques allow to raise the level of provitamin A in maize crops and offer a viable avenue to sustainably improve nutrition in rural communities and add value for farmers. Kernels of golden maize are packed with beta-carotenoid which give its characteristic orange color, and after ingestion these compounds are converted into vitamin A by enzymes as per the need in the body, which results in balanced nutrition unlike is the case for synthetic supplements. A large range of golden maize varieties have been released and are marketed in Sub-Saharan Africa, and through close collaboration between seed companies, farmers, policy makers and researchers these seed technology has been successfully scaled in major growing areas.

Technical Description

Golden maize varieties are developed using lines from Central and South America that are naturally provitamin A enriched and crossing these with elite natural land races and hybrid lines of maize that got high yield potentials and improved agronomic traits such as disease resistance and drought tolerance. The beta-carotene in golden maize is preserved during storage and processing, unlike common varieties of maize in which a large amount of provitamin A is oxidized and forms off-flavors before the food is consumed. Novel breeding techniques enable rapid development of golden maize varieties that contain 2 to 3 times more provitamin A than the original parent material from which it was developed, reaching levels that allow to fulfil a large part or all of the nutritional requirements in communities who depend on this food as staple. Genomic modification is further used to silence the activity of enzymes that breakdown provitamin A, and does not reduce yield potential and interfere with other agronomic traits. Scaling programs for golden maize in Sub-Saharan African countries demonstrated to be highly effective in reducing vitamin A deficiency and related health issues in children and adults, and have boosted maize value chains at local and regional scale by increasing the production and value of grain.

Uses

Provitamin A fortified maize varieties are offering a cost-effective approach to tackle malnutrition in regions where people eat a lot of maize, and could provide half of the daily vitamin A requirement. Suitable varieties of golden maize are available for all major growing areas in Sub-Saharan Africa that are ready to be scaled for addressing malnutrition and increasing producer's profits margins. Acceptability studies have shown that consumers do not object to the color and like the flavor of provitamin A enriched maize. There is a range of open pollinating lines of golden maize that can be multiplied by community and private enterprises that enable to rapid scaling and commercialization in growing areas. Hybrid types of provitamin A enriched maize typically possess other improved traits that make them highly appropriate for farming systems where production is limited by diverse challenges, but

Composition

Breeders have released more than 50 varieties of golden maize in Sub-Saharan Africa that contain high levels of provitamin A, i.e., 8 to 15 parts per million, that allow to fulfill the prescribed intake of antioxidants by children and adults for nutritional health, or at least a large part of it. There are specific lines of golden maize that are adapted for cultivation in mid-altitude highlands and lowlands with humid to semi-arid climate regimes, which possess desired agronomic traits for growing areas and reach similar yields as non-biofortified hybrids. Golden maize varieties that are tolerant to dry spells and low rainfall, and resistant to common pests and diseases, or chemical control agents, are developed from parent materials with those traits using novel breeding techniques and genomic modification. There are a large number of multipliers and private seed companies that are marketing open pollinating and hybrid golden maize varieties in multiple countries across Sub-Saharan Africa which have proven to increase food sufficiency and dispensable incomes of farmers.

Means of application

Golden maize varieties are cultivated following best planting methods, and soil and fertilizer management prescribed for particular growing areas and conditions. Appropriate inputs and formulations of inorganic fertilizers are widely shown to get farmers higher yields from biofortified maize because the applied nutrients are addressing limitations in soils that make the crop to grow stronger. On farmlands with low soil fertility status, like there are many in Africa, it is recommended that the use golden maize is combined with legume intercropping or rotation, manure application and mulching in order to improve availability of nutrients and water for the golden maize crop.

Agroecologies	All Agroecologies.
Regions	Africa.

Developed in Countries	Cameroon, Democratic Republic of the Congo, Ghana, Kenya, Malawi, Mali, Nigeria, Rwanda, Tanzania, Zambia, Zimbabwe.
Available in	Cameroon, Democratic Republic of the Congo, Ghana, Kenya, Malawi, Mali, Nigeria, Rwanda, Tanzania, Zambia, Zimbabwe.
Solution Forms	Genetics.
Solution Applications	Improved variety.
Agricultural Commodities	Maize.
Target Beneficiaries	Small-scale farmers, Commercial farmers.

Commercialization

Commercialization Category

Commercially available

Startup Requirements

1) Clearly define quality parameters, norms and screening methods for golden maize varieties from the viewpoints of all actors in the maize value chains, 2) Multipliers and seed companies in the region need to produce and market high quality seed that get the same or higher maize grain yield as non-biofortified varieties, 3) Link seed suppliers, maize growers, food processors and consumer groups to create demand for naturally nutrient enriched food, and 4) Provide financial support for local suppliers and smallholder farmers that catalyzes investments and purchases of golden maize seed.

Production Costs

Development of golden maize varieties involves advanced breeding techniques in the lab and screen house, and extensive testing of in the field that require significant investment from commercial and non-commercial breeders. The costs associated with producing seed of maize with high carotene levels are not substantially different from a common hybrid variety that is not biofortified. Large agro-input suppliers are selling golden maize seed to farmers in Sub-Saharan African countries at USD 0.8 to 1.2 per kilogram (TBC). Farmers need to co-invest in fertilizer inputs, and crop and soil

management practices, in order for the use of golden maize to result in effective and sustainable increases of nutrition and income.

Customer Segmentation

Private and community-based seed suppliers, Subsistence and commercial maize growers

Potential Profitability

The value of grains from golden (orange) maize on markets in Sub-Saharan Africa is 10% to 20% higher than that of white non-biofortified hybrid maize. Cultivating provitamin A enriched maize thus offers has a substantial economic advantage over similar yielding varieties and non-improved types which makes it attractive for commercial and subsistence farmers. Other traits of provitamin A rich varieties such as a short growth cycle, and resistance to drought and pests, reduce risks of crop failure that lead to more stable incomes, especially benefiting smallholder farmers that have limited financial resources to invest. Scaling programs in several countries have shown there is a very high degree of acceptance and widespread demand for provitamin A enriched maize by subsistence households, commercial growers, food processors, and consumers on local and regional markets.

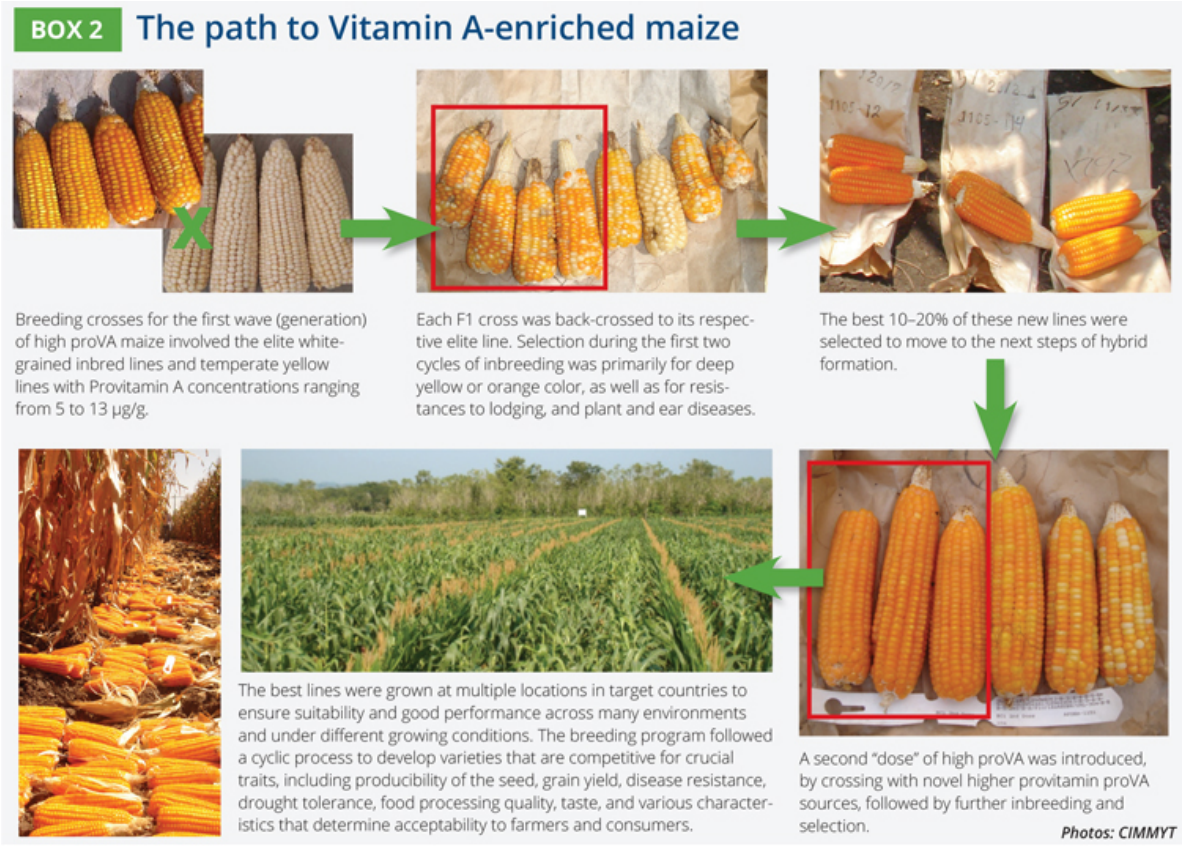
Licensing Requirements

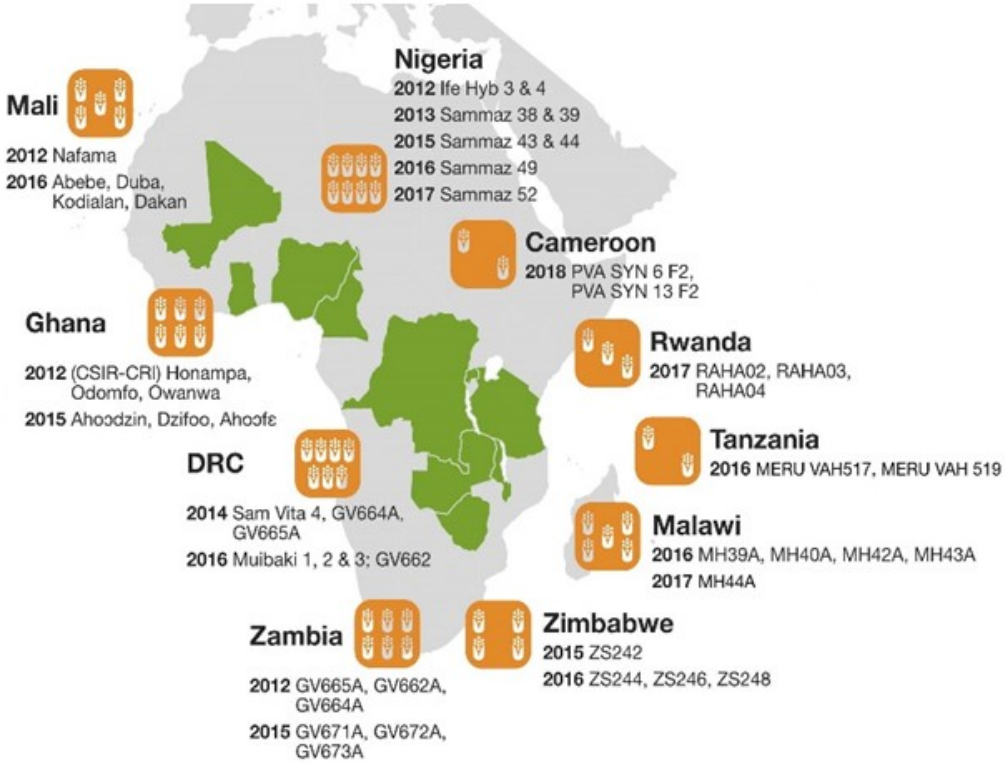
Hybrid varieties of golden maize are marketed under a commercial license, while open pollinating varieties are royalty-free for multiplication and sales by farmers but does require certification following national compliance for seed systems.

Innovation as Public Good

The International Maize and Wheat Improvement Center and International Institute of Tropical Agriculture are responsible for the public development of golden maize varieties that are released to countries in Sub-Saharan Africa.

Solution Images




Mali
2012 Nafama
2016 Abebe, Duba, Kodialan, Dakan
Nigeria
2012 Ife Hyb 3 & 4
2013 Sammaz 38 & 39
2015 Sammaz 43 & 44
2016 Sammaz 49
2017 Sammaz 52
Cameroon
2018 PVA SYN 6 F2, PVA SYN 13 F2
Ghana
2012 (CSIR-CRI) Honampa, Odomfo, Owanwa
2015 Ahoɔdzin, Dzifoo, Ahoɔfɛ
Rwanda
2017 RAHA02, RAHA03, RAHA04
Tanzania
2016 MERU VAH517, MERU VAH 519
DRC
2014 Sam Vita 4, GV664A, GV665A
2016 Muibaki 1, 2 & 3; GV662
Malawi
2016 MH39A, MH40A, MH42A, MH43A
2017 MH44A
Zambia
2012 GV665A, GV662A, GV664A
2015 GV671A, GV672A, GV673A
Zimbabwe
2015 ZS242
2016 ZS244, ZS246, ZS248

Institutions

Accompanying Solutions

Drought tolerant varieties (DTMA, WEMA, others), Specialized pre-plant fertilizer blending and N topdressing, Maize-legume rotation and intercropping, Fall armyworm control in maize production (e.g. FORTENZATM Duo)