GrainMate Grain Moisture Meter: Low-Cost Moisture Testing Addresses Mycotoxin Contamination in Ghana

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Food Science in Action:

- ✓ Food Safety
- ✓ Food Engineering

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With mycotoxins affecting the agricultural sector due to climate conditions (annual rainfall thus prolonged drying time), Ghana continues to battle their elimination. **GrainMate Grain Moisture Meter** was developed by Sesi Technologies to help address this problem by using cost-effective technology to monitor the moisture content, which is a key parameter in mold growth during crop storage.

Introduction

Key food items such as grains, tubers, nuts, and oilseeds form the dietary basis of most sub-Saharan African populations. Agriculture in Ghana is dominated by smallholder farmers who utilize traditional farming techniques. Despite their important contributions to food security, their lack of technical expertise in modern farming methods has been implicated in massive annual food losses.[1] These losses are predominantly attributed to post-harvest mismanagement such as inadequate drying and poor storage.[2] Fungal infection has been identified as one of the major microbial contaminations in stored grains.[3] The Food and Agriculture Organization (FAO) estimates that 25% of agricultural crops worldwide are contaminated by mycotoxins, especially aflatoxins.[4] In Ghana, post-harvest losses, including mycotoxin contamination, account for about 319,000 tons or 18% of the country's annual maize production.[5]

Notwithstanding the monetary losses incurred, there are serious public health risks posed by secondary metabolites of fungi. Prominent among them are aflatoxins, biosynthesized by two major species of *Aspergillus* (*flavus* and *parasiticus*).[6, 7] The intake of high doses of aflatoxin can cause acute aflatoxicosis, genotoxicity, hepatocellular

carcinoma, suppression of the immune system, and impaired childhood growth.[2, 8]

Due to the toxic nature and health threat that aflatoxin poses to humans and livestock, developed countries have in place regulations with permissible limits in food. For example, the United States uses a limit of <20 ng/g, while the limit is 2-4 ng/g in the EU and 0 ng/g in Japan. In Ghana, the limit is set at <10 ng/g, 10 although it is rarely enforced due to the lack of robust regulatory systems across the country.

Aflatoxin contamination has been found to occur both at pre- and post-harvest stages of the production chain. In Ghana, the bulk of the aflatoxin contamination occurs at the post-harvest stages which are mainly due to improper food handling and storage practices.[9]

Recent studies have isolated both species of Aspergillus from maize sold at open markets in Ghana. Moreover, a study conducted to assess the distribution of Aspergillus flavus and aflatoxin accumulation in stored maize grains across three agro-ecologies in Ghana were as high as 692 ng/g.[8, 10]

Most grains produced in Ghana are either used for home consumption or sold in the local markets[7]. Hence, the high levels of contamination in grain staples such as maize and nuts limit the potential to develop these crops into export commodities. For both food safety and economic reasons, there is the need to develop effective ways to mitigate the high and unacceptable levels of aflatoxins in food.

Several proposals have been made to address the prevalence of aflatoxins in grains over the years. One of the solutions is to alter the moist and warm conditions conducive to fungus growth prior to storage. This is primarily achieved by reducing the moisture in grains before storage. Higher moisture levels or a water activity of 0.85 and above encourages the growth of fungus and pest in grains.[11] Traditionally, farmers have assessed the moisture content of grains through physical inspection, which was proven unreliable due to inaccuracy of sensory perceptions. The GrainMate moisture meter seeks to measure the equilibrium moisture content of grains.[12]

Project Overview

The United States (U.S.) government's global hunger and food security initiative, Feed the Future, draws on the expertise of top U.S. universities and research institutions in developing countries to tackle some of the world's greatest challenges in agriculture and food security.[1] There are a total of 24 Feed the Future Innovation Labs across universities in the U.S.

These Innovation Labs are central to advancing novel solutions that support the goals to reduce global hunger, poverty, and undernutrition. The Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss (PHLIL) at Kansas State University is a strategic, applied, research and education program aimed at improving global food security by reducing post-harvest losses in stored product crops, such as grains, oilseeds, legumes, root crops, and seeds.[13]

PHLIL's efforts are focused on four Feed the Future countries of which Ghana is a member.

Testimony from farmer

"I am pleading with my fellow farmers to secure a GrainMate moisture meter to help them assess the moisture content of their corn before they put them into storage in hermetically sealed bag. This will help them reduce losses and increase their margins from the farming. I think it is cheap enough to procure compared to the completion."

Photo: www.sesitechnologies.com

Through collaborations between U.S.-based universities, local universities in Ghana, and research institutions, PHLIL conducted research, testing, and outreach related to drying, storage and mycotoxin detection for these key crops.[1]

In one such collaboration with the Department of Agricultural and Biosystems Engineering of the Kwame Nkrumah University of Science and Technology, researchers were tasked to find viable and affordable post-harvest loss mitigation technologies that could easily be manufactured locally and scaled for the benefit of smallholder farmers in Ghana and beyond.

One of the participating researchers was tasked with redesigning a prototype of a moisture meter developed by Dr. Paul Armstrong, an engineer at the U.S. Department of Agriculture. The leader, Mr. Sesi, put together a team that successfully redesigned the hardware and software of the device, assembled dozens of units, and built an accompanying mobile app. The team sourced local craftspeople to make the packaging for the devices.

The low-cost PHLIL moisture meter uses equilibrium moisture content (EMC%) and was designed and developed to be affordable and user-friendly. It has now been extensively tested in Ghana and is comparable in accuracy to commercial moisture meters. With a wide measurement range, the ability to measure the moisture of multiple grains and legumes, and low power consumption, farmers and aggregators can have confidence in the moisture meter's ability to efficiently measure the moisture of their grains.[14] The moisture meter is marketed under the brand name GrainMate and can measure the moisture content of commodities including corn, rice, soybeans, sorghum, millet, groundnut and wheat with more commodities on the way.[5, 15]

Successes

So far Sesi Technologies has managed to sell over 1000 GrainMate meters to farmers, aggregators, feed producers and non-profits involved in the grain value chain. Moreover, they have trained over 2000 farmers through 37 farmer-based organizations across the country on how to use the device. The device has the potential to revolutionize farming in Ghana and beyond because it provides accurate measurement of the moisture content of grains thus giving farmers, feed producers and industry players the needed information to decide the right moisture level to store their grains.[16]

Looking Ahead

GrainMate has the potential to greatly reduce post-harvest losses if adopted on a wider scale, hence the government of Ghana and various

Challenges

The journey has not been smooth thus far. Starting an agrotech hardware startup in Ghana is exceedingly challenging due to the non-existent hardware manufacturing industry because of the funding, equipment, and even skilled personnel required.[17] Feed the Future Labs facilitated most of the logistics for this project and the contacts of technical people engaged during the project. Secondly, the adoption of the GrainMate Moisture Meter was slow in its early days among traditional farmers. It took the demonstration of the device through practical experiments that engaged the farmers directly to accelerate acceptance and subsequent appreciation of the technology.

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stakeholders in the food industry should invest in the initiative to increase the adoption of the device nationwide and beyond. This will not only ensure the sustainability of the business by delivering more GrainMate meters into the hands of farmers but also go a long way in reducing postharvest losses.

Further Reading

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