LIVESTOCK DEVELOPMENT NOTES: NO 5

MYCOTOXICOSIS: I - A CAUSE OF SOME CONCERN FOR PAPUA NEW GUINEA?

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ABSTRACT

Mycotoxin-producing moulds are found in Papua New Guinea. Some of the climatic and agricultural factors which are likely to influence the outcome of mycotoxin-related problems are discussed along with three suspected cases of mycotoxicosis.

***Key words:** spoilage fungi, mycotoxins, fungal poisoning, feedstuff, livestock*

INTRODUCTION

In food production, one, if not, the most important underlying issue is to ensure that what is produced is wholesome and safe for human consumption. One of the constant menace in food production is the spoilage of foodstuffs by fungi. In the humid tropics (e.g. Papua New Guinea (PNG)) especially, massive volumes of food or feedstuffs have been and will continue to be downgraded or wasted because of this. However, what is perhaps of most concern is that many of these common spoilage moulds (e.g. *Penicillium*) have the genetic capacity in which to produce a "cocktail" of secondary compounds known as mycotoxins. Many of these compounds are highly toxic to animals including humans.

A mycotoxicosis (*myco* - mould; *toxicosis* - poisoning) is a disease caused by consumption of food or feed containing these compounds (toxins); collectively known as mycotoxins (mould toxins).

Very little is known about the ability moulds in producing toxins or the levels of the toxins they produce in a particular food or feedstuff in PNG. Of immediate concern for us is the fact that little is known about the connection between mycotoxins and some human diseases of unknown causes (e.g. sago hemolytic disease). Especially when some disturbing cases of human mycotoxicosis have occured in this country (*see below*). This communication intends to highlight the importance of mycotoxicosis to PNG livestock agriculture, particularly in view of the fact that downgraded or waste food are usually used as feed for the animals.

SOME ASPECTS OF CONCERN

Toxigenic fungi and their toxins

There are about 100 000 species of moulds in nature. Many of these moulds usually form a normal part of the microbial population which mounting data indicate that most frequently the commodities are contaminated by one or by a number of mycotoxins produced by a single mould or several moulds. This is not totally unexpected, because most toxigenic moulds coexist on commodities and many share the environmental conditions and the biochemical processes for growth and toxin production.

The toxigenic potential of PNG mycoflora has not been established. However, the most common spoilage moulds (e.g. *Alternaria*, *Aspergillus*, *Fusarium* and *Penicillium* genera) are normal part of the crops grown in the country (P. Kokoa, personal communication.).

Preliminary findings from my recent work on peanuts in the Markham Valley tend to support this viewpoint. In that study, it was found that both aflatoxigenic moulds, *A. flavus* and *A. parasiticus*, frequently infect peanuts grown in the Valley. Other moulds, most notably, *Fusarium* species were also isolated from the peanuts in addition to the aflatoxigenic moulds.

Interestingly, in 1979, a soil sample which has been under some years of sorghum cultivation in Markham Valley was examined by the Fusarium Research Laboratory at the University of Sydney, Australia. A mould with unique features belonging to the genus *Fusarium* was subsequently isolated from the soil sample. It was found to be a new species and was named, *F. beomiforme* (Nelson *et al.* 1987). Besides PNG, only two other countries (Australia and South Africa) appear to have this new species as part of their mycoflora. However, in these two countries the mould was found to be confined to uncultivated (virgin) soils. Its toxigenic potential has yet to be determined.

Climatic conduciveness

Year-round warm temperatures (22-30°C in the lowlands; 11-25°C in the highlands), high humidity (over 80 %) and constant day-length (12 -13 hrs) are characteristic features of PNG climate. Such climatic conditions are also ideal for the moulds since these conditions fall within the optimum range they require for growth and toxin production. Surveys determining the occurrence and the distribution of the moulds or their toxins in foodstuffs from an area are needed in establishing the potential extent of the mouldy -problem in an area. Unfortunately, there are no such data available in PNG. Thus, it is difficult to draw up an accurate picture of this problem in PNG.

Impact of agricultural developments

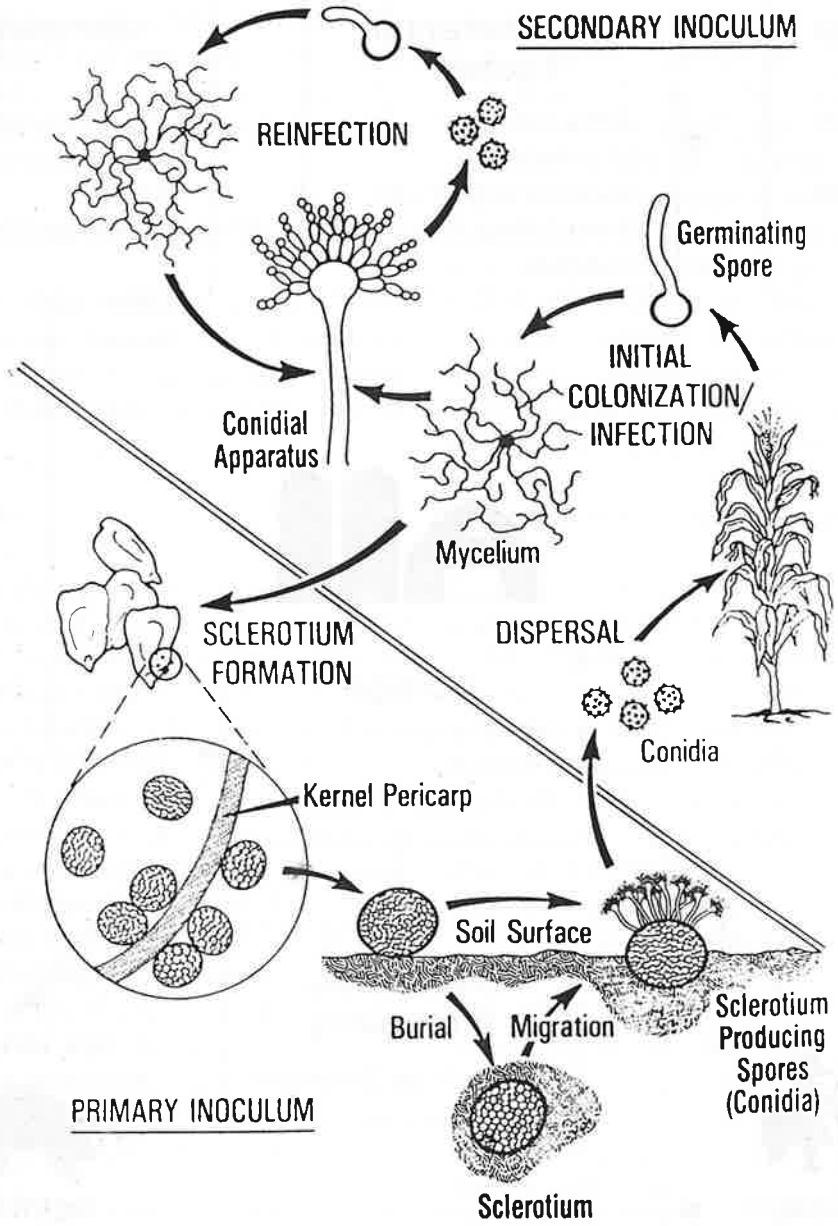
In the last 30 years there have been gradual, but significant changes in our food production system. In effect, these changes have even filtered through to the subsistence food production system, as can be seen in the type and number of crops now being grown in food gardens, and the animals that are being reared. No doubt these changes are necessary, especially if PNG is to keep pace with its population growth (2% per annum). However, as it invariably happens, whenever there is a change a new problem or a challenge is also born. Therefore it should pay to keep a close watch on the impact caused by the introduction of desirable but new technologies.

The recent introduction and continuous use of monoculture technology in food crop (e.g. rice, sugar cane, feed grain and peanut) and pasture production is a case in point. Monoculture basically means two things:

- a large land area is cultivated with a single crop (pasture)
- massive volumes of a commodity is produced as a result.

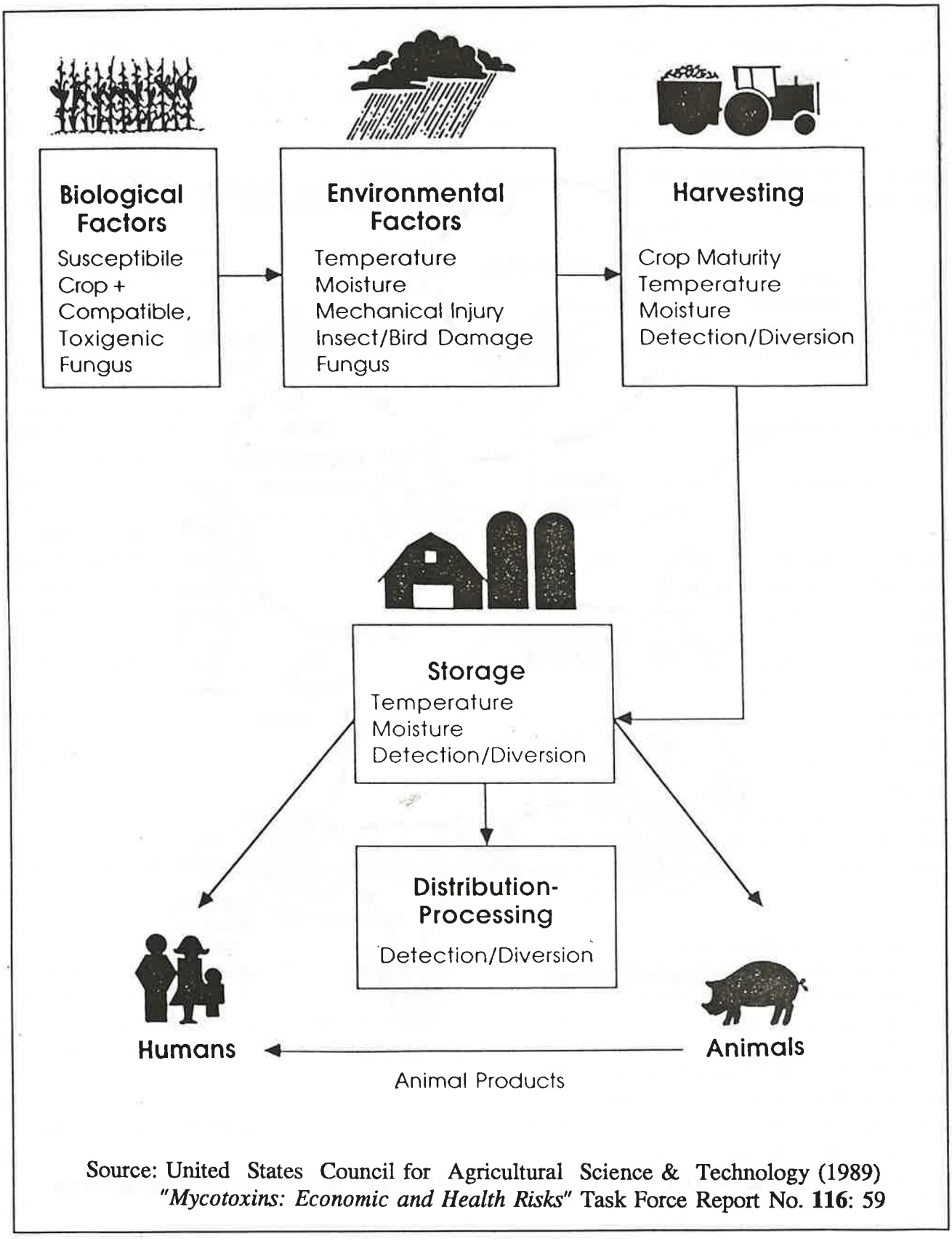
In many ways, such a technology increases exposure of crops or pastures to moulds and therefore the risk of being contaminated with mycotoxins. Moreover, because massive volumes of a produce is produced, most of it have to be stored in large storage bins or silos for later use. When commodities are stored in such a manner, a number of things can happen, and these include moisture condensation due to temperature differentials within the stored commodities ("hot spots") and damage by insects and other pests. Such conditions are ideal for the "storage" moulds to grow and produce their toxins (*Figure 1, 2*).

Of considerable bearing to PNG livestock industry is our present efforts in developing a feed grain industry. Grains can sustain as many as 150 species of moulds and are preferred substrate for toxin production. So far, no attempt has been made to guage the potential problems associated with contamination of grain crops by fungi. If my observations of the 1993-94 maize crop in Markham Valley have any significant then, a large proportin of the maize crop produced (as stock feed) in the Valley can be expected to be infected with *Fusarium* (*Figure 3*), a well knowned toxigenic mould.



Source: Wicklow, D.T and J.E Donahue (1984) *Trans. Brit. Mycol. Soc.* **82**: 621-624.

Figure 1: **Ecological relationships of asexual and vegetative elements of *Aspergillus flavus* with infection of maize.**



Source: United States Council for Agricultural Science & Technology (1989) *"Mycotoxins: Economic and Health Risks"* Task Force Report No. **116**: 59

Figure 2: **Factors affecting mycotoxin occurrence in the food chain.**

Monitoring of mycotoxins in commodities

Mycotoxins (e.g. aflatoxins) are considered as unavoidable contaminants of food or feedstuffs. The only means to establish their potential threat and safe guard livestock as well as the public from their undesirable consequences is by checking for their presence in food or feedstuffs. For these checks to be of any value, they have to be made on a continous basis because mycotoxins are produced from time to time (when the conditions are favourable).

MYCOTOXICOSIS IN PAPUA NEW GUINEA

The extent of mycotoxin-related problems in PNG is not well understood. Nevertheless, it appears that we have a problem on our hands if the type and severity of cases discussed below are of any significance.

Sago haemolysis

Sago haemolysis, a suspected human mycotoxicosis, is a disease which attracted some attention of the authorities (kiaps) in Maprik, East Sepik Province, since 1961. Little was known about the disease until a report of the 1973 outbreak of the disease in the area appeared in the PNG Medical Journal (Taufa 1974). Initially, the problem was thought to be confined to the Maprik area. However, following the above report, other health workers in Western Province also reported outbreaks of a similar disease in Lake Murray and Morehead areas (Donovan *et al.* 1976). A total of 21 people from five different families were reported to have suffered from these outbreaks, and four died; a more recent case in Madang Province has also claimed three lives (W. L. Bryden, personal communication).

The disease occurs in areas where sago is a staple in the diet. These reported outbreaks of the disease therefore could well be the "tip of the iceberg" because sago is an important staple food for about 400 000 people (about 10 percent of PNG population). Consumption of stale or mouldy sago appears to be the cause of the disease. To date, at least, two species of fungi, *Paecilomyces lilacinus* and *Tilletiopsis minor*, have been isolated from greenish grey sago implicated in one of the disease outbreak (Donovan *et al.* 1977). Other microbes which have also been isolated include two species of yeast and three species of *Bacillus* bacteria, *B. megaterium, B. subtilis* and *B. cereus*.

The most common clinical signs of the disease include severe anemia, sudden onset of jaundice and dark red urine - the latter is due to excretion of blood cells disintegrated by toxin(s), and is the characteristic feature of the disease. Other notable symptoms that have been associated with the disease are fever, vomiting and, in most severely affected patients, mental confusion and loss of consciousness. People with deficiency in an enzyme called, glucose-6-phosphate dehydrogenase, in their blood are more likely to suffer more from the disease than those with normal levels of this enzyme in their blood.

Mouldy sweet potato toxicosis

As the name suggests, the disease stems from ingestion of mouldy (brown storage rot) sweet potato (*Figure 4*). The disease has been reported mostly in cattle fed mouldy sweet potato. One case report from PNG however, suggests pigs may be as equally suceptible to the disease (Low *et al.* 1993). This appears to be the first case of the disease involving pigs. The disease was noted at the PNG University of Technology farm after some of the sows were allowed out to "graze" old sweet potato plots, a farming practice widely practiced in sweet potato based agriculture system. The sows suffered severe respiratory distress prior to their deaths, and their skins turned purple after death.

One of the unique things about this type of poisoning is that the fungus, *Fusarium solani*, does not actually "excrete" or produce the toxins. Rather, it converts the compounds called phytoalexins which the tubers produce in response to stress, physical, insect or disease injuries, into a number of chemically different mycotoxins (furanoterpenoids). These toxins affect the lungs (pneumotoxins) as their target organs when ingested. Thus, the disease is characterised by respiratory distresses which include rapid brething rate, extension of the head and neck

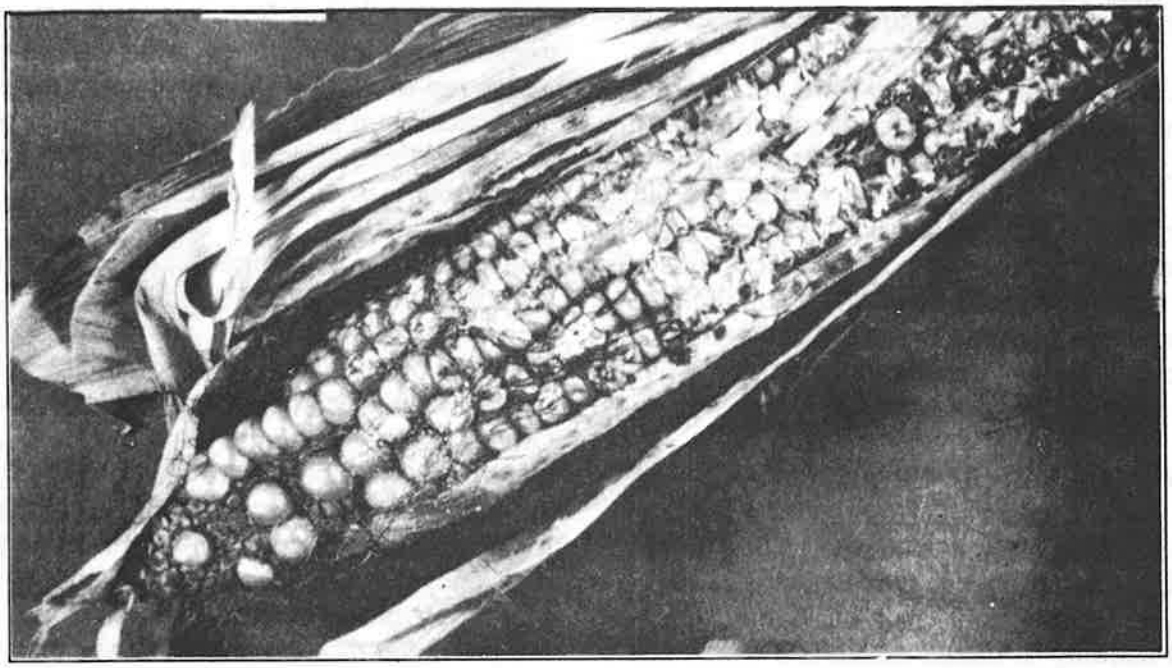


Figure 3: ***Fusarium*** **- infected maize from 1993 - 1994 crop in Markham Valley.**

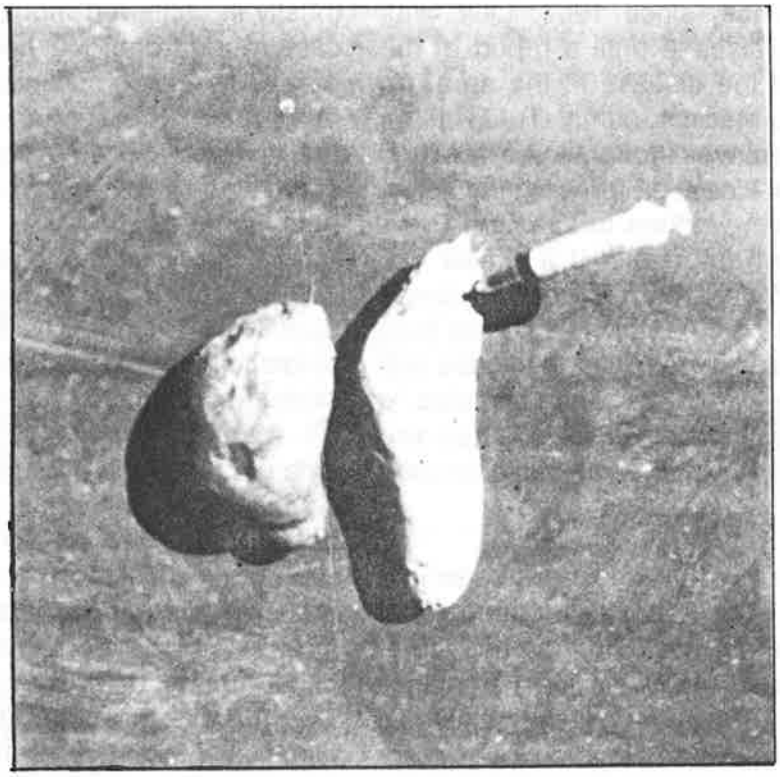


Figure 4: **Brown storage rot in sweet potato tubers caused by *Fusarium solani*.**

associated with breathlessness, and frothy exudate around the mouth before death.

It is equally alarming to note that incidence of chronic respiratory disease in PNG is much higher in farming systems where sweet potato is a staple. It has been suggested that it is likely the malady may be due to consumption of mouldy sweet potatoes "laced" with furanoterpenoid-mycotoxins (Wilson 1973).

Mouldy sorghum toxicosis

In 1982 a number of chicken farms in Lae experienced unusual losses in productivity in the form of higher mortalities and reduced growth rates, feed conversion efficiency and egg production. Tests for possible bacterial or viral infections proved negative. But, upon careful check on the history of the feed used, it was found that the batch of sorghum used in the feed was from an earlier crop which was not harvested in time when the crop was ready because of prolonged wet season. Most of the crop was used in the formulation of poultry rations, making up over 60% of the composition. Consequently, this led the producers to believe that the poultry rations they have been using may have been contaminated with toxins. Thus, a substantial compensation claim against the feed manufacturer was pursued through the court, the first court case of its kind in PNG. The case came to an end in 1985 when it was appreciated that there is insufficient evidence, despite the circumstances.

Such is the situation when it comes to cases involving mycotoxicosis. That losses can be very severe, often fatal, but, unless proper records are kept, and more importantly, mycotoxins are proven to be present in suspected ingredients or feed samples, any other evidence is purely circumstantial.

CONCLUSION

Since PNG has no data on the problems associated with mycotoxins in feedstuffs, there is a need to be cautious in feeding mouldy feedstuffs to livestock. Perhaps, the best word of advice is to take care of the feeding material and avoid using any feed that has gone mouldy.

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