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Research Article

Geographical Distribution, Diversity and Production of Banana and Plantain in Malawi

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Abstract

Banana (*Musa* spp.) is an important staple and cash crop in Malawi, yet its production has declined sharply over the past two decades due to widespread cultivar loss, pests, diseases, and climatic pressures. This study provides an updated assessment of the geographical distribution, diversity status, and production constraints of banana and plantain cultivars across ten districts. Using 110 survey sites, household interviews, focus group discussions and direct field observations, a total of 27 distinct cultivars were recorded. Cultivar richness per district ranged from 3 to 10, with Karonga exhibiting the highest diversity and Rumphi the lowest. Shannon–Wiener diversity indices (H′) varied widely, from 0.7356 in Rumphi to 2.2719 in Karonga, while evenness values ranged from 0.7414 to 0.9867, indicating variable. Zibowa was the most abundant cultivar nationally (15.06%), whereas Kabuthu, once dominant in Malawi, was now extremely rare (0.6%). Farmers reported significant cultivar erosion over the past 20 years, with 91% attributing losses to Banana Bunchy Top Disease (BBTD). The most preferred cultivars remained William, Kabuthu, Sukali and Ndoki. The findings demonstrate marked genetic erosion and highlight the urgent need for strengthened germplasm conservation, enhanced clean-seed systems and targeted breeding initiatives to restore banana production resilience in Malawi

Keywords: *Musa spp, Diversity indices (H), cultivar evenness, cultivar diversity, Genetic erosion.*

Introduction

Banana (*Musa* spp.) is a significant food and cash crop that plays a substantial role in ensuring global food security (Alemu 2017). The crop is cultivated in various countries, predominantly within the warm, humid tropical regions of the world, which are characterized by plentiful precipitation. These regions include Africa, Latin America, the Caribbean, Asia, and the Pacific (Anuradha et al. 2025). In Africa, more than 70 million individuals obtain 25% of their dietary energy from bananas and plantains. (Edward and Fredy, 2012). Bananas can be eaten in several ways, such as raw, cooked, baked, steamed, or fermented (Fungo and Pillay, 2011). Bananas are perennial crop that produce fruits all year around thereby help “bridge” the hunger and income gap between crop harvests. The popularity of the crop makes it a good food and cash crop for smallholder farmers. Production of the crop in Malawi is dominated by locally evolved cultivars and its production has expanded to non-traditional growing districts and marginal areas (Soko et al. 2009). In both food security and income generation (Olufomi 2024), bananas are ranked sixth in Malawi after maize, rice, groundnuts, vegetables and beans (Malawi Government 1995). In some northern parts of Malawi, bananas are the staple food. Cooking bananas (Bluggoe and Pisang awak, both ABB genomes) and Plantains (both French and Horn plantains, AABs) are used in these areas mostly as food. Most of the bananas in Malawi are produced on small plots of < 0.5 ha (Soko 2009).

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Bananas generally exhibit robust growth in regions characterized by an optimal mean monthly temperature of 27°C, with a minimum mean annual temperature of 12-13°C being a prerequisite for successful cultivation (Kumbirai et al. 2022). The plant exhibits a high degree of water affinity, requiring approximately 25 millimeters per week for optimal growth. The annual rainfall required by bananas is between 1500 and 2500 millimeters. However, with effective management or irrigation systems, bananas can thrive in regions with a mean annual rainfall of 1200 millimeters or less. The prevalence of banana production in the Thyolo Highlands and Mulanje, Malawi, can be attributed to the conducive environmental conditions that prevail in these regions. With the exception of the Thyolo Highlands, banana production in other regions of the country is limited in scale. Although the production levels in other regions of the country are not significant, the implementation of irrigation schemes has enabled the plantations to yield high-quality fruits.

Despite its importance, banana production in Malawi has faced unprecedented decline. The most devastating factor has been the spread of Banana Bunchy Top Disease (BBTD), caused by Banana Bunchy Top Virus (BBTV) and transmitted by the banana aphid *Pentalonia nigronervosa* (Niyongere et al. 2012). The BBTD was first noted in Malawi around Thiwi area in Nkhotakota in 1994 but confirmed in 1997 (Kenyon et al. 1997). Since then, the disease has ravaged Cavendish plantations and contributed to the disappearance of several locally important landraces. Its impact has been compounded by climate variability, declining soil fertility, land limitations, and socio-economic constraints that restrict farmers' ability to renew infected fields with disease-free material.

Although earlier studies such as Gondwe (2004) and Changadeya et al. (2009) documented cultivar richness and diversity patterns, these assessments were conducted before the extensive spread of BBTD. Thus, there has been a significant knowledge gap regarding how cultivar distribution and diversity have changed in the post-BBTD era. This study therefore sought to provide an updated national overview of banana and plantain diversity, with specific focus on identifying the current distribution of cultivars, understanding the extent of cultivar disappearance, documenting farmer preferences and examining production constraints shaping the banana sector today.

Materials And Methods

Study Area

The present study was conducted in the year 2025 at one hundred and ten sites covering ten districts under six Agricultural Development Divisions (ADDs). The districts represent five traditional banana growing districts thus Thyolo, Mulanje, Nkhotakota, Nkhatabay and Karonga and five non-traditional banana growing districts thus Dowa, Kasungu, Mzimba, Mchinji and Rumphi (Figure 1). The majority of the district's populations are smallholder farmers under Extension Planning Areas (EPAs) in the districts.

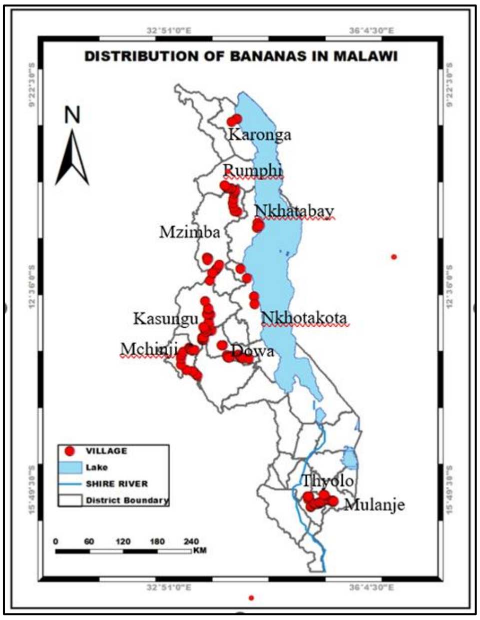

Fig 1: Distribution of Bananas Malawi

Field survey data collection
The study employed focus group discussions, household surveys and direct field observations. A structured questionnaire was designed and used to meet the objective of this study. Data collection in this research used KoBo Collect/Toolbox as a data collection instrument. The use of KoBo Collect/Tollsbox was in the form of questionnaires that was filled summarily in a smartphone. At the beginning of each interview the objective of the survey was explained to the farmer/respondent in the local language and their consent was obtained. The questionnaire was administered to the farmers by the interviewers who filled the corresponding question according to the farmers' response to the questions. The data were collected through questionnaire survey from a stratified random sample of farmers. Extension/Agricultural officers in the districts were contacted to assist in identifying important banana growing areas in the districts.

Data Analysis
The collected data were analyzed using Microsoft excel software. Descriptive statistics was applied to determine the relative frequency and abundance of the cultivar. Cultivar proportions per district were determined by measures of cultivar abundance and were explained by determining cultivar richness and evenness. The cultivar richness and evenness in the study were determined through cultivar diversity indices based on; Shannon-Weaner diversity index:
Diversity Index (DI) = -Σpi ln pi

$$H' = -\sum_{\infty}^{s} (p_i)\,[\ln(p_i)]$$

Where s = Number of cultivars (or varieties);
pi = The proportion of individuals or the abundance of the ith cultivar; expressed as a proportion of the total sample;
ln = Natural logarithm
Shannon's equitability/evenness, calculated as:
Equitability (EH) = DI / DI max = DI / ln S
Where: S = Total number of cultivars

Results And Discussions

Geographical distribution and diversity
Figure 1 illustrates the results of coordinate data generated by Kobo Collect/Toolbox about the location where data on geographical distribution, production and diversity of banana and plantain in Malawi was collected. In the present study, thirty-seven cultivar names were documented, but this number was reduced to twenty-seven names after known synonyms were replaced with standard names. Cultivar number per district ranged from three to ten (Figure 2). Karonga district recorded the highest (ten) number of cultivars while Rumphi had the lowest (three). The number of cultivars on individual farmer ranged from one to four. Nonetheless, government institutions such as Thuchira Residentional Tranning Centre (RTC) and Research stations had higher number of cultivars but were not utilised in this study.

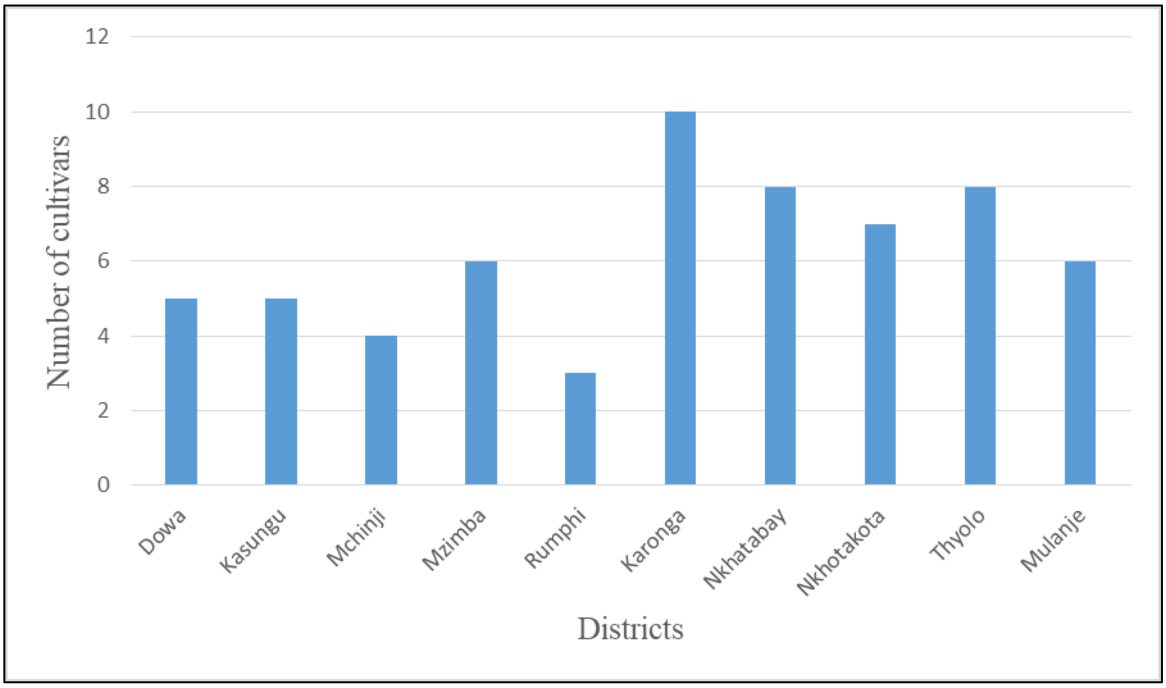

Fig 2: Number of cultivars currently in the districts

The list of identified cultivars of banana, along with their respective distribution areas, are enumerated in Table 1. The current distribution and diversity of different banana and plantain cultivars was mainly as a result of the banana bunchy top disease, land pressure and plant nutritional problems. A few cultivars were widespread but absent from some districts (Table 1). The most widely distributed banana cultivar per district was Zibowa while Kabuthu was very rare (Table 1). William cultivar was widely distributed across all districts (Table 1). Our results recorded an increasing reduction of banana cultivar diversity. Hence, certain banana cultivars have become rare or completely disappeared in some areas. The results of the present study stand in contrast to those previously reported by Gondwe (2004). The study identified Kabuthu and Mulanje (Cavendish) as the most prominent and extensively disseminated banana cultivars in Malawi. Zibowa and Kabuthu landraces exhibit distinctive genetic characteristics that set them apart from other varieties. Zibowa possesses a pivotal characteristic that fosters its resilience against strangely high temperatures, infestations, pathogens, and variable climatic conditions. Kabuthu is susceptible to pests and diseases, which have led to its local extinction in certain areas in the districts and have diminished the gene pool available for breeding new, resilient crop varieties. A narrow range of crop varieties causes a state of heightened vulnerability with respect to crop failures (Begna 2021). Conversely, the implementation of diverse cropping systems has been demonstrated to produce greater resilience in the face of environmental stresses, thereby enhancing food security.

Table 1: Distribution and diversity of banana cultivars in Malawi

NUMBER	**Cultivar name**	**Genome**	**DA**	**KU**	**MC**	**KK**	**NB**	**MZ**	**RU**	**KA**	**TO**	**MJ**	**TOTAL**	**Abundance (% of plants)**
1	Kasolokoto		5										5	3.01
2	Nakasuga		4										4	2.41
3	Magombo		2	2				1					5	3.01
4	William	AAA	2	4	1	1	1	1	1	1	5	3	20	12.05
5	Sukali	AAB	1	4	5								10	6.02
6	Zomba red	AAA		1		1				1			3	1.81
7	Zambia	ABB				4	2	12	6				24	14.46
8	Kabuthu	AAA						1					1	0.60
9	Mbirindola	ABB				1		1					2	1.20
10	Chizete							1	1				2	1.20
11	Makumbuk	ABB			8								8	4.82

	a													
12	Kasisi	AAA			1		1						2	1.20
13	Katuma	AAA				1				1			2	1.20
14	Harare	ABB		10			1			2			13	7.83
15	Mulanje	AAA								1	1		2	1.20
16	Grand 9	AAA								1	1		2	1.20
17	Nzeru	AAB				1	1						2	1.20
18	Chituwitsa						1			1			2	1.20
19	Zibowa	ABB				1					17	7	25	15.06
20	Kambani	AB						1		1			2	1.20
21	FHIA 17	AAAA									3		3	1.81
22	Zanda	ABB									11	6	17	10.24
23	FHIA 21	AAAB									1	1	2	1.20
24	FHIA 25	AAB										2	2	1.20
25	Katuma						1			1			2	1.20
26	Muli	AAA									1	1	2	1.20
27	Ndoki	AAB					1			1			2	1.20

DA=Dowa, KU=Kasungu, MC=Mchinji, KK=NKhotakota, NB=Nkhatabay, MZ=Mzimba, RU=Rumphi, KA=Karonga. TO=Thyolo, MJ=Mulanje

Shannon Weaner diversity

The study has demonstrated significant regional heterogeneity in banana cultivar variety throughout Malawi, as quantified by the Shannon–Wiener index (H′) and Pielou's evenness (E) (Table 1). The significant diversity in Karonga (H′ = 2.2719) and Nkhatabay (H′ = 2.0432) indicates that these northern districts serve as refugia for banana genetic resources. Such concentrations of diversity are characteristic of areas where traditional agroforestry and mixed-cropping systems are preserved, facilitating the enduring presence of numerous cultivars (Ruas *et al.,* 2017; Karamura *et al.,* 1996). The remarkably high evenness in these districts (E > 0.98) suggests a nearly uniform distribution of cultivars, hence augmenting ecological and disease resilience in smallholder banana systems (Jarvis *et al.,* 2008).

Table 2: Diversity indices for different cultivar groups in the study areas in Malawi

Study Districts	Diversity indices (H)	Cultivar Evenness
Dowa	1.47013	0.91344
Kasungu	1.35393	0.84124
Mzimba	1.2338	0.6340
Rumphi	0.7356	0.6696
Karonga	2.2719	0.9867
Nkhatabay	2.0432	0.9826
Nkhotakota	1.3863	0.8614
Mchinji	1.0629	0.7667
Thyolo	1.5418	0.7414
Mulanje	1.5493	0.8647

The continued existence of various landraces in the northern lakeshore districts aligns with past trends of BBTD dissemination. Epidemiological studies indicate that Banana Bunchy Top Virus (BBTV) generally disseminates progressively from initial epicentres, while peripheral or distant areas sustain elevated genetic diversity for extended durations (Kumar *et al.,* 2015). The inaugural confirmed epidemic of BBTD in Malawi transpired in the mid-1990s in central Malawi (Kenyon *et al.,* 1997), elucidating the subsequent delayed disease pressure in northern areas, which consequently maintained greater diversity.

Conversely, Rumphi has the lowest diversity (H′ = 0.7356), signifying a pronounced diversity bottleneck marked by the predominance of one or two surviving cultivars. Such declines are extensively recorded in banana-producing areas affected by extended viral and fungal outbreaks, where vulnerable AAA-genome cultivars are deliberately eradicated, resulting in a limited residual genetic pool (Dale *et al.,* 2017). A low evenness score (E = 0.6696) further corroborates the idea of asymmetrical cultivar survival influenced by selection disease pressure.

The intermediate diversity levels recorded in Nkhotakota, Thyolo, and Mulanje (H′ = 1.3863–1.5493) presumably indicate districts that have seen epidemic pruning, subsequently stabilising around more hardy AAB and ABB cultivars. This pattern aligns with research in East and Central Africa, indicating that B-genome–rich cultivars have enhanced tolerance to BBTV, drought, and nutrient-deficient soils (Nyine *et al.,* 2017). Their modest evenness ratings indicate that despite a reduction in cultivar richness, the remaining cultivars are still quite widely dispersed.

Mzimba and Mchinji exhibit relatively low diversity (H′ < 1.25), characteristic of non-traditional banana-growing areas where cultivar introductions transpire through restricted avenues, frequently dominated by a limited selection of popular cultivars provided by government or NGO initiatives (Tripathi *et al.,* 2019). Such systems typically exhibit inadequate genetic buffering, rendering them more vulnerable to disease outbreaks and environmental stressors (Ruas *et al.,* 2017). On the other hand,

Dowa and Kasungu districts exhibited moderate variety with relatively high evenness (E = 0.84 – 0.91), indicating they are in transitional states. Their diversity profiles indicate continuous adaptation processes, either via the persistent loss of sensitive cultivars due to BBTD exposure or through gradual diversification facilitated by farmer-to-farmer exchange of planting materials (Van den Bergh *et al.,* 2012).

From a genetic conservation perspective, the high-diversity regions of Karonga and Nkhatabay serve as essential reservoirs for Malawi's banana germplasm. Comparable proposals have been highlighted in many African nations where variety hotspots function as crucial resources for breeding, disease recovery, and climate adaptation initiatives (Ortiz & Swennen, 2014). In contrast, the low-diversity areas, including Rumphi and Mchinji, necessitate immediate action to prevent more genetic erosion, in accordance with global guidelines for protecting clonally propagated crops under epidemic pressure (Jarvis *et al.,* 2008; Dale *et al.,* 2017).

Cultivar Disappearance

A number of banana cultivars were reported to have disappeared in some areas. All the respondent interviewed in the ten districts acknowledged loss of some cultivars in their areas over the last twenty years. Cultivars recorded to have disappeared include; Kabuthu, Molele, Ngerezi, Phwiza, Bondo, Mzungu mtuwa, Kazizi, Zomba red and Mulanje. Diseases were recorded as the highest cause (described by 91% of farmers) of cultivar disappearance in all districts (Figure 3). To be specific banana bunchy top disease was mentioned as the main disease of banana in Malawi. Kabuthu, Molele and Mulanje were the most affected cultivars by the disease. The disease could explain the decline in the ranking of Kabuthu previously reported as the most popular cultivar in Malawi by Gondwe (2004). Changadeya at al. (2009) find larger number of banana cultivars in Malawi than the present study. The other cause of cultivar erosion comprised poor soils (6%) and poor suckering ability (3%) of some cultivars such as Ndoki (Figure 3).

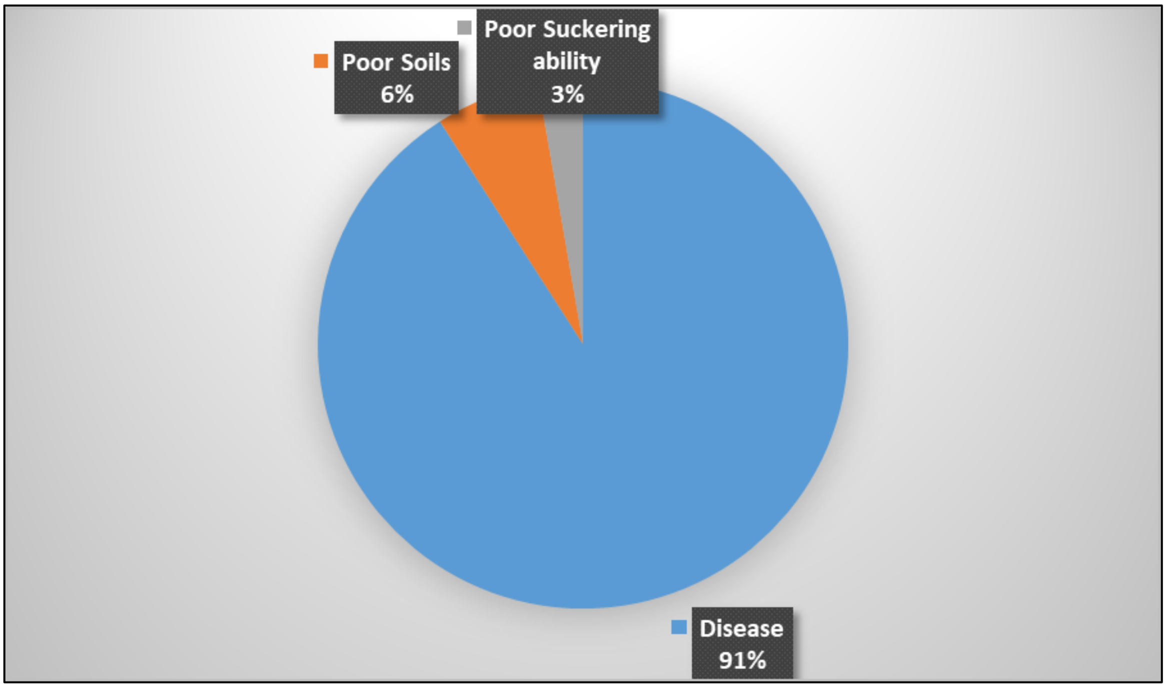

Figure 3: Causes of cultivar disappearance

Sources of banana suckers

Three main sources of banana planting materials were recorded. These were; 1) Research stations/department of crop development (DCD) (Government); 2) Own plantation and; 3) Local markets/other farms. Most farmers in Dowa (63%), Kasungu (68%), Mzimba (67%), Rumphi (75%), Mchinji (42%), Karonga (75%) and Nkhatabay (100%) sourced their planting materials from existing own plantation (Figure 4). Only Thyolo (68%) and Mulanje (57%) recorded highest banana planting materials sourced from research station and DCD, government service providers. Farmers also sourced planting materials from local markets, relatives, and neighbors. However, most farmers could prefer to source banana planting materials from research stations and DCD because they could be ensured of getting clean planting materials free from pests and diseases. Nevertheless, there were some key reasons why farmers sourced banana planting materials from elsewhere: 1) insufficient banana planting materials available in their own orchard; 2) interest in other varieties, and; 3) observation of high-performance bananas (high yielding varieties) on somebody's farm.

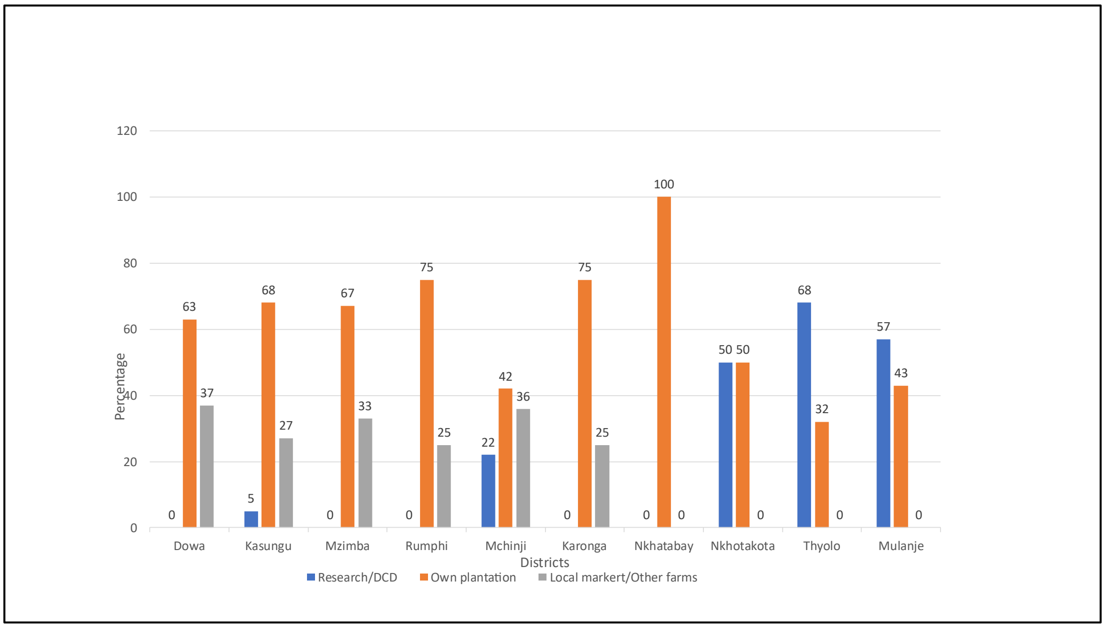

Figure 4: Sources of banana suckers

Preferred cultivars and use of banana in Malawi

Farmers' preference for banana cultivars was mainly based on Fruit taste, bunch size, Marketability and stress tolerances. However, some traditional practices prompt farmers to maintain small cultivars that may have low productivity. In this present study most, farmers used bunch size (53%), marketability and fruit taste (24% each) as the key criteria for selecting cultivars (Figure 5). Preference by farmers play important role in the diversity of cultivars. Consideration of the farmers' cultivar choice at the beginning of a breeding program enables plant breeders to be more focus on the objectives. This will help breeder to produce banana cultivars that are more likely to be accepted by the farmers.

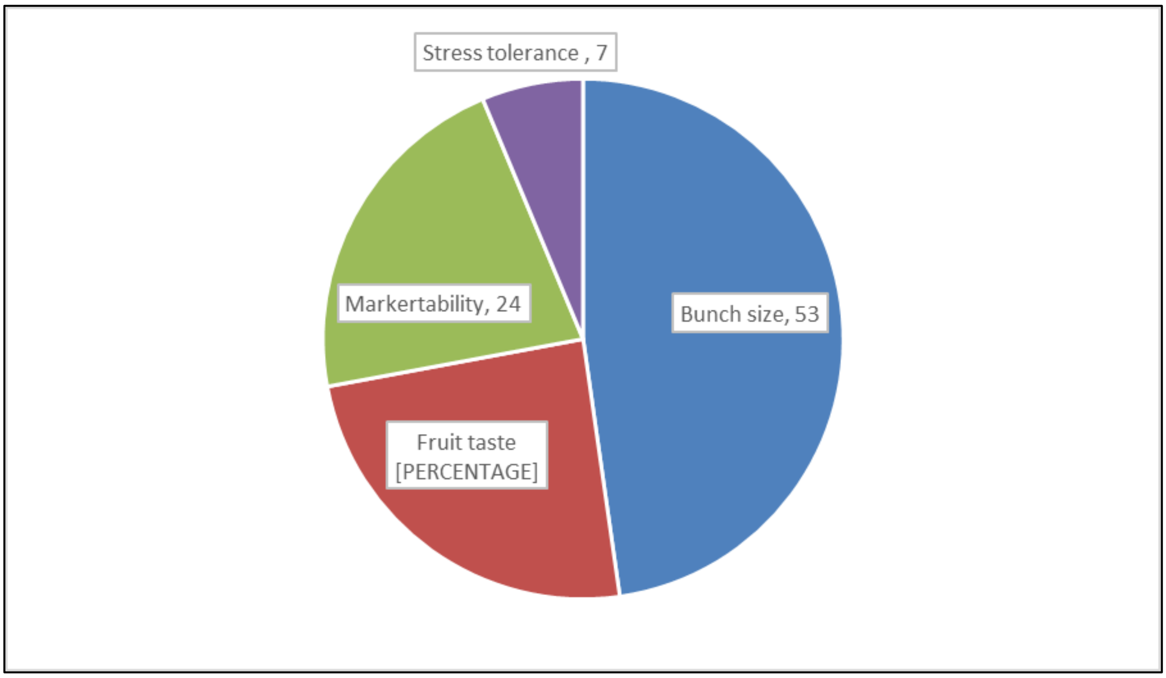

Figure 5: Farmers' preference for banana cultivars

The most preferred banana cultivars in the present study were William, Kabuthu, Sukali and Ndoki (Figure 6). Physically and physiologically, these cultivars display different characteristics. William was chosen because the cultivar has a big bunch size with good taste and it's a quick maturing cultivar. The variety also fetches good prices on the market. Kabuthu and Sukali have good sweet taste and produces many suckers which farmer can sale or used to expand their orchard, unlike Ndoki which produces few suckers. Although Ndoki was rare but it was recorded as one of the preferred cultivars in Malawi especially in Karonga.

Banana plant parts are utilized differently in different societies in Malawi. Ndoki is commonly used as staple food. It is eaten as boiled or stewed. All banana plant cultivars depending on districts were used as livestock feed, domestic material, shelter, ornament, medicine, ceremonial and ritual events, and many other uses and the banana leaves was used for cooking delicacies by wrapping in banana leaves.

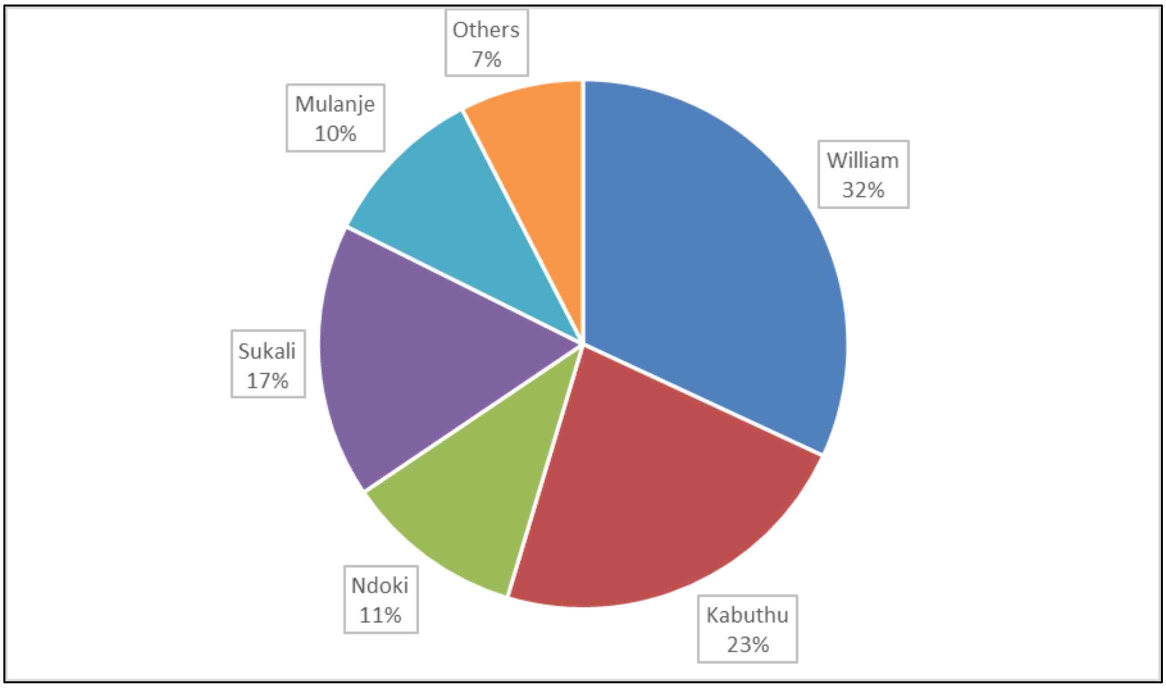

Figure 6: Preferred cultivars of banana in Malawi

Production constraints

Different production constraints were identified and varied between districts. Diseases (37%) and lack of clean planting materials (35%) were recorded as the most important constraints and cutting across all surveyed districts (Figure 7). Banana Bunchy Top, Black Sigatoka, Fusarium Wilt (Panama disease) and Banana Xanthomonas Wilt were among the diseases identified. Sarkar and Das (2024) reported that these constraints are further complicated by genetic uniformity of the crop, which is prone to the diseases. Similar constraints were reported by Davies (1995) with Banana bunchy top as the most devastating disease (Soko 2009). The diseases were variety dependent, with high incidences of banana bunchy top in all districts where Cavendish varieties with A genome were heavily affected compared to varieties like Zambia, Zanda and Zibowa with B genome. Drought, low soil fertility, lack of enough land and poverty were among the major production constraints in the ten surveyed districts. Banana farmers manage drought stress by mulching and irrigation. This is in agreement with scientific facts observed by Fandika et al. (2014) who concluded that it is ideal and profitable to produce banana under supplementary irrigation (100% ET) other than non-irrigated. Poor soil fertility was managed by applying manure, lack of enough land by intercropping. Bananas were cultivated together with other food crops which included potato, cassava, common beans, soya beans, tomato and coffee. This practice helped farmers to ease land shortage.

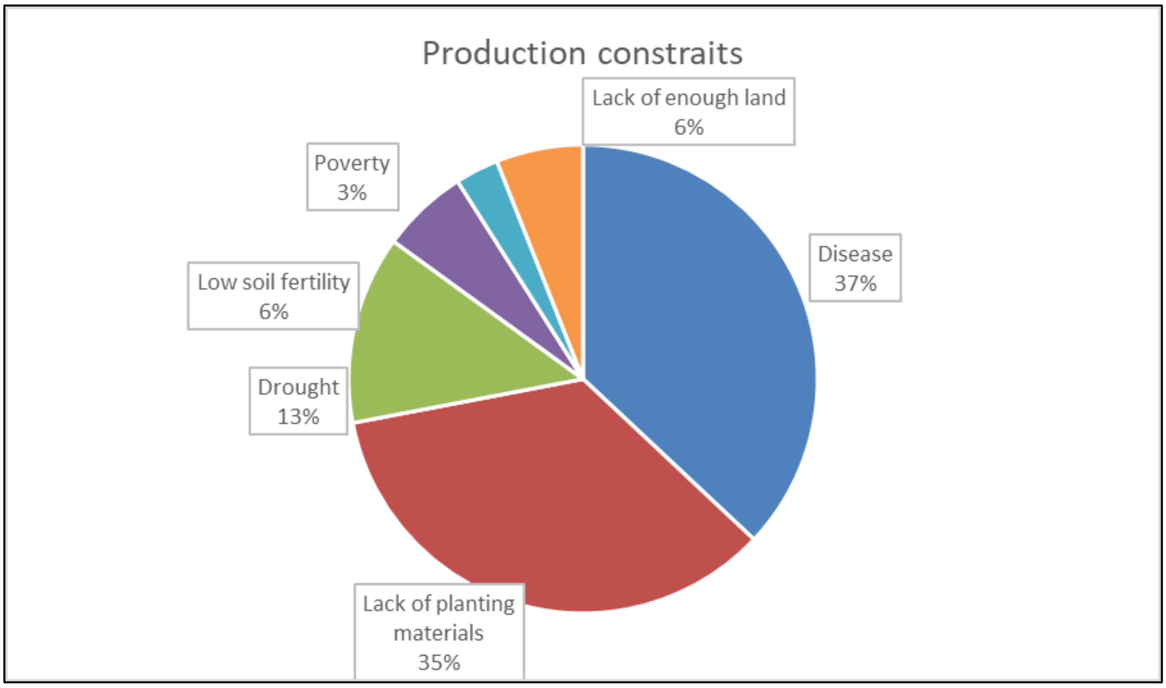

Figure 7: Banana production constraints

Conclusions and Recommendations

This study demonstrates a marked decline in banana cultivar diversity in Malawi compared to earlier assessments. Several cultivars have disappeared entirely from some districts, and once-dominant varieties such as Kabuthu have become rare. BBTD remains the most serious threat to banana production and is the leading driver of genetic erosion. Other challenges, including drought, nutrient-poor soils, limited land availability and socio-economic constraints, further undermine production.

The study highlights the urgent need for a coordinated national approach to banana conservation and recovery. Germplasm conservation, particularly through tissue culture and field gene banking, is critical for preserving the remaining diversity and preventing further losses. Expanding the production and distribution of clean planting materials, strengthening surveillance and diagnostic systems for BBTD, and promoting the cultivation of disease-tolerant and farmer-preferred cultivars can help rebuild the sector. Integrating conservation strategies into national agricultural policy and extension programs will be essential for restoring banana production resilience and ensuring sustainable food security.

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