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Assessment of farmer's awareness on occurrence, prevalence and management of sisal bole rot disease in Muheza district

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Abstract

In Tanzania, sisal is a good source of income and employment to many rural residents whose livelihoods depend on agriculture. For many years, Tanzania has been promoting sisal industry especially small scale farmers' participation in the sisal industry. One of the important disease threatening sisal production is bole rot, a disease that is associated with fungus of Aspergillus species. This study aimed to determine farmer's level of awareness regarding occurrence, prevalence and management of bole rot disease. Interview administrated questionnaire was employed to obtain both qualitative and quantitative data from 71 small scale farmers and three sisal estates from the three major sisal growing wards in different agro-ecologies of Muheza district. Data was collected using Open Data Kit (ODK) Collect v2021.2.3 tool and inputted using Statistical Package for Social Science (SPSS 20) software, transformed using Arcsine and analyzed using descriptive and inferential statistics. Pearson product moment correlation was used to find the relationship between selected demographic variables, production practices and farmers level of awareness on bole rot disease. The study revealed that, majority of the sisal farmers had moderate level of awareness regarding sisal bole rot disease. All the selected demographic variables and many production variables were found to have significant relationship with farmer's level of awareness on bole rot disease. The results also revealed that majority of the sisal farmers are relying on their fellow sisal farmer's and extension officers to obtain information on sisal production. Campaigns are needed to improve farmers' awareness on sisal bole rot disease through public awareness and capacity building to extension officers.

Keywords: *Agave sisalana*; Aspergillus; Awareness; Bole rot; Muheza; Sisal

1. Introduction

Sisal (*Agave sisalana* L.), is a plant originated from Northern and Central America, being cultivated in tropical countries. In Tanzania, the sisal land use is basically a high input, large-scale monocropping system, dominating the hotter and drier areas below 900 masl [1]. The crop is mostly grown in large plantations owned by companies and currently there are 48 sisal estates as well as small scale farmers [2]. In 2012, approximately 25% of sisal was produced by small scale farmers [2]. The production of seeds in sisal is rare, plant multiplies vegetative through bulbils produced on the inflorescence pole or by stolons/suckers that emerge from the rhizome (subterraneous stem) of adult plants. The use of stolons/suckers is the most common form of propagation used by small scale farmers and sisal estates in Muheza district, but bulbils are also used especially in research institutes and in few estates. Sisal, although is tolerant to drought stresses and resistant to most pests and diseases, it is being attacked by a fatal fungal disease known as bole rot [3]. The disease has become increasingly important in the last few years as it is one of the factors responsible for the decline of sisal production [4].The disease has been reported in Brazil and in Tanzania by [3,4]. It is caused by black aspergilli,

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including *A. niger*, *A. brasiliensis, A. welwitschae and A. tubingensis*, but *A. niger* is the most important agent [5]. The diseased plants exhibit yellowing of the aerial parts and a red-colored rot of the bole that leads to plant death [4].

Farm management levels within the small scale and estate farmers pertaining to their productivity, yields and bole rot disease management vary considerably and much of variability has been attributed to their different level of awareness regarding sisal bole rot disease occurrence, prevalence and management practices**.** The challenge now is to deliver the correct technology pertaining to management of bole rot disease to rise up farmer's level of awareness on bole rot disease**.** Rogers and Anane [6, 7] both indicated that, awareness and knowledge of a new technology is the first step in the adoption process. Through lack of awareness or through inaccurate perceptions, farmer's evaluation of an innovation may not agree with an expert's**.** Several reports have found that, higher level of awareness of farmers will results into better adoption of management practices of diseases of plants. Amon-Armah [8] reported that higher knowledge about black pod disease of cocoa was significantly translated into adoption of the proper way of disposing the diseased pods compared with farmers with lower knowledge. Bua [9] reported that, lack of awareness on disease recognition and management of Cassava Brown Streak Disease (CBSD) among smallholders in Northern Uganda contributed significantly to rapid spread of the disease. A survey conducted in the Philippines by Heong and Ho [10] found that, most rice farmers were able to describe tungro disease symptoms of rice but gaps existed in their understanding of the causes and modes of spread. Most of them were unaware of the risk of leaving infected plants in the field, which can act as a source of disease inocula, which in turn became a threat to new planting. It is important to assess farmer's level of awareness on bole rot disease so as to be able to design effective extension services that will improve farmers level of awareness on bole rot disease that would help them to further manage the disease effectively especially during the selection of planting materials and carrying out of production practices. Thus, this study was conducted to determine farmer's level of awareness on occurrence, prevalence, and management of bole rot disease, as well as the relationship between some selected demographic variables, productions practices carried out by farmers with their level of awareness on bole rot disease.

2. Material and methods

2.1 Description of the study area

The study was carried out in three wards selected randomly at different altitudes of Muheza district. The three wards are: Ngomeni located at the altitude of 107msl, longitudes of 38.9191 S and latitudes of -5.1866 E; Tanganyika ward located at altitude of 200 msl, longitudes of 38.8055 S and latitudes of -5.1613 E and Kigombe ward located at the altitude of 22 msl, longitudes of 39.0018 S and latitudes of -5.2907 E (Fig. 1).

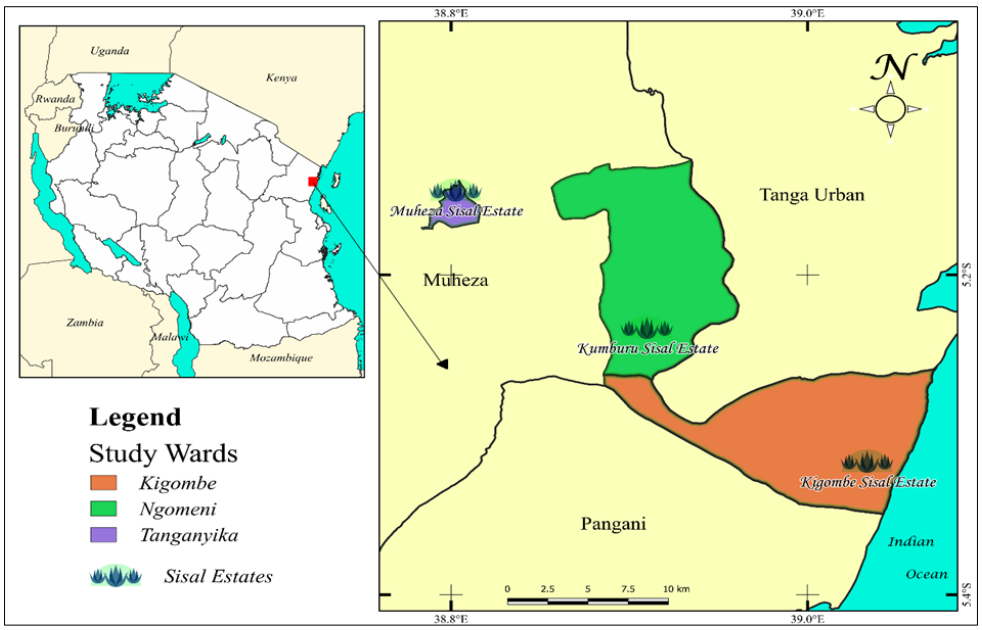


Figure 1 A map of Muheza district shown sisal bole rot disease study wards in Muheza district

2.2 Survey, data collection and analysis

2.2.1 Assessment of farmer's awareness on occurrence, prevalence and management of bole rot disease

The study on assessment of farmer's awareness on occurrence, prevalence and management practices of bole rot disease on sisal in Muheza District was carried out by obtaining the number of farmers who grows sisal from ward offices through ward agricultural officers. The population of study consisted of all sisal farmers present in the three study wards which are 74, seventy one (71) are small scale sisal farmers and three sisal estates. In proportionate, 55 respondents were small scale farmers from Ngomeni ward, 13 in Kigombe ward, three from Tanganyika ward and one sisal estate per ward. The study employed a survey research methodology of using interview administrated questionnaire to gather information pertaining to farmer's awareness occurrence, prevalence and management practices of bole rot disease. A structured self-administered questionnaire was used to collect data on farmer's socio demographic characteristics, production practices and awareness on occurrence, prevalence and management of bole rot disease. A total of 10 questions with 21 answers about farmer's awareness on occurrence, prevalence and management of bole rot disease were developed. Initially, the questionnaire was pre-tested to ascertain its suitability and/or reliability where a total of 10 farmers were interviewed. Based on the feedback from the pre-test, the questionnaire was revised into its final format. Upon completion, the questionnaire was administered to 71 small scale farmers and three (3) sisal estates found in Muheza district using Open Data Kit (ODK) Collect *v2021*.2.3 tool. The questionnaires were written in Swahili and some in English language to make it easy for the non-Swahili speaking participants to understand. For those participants that were unable to read, the investigator read each question and the participants responded verbally.

2.2.2 Statistical analysis

Collected data from questionnaire were coded and entered into Microsoft Excel 2016, transformed using the arcsine square root transformation formula as described by Mousanejad et al. [11] as: $Y = \text{Arcsin } \sqrt{P}$, Where, Y is transformed data, and p is the observed proportion. Analysis was done by using Statistical Package for Social Science (SPSS 20) software using descriptive and inferential statistics. Descriptive analyses such as frequencies, percentages and means were employed to clarify the general data of the study. Quantification of farmer's level of awareness on occurrence, prevalence and management of bole rot disease was made by giving one score and zero score for correct and incorrect answers respectively. The score of all the individual items was summed to get the final awareness score of respondents. Based on the total score obtained, respondents were categorized into three categories of low, moderate and high level of awareness. In addition, to fulfill the objective of identifying any relationship that might occur between some selected demographic variables, production practices with farmer's level of awareness, inferential analysis (Pearson product-moment correlation) was applied.

3. Results

3.1 Assessment of farmers awareness on bole rot disease

The assessment of farmer's socio-demographic information, awareness on occurrence, prevalence and management of sisal bole rot disease, and the relationship between some selected demographic variables, production practices and farmers level of awareness on sisal bole rot disease were done in three wards of Muheza district and responses are presented in (Table 1 – 5, Fig. 2-4).

3.1.1 Socio-demographic information of farmers

The demographic data of the surveyed sisal farmers in Table 1 demonstrates that, majority of the farmers were males as they represent 63.5% compared to only 36.5% of female. A total of 31.1% sisal farmers were in the age above 50 years, followed by 29.7% who were between the age of 41-50 years. Farmers with the age of 31-40 years were 21.6% and those with age between 21-30 years were 17.6%. None of the farmer interviewed was in the young category age of ≤ 20 years. The mean age of the farmer's was 45.8 years old. The results revealed that, 55.4% of farmers interviewed in all wards had attained primary education, followed by 27% who possessed secondary school qualification while 17.6% had tertiary education (colleges and university). There was no farmer who did not have any formal education. More than half of the sisal farmers (59.5%) were not full time sisal producers as most of them were self-employed and working on other business such as farming other crops (40.9%), businessman (27.3%), government and private employees (25.0%), livestock keeper (15.9%), other occupations (15.9%) and fisherman (4.6%). The results revealed that, 68.9% of the farmers family income was obtained from farming, followed by business (18.9%) and livestock keeping which was 16.2% (Table 1). It was noted that, 62.2% of the interviewed farmer's positions in the household are fathers, 29.7% are mothers and children were 8.1%. The study found that 63.5% of the small scale sisal farmers cultivated land of an average of one to two (1-2) hectares, followed by 27.0% with three to four (3-4) hectares, 5.4%

farmers with five to six (5-6) hectares of sisal farms and 4.1% (all the three estates) had more than six hectares of sisal farms. The average size of land for the small scale farmers was 2.6 ha.

Table 1 Socio-demographic profile of farmers

Categories	Frequency (N)	Percentage (%)	Mean Scores
Gender			
Male	47	63.5	
Female	27	36.5	
Age (years)			45.8
<20	00	0.0	
21- 30	13	17.6	
31- 40	16	21.6	
41- 50	22	29.7	
> 50	23	31.1	
Level of Education			
Primary school education	41	55.4	
Secondary school education	20	27.0	
Tertiary education	13	17.6	
Full time sisal farmer			
Yes	30	40.5	
No	44	59.5	
Other occupations			
Farmer	18	40.9	
Livestock keeper	7	15.9	
Businessman	12	27.3	
Fisherman	2	4.6	
Government/private sector employee	11	25.0	
Other occupations	7	15.9	
Respondent position in the household			1.5
Father	46	62.2	
Mother	22	29.7	
Children	6	8.1	
Sources of family income			
Farming	51	68.9	
Livestock keeping	12	16.2	
Business	14	18.9	
Contribution of sisal in farmers economy			
Provide income	62	83.8	
Improve living standards	57	77.0	
Provide self-employment	53	71.6	

Used as a field marker	26	35.1	
Size of sisal farm (ha)			2.6
1-2	47	63.5	
3-4	20	27.0	
5-6	4	5.4	
> 6	3	4.1	

Source: Own compilation from field survey data (2022), the total number of respondents is not 74 due to multiple selection

3.1.2 Influence of sources of information on farmer's awareness on occurrence, prevalence and management of sisal bole rot disease

Sources of information on sisal bole rot disease used by farmers presented in (Table 2; Figure 2) indicated that, majority of sisal farmers depend on their fellow sisal farmers (89.19%) and the extension officers (81.08%) for information on sisal bole rot disease. The least amount of information was sourced from friends (18.92%), village leaders (6.76%), and school during studying for those with tertiary level of education (6.76%), TV/radio (9.46%) and posters (2.70%). Other sources of information included phones (21.06%) and internet (9.50%).

Table 2 The influence of sources of information on farmer's awareness on sisal bole rot disease

Sources of information	Frequency (n)	Percentage (%)
Friends	14	18.92
Sisal farmers	66	89.19
Poster	2	2.70
Radio/TV	7	9.46
Extension officers	60	81.08
Village leaders	5	6.76
School	5	6.76
Other sources: Phone	16	21.06
Internet	7	9.50

Source: Own compilation from field survey data (2022), the total number of respondents is not 74 due to multiple selection

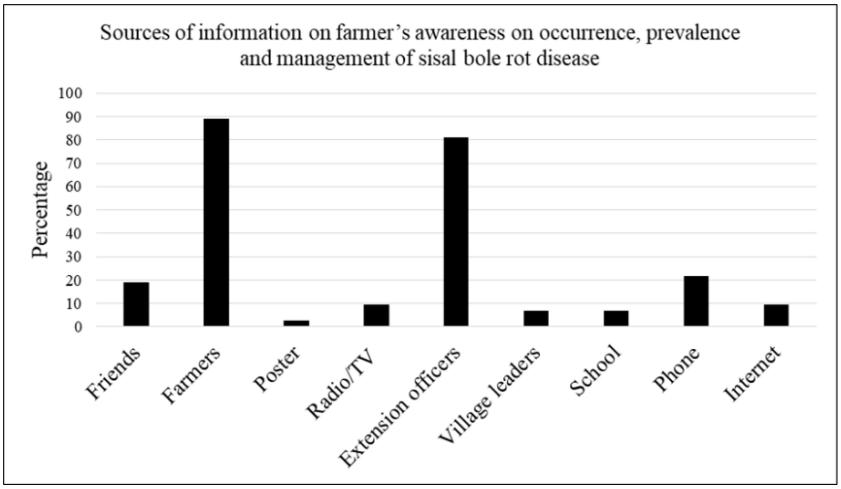


Figure 2 Farmers sources of information on sisal bole rot disease

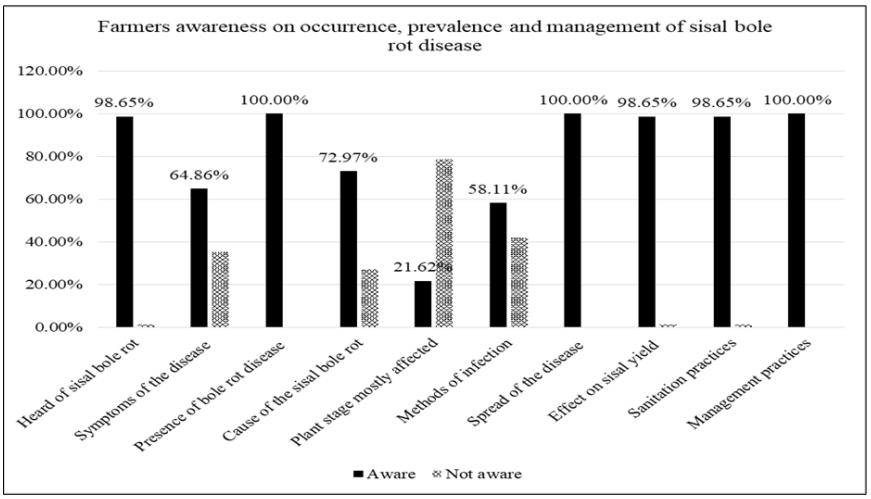
3.1.3 Farmers awareness on sisal bole rot disease

Farmer's awareness on occurrence, prevalence and management of sisal bole rot disease results presented in Table 3 shows the correct and incorrect answers by farmers based on a total of ten questions with 21 answers related to occurrences, prevalence and management of sisal bole rot disease. Results in Table 3, Fig. 3 shows that, almost all farmers (98.7%) answered that they have heard about sisal bole rot disease. The results revealed that, more than half (64.9%) of farmers were aware that sisal plantlets at the nursery stage are mostly infected by *A.niger.* Based on the percentage of correct answers in Table 3, all farmers (100%) were able to identify the symptoms of bole rot disease at field. The analysis shows that 72.9% of the total farmers reported of having bole rot disease in their sisal fields and majority of the respondents (78.4%) did not know that bole rot disease is caused by fungus as most of them said it is caused by bacteria, virus, nematodes and others said they don't know. All the sisal farmers, 100% managed to answer correctly the spread of bole rot disease from infected to new sisal fields and 58.1% of farmers were able to identify the methods of infection of the fungus to the crop. The results revealed that 98.7% farmers (small scale farmers and estates) across all the three wards were able to recognize the effect of bole rot disease as they all experience losses of sisal production in terms of quantity and quality. It was also observed that, 98.7% of sisal farmers were using various sanitation practices and all sisal farmers (100%) were using different management practices in their field to reduce the incidence of bole rot disease (Table 3, Fig. 3). Therefore, results in (Table 4, Fig. 4) revealed that few farmers (6.76%) had low level of awareness regarding occurrence, prevalence and management of bole rot disease followed by 68.92% that belong to moderate level and 24.32% of farmers had high level of awareness on occurrence, prevalence and management of bole rot disease.

Table 3 Farmers awareness on occurrence, prevalence and management of sisal bole rot disease

Questions/statements	Farmers level of awareness			
	Correct answer		Incorrect answer	
	N	%	n	%
Heard of sisal bole rot disease by farmers	73	98.7	01	1.4
Plant stage mostly affected by bole rot disease	48	64.9	26	35.1
Symptoms of the disease to sisal crop	74	100.0	00	0.0
Presence of bole rot disease in the sisal field	54	72.9	20	27.0
Cause of the sisal bole rot disease	16	21.6	58	78.4
Methods of infection of fungus to sisal crop	43	58.1	31	41.9
Spread of bole rot disease in the field	74	100.0	00	0.0
Effect on sisal yield due to bole rot disease	73	98.7	01	1.4
Sanitation practices used to reduce bole rot	73	98.7	01	1.4
Management practices of sisal bole rot	74	100.0	00	0.0

Source: Own compilation from survey data (2022)



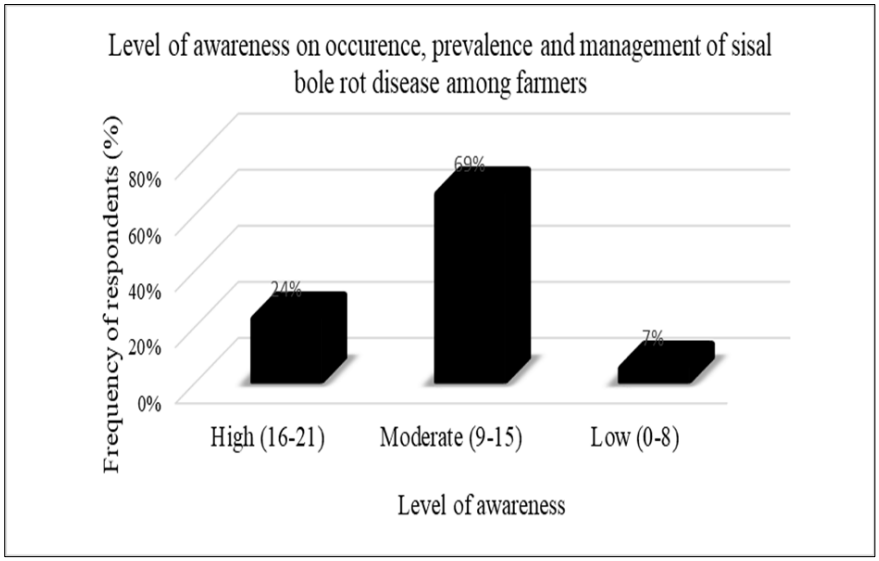
Source: Own compilation from survey data (2022).

Figure 3 Farmers awareness on occurrence, prevalence and management of sisal bole rot disease

Table 4 Categorization of farmers based on their level of awareness on occurrence, prevalence and management of sisal bole rot disease

Level of awareness	Frequency (n)	Percentage (%)
Low (0-8)	5	6.76
Moderate (9-15)	51	68.92
High (16-21)	18	24.32

Mean=13.03, SD=3.29, N= 74, Min=8 and Max=21



Source: Own survey data (2022)

Figure 4 Respondents level of awareness and their frequency

3.1.4 Correlation of selected social-demographic variables and production practices with the level of farmer's awareness

Table 5 Relationships between selected social-demographic variables and production practices with farmer's level of awareness on occurrence, prevalence and management of bole rot disease using Pearson product moment correlation

Variables	Correlation coefficient (r)
Age	0.0078**
Gender	0.0063**
Education	0.0006**
Experience (years) in sisal production	0.0006**
Sisal farm size (ha)	0.9541^{ns}
Full time sisal farmer	0.0044**
Hire labour to conduct farm work	0.5972 ^{ns}
Kind of planting material used to establish sisal field	0.0077**
Consideration of mother plants age during selection of planting materials	0.0022*
Disinfection of tools/machineries/cloth/shoes/hands	0.9835^{ns}
Application of lime in acidic soil, water logging areas	0.0053**
Use of fertilizers with (Ca) to prevent plant stresses	0.1183^{ns}
Times in a year for carrying out weeding in sisal field	0.0283*
Season of harvesting sisal crop	0.0051**
Removal and destruction of diseased plants	0.0158*
Attended training on sisal production	0.0009**
Adopted any new technology on sisal production	0.0022**
Number of adopted new technology on sisal production	0.2241^{ns}

**Correlation is significant at 1% level, * Correlation is significant at 5% level (2-tailed) and ns is not significant at 1% or 5% level of significance

Pearson product-moment correlation analysis was conducted to identify the relationship between selected social-demographic variables and production practices with the farmer's level of awareness on occurrence, prevalence and management of bole rot disease. Results in Table 5 shows that social-demographic factors such as age, gender, education level, and production practices such as experience on sisal production, full time sisal farmers, kind of planting material used to establish sisal field, consideration of mother plants age during selection of planting materials, times for carrying weeding in sisal field, harvesting season of sisal crop, removal and destruction of infected plants, ever attended training on sisal production, and adopted new technology on sisal production have significant relationship at 5% and 1% level of significance with the farmers level of awareness on occurrence, prevalence and management of bole rot disease. Factors such as farm size, hiring of labour, use of fertilizers with Calcium to prevent plant stresses, disinfection of tools/machineries/cloth/shoes/hands and number of adopted new technology on sisal production were identified to be non-significant at 5% and 1% level of significance with farmer's level of awareness on bole rot disease as they were not correlated.

4. Discussion

4.1 Farmer's awareness on occurrence, prevalence and management of bole rot disease

4.1.1 Socio-demographic characteristics of sisal farmers

The study on socio-demographic characteristics of sisal farmers found that most of the sisal farmers were male rather than female. This result tally with those of Marechera et al. [12] who reported that, males in Tanzania are more active in agricultural activities than females. Additionally, this finding is supported by Anitha et al. [13]who found that high

proportion of farmers in Ghana are males rather than females due to cultural differences. Furthermore, most of the sisal farmers were older farmers with no involvement of younger generation in sisal production sector. This data are consistent with most of the local studies on agriculture conducted in Malaysia by Adnan et al. [14] who found that, in Malaysia there are still having inadequate number of young farmers. Parthiban et al. [15] indicated that most of the oil palm smallholders were older farmers with less involvement of younger generation in the oil palm sector. Furthermore, Sebaggala and Matovu [16] in their research indicated that, although older farmers may be more experienced, which could have a positive effect on access to information; younger farmers are wanted in crop production as they may have a longer planning horizon hence vibrant in searching for information. This research found that, there was no farmer who did not have any formal education. This finding was in agreement with that of National Bureau of Statistics [17] in Tanzania who reported that over 80% of the populations in Tanzania mainland have attained primary education. Education level was directly related to the awareness of disease. In addition, the study conducted by Rizwan et al. [18] found that people who are more educated are more aware of the risks associated with plant diseases compared to less educated people. More than half of the sisal farmers were not full time sisal producers as most of them were self-employed and working on other business such as farming other crops, businessman, public and private employees, livestock keeper, fisherman and other occupations. Majority of sisal farmers acknowledged the contribution of sisal in their economy as it is the most source of family income, improve family living standards, provide self-employment and employment to others and whenever planted across the field borders was used as markers. The mean size of sisal farmers was 2.9 ha as majority of the farmers were small scale, having farm size of 1-2 ha and most of them have recently entered in sisal production sector. Previously, sisal cultivation was done by estates, big companies and not on small scale cultivation. This finding is supported by Catherine [2] and Tanzania Sisal Board [19]who indicated that sisal crop is mostly grown in large plantations owned by companies and currently there are 48 sisal estates but small scale farmers also grow sisal. FAO [20] as cited in Mwaniki and Baleko [21, 22] commented that, approximately 25% of sisal is produced by small scale farmers.

4.1.2 Sources of information on sisal bole rot disease among small scale and estate farmers in three wards of Muheza district

The study found that, majority of the sisal farmers depend mostly on their fellow sisal farmers and extension officers to obtain information on sisal production. This finding suggested that extension officers and farmers themselves play an important role in disseminating information, so it is necessary to equip extension officers and key farmers if not all with the right information. Farmers themselves play a big role and at a faster rate in disseminating information to each other especially if they have got the right information. Furthermore, some farmers were sourcing information from their friends and with the least amount of information sourced from village leaders, schools, posters, radio and Television and other sources included phones and internet. Radio and television are very effective in communicating to farmers who cannot read. This finding is in agreement with that of Javaid [23] who reported that friends and village leaders were among the most preferred and trusted source of agricultural information among rural community as it is easily and frequently available. Additionally, Mittal and Mehar [24] reported that, farmers extensively rely on other farmers and face-to-face interactions as their sources of information.

4.1.3 Farmers level of awareness on occurrence, prevalence and management of sisal bole rot disease

All sisal farmers interviewed had moderate level of awareness on occurrence, prevalence and management of bole rot disease and almost all have heard about the disease and more than half, their sisal fields are infected. This might be due to the fact that they all use suckers/stolons which might have been infected when establishing their new sisal fields. This finding is in agreement with those of Cruz-Magalhães et al. [3] who said that, most farmers use plantlets from stolons to establish new plantations, and infected plant material contributes to the spread of the disease to new areas. Farmers need to be educated on how to select healthy seedlings and encouraged to buy healthy seedlings from research institutes or recognized areas.

Additionally, majority of the sisal farmers had a basic understanding on sisal bole rot disease as they were able to identify the symptoms of bole rot disease which are wilting of leaves, yellowing of leaves at the stem base, plant internal tissues become brown with reddish border, bole starts to rot and death of plant. Furthermore, they managed to list different ways of spreading bole rot disease which are planting of affected planting materials, using contaminated tools/machineries and through contaminated clothes, shoes and hands. Majority of farmers were correctly able to identify methods of infection of the fungus and different management practices (preventive measures) for reducing sisal bole rot such as washing and disinfection of tools and machinery before and after farm work, disinfection of shoes, cloth, and hands before and after farm work, weeding the sisal farms, uprooting and destruction of infected plants, using of health planting materials, harvest when it is dry, application of lime material in areas with acidic soil and water logging areas and the use of fertilizers enriched with Calcium effectively in the fields to reduce the incidence of bole rot

disease. These results are in agreement with those of Jacobsen et al. [25] saying that, the establishment of new areas using healthy plant material is thought to be one of the most effective ways to prevent the introduction of the pathogen, removal and destruction of diseased plants from the plantations, avoid nutritional stresses through balanced fertilization to prevent stresses and disinfection of the tools used in diseased plants are other measures recommended to decrease the incidence and avoid the spread of the disease to new areas. Additionally, the results are supported by Cruz-Magalhães et al. [3] who indicated that, for the moment, preventive measures should be employed to avoid the establishment of the pathogen in the area. On the other hand Parthiban et al. [15] indicated that, there are few numbers of disease control and management techniques that can be applied to reduce long term losses due to Ganoderma disease and preventive control are such as sanitation by removal of diseased palms and usage of biofertilizers. Contrariwise, most of the sisal farmers were not aware that sisal plantlets at the nursery stage are mostly infected by *A.niger* and also unaware that bole rot is caused by fungus as great number of sisal farmers said it is caused by bacteria, virus, nematodes and others said they don't know. This might be due the fact that most of the sisal farmers had a basic understanding on bole rot disease and not in-depth knowledge of bole rot disease because most of them were obtaining information from their fellow farmers and some from their friends who might be having low level of awareness on bole rot disease. The finding is being supported by those of Parthiban et al. [15] who indicated that most of the respondents interviewed had a basic understanding on basal stem rot (BSR) rather than in-depth knowledge due to the fact that most of the respondents were referring to their friends as one of the source of information who themselves might have a limited knowledge on BSR. Therefore, extension services need to be easily and frequently available to sisal farmers as a way to encourage them to sought information from extension agents. Therefore, results of level of awareness on occurrence, prevalence and management practices on bole rot disease revealed that majority of the sisal farmers in the study wards had the basic knowledge on sisal bole rot disease and few who were unaware might be the new farmers who have just entered in the field of sisal production.

4.1.4 Correlation of farmer's production practices and selected demographic variables with farmers level of awareness on bole rot disease

The results for correlation analysis revealed that, there is a significant and positive relationship between education level and farmer's level of awareness on sisal bole rot disease. The educated farmers are more likely to be aware of recommended sisal production practices which reduce bole rot disease than those with less or no education. Results are more similar to those obtained by Muddassir et al. [26] found that more educated farmers were more likely to adopt the recommended crop production practices than those with less or no education. The educated farmers could expedite technology uptake and impact positively on any developmental program executed in the management of bole rot disease in the wards. Grimaccia and Naccarato [27] said that education plays a vital role in the adoption process because it is easy to understand and getting required information by educated persons than the illiterate ones. Ashraf et al; Rahaman et al. [28, 29] documented significant relationship between education and awareness and indicated that, education develops sense among farmers to adopt the cost effective technologies.

Additionally, the results indicate that there was existed positive relationship between age and awareness of sisal farmers on bole rot disease. Farmers who were aged had high level of awareness than the young ones. This finding is in line with those of Ashraf et al. [28] which infer that, as the age of the farmers' increase, maturity increase which may boosts the interest to acquire new information. On contrary, this finding differs from that of Bagheri et al.; Chia et al. and Khan et al. [30-32] who were of the view that, age and awareness of farmers have a negative association. These authors said that with the age increasing, interest to seek new information goes down.

Furthermore, the analysis revealed that farmers who work full time on their sisal farm had high level of awareness on bole rot disease as they are more committed in seeking knowledge compared to non-full time farmers. Parthiban et al. [15] reported that, farmers who spend more time at farm tend to have high level of awareness as they are able to identify any unusual problems at their farm and seek appropriate solution. These farmers hire little external labour to conduct their farm works such as planting, weeding and harvesting. Experienced people in sisal production practices have high level of awareness on occurrence, prevalence and management of bole rot disease as indicated in the correlation analysis because they gain more knowledge based on their long years of experience. These results coincide with those reported by Šūmane et al. [33] that, extensive training need to be given to farmers as a way to increase their experience which will eventually result in to higher level of awareness. The analysis of correlation between production practices with farmers level of awareness revealed that farmers who were able to carry out production practices, which are management practices for reducing bole rot disease such as to consider the kind of planting material to be used to establish sisal field, the age of the mother plants before harvesting planting materials, application of lime in acidic soil and water logging areas to reduce plant stresses, removal of infested plant materials from the fields, carrying out weeding in sisal field to keep the farms clean, do harvesting during dry seasons, attended training and adopted any new technology on sisal production are those with high level of awareness on occurrence, prevalence and management of

bole rot disease because they manage to apply different management practices in their sisal farms to reduce the disease prevalence but respondents with low level of awareness were unable to carryout management practices in their sisal fields during sisal production. There was a significant correlation between most production practices variables and the level of awareness showing that respondents understood management practices for reducing sisal bole rot disease and they were able to apply them correctly in the field without affecting the development of sisal plants. Cruz-Magalhães et al. [3] indicated that mechanical lesions in sisal plants are used by the pathogen as penetration sites, and this has direct implications for crop management since leaf harvest causes wounds in the plant. The establishment of new areas using healthy plant material is thought to be one of the most effective ways to prevent the introduction of the pathogen. Removal and destruction of diseased plants from the plantations and application of agricultural lime in highly acidic soils are measures recommended to decrease the incidence and avoid the spread of the disease to new areas. This coincides with sisal production guideline [34] which indicated that the fungus causes a basal dry rot when it enters the base of the bole through damage and recommended that, application of calcium-rich fertilizers in waterlogged, application of agricultural lime in highly acidic soils, removal of infested materials from the field and harvesting under dry conditions reduces the disease incidence. These production practices could only be done by farmers with high level of awareness on bole rot disease.

It is clearly shown that, respondents who attended training on sisal had better level of awareness on bole rot disease as compared to respondents who did not attended any training. Similarly, adoption of new technologies by farmers on sisal production had significant correlation to the level of awareness on bole rot disease. Therefore, extension offices should introduce and increase the number of trainings and new technologies to sisal farmers. Parthiban [15] indicated that, adoption of new technology contribute significantly towards the level of awareness. This is so because farmers who are adopting new technology are always acquiring the latest information thus increasing their awareness. Better transfer of technology need to be introduced to sisal farmers to increase their participation thus increasing their level of awareness.

5. Conclusion

The objective of this study was to identify level of awareness on occurrence, prevalence and management of bole rot disease in small scale and sisal estates farmers in Muheza district. It was revealed from the Pearson product-moment correlation analysis that, some selected social-demographic variables such as age, education, gender, and experience in sisal production, full time sisal farmers together with several sisal production practices done by farmers in their sisal fields had significant relationship with the level of awareness on occurrence, prevalence and management of bole rot disease. Farmers who are able to carry out production practices in their sisal field had high level of awareness on bole rot disease than those who are not able to practice the above identified production activities. Since majority of sisal farmers depend much on extension officers and their fellow sisal farmers as their main source of information on sisal production, extension services need to be easily and frequently available to sisal farmers as a way to increase their participation in extension programs to increase their awareness. Based on the findings of this study, it has been recognized that education is important for improving farmers' awareness regarding occurrence, prevalence and management of bole rot disease. Extension office in Muheza district should prepare a comprehensive training module on bole rot disease and introduce it to sisal farmers as a way to increase their awareness. One of the limitations of this study is that it only involved sisal farmers from three wards of Muheza district rather than farmers from all areas of sisal production in Tanzania. While the study greatly helped in identifying level of farmer's awareness on occurrence, prevalence and management of sisal bole rot disease in three wards of Muheza district, it is difficult to generalize the results to the entire sisal growers in Tanzania. Therefore, further study should be conducted comprising respondents representing farmers from all sisal growing areas in Tanzania.

Compliance with ethical standards

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Disclosure of conflict of interest

No competing interests.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Author Contributions

Conceptualization up to development of the manuscript: MZM; review, editing and supervision of the work: PJN

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