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Effects of Kenneth Cyclone on Groundnut Crop (*Arachis hypogaea* L.) in Two Districts of Northern Mozambique

Ibraimo Teleha Chabite[1], Ali Magido[2], Florência Joaquim[3], Cesário Evódio[1] and Armindo Sábado Andate[1]

1. Laboratory of Quality and Food Safety (LQSA), Lúrio Interdisciplinary Study Center (CEIL), Lúrio University, Street No. 4250, Nampula, Mozambique

2. HELVETAS Swiss Intercooperation, Parque dos Continuadores, No. 31, Nampula Office, Mozambique

3. Researcher and Independent Consultant, Muhala Expansão, Street No. 3, Nampula, Mozambique

Abstract: In Mozambique, groundnut (*Arachis hypogaea* L.) in terms of importance is the third crop after maize (*Zea mays* L.) and cassava (*Manihot esculenta*). But due to geographical location, the country suffers major impacts of climate change and natural phenomena that also influence the production of this crop. The recent Kenneth cyclone that has affected Northern Mozambique, Cabo Delgado and Nampula provinces, is an example of such problems. This study aimed to evaluate the effects of Kenneth cyclone on groundnut cultivation in Eráti and Meconta districts in Nampula province. The research used a questionnaire with closed and open questions to collect data from 31 producers and five traders in Eráti and Meconta districts. Based on the data the sum of the overall average production losses between the two districts was approximately 60%, in which Eráti lost 52% and Meconta 67% of the total production expected for groundnut. The biggest impact was the loss of unharvested groundnut germination and the deterioration of the groundnut in the field while drying. Kenneth cyclone created appropriate conditions for the proliferation of fungus causing aflatoxin, *Aspergillus flavus*. Samples collected for laboratory analysis showed high levels of total aflatoxins, some 269.4 ppb in Meconta and 148.3 ppb in Eráti. The purchase price of groundnut in Eráti during this period varied naturally based on product quality, with 0.8 US $/kg of groundnut that looks good quality (without the presence of fungus or mould, insect damage, rotten and germinated nuts) and 0.6 US $/kg for the poor quality (presence of fungus or mould, insect damage, rotten and germinated nuts). Kenneth cyclone affected the expectations of farmers in groundnut yields in the 2018/2019 season.

Key words: Groundnut, Kenneth cyclone, aflatoxin, Mozambique.

1. Introduction

Groundnut (*Arachis hypogaea* L.) is the most important leguminous crop in Mozambique [1] and is the third most important crop after maize (*Zea mays* L.) and cassava (*Manihot esculenta*) [2], being the provinces of Nampula and Cabo Delgado the main producers [3]. In Southern Africa, Mozambique is the largest producer of groundnut. Some of the peanut production is consumed internally and some is exported to South Africa, India, China and Europe [4]. Production is predominantly made by small holders using them as a cash crop that they produce and harvest under raining conditions [2, 4], it is also used as an important source of edible oil [3]. But Mozambique due to its geographical location is a country vulnerable to climate changes and vast areas are exposed to tropical cyclones, droughts and floods accompanied by storms [5]. The kind of climatic adversities alternates from year to year and sometimes simultaneously, as is the case of this year that was reached by Idai and Kennedy Cyclone in the center and north and drought in the south of the country [6].

Tropical cyclones are intense circular storms characterized by a low-pressure center, associated with torrential rain and maximum sustained wind speeds, that occur over tropical or subtropical waters, with temperatures above 26.5 °C and weak vertical shear of the winds having as characteristics the

Corresponding author: Ibraimo Teleha Chabite, M.Sc., research fields: biological agriculture and nutrition.

organized shape of the storms, the typical diameter being on the order of 300-800 km [7]. Kenneth cyclone was a tropical cyclone that reached Northern Mozambique, in the provinces of Cabo Delgado and Nampula (Fig. 1) on April 25th, 2019. It was the most intense hurricane that has ever reached the African continent [8]. It was the first time that two cyclones reached Mozambique during the same season. Indeed, six weeks before the country was hit by the deadly Idai cyclone on March 14th, followed by Kenneth typhoon causing substantial damage to economic and social life [8]. With a maximum wind speed of 225 km/h and gusts that reached 270 km/h, cyclone equivalent to category 4 [8-10], took off roofs and generated heavy rains, resulting in huge floods [8]. According to preliminary government data, more than 160,000 people were affected, mainly in the rural region. More than 35,000 houses, many roads and bridges on the cyclone path were partially or totally destroyed by the storm [11].

Many countries in Africa are at great risk from climate-related disasters and suffer from them frequently. Climate related disasters have affected an average of 16 million people over the past 10 years and each year caused 670 million US$ in damages across the continent. To support the rapid growth of safe markets and establish strategic regional grain reserves to contain food price volatility and prevent

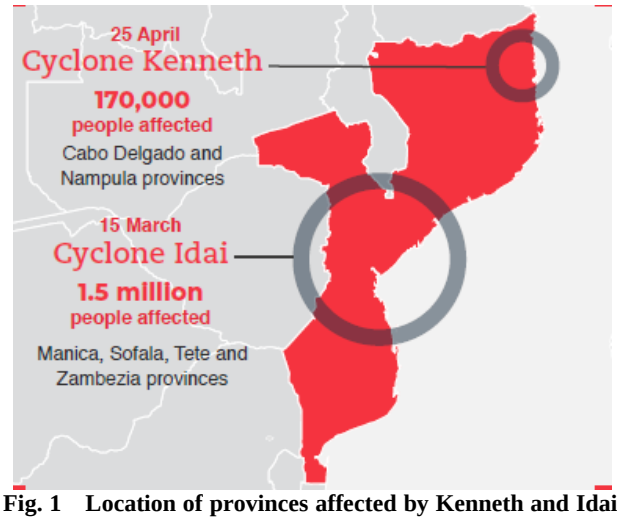

Fig. 1 Location of provinces affected by Kenneth and Idai cyclones [12].

food crises, greater efforts are needed [13]. Agriculture remains the main economic activity in Mozambique and the cultivation of groundnut has a major contribution. Kenneth cyclone largely affected the production and marketing of groundnut, so the objective of this research was to verify the effects caused on groundnut crop yields in the districts of Eráti and Meconta in the province of Nampula and to suggest some solutions that can help minimize or mitigate the problems in subsequent agricultural seasons.

2. Materials and Methods

2.1 Characterization of the Study Location

The research was carried out in two districts of Nampula province: Eráti and Meconta. The Eráti district is located in the north of the Nampula province with a surface area of 5,751 km^2, a semi-arid and dry sub-humid climate and with an average of annual precipitation between 800-1,200 mm. The annual average temperature varies from 20 °C to 25 °C and is at an altitude of 200-500 m. Most soils have medium to heavy texture, deep, well to moderately well drained [14]. The Meconta district is located in the eastern center of Nampula province and has a surface area of 3,786 km^2, with a sub-humid climate, where the average of annual precipitation varies from 800 mm to 1,000 mm. The annual average temperature during the growth of the crops exceeds 25 °C. It is characterized by its sandy, washed and moderately washed soils, predominantly yellow to gray-brown [15].

2.2 Data Collection

The research started on May 22nd, 2019, 25 d after the passage of Kenneth cyclone. A questionnaire with closed and open questions was used to collect information for 31 farmers from Eráti and Meconta districts and five traders (four informal and one formal). Data collection was carried out in two phases of four weeks each. These phases were thus chosen because they coincided with the stage of harvest,

drying and storage of the groundnut crop. In Eráti district, the data collection was carried out on May 22nd and 23rd of 2019, in first phase, June 27th and 28th, 2019, for second phase, at the Administrative Posts of Namapa main village (localities of Mucuegera and Nacole), and Administrative Post of Mirrote (localities of Chacas and Murima). While for Meconta, data collection was carried out on May 24th of 2019, first phase, and on June 29th, 2019, second phase, at the Administrative Post of Namialo (localities of 25 de Setembro and Teterrene), and Administrative Post of Meconta (localities of Nacoma and Katipa).

2.3 Materials and Laboratory Procedures

The aflatoxin level was measured using fluorometer Series-4EX (VICAM, USA). The method used was from the Association of Official Analytical Chemists (AOAC) which follows the following procedures:

(1) Sample extraction: weigh 25 g ground samples of groundnut with 5 g NaCl and place in blender jar. Add to jar 125 mL 70% methanol:30% water (*v*/*v*). Cover blender jar and blend at high speed for 2 min. Remove cover from jar and pour extract into fluted filter paper. Collect filtrate in a clean vessel.

(2) Extract dilution: pipet or pour 15.0 mL filtered extract into a clean vessel. Dilute extract with 30 mL distilled water. Mix well. Filter dilute extract through glass microfiber glass filter into glass syringe barrel using marking on barrel to measure 15 mL.

(3) Column chromatography: pass 15 mL of filtered extract completely through the AflaTest column (used to capture aflatoxin) at a rate of 1-2 drops/second (15 mL = 1.0 g sample equivalent). Wash the column with 10 mL of distilled water at a rate of 1-2 drops/second. Once more, wash the column with 10 mL of distilled water at a rate of 1-2 drops/second, until air comes through column. Elute AflaTest column with 1.0 mL high performance liquid chromatography (HPLC) grade methanol at a rate of 1-2 drops/second and collect all of the sample eluate (1 mL) in a glass cuvette. Add 1.0 mL of freshly made AflaTest Developer (used to give color the simple eluate) to eluate in the cuvette. Mix well and measure fluorescence in a calibrated fluorometer. Read aflatoxin concentration after 60 s [16].

2.4 Data Analysis and Statistics

The production loss was calculated by taking the difference between the expected harvest and the harvest obtained on the basis of the information provided by the farmers during the data collection.

The results were expressed as the averages of seven replications for production loss and three replications for aflatoxin level. The graphs were drawn by Microsoft Excel 2007.

3. Results and Discussion

3.1 Production

Kenneth cyclone had a major impact on groundnut crop production in Eráti and Meconta districts in the 2018/2019 agricultural season. Kenneth cyclone reached the region at a time when most of the production crops in the region, including groundnut, were harvested and dried. Based on the data obtained from farmers, the sum of the global average of groundnut production losses between the two districts was 60%. The district of Eráti had a global average loss of groundnut production of 52%. The locality of Mucuegera was the one with the highest losses with 64% and the locality of Murima the one with the lowest losses with 37% (Fig. 2). The Meconta district had a greater loss in groundnut production with an average of 67%, compared to the Eráti district. The localities of 25 de Setembro and Teterrene had the highest losses, reaching 80%, and Nacoma was the place with the lowest loss in this agricultural season, with 35% (Fig. 2).

Most of these losses in both districts were considered due to the effect of Kenneth cyclone. Based on the 100% of the interviewed farmers, the cyclone was accompanied by heavy and intermittent

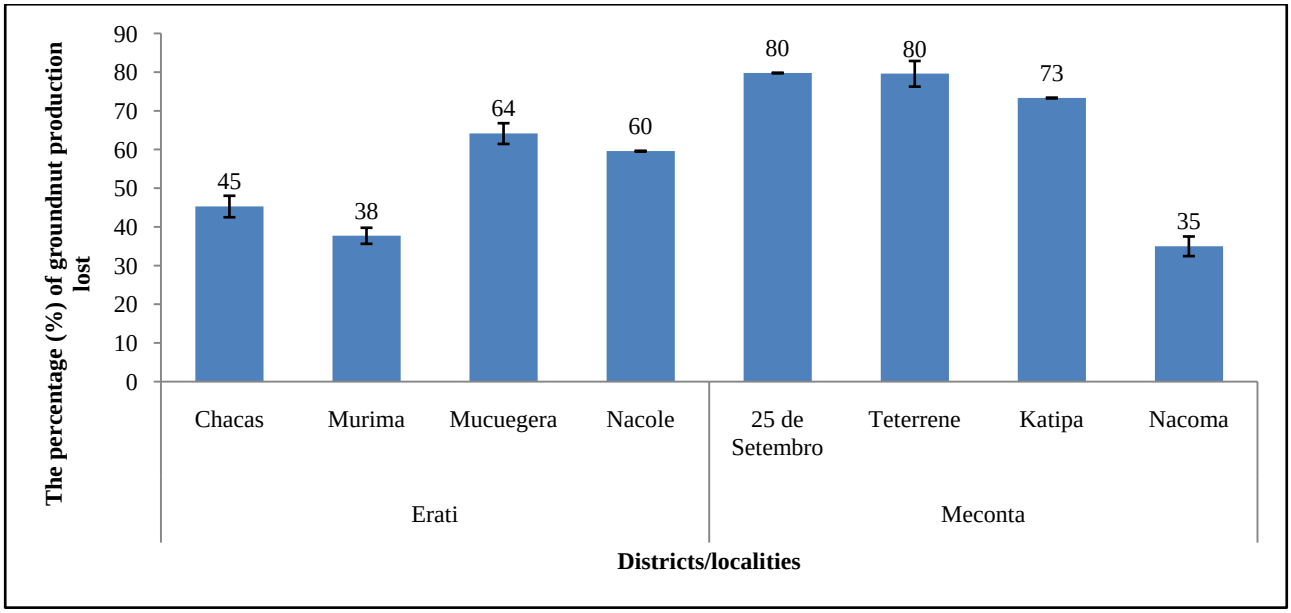

Fig. 2 The percentage (%) of groundnut production lost in Eráti and Meconta districts.

Fig. 3 Groundnut field that was about to be harvested and germinated affected by Kenneth cyclone in Katipa, Meconta district.

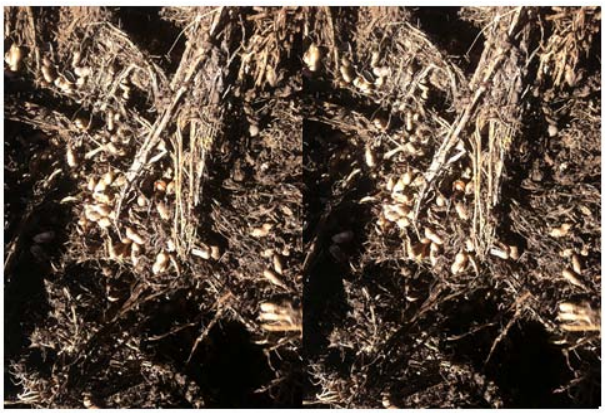

Fig. 4 Groundnut rotted due to the effects of Kenneth cyclone during the drying process in Mucuegera, Eráti district.

rains for 7 d, which caused the germination of groundnut (Fig. 3) that had not yet been harvested and on the other hand the rot and also germination of groundnut that was in the field waiting to be dried (Fig. 4). The farmers who suffered the least loss were those who used the short cycle groundnut varieties which allowed them to harvest, dry and transport a large part of their production in time to store in their dwellings. In order to minimize the effects of the calamities that devastate the country cyclically, the farmer must be advised on the type of varieties to be used. According to Vizcayno *et al.* [17], the choice of appropriate crops and varieties to be adopted by farmers in areas prone to the threat of climatic adversity is complex and farmers have to take into account several factors, such as drought tolerance, short cycles to reduce the risk of coincidence with threats and resistance to prevailing pests and diseases.

Although this study focused on groundnut crop, it also researched other crops and noted that farmers also lost a portion of their maize, mung bean (*Vigna radiate* L.) and vegetable crops in the low-lying areas. Around 83,700 ha of crops were partially or totally destroyed.

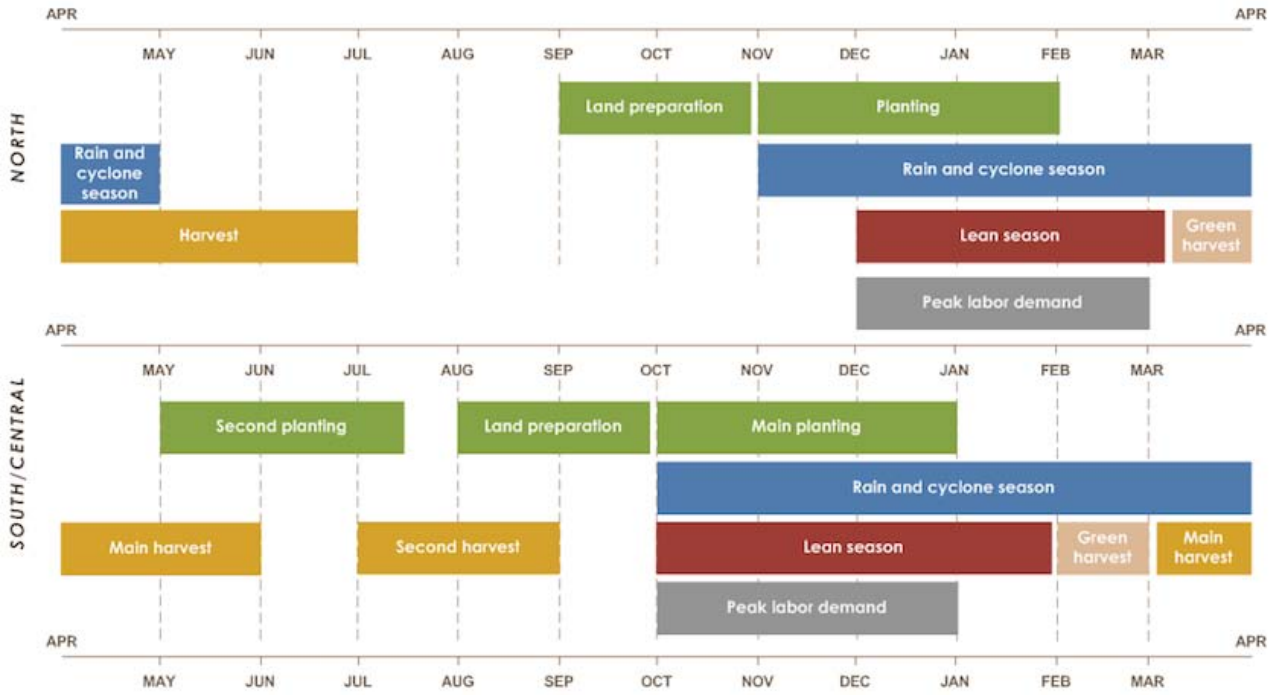

Fig. 5 Mozambique's seasonal calendar for a typical year [18].

Some farmers delayed harvesting, in addition to the variety cycle, due to the possession of several production plots, one near and another further, where they produce different crops whose harvest time often coincides. For this reason farmers opt for a phased harvest for each crop, and groundnut is often left in second plan due to the treatments that the crop requires, preferring only to remove the groundnut and leave it to dry on the ground in the field and then continue to harvest other crops to put in their traditional barns or indoors. And only subsequently they return to finish the groundnut harvest, separating the pods from the plant and drying again, if necessary, in their homesteads.

Some producers (3%) also reported that apart from the losses caused by Kenneth cyclone there were also those caused by low seed germination and viral disease (Rosetta by *Aphis craccivora*). Because it is customary for farmers to keep part of their production in their barns for use in the following season, most claimed they had no seed to launch in the next season. Because of climate change it is necessary to pay close attention to the agricultural calendar (Fig. 5), especially with regard to crop's sowing. With these problems caused by Kenneth cyclone, specific actions must be taken so that in the coming years the affected areas do not worsen food insecurity, as shown by Food and Agriculture Organization (FAO) [13] that in 2016 and 2017 climate shocks created food production deficits and/or a general lack of access to food and left millions of people in some African countries, including Mozambique, in need of urgent aid at the beginning of the following year.

3.2 Trading

Most of the farmers interviewed in the localities of the Eráti district reported that they have been selling their product in Namapa main village hence a small round was performed at his location to obtain information about the groundnut selling process. It was found that traders were buying all of the groundnuts including the bad quality affected by Kenneth cyclone (Fig. 6), and what differentiated at that time was the price used for the different qualities of groundnuts. The good quality groundnut (without the presence of fungus or mould, insect damage, rotten

Fig. 6 Moments of groundnut trading in Namapa main village, Eráti district.

Fig. 7 Purchase and quality selection of groundnut during trading in Namapa main village, Eráti district.

and germinated nuts) was around 0.8 US $/kg and the bad quality at a price of 0.6 US $/kg. Poor quality groundnut had a certain percentage of fungus or mould, insect damage germinated and some rotten nuts (Fig. 7). Based on the traders interviewed a part of the selected groundnut, the good one, was bagged and resold in the big markets or traded in the marketing and export companies, while the other part, the bad quality one, was either resold to small sellers to make groundnut candy which is sold in the same market or was used to mix in the homemade food. The consumption of this poor quality groundnut can cause serious problems for public health, highlighting the problem of contamination by fungi such as *Aspergillus*, which can produce aflatoxins [19, 20].

3.3 Aflatoxin Levels

The International Agency for Research on Cancer (IARC) classifies aflatoxins and includes in Group 1 carcinogenic substances for humans produced by fungi *Aspergillus flavus*, *A. parasiticus* [19, 21-23]. The major groups of aflatoxin are B_1, B_2, G_1 and G_2 and aflatoxin B_1 (AFB1) is most toxic and carcinogen [21-23]. According to different international bodies, such as the European Union, European Food Safety Authority and Codex Alimentarius, for total aflatoxin

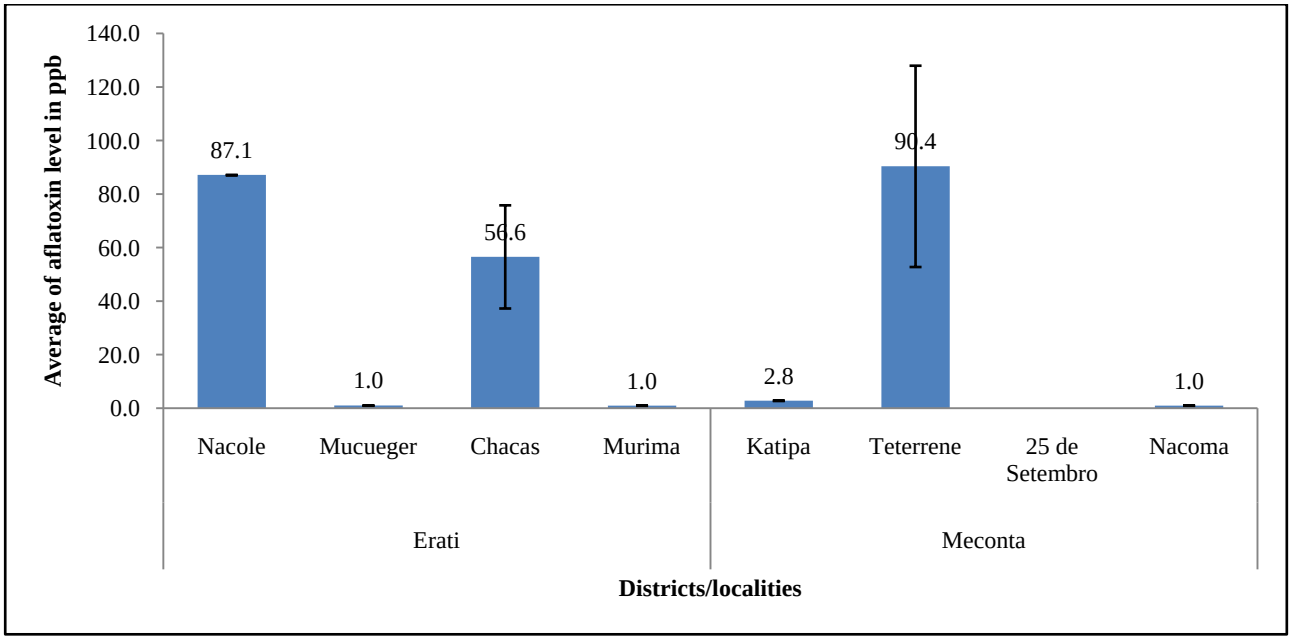

Fig. 8 Average of aflatoxin levels in ppb in Eráti and Meconta districts.

(B_1 + B_2 + G_1 + G_2) the maximum intake limits for humans are 10 µg/kg or ppb in nuts [3, 21-23]. In this study to check the quality of the groundnut affected by Kenneth cyclone, samples were taken from farmers to perform the aflatoxin analysis. Groundnut is a crop susceptible to the attack of the fungus *A. flavus* [3], and the cyclone created favorable conditions for the proliferation of this fungus in the affected areas.

Based on laboratory analyses the aflatoxin levels of samples that collected the highest values recorded in the two districts were 269.4 ppb for Teterrene (Meconta district) and 148.3 ppb for Chacas, (Eráti district). The lowest values were registered in Murima with 0.48 ppb and in Nacoma with 0.65 ppb in Eráti and Meconta districts, respectively. The global averages found are shown in Fig. 8. In the locality of 25 de Setembro there were no aflatoxin data obtained because farmers did not have groundnut samples stored during the samples collection.

It is known, according to Cambaza *et al.* [3], that groundnut exports in Mozambique in recent years have decreased mainly due to problems related to the aflatoxin index and are reflected in annual revenues in some four million US dollars. To minimize the effects of aflatoxin and as well as the effect of bad weather during the groundnut drying season, it is recommended the farmers use an A-Frame or tarpaulin drying method [2] and not dry in the ground as they usually do.

4. Conclusions

The Kenneth cyclone that passed through Northern Mozambique caused an average of 60% loss on groundnut crop production between the districts of Eráti and Meconta in Nampula province. The Meconta district had the biggest loss with a percentage of 67%. The farmers who suffered the least loss were those who used the short cycle groundnut varieties. This has influenced the trading of this crop and the presence of high levels of aflatoxin reached a high level of 269.4 ppb in Teterrene (Meconta district). As a consequence, it lowered the purchasing power of farmers, significantly reduced the availability of seeds for the coming agricultural seasons and influenced food security among the population in these regions. To minimize these effects, it is recommended to follow the correct timeline of groundnut cycle production and use the best technologies during the

drying stage.

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