The impact of prolonged rainfall on maize quality

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In the context of increasing climate variability and the occurrence of extreme weather events during the cropping season, landrace maize (Zea mays L.) varieties face significant challenges that can adversely affect plant development, grain quality, productivity, seed security and food security. Prolonged rainfall events, as experienced in most part of the South African provinces, often associated with climate change, has evidently led to waterlogging, increased lodging incidence, delayed physiological maturity, and heightened susceptibility to fungal diseases such as ear rot and disease infestation. Excess moisture during the reproductive and grain-filling stages creates conducive conditions to the explosion of toxigenic fungi, particularly *Fusarium* and *Aspergillus* species, which synthesize mycotoxins including aflatoxins, that pose significant risks to food and feed safety.

Simultaneously, sustained soil saturation and high percentage of relative humidity impede kernel drying process, resulting in elevated grain moisture content at harvest that renders the grain physiologically susceptible to microbial respiration, heating, and structural deterioration during storage.

Picture 1 Illustration of maize sprouting on different landrace maize varieties

The physical kernel integrity is further compromised through a plethora of factors such as waterlogging-induced lodging, ear rot and grain mould development, and stress cracking.

Observations at landrace seed multiplication confirmed that persistent wet conditions induce pre-harvest sprouting, reduce kernel weight, and test weight, and diminish seed vigour and germination potential. Waterlogged soils and accompanying winds also increase the incidence of lodging and ear drop, resulting in substantial harvest losses. Collectively, these factors reduce the economic value of maize grain and pose challenges for shelling, storage deterioration, processing, and food safety.

Pre-harvest sprouting

Pre-harvest sprouting represents a significant challenge to agricultural productivity, characterized by the premature germination of grains while the cob is attached to mother plant. This was observed on at sites and was associated with rainfall and high humidity during late February/March 2026 heavy rainfall which occurred 5-7 days consecutive days of severe rainfall, ranging between 10 to 25 mm/day (Picture 1 & 2), this finding was also recorded by. The dry and wet fluctuations result to grain swell and shrink, facilitating seed cracking and renders the kernel susceptible to germination under favourable environmental conditions. This process results in the hydrolysis of starch granules, a decrease in molecular weight, and a marked reduction in peak and final starch viscosities. This further results in the loss of grain viability and seedling vigour, rendering the seeds unsuitable for future planting. Moreover, many traditional and modern varieties have reduced levels of seed dormancy, which makes it more susceptible to sprouting when environmental conditions are ideal for absorption of water.

Difference between mould and mycotoxin

Molds and mycotoxins are closely related but fundamentally different (Table 1). Molds are living microscopic fungi that grow on crops, food products, and other organic materials under favourable climatic conditions such as high atmospheric relative humidity, high water content and warm temperatures. In contrast, mycotoxins are toxic chemical compounds also referred to as secondary metabolites produced by certain Mold species during its growth and development. While Mold contamination is often visible as discoloured, powdery, or fuzzy growth on plant tissues, mycotoxins are invisible and may remain in the crop even after the Mold is no longer present. In maize, fungal species such as Fusarium and Aspergillus infect ears and kernels, particularly under prolonged wet conditions, leading to the production of mycotoxins such as Fumonisin and Aflatoxin. Therefore, although Mold growth can reduce grain quality and market value, the presence of mycotoxins poses a more significant threat to food safety, animal health, human health, and economic sustainability due to their persistence and toxicity.

Table 1. The key practical differences between Mold and mycotoxins

	Mold	**Mycotoxins**
Nature	It is a living organism, mushrooming under conducive climatic conditions	A secondary metabolite, chemical compound
Visibility	Often visible as fuzzy patches (white, green, black, and other colours)	Invisible, odourless, and much smaller than spores and can penetrate deeper into the lungs
Purification	Yes, the spores can be removed by using decontaminators	Chemically stable: mycotoxins persist even after the mould is removed
Health risks	The spores can cause allergic reactions and respiratory irritation when inhaled	Toxic effects (liver damage, immunosuppression, carcinogenesis)
Path of exposure	Inhalation of spores	Ingestion of contaminated food, inhalation, and skin contact
Examples	Aspergillus, Fusarium, Penicillium.	Aflatoxins, fumonisins, deoxynivalenol (DON), zearalenone, ochratoxin A.
Impact on crops	Causes spoilage, discoloration, reduced quality, and diseases such as ear rot in maize.	Causes food safety risks, livestock toxicity, human health problems, and economic losses.

Mold growth

Mold growth on landrace maize is a major concern, particularly under conditions of prolonged rainfall, high humidity, poor field drainage, and inadequate post-harvest drying (Picture 2). Landrace maize varieties are traditionally cultivated and genetically diverse and exhibit varying levels of resistance or susceptibility to fungal infection depending on genetic strains and environmental conditions. These fungi can infect maize ears before harvest when wet conditions persist during flowering, grain filling, and maturity. Ear damage caused by insects, birds, or lodging further increases susceptibility to fungal colonization. Once established, moulds can continue developing during storage if grain moisture remains above safe levels of about greater than 14% and when seed segregation of contaminated seeds was not performed. Evidence underscores that the moisture content at the time of threshing is a critical determinant of long-term storage stability; for example, grains threshed at higher moisture levels (e.g., 23%) exhibit significantly higher rates of mould growth over storage periods compared to those threshed at optimal, lower moisture levels. The consequences of mould growth extend beyond visible grain deterioration. Mold infestation also reduces grain quality, market value, seed viability, and overall productivity.

Picture 2 Showing the mushrooming of fungal infestation on maize cobs.

Mycotoxin contamination

Mycotoxins occurrence is strongly influenced by environmental conditions, particularly temperature and moisture in landrace maize production systems. Under scenarios of climate variability and prolonged rainfall events, maize is increasingly vulnerable to mycotoxin accumulation. In landrace maize populations, variability in genetic resistance and ear morphology influence susceptibility to contamination, highlighting the need for integrated management approaches that combine resistant germplasm, timely

Table 2. Different types of mycotoxins, favourable climate conditions and major effects.

Mycotoxin	Producing Fungus	Favourable Conditions	Major Effects
Aflatoxins	*Aspergillus flavus*, *A. parasiticus*	High temperatures, drought stress, poor storage	Liver damage, cancer, immune suppression
Fumonisins	*Fusarium verticillioides*, *F. proliferatum*	Warm, humid conditions	Esophageal cancer, neural tube defects, livestock diseases
Deoxynivalenol (DON/ Vomitoxin)	*Fusarium graminearum*	Wet and cool conditions	Feed refusal, vomiting, reduced growth
Zearalenone (ZEN)	*Fusarium graminearum*	Cool, wet weather	Reproductive disorders in animals
Ochratoxin A	*Aspergillus* and *Penicillium* spp.	Poor storage conditions	Kidney damage, immunotoxicity

harvesting, effective drying, and improved storage practices to safeguard food safety and nutritional security.

Mycotoxins are toxic secondary metabolites produced by certain fungi, mainly species of Fusarium, Aspergillus, and Penicillium. In landrace maize, the most common mycotoxins include fumonisins, aflatoxins, deoxynivalenol (DON), and zearalenone (ZEN) (Table 2). These toxins can accumulate in maize kernels when fungal pathogens infect the crop during flowering, grain filling, or storage. Environmental stresses such as excessive moisture, insect damage, and temperature fluctuations further increase the risk of contamination.

Mycotoxins poses a critical threat to human and animal health. Ingestion of fumonisins has been identified as a risk factor for serious health conditions, including neural tube defects and craniofacial abnormalities in unborn children, while chronic exposure to aflatoxins is associated with various toxic effects.

Effective management strategies

Mold and mycotoxin management is most effective as a multi-layered approach that addresses prevention, detection, and remediation instantaneously. Controlling moisture is the cornerstone of prevention, as maintaining indoor relative humidity below 60%, fixing water leaks promptly, and ensuring adequate ventilation denies mould the conditions it needs to grow.

In food systems, the focus shifts to harvest and storage practices combined with regulatory testing and removal of source and addressing the root moisture cause leading to recurrence. Therefore, effective management strategies including the use of resistant landrace varieties, improved field sanitation, timely harvesting, proper drying, and adequate storage conditions are indispensable for minimizing mould development and ensuring food safety.

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Reference list

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