Two extra-early maturing white maize hybrids released in Nigeria

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Two extra-early maturing hybrids with combined resistance/tolerance to *Striga*, drought, and low soil nitrogen have been released in Nigeria by the Institute of Agricultural Research and Training (IAR&T) in Nigeria. The extra-early hybrids originally known as IITA Hybrid EEWH-21 and IITA Hybrid EEWH-26 and now designated as Ife Maizehyb-5 and Ife Maizehyb-6 were developed by IITA, and tested extensively in Nigeria in partnership with IAR&T, through the funding support of the Drought Tolerant Maize for Africa (DTMA) Project. The DTMA Project is executed by CIMMYT and IITA with funds provided by the Bill & Melinda Gates Foundation.

Early (90-95 days to maturity) and extra-early (80-85 days to maturity) maize varieties can contribute to food security especially in marginal rainfall areas of West and Central Africa (WCA). These varieties are ready for harvest early in the season when other traditional crops such as sorghum and millet are not ready, and are thus used to fill the hunger gap in July in the savanna zone when all food reserves are depleted after the long dry period. Furthermore, there is a high demand for the early and extra-early cultivars in the forest zone for peri-urban maize consumers.

These maize varieties provide farmers the opportunity to market the early crop as green maize at a premium price in addition to being compatible with cassava for intercropping. However, despite the potential of early and extra-early maize to contribute to food security and increased incomes of farmers in the subregion, maize production and productivity in the savannas are severely constrained by drought, *Striga* parasitism and low soil-nitrogen.

During the last two decades, IITA in collaboration with national scientists in West and Central Africa, has developed a wide range of high-yielding drought-tolerant and/or escaping extra-early *Striga* resistant populations (white and yellow endosperm), inbred lines, and cultivars to combat these threats (Badu-Apraku et al. 2013a,b). The potential yields of Ife Maizehyb-5 and Ife Ife Maizehyb-6 inNigeria are 6.0 and 5.5 t/ha, respectively while local varieties yield about 1.5 t/ha.

The adoption and commercialization of the stress tolerant extra-early hybrids should contribute to food security, improved incomes and livelihoods of farmers in WCA.

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Ensuring the safety of African food crops

aflasafe™ team

Ground-breaking research by scientists at IITA and partners is ensuring safe food and health for Africans.

IITA, in collaboration with the United States Department of Agriculture – Agricultural Research Service (USDA-ARS) and the African Agriculture Technology Foundation (AATF), has developed a natural, safe, and cost-effective biocontrol product that drastically cuts aflatoxin contamination in African food crops.

Aflatoxins are highly toxic chemical poisons produced mainly by the fungus *Aspergillus flavus* in maize and groundnut, and on yam chips, but which also affect other high-value crops such as oilseeds and edible nuts. The fungal chemicals cause liver cancer and also suppress the immune system, retard growth and development, lead to chronic liver disease and cirrhosis, and death in both humans and animals. Livestock are also at risk and poultry are particularly susceptible. Cattle are not so susceptible but if

Maize cobs with Aspergillus *growth.* Photo by R. Bandyopadhyay, IITA.

The aflasafe team consists of Ranajit Bandyopadhyay, Joseph Atehnkeng, Charity Mutegi, Joao Augusto, Juliet Akello, Adebowale Akande, Lawrence Kaptoge, Fen Beed, Olaseun Olasupo, Tahirou Abdoulaye, Peter Cotty, Abebe Menkir, and Kola Masha, with several national partners.

they are fed with contaminated feed the toxin "Aflatoxin M_1" passes into the milk.

The biocontrol product—aflasafe™ uses native strains of *A. flavus* that do not produce aflatoxins (called atoxigenic strains) to "push out" their toxic cousins so that crops become less contaminated in a process called "competitive exclusion". When appropriately applied before the plants produce flowers these native atoxigenic strains completely exclude the aflatoxin producers.

IITA recommends broadcasting 10 kg/ha aflasafe™ by hand on soil 2–3 weeks before the flowering stage of maize to prevent the aflatoxin-producing fungus from colonizing and contaminating the crop while it remains in the field

Chickens fed with feed containing 100% aflasafe™ as energy source. Photo by R. Bandyopadhyay, IITA.

The aflasafe™ journey: Research milestones

- **1996** — USDA-ARS demonstrates the effectiveness of aflatoxin biocontrol through the principle of "competitive exclusion".
- **1999** — Initial work on aflatoxin biocontrol starts in IITA-Cotonou but focus changed from biocontrol to studies on the impact of aflatoxin on stunting.
- **2003** — Aflatoxin biocontrol research shifts to IITA-Ibadan in Nigeria in partnership with USDA-ARS, University of Bonn, and University of Ibadan.
- **2007** — Four strains of *Aspergillus flavus* incapable of producing aflatoxin are selected to constitute the biocontrol product aflasafe™ in Nigeria.
- **2009** — aflasafe™ receives approval for provisional registration from the Nigerian regulatory agency, NAFDAC.
- Trials in farmers' fields in Nigeria demonstrate the excellent efficacy of aflasafe™ in reducing aflatoxin contamination in maize and groundnut.

and subsequently in storage. Even if the grains are not stored properly, or get wet during or after harvest, the product continues to prevent infestation and contamination.

The reduction of aflatoxin in maize fields is greater with the application of aflasafe™ than with the deployment of putative low-aflatoxin maize lines. For example, field studies during 2010 and 2011 in Nigeria established that aflatoxin reduction was 16–72%, due to resistant maize hybrids, 80–92% with aflasafe™, and 80–97% with the combined use of resistance and aflasafe™.

Field testing of aflasafe™ in Nigeria between 2009 and 2012 consistently showed a decrease in contamination in maize and groundnut by 80–90% or more.

In 2009, Nigeria's National Agency for Food and Drug Administration and Control registered aflasafe™ and permitted treatment of farmers' fields to generate the data on product efficacy for obtaining full registration. In 2011, IITA distributed about 14 t of aflasafe™ to more than 450 maize and groundnut farms, enabling farmers to achieve an 83% reduction in contamination.

The success of the project has led to the expansion of biocontrol research in Burkina Faso, Ghana, Kenya, Mozambique, Senegal, Tanzania, and Zambia.

Between 2004 and 2006, nearly 200 Kenyans died after consuming aflatoxin-contaminated maize. In 2010 over 2 million bags of maize in Kenya's Eastern and Central

2010

- Biocontrol development begins in Burkina Faso, Kenya, and Senegal. In all countries, four strains have since been identified to be advanced into a biocontrol product that can be tested in farmers' fields.

2011

- Aflatoxin biocontrol laboratory infrastructure is established in Burkina Faso, Kenya, and Zambia.
- Work begins on biocontrol development in Zambia and models for commercialization in Nigeria.

2012

- Research to develop regional aflatoxin biocontrol product begins.
- Area-wide application of aflasafe SN01 begins in Senegal.
- G20 countries announce 'AgResults' initiative as an incentive to promote the use of aflasafe™ in 200,000 ha in Nigeria.
- Launching of the new aflatoxin biocontrol projects in Ghana and Tanzania.

2013

- Launching of the new aflatoxin biocontrol project in Mozambique and sample collection mission in Rwanda.
- A new project begins in Eastern Africa to develop regional biocontrol strains and policies on aflatoxin issues in the East African community.

Maize farmer in her grain store, Kenya.
Photo R. Bandyopadhyay, IITA.

provinces were found to be highly contaminated and were declared as non-tradable.

Research conducted by Leeds University and IITA found that 99% of children at weaning age are exposed to health risks linked to aflatoxin in Bénin and Togo.

Across the world, about US$1.2 billion in commerce is lost annually due to aflatoxin contamination, with African economies losing $450 million each year. Aflatoxins are also non-tariff barriers to international trade since agricultural products are rejected that have more than the permissible levels of contamination (4 ppb for the European Union and 20 ppb for USA).

IITA has identified separate sets of four competitive atoxigenic strains isolated from locally grown maize to constitute a biocontrol product called aflasafe KE01™ in Kenya and aflasafe BF01 in Burkina Faso and aflasafe SN01 in Senegal.

The adoption of this biocontrol technology with other management practices by farmers will reduce contamination by more than 70% in maize and groundnut, increase crop value by at least 5%, and improve the health of children and women.

In 2012, G20 leaders launched a new initiative—AgResults—which included aflasafe™ in Nigeria as one of the first three pilot projects to encourage the adoption of agricultural technologies by smallholder farmers.

IITA's experience in Nigeria has shown that the cost of biocontrol (about $1.5/kg with a recommended use of 10 kg/ha) is affordable for most farmers in the country.

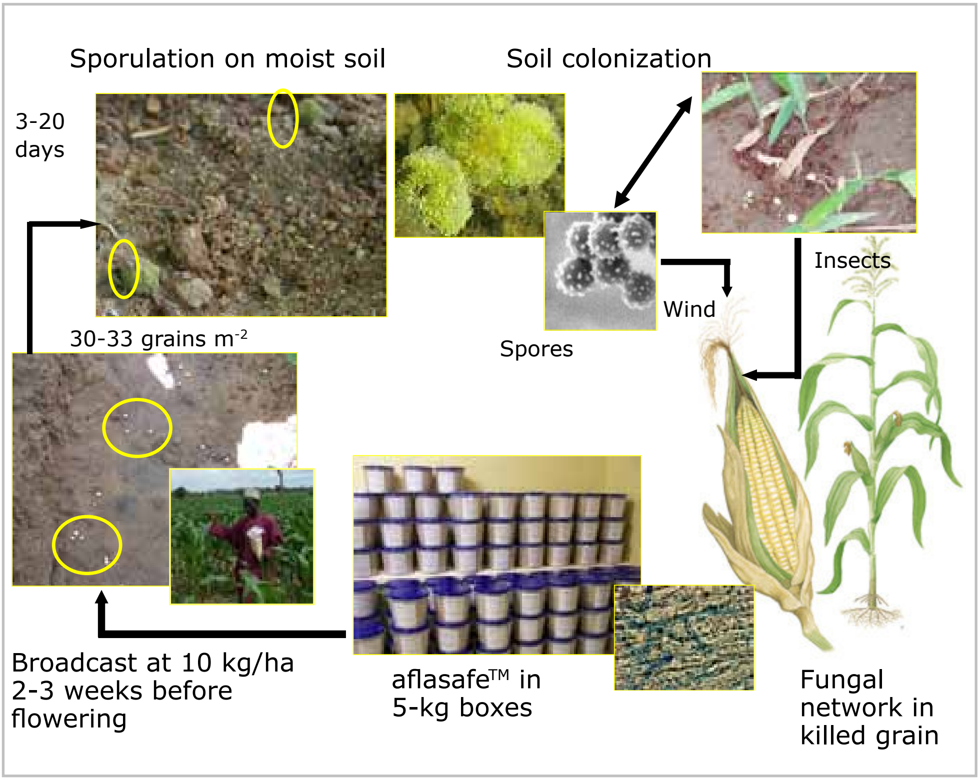
The biocontrol product aflasafe SN01 can potentially reinstate groundnut exports to the European Union lost by Senegal and The Gambia due to aflatoxin contamination. The World Bank has estimated that in Senegal, an added capital investment cost of $4.1 million and 15% recurring cost would attract a 30% price differential to groundnut oil cake. Exports are expected to increase from 25,000 to 210,000 t. The increased export volume and price would annually add $281 million to groundnut exports. For confectionery groundnut, adherence to good management practices would increase export value by $45 million annually.

Currently, a demonstration-scale manufacturing plant for aflasafe™ is under construction at IITA with a capacity to produce 5 t/h. Market linkages between aflasafe™ users, poultry producers, and quality conscious food processors are also being created to promote aflasafe™ adoption, in collaboration with the private sector.

Costs and benefits

Biocontrol of aflatoxin is one of the most cost-effective control methods, with the potential to offer a long-term solution to aflatoxin problems related to liver cancer in Africa. Cost-effectiveness ratio (CER) of treating all maize fields in Nigeria with aflasafe™ is between 5.1 and 9.2, rising to between 13.8 and 24.8 if treatments were restricted to maize intended for human consumption. Up to 162,000 disability-adjusted life years (DALYs) can be saved annually by biocontrol in Nigeria.

Initial data from a separate study in Nigeria suggest that farmers will receive a return of from 20 to 60% on investment in aflasafe™ from the sale of maize harvested from treated fields to poultry feed manufacturers and quality-conscious food processors.



How aflasafe™ works.

Maize vendor. Photo by IITA.

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