

Technologies to Mitigate Aflatoxin
APPENDIX B: OTHER INDUSTRIAL PRODUCTS

Preharvest

Sr./ No.	Product name	Technology type	Crops	Rating	Details	Advantages	Disadvantages
20	Protective irrigation + insecticide	Drip irrigation	Groundnut and maize	2	<p>Irrigation, 3–4 weeks before harvesting, reduced A. flavus invasion and aflatoxin contamination in groundnuts.</p> <p>\$1,100–\$1,300/acre to install irrigation. Drip-Micro Irrigation System \$960–1,770 / acre for the drip on orchard (surface) irrigation system (CI) \$1,300–2,250/acre for the drip on orchard (buried) irrigation system (CI) \$640–1,600/acre (CI) + \$240–480 (AC for hose replacement cost) for the above ground row crop drip system \$ 1,440–4,010/acre for permanent installation cost of subsurface row crop drip</p> <p>Sprinkler Irrigation System \$ 740–940/acre (CI)+ \$130 –170 (AC) Surface Irrigation System \$400–810/acre (CI) + \$220/acre (AC) for the siphon tube \$210–420/acre (CI) + \$170/acre (AC) for the gated pipe \$600–1,200/acre (CI) + \$250 (AC) for the surge flow \$340–680/acre (CI) + \$190 (AC) for the cablegation pipe</p> <p>CI = Capital investment, AC = Annual cost</p>	It reduces 99% Aflatoxin in Maize (Khlangwiseta & Wua, 2011).	This combined intervention might be costly for less developed country. where irrigation systems are not installed (Khlangwiseta & Wua, 2011).

Post-Harvest

Sr./ No.	Product name	Technology type	Crops	Rating	Details	Advantages	Disadvantages
21	Nimbus BSI sorting machine (TOMRA company)	Sorting	Nuts, raisins and sunflower seeds		Combines the efficiency of laser detection on foreign material with the camera to sort discolorations and shape of products in free-fall. Nimbus 640: Capacity : 2 - 6 tons/hr Nimbus 1200:	Uses advanced technology (BSI sensors) to sort the infected grains. The discoloured and spoiled grains gets sorted out with powerful laser sorter.	High acquisition Cost. Can be used mostly in industries. Technology difficult to be purchased directly by smallholder farmer.
22	Detox Aflatoxin laser sorter (BEST company)	Sorting	wide range of crops; Nuts, dried fruits and grains.		Uses a new optical laser technology to be able to detect and reject aflatoxin contaminated products at a normal processing flow.	Best uses optical laser technology to detect and reject aflatoxin contaminated products.	High acquisition Cost. Can be used mostly in industries. Technology difficult to be purchased directly by smallholder farmer.
23	LumoVision solution (Bühler company)	Sorting	Grains		Uses a sorting technology that identifies and removes cancer-causing, aflatoxin-infected grains.	It's a data driven optical sorting system helping to remove aflatoxin contaminated grains.	High acquisition Cost. Can be used mostly in industries. Technology difficult to be purchased directly by smallholder farmer.
24	Gamma radiation	Electromagnetic radiation treatment	Variety of agricultural produce especially nuts and grains.		Very high- energy photons generated by a gamma source such as cobalt-60 (⁶⁰ Co) are used to destroy the Aflatoxin microorganisms by causing direct damage to their DNA in the microbial cells (Udomkun et al., 2017).	The aflatoxin contamination could be reduced in Barley, Barn and Corn by 89%, 86% and 84% respectively at 10kGy radiation dose (Ghanem et al., 2008).	The efficiency of gamma radiation depends on factors such as dose of application, type of fungal strain, humidity and food composition (Udomkun et al., 2017).
25	Pulsed Light (PL)	Electromagnetic radiation treatment	Variety of agricultural produce especially rice.	2	The synergy between the full spectra of ultraviolet, visible, and infrared light generated by PL destroys both the cell wall and nucleic acid structure of microorganisms present on the surface of either food or packaging materials in a few seconds (Wang et al., 2016).	PL treatment in rough rice for 80s can reduce levels of AFB1 and AFB2 by 75.0% and 39.2%, respectively. PL treatment in rice barn for 15s can reduce levels of AFB1 and AFB2 by 90.3% and 86.7%, respectively (Wang et al., 2016). Other benefits include safer food, a longer shelf life for product, lower costs compared to gamma radiation (Guo, 2013).	The major disadvantage is penetration and overheating after an exposure for a long period of time (Guo, 2013).
26	Radio Frequency (RF)	Electromagnetic radiation treatment	Nuts and seeds.		The Dielectric process of radio frequency heat treatment can highly inhibit Aflatoxin strain AF-B1	Flavus and AF-B1 in Perilla frutescens L. highland oil seed with initial moisture content of 18% w.b. were highly inhibited by RF heat treatment at 90C for 7 minutes (Udomkun et al., 2017).	

27	Microwave (MW)	Electromagnetic radiation treatment	Maize		MW application on maize during post-harvest can reduce AF-B1 and AF-B2 by 36% and 58% respectively.	The MW treatment for 120s can reduce <i>A. parasiticus</i> count on in-shell hazelnut without any noticeable change in the nutritional and organoleptic properties (Udomkun et al., 2017).	
28	Ozonation	Ozone fumigation	Grains, seeds and nuts.	1	Costs: costs only \$5 per ton. Ozone, the triatomic form of oxygen (O ₃), is one of the most powerful disinfectants and sanitizing agents that can be applied as an antimicrobial agent in the food industry. This method completely breaks up the Aflatoxin ring into small fragments thus making it hard to reform. However, the research on whether it is harmful to ingest the fragmented bits of the Aflatoxin ring is still ongoing.	It costs low \$5 per ton (Khlungwiseta & Wua, 2011).	Ozone fumigation might degrade essential nutrients or might produce new toxins (Khlungwiseta & Wua, 2011).
29	Nixtamalization	Chemical (alkali) treatment.	Maize	1	The grains are soaked and cooked in an alkaline solution then hulled. Alkalis cause the hydrolysis of the lactone ring in Aflatoxin; however, evidence suggests that the hydrolyzed lactone ring can close again under acidic conditions and regenerate back to its initial form. Therefore, it can easily regenerate when it comes into contact with the HCL in the stomach.	Nixtamalization was successful in reducing FB1 content in tortillas by 82% by hydrolysis of ester bonds of fumosins (Karlovsky et al., 2016).	
30	Ammonia treatment	Chemical treatment	Peanut, cotton and corn.	1	Treatment with ammonia in gaseous phase, in solution or substances capable of releasing it, achieves a reduction of Aflatoxin in agricultural produce.	Ammoniation can decrease level of Aflatoxin by 75% in maize (Karlovsky et al., 2016).	Handling Ammonia can be dangerous and can create a byproduct which may contain health risks (Khlungwiseta & Wua, 2011). Difficult to reduce Aflatoxin contamination without reducing nutrients value.