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Case Report

Maize Landraces Amidist Highly Marketed Hybrid Maize Seed – A Potential Risk to Household Food Security for Small-Scale Farmers

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Abstract

Maize production has played an increasing and diverse role in global agriculture food systems. For example, worldwide production has increased from 318 million metric tons in 1973 to 1.2 billion metric tons in 2022, growing at an average annual rate of 3.04% more than any cereal crop. While this trend corresponds with a sharp increase in hybrid maize cultivation, it has seen a sharp decrease in maize landrace cultivation. This was revealed during the study that investigated the prevalence of hybrid maize seeds and maize landraces cultivation among small-scale farmers in Zambia particularly Pemba District of Southern Province. In terms of the methods, the study utilised a mixed- approach to data collection, semi-structured questionnaire, interview guide, and focus group discussion. A sample size of 76 Small-scale farmers and 18 key informants were interviewed leading to descriptive and thematic analysis. The results showed that hybrid maize poses a huge threat to the cultivation and existence of maize landraces as only 4% of the smallholder farmers cultivated landraces in Pemba District. This situation is fuelled by anti-maize landraces and pro-hybrid government policies which present a risk of maize landraces extinction and a missed opportunity by the government to increase the staple food, eliminate the cost of hybrid maize seed from the farmer, and reduce rural poverty. Without deliberate action to address this problem, the smallholder agricultural food system will remain more vulnerable to climate change, leading to compromised food security. It is therefore recommended to the government to embark on promoting maize landraces as they have the advantage of being recycled to help farmers achieve household food security at a minimal cost.

Introduction

Maize is one of the world's leading staple cereals cultivated on approximately 200 million (ha). It is an established and important human food crop in several countries, especially in Sub-Saharan Africa (SSA), Latin America, and a few countries in Asia, where maize consumed as human food contributes over 20% of food calories [1]. Maize originated from Mexico and was domesticated about 9,000 years ago in the Tehuacán Valley in the Mexican highlands by indigenous people. Later, it was spread to the Mexican lowlands, other regions of Latin America, the Caribbean, New Mexico and Arizona. During the first millennium, maize cultivation spread more widely to northern America and Canada. After European contact with the Americans in the late 15th – early 16th centuries,

explorers and traders carried maize to Europe, and from there to Asia and Africa [2]. Globally, it is not clear how many countries cultivate maize landraces, but it is understood that maize in general is cultivated in more than 170 countries across different continents, including regions of Africa, Latin America, Asia, and even parts of Europe where traditional farming practices have been maintained [2]. In Africa, maize is life to more than 300 million of Africa's most vulnerable populations and is Africa's most important cereal food crop [3]. Just like at global level, there is limited data of how many countries cultivate maize landraces in Africa, but it is said that 51 African countries are maize dominated economies [2]. In Zambia, maize is the single most important crop widely grown by smallholder farmers, representing the vast majority (approximately 90 percent) of Zambia's agricultural producers [4]. It is the country's staple food, accounting for about 60 percent of national calorie consumption and serving as the dietary mainstay in central, southern, and eastern Zambia [5]. Zambia annual average maize production is said to range between 3 to 3.6 million metric tons [6], and consumes approximately 2.4 million metric tons [7]. Maize is also the main source of income (cash crop) for smallholder farmers who occasionally sell their surplus to private companies and the government. It accounts for 41 percent of the smallholder farm's gross income and 33 percent of total household crop sales [8]. Most of the country's maize (90%) is produced by smallholder farmers [9]. As such, the importance of maize in ensuring household income, food, and nutrition security, especially among the rural population which is the majority of the country's population (60%) cannot be overemphasized [10]. A huge challenge facing most of Sub-Saharan Africa (SSA) countries like Zambia is to increase maize productivity of smallholder farmers, which has remained very low over the past decades [3]. Until the 1960s, smallholder farmers were dependent on landraces for maize production. A landrace is a 'dynamic population(s) of a cultivated plant that has a historical origin, distinct identity, and lacks formal crop improvement, as well as often being genetically diverse, locally adapted, and associated with traditional farming systems' [11]. Around the late 1960s, however, hybrid maize seeds were introduced to smallholder farmers as "improved seeds" to increase maize productivity and profitability in the country. Coupled with the government's extensive promotion mainly through subsidies, hybrid maize seed adoption took hold in the smallholder farming system very quickly, a trend that has continued up to date. In the face of this rapid adoption of hybrid maize seed among smallholder farmers, the cultivation of maize landraces is rapidly decreasing and widely being forgotten, relegating them to the status of Neglected and Underutilized Crop Species (NUCS). However, maize landraces have been identified as "having [the] potential to reduce food and nutrition insecurity, particularly for resource-poor households in Sub-Saharan Africa…because of their adaptability to low input agricultural systems and nutritional composition" [12], as well as their drought resistance [13]. Hence, the study aim: to understand how maize landrace cultivation has evolved in the face of highly marketed hybrid maize seed and what this means for food security among small-scale farmers.

Discussion

Study Background and Context

Over the years, agriculture has been regarded as the backbone of countries' economic development and a significant tool to end hunger and poverty in many countries. The sector produces various agricultural products that contribute to food security, nutrition, and countries' Gross Domestic Product (GDP). One crop that has survived and established itself as a reliable crop and providing food security is maize. Since its domestication some 9,000 years ago, maize (Zea mays) has played an increasing and diverse role in global agriculture food systems. Globally, it is cultivated on approximately 200 million (ha) and as stated in the above pages, its worldwide production has increased from 318 million metric tons in 1973 to 1.2 billion metric tons in 2022 growing at an average annual rate of 3.04% more than any cereal crop. Maize is an established and important human food crop in several countries, especially in SSA, Latin America, and a few countries in Asia, where maize consumed as human food contributes over 20% of food calories [1] [11].

In Africa, maize is life to more than 300 million of Africa's most vulnerable populations and is Africa's most important cereal food crop [3]. It occupies approximately 24% of farmland and the average yield stagnates at around 2 tons/hectare/year [14]. Africa's maize production is on average around 90 million metric tons per year and is cultivated on approximately 40.7 million (ha) of land which is approximately 20.9% of world area planted to maize [3]. It accounts for approximately 7.5% of world maize production [15], and its average annual consumption is said to be around 37 million metric tons per year [16]. In Zambia, the annual average maize production is said to range between 3 to 3.6 million metric tons per annum [6], with an annual consumption of approximately 2.4 million metric tons [7]. It is the single most important crop widely grown as staple food, accounting for 72% of total crop production in the 2021/2022 farming season and contributes about 60 percent of national calorie consumption [5]. Maize is also the main source of income (cash crop) for smallholder

farmers. It accounts for 41% of the smallholder farm's gross income [8] and contributes 3.1% to the country's Gross Domestic Product [9]. Smallholder farmers are the main producers of maize in Zambia, representing approximately 90 percent of Zambia's agricultural producers [4] and producing approximately 90% of the maize in the country [9]. Traditionally, maize production in Zambia was highly known and defined by maize landraces, an important component of Zambia's agricultural practice [17]. Landraces played a critical role in the production of food before the proliferation of modern seed-breeding companies in developing countries, and local farmers entirely depended on maize landraces for food production (32). Over the years, however, farmers seem to be moving away from maize landraces cultivation to hybrid maize cultivation [18]. In 1970, the first Zambian hybrid, ZH1, and a composite, ZCA, were put on trials and released for commercial production in 1972. They were bred by John Abington, the maize breeder of Mount Makulu Research Station [19]. Since then, hybrid maize seed has rapidly penetrated the smallholder farming system and continues to do so with huge support (fertilizer subsidies, pan-seasonal and pan-territorial pricing, and geographically dispersed market depots) from the government [20].

Despite the high penetration/adoption rate and huge public expenditure (K4.7 billion through the Farmer Input Support Program (FISP) over 13 years) on hybrid maize, the rural poverty rate in Zambia still remains high at 80%. Hybrid adoption and use of fertilizer among smallholder farmers is driven mainly by government support and a policy change in 1991–1992 and 2002–2003 that saw reduced support to smallholder farmers led to retraction of maize production areas, a drop in hybrid adoption from an estimated 72 percent in 1990 to under 22 percent in 1996, and a decline in fertilizer use on maize. Smallholder farmers went back to maize landraces and other traditional crops [21]. Howard and Mungoma [20] described this consequence as "potentially beneficial", and a clear indication that the adoption of hybrid maize and the use of fertilizer at the market price cannot be sustained by smallholder farmers. Another important issue is the clear failure of hybrid maize cultivation to increase productivity among smallholder farmers. Results are mixed, but there is a consensus that most smallholder farmers fail to adequately manage hybrid maize seed to secure a good yield mainly due to high input costs such as fertilizer which is a primary input to guarantee high performance [22]. As a result, the majority of smallholder farmers opt for cheaper landrace maize cultivars in the absence of subsidized hybrid maize. Maize landraces though not as high-yielding as the hybrids, have good yield stability and perform well under marginal agro-climatic conditions and low-input agricultural systems [23, 24]. They are often well adapted to local growing conditions [25], which are often marginal and harsh, [26] and offer crop diversity essential to cope with impacts of climate change and increase in pests and diseases under climate change and variability [12]. With climate change (drought, floods, temperature, heat waves) occurrences predicted in the country, maize landraces present a good option that can ensure the diversity, viability and resilience of the smallholder farming system [12].

However, maize landraces which are a source of diversity are declining and their existence is threatened in the face of highly marketed hybrid maize seed. Smallholder farmers are abandoning/leaving maize landraces for hybrid maize mainly because of the preferential treatment that hybrid maize continues to receive and enjoy from policies, markets, and institutions in Zambia as well as the desire for high maize productivity [27]. As a consequence, small-scale farmers are rapidly than ever before becoming dependent on hybrid maize seed which they cannot produce and reproduce. Maize production control is being left to the local and multinational seed companies to be in charge of maize seed supply and replace local maize seed systems. This is degrading local maize seed systems, reducing resilience, and creating a high level of dependency on subsidies and credit, putting small-scale farmers at high risk of food insecurity [28]. Therefore, this research sought to investigate the extent to which hybrid maize seed influence the cultivation of maize landraces and the implications of this on food security in the context of worsening climate change impacts.

Study Methods

The study was carried out in Zambia in Pemba District and focused on three (3) agriculture camps namely Demu, Michelo and Muzoka. These agricultural camps were selected based on the justification that they were typical rural agriculture camps, far from urban center and whose residents were more dependent on agriculture for survival with limited opportunity to formal employment. Being heavily dependent on agriculture also meant that the farmers were more vulnerable not only to climate change, but also to food insecurity and income vulnerability than the urban farmers, and therefore were more likely to use maize landraces seed in their farming system. The study participants were small-scale farmers in Pemba District and were drawn from three agriculture camps (Demu, Michelo, and Muzoka) using the Ministry of Agriculture modus operandi. The study further restricted itself to only farmers that cultivated less than 5 hectares as these were considered to belong to the category of small-scale farmers by definition. Pemba District is located in

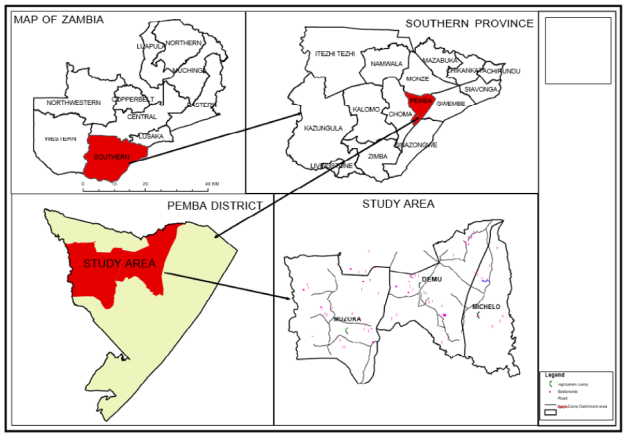

Figure 1: Map of Study Area

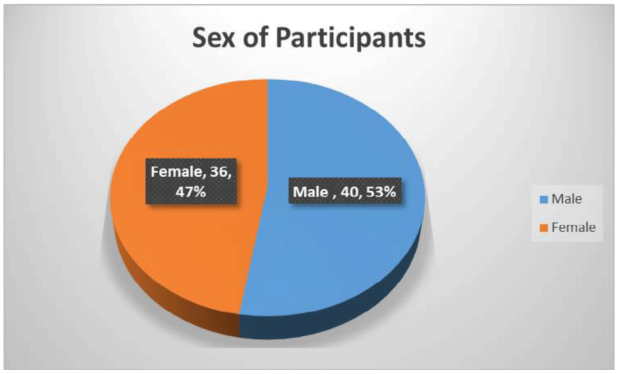

Figure 2: Sex of Participants

Southern province of Zambia and has a total area of 988 km2 with a population of 127,604 people as estimated in the Zambia Administrative Division City population report. It lies on latitude -16.5211° S and longitude +27.3675° E. The district's main economic activity is agriculture, with most of the people involved in the growing of maize at subsistence level, and rearing of cattle, goats, chicken and sheep.

The study used simple random sampling as its sampling technique to select farmers for inclusion, while purposive sampling was used to seek critical information from institutions and individuals with rich backgrounds on landraces from government ministries, non-governmental organisations (NGOs) and seed companies. Using an online RAOSOFT sample size calculator, a sample of 76 farmers was picked calculated from a population size of 303 farmers. Quantitative data was collected through questionnaires while qualitative data was collected using interview guide. Quantitative data collected through questionnaires was analysed using advanced excel, where correlations between the relationship of two variables were established. Thematic analysis was used to analyse qualitative data where common themes and concepts were established for analysis. Ethical clearance/approval was sought from the ethics committee of the university and consent was further secured from the research participants.

Study Results

Research Demographic Characteristics

This section looks at research demographic characteristics data of the research respondents. Three (3) demographic characteristics were analyzed namely: sex, age and education levels. The reasons for analysing these demographics are presented in their individual sections.

Sex of Research Participants

Sex of research participants was collected and analyzed given the potential differences that might arise in seed cultivation preferences between male and female and the factors driving the variance. The disaggregation was important in order to under the household division of labour and its possible household power sharing. Decision-making power within households and communities can affect agricultural outcomes. In many contexts, men may have more influence over decisions related to crop choices, investments, and marketing, whereas women's contributions and preferences are sometimes marginalized.

Out of the 76 farmers who participated in the study, 53% (40) were male while 47% (36) were female. Figure 2 above shows gender disaggregated data for the research participants. The above results were important in that in many agricultural communities, including those involved in maize cultivation, specific tasks related to planting, tending, harvesting, and processing maize may be traditionally assigned based on gender roles. Understanding these roles is important for developing agricultural interventions that are practical and effective. Gender influences access to land, seeds, fertilizers, tools, and other resources necessary for maize cultivation. Women, for example, may face barriers in accessing these resources compared to men, impacting their productivity and ability to engage in agricultural activities.

Age of Participants

Apart from categorising the participants into male and female, the study also collected data pertaining to the participants age based on the understanding that farmers of different age groups may have different seed cultivation preferences and life experiences coupled with changing

Table 1: Age of Participants

Variable	Category	Frequency	Percentage
Age Group	16-25	2	3%
	26-35	16	21%
	36-45	28	37%
	46-55	14	18%
	56-65	13	17%
	Above 66	3	4%

tastes and behaviours as they grow old. Age influences the physical capabilities and endurance of individuals involved in maize cultivation. Younger individuals may have more energy for intensive tasks like planting and harvesting, while older individuals may contribute through knowledge, supervision, and management roles. Understanding age-related capacities helps optimize labor distribution and efficiency on farms.

From table 1 above, it can be seen that more farmers were in the range of 36 to 45 years old accounting for 37% of the total interviewed farmers. However, when looked at from a productive age, more farmers were between the age of 26 to 55 years (combined percentage of 76%). In other words, age often correlates with experience and traditional agricultural knowledge. It can also be said that considering age in maize landraces cultivation is essential for optimizing labor efficiency, leveraging traditional knowledge, fostering innovation, managing risks, promoting intergenerational collaboration, and designing inclusive agricultural policies.

Education Levels of Participants

The education of participants was another variable that was ascertained during the study. The purpose was to understand the perceptions and experiences of farmers with different educational levels in relation to hybrid or/ and maize landraces cultivation. Education empowers farmers to advocate for their interests, engage in policy dialogue, and participate in community development initiatives related to agriculture. Educated farmers are more likely to adopt innovations, engage in cooperative farming ventures, and advocate for agricultural policies that benefit their communities.

The findings were that out of the 76 participants, most of the farmers attained secondary and primary education accounting for 51 and 45 percent respectively. Figure 3 above shows the education levels of the research participants. Education plays a transformative role in maize

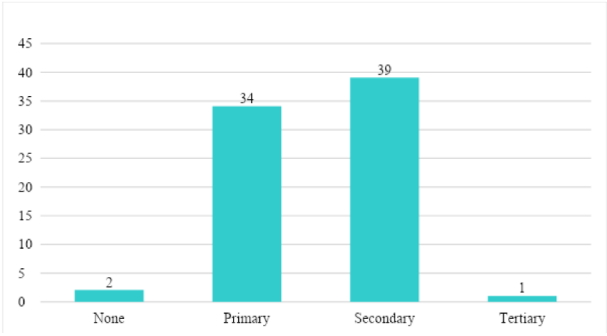

Figure 3: Participants Education Status

cultivation by enhancing knowledge, skills, sustainability practices, market access, decision-making capabilities, and overall livelihoods of farmers. With education and capacity to make decisions, farmers are able to switch local varieties due to hybrid seed being expensive.

Prevalence of Maize Landraces Versus Hybrid Cultivation Among Small-Scale Farmers

Prevalence of Hybrid and Maize Landraces

The study sought to establish the prevalence of maize landraces cultivation in comparison to hybrids among small-scale farmers. This analysis was important as it gave a picture of how many farmers were cultivating one or both crops and which crop was commonly grown among the farmers. This was achieved by determining the type of seeds respondents cultivated (see Figure 11 below), and the results showed that most farmers cultivated hybrid only (50 percent) followed by those that cultivated both hybrid and landraces (46.1 percent). Farmers that cultivated landraces only were the least at 4 percent. In the same vein, the study went further to establish whether farmers that cultivated both hybrid and landraces allocated equal amount of land to each of the two maize varieties (refer to figure 11). Out of 46 percent, 22.4 percent of the farmers

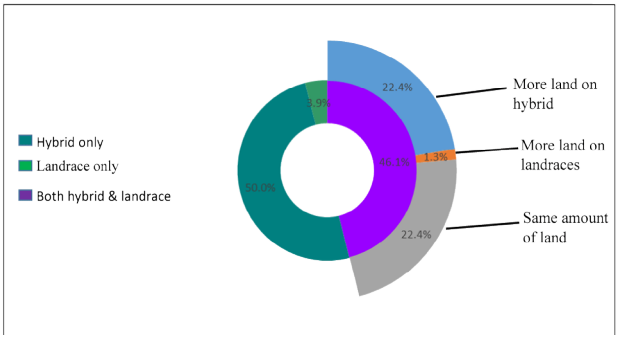

Figure 4: Farmer Crop Cultivation Pattern

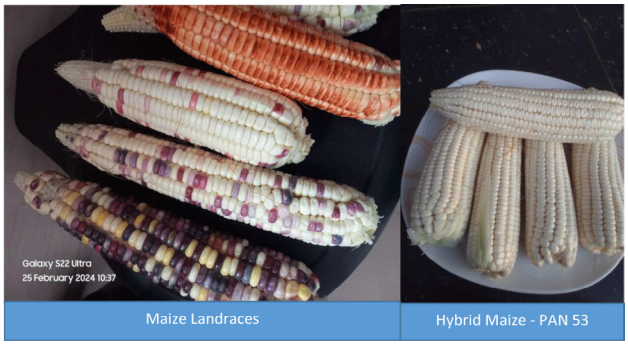

Figure 5: Pictures of Fresh Maize Landraces and Hybrid Maize Grown in 2023/2024 Farming Season by the Researcher.

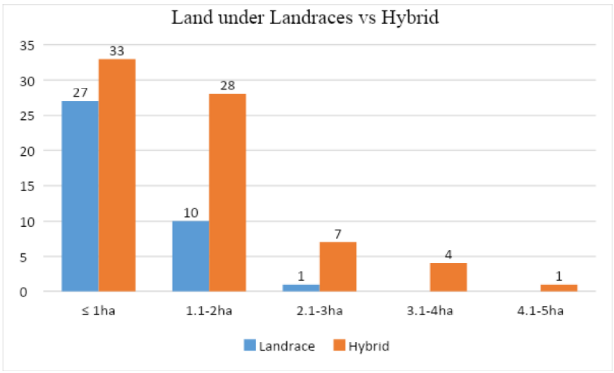

Figure 6: Land under Landraces vs Hybrid

allocated more land to hybrid while another 22.4 percent allocated the same amount of land to both hybrid and landraces. This left the proportion of farmers that allocate more land to landraces at only 1.3 percent.

Farmers validated these results during focus group discussions. They testified cultivating both hybrid and maize landraces and allocating more land to the latter.

As one focus group discussion puts it: "*In our community people grow more of hybrid maize because of the high yield we experience. But side by side with hybrid, we also grow landraces though less land is allocated to landraces. This is because we view the growing of hybrid maize and maize landraces as complementary in case of extreme weather conditions are experience*d."

The reason for allocating more land to hybrid maize seed was because of its high yields. One discussant explains: *"The harvest from hybrid maize fields is in most cases more compared to local varieties. This means more bags of maize and more money. It is for this reason that I allocate a large portion of my field to hybrids and encourage others to do the same during farmer field days."*

The yield also informed the decisions on what type of variety farmers planted. One discussant explains: *"We have a number of maize landraces varieties in our community. The choice of which one to grow is dependent on the farmer. But most of us look at the yield that maize landrace produces. We have yellow maize, Kampelya, Kankoti, and Tandanzala as some of landraces varieties".*

For those that allocated more land to maize landraces felt strongly rooted and associated with landraces in their lives as demonstrated by one of the discussants*: "I am a product of maize landraces. My parents planted, lived and survived on maize landraces. Your coming (Researcher) to our village has actually taken me to the good old days where landraces were just part of each household farming system until recently when hybrids were introduced leading to loss of our landraces growing culture. Today, when I move round the villages, our indigenous local maize varieties are nowhere to be seen. All I see are fields with hybrid maize. We have killed our own God given heritage and we need to do something about it."*

Land Under Landraces Versus Hybrid

The study also tried to investigate farmers land allocation patterns between maize landraces and hybrid and what factors influence its allocation. This was based on the fact that the decision to allocate land between hybrid maize and maize landraces depends on various factors, including agricultural reasons, economic, environmental, and cultural considerations. Hybrid maize varieties are often bred for high yield potential under optimal conditions. Farmers may allocate more land to hybrid maize to maximize production and ensure higher yields per hectare compared to maize landraces, which typically have lower yield potential. Market preferences and demands can also influence land allocation decisions, coupled with **Government policies and support** which promote the adoption of hybrid maize for increased productivity.

The results showed that despite farmers cultivating different amounts of land, all of them allocated more land to hybrid than to landraces. For example, those that cultivated land between one to two hectares, allocated more land to hybrid. A closer analysis of the results obtained above reveal that the more land cultivated, the higher the chances of it being allocated to hybrid and almost nothing to landraces. The opposite was also true in that where a farmer is only able to cultivate less than a hectare, equal land was almost allocated to both landraces and hybrid. The balance between hybrid maize and maize landraces in land allocation is often a strategic decision aimed at optimizing productivity, profitability, sustainability, and

Table 2: Landraces and Hybrid yield

	Mean	Median	Mode	Standard Deviation	Standard Error	Range	Total Sample
Hybrid	44.33	24	8	52.59	6.15	299	73
Landrace	15.39	10	15	18.26	2.96	99	38

Table 3: Landraces vs Hybrid adoption

Years of Cultivation	Landrace		Hybrid	
	Frequency	Percentage	Frequency	Percentage
< 5	5	13%	32	44%
≥ 5	33	87%	41	56%
Total	38	100%	73	100%

cultural preservation in maize cultivation.

The reason for allocating more land to hybrid maize seed was because of its high yields and pro-government support policies through the Farmer Input Support Programme as one discussant explains in a focus group discussion: *"Most of us are on government FISP programme and only hybrid maize is distributed under FISP making us to shift to hybrid maize and neglect landraces. We are also given fertiliser that makes our hybrid do well. It is for this reason that I allocate a large portion of my field to hybrids knowing very well that I have farming inputs from the government."* The above analysis was important as it gave a direction as to where the farmers were drifting more to, and as a possible sign of what type of crop was being preferred. Thus, in terms of hectares dedicated to maize landraces and hybrid maize, the results showed that hybrid maize cultivation was still dominant.

Landraces and Hybrid Yield

Apart from the production levels, the study tried to also establish the productivity levels for the two crop types. The yield comparison variable was cardinal as it was seen as to empower farmers to make informed decisions about which maize type to cultivate based on their specific goals, resources, and local conditions. Farmers can choose between higher-yielding hybrids for commercial production or maize landraces for cultural preservation and resilience in diverse farming systems. Yield comparisons contribute to food security by identifying maize varieties that can reliably produce sufficient quantities of food. High-yielding maize varieties can help meet food demands and improve household incomes through increased crop sales. Table 2 below shows the calculated crop yield based on the collected data.

The results in table 2 above, showed that the yields farmers realised from maize landraces cultivation and hybrid cultivation had the same trend. On average, farmer's hybrid yields were higher (44 * 50kg bags) than maize landraces (15 * 50kg bags). However, the standard deviation and range for both hybrid and maize landrace were very high, making the mean unreliable due to its sensitivity to high deviations. Therefore, the study relied on a median which was higher for hybrid (24 * 50kg bags) than maize landraces (10 * 50kg bags).

Landraces Hybrid Adoption and Abandonment

The prevalence of hybrid and/or landraces cultivation is not adequate or complete without establishing the rate of adoption and abandonment. The idea to aanalyze the adoption rate of hybrid crops among farmers provided valuable insights into the agricultural sector's dynamics, technological advancements, economic impacts, and sustainability efforts.

The results (Table 3 above), revealed that out of the 38 farmers that cultivated landraces (i.e. landraces only 3; landraces and hybrid 35), 87 percent translating into 33 farmers adopted maize landraces cultivation, planting it consistently for more than five years. On the other hand, only 56 percent (41 farmers) of the 73 farmers that cultivated hybrid maize had adopted it. Thus, the adoption rate of maize landraces among maize landraces cultivators was higher (87 percent) than the adoption rate of hybrid among hybrid cultivators (56 percent). There is a change, however, when these adoption rates are calculated based on the total sample of 76 small scale farmers. While the

adoption rate reduces for both landraces and hybrid, hybrid (54 percent) becomes greater than maize landraces (43 percent), which gives a difference of 12 percent. In addition, farmers that were cultivating hybrids for less than five (5) years were higher (44%) compared to landraces (13 percent). Thus, more hybrid adoptions are likely to be recorded in the near future. The study also established the abandonment levels of maize landraces and hybrids among the 3 farmers that cultivated maize landraces only and the 38 farmers that cultivated hybrid only (see Table 4 below). Investigating abandonment rates helped prioritize conservation efforts and interventions aimed at promoting the sustainable use of landraces.

The results showed that the three (3) farmers that cultivated maize landraces only had never cultivated hybrids. On the contrary, the results showed that out of the 38 farmers that cultivated hybrid maize, 11 (29 percent) and 22 (58 percent) had cultivated landraces for less than five (5) years and equal or greater than five (5) years, respectively. The number of farmers that had never planted maize landraces was 5 (13 percent). Thus, the abandonment rate of maize landraces by farmers cultivating hybrids was 58 percent. This rate of abandonment is lower (29 percent) when calculated out of the total sample of 76. Notwithstanding the adoption and abandonment rates above, the periods for adoption and abandonments were also determined to provide further insight into the farmer agricultural practice as tabulated in table 5 below.

The study revealed that on average farmers have been planting landraces for a longer period (12 years) than hybrid (8 years) as seen in table 9 below. The results also showed that most of the farmers that were cultivating hybrids had been doing so for 3 years while most of the farmers that were cultivating landraces had been doing so for 5 years. It was further established that while others have been cultivating hybrids for as long as 22 years and maize landraces for as long as 28 years, others had planted them for just one year and two years respectively.

Most Cultivated Maize Landrace and Hybrid Varieties

In order to find out how much farmers had drifted to either crop, the study investigated the most cultivated maize landraces and hybrid varieties among small-scale farmers. The inquiry was important so as to know which maize variety both within landraces family as well as hybrids was most preferred by farmers. Also, investigating the most grown crop type by farmers was essential for informed decision-making to promote sustainable agricultural practices, foster economic growth, and build resilience in agricultural systems.

Table 4: Landraces Abandonment

Years of Non-Cultivation	Frequency	Percentage
< 5	11	29%
≥ 5	22	58%
Never planted	5	13%
Grand Total	38	100%

The findings revealed that within landraces family, the Gankata variety was the most-grown maize landrace among respondents followed by hecklocking and go-by-red as shown in the figure 6 above. On the other hand, and under the hybrid family, the study found Panner seed followed by Seed-co as the most grown hybrid maize varieties among respondents as seen in figure 7 above. The results helped to identify the predominant crops grown by farmers, and helped to assess food availability in local communities.

Technocrats and smallholder farmers contemporary view of landraces

Landraces may be looked at from a technical view as well as from the angle of a smallholder farmer. Technocrats that are interested in agricultural biodiversity and sustainability look at maize landraces for their genetic diversity. They might see them as valuable resources for breeding programs aimed at developing more resilient and adaptable maize varieties. These traits become the main focus of the breeders than anything else. For agriculture technocrats under the Ministry of Agriculture, planting landraces by a farmer signify crop diversification and a road to household food security as explained by key informant (KI_3) from lower management:

"As Ministry of Agriculture, we do recognize the role that landraces have played in maintaining the nutrition and food security status of our farmers over time and also the role they play in providing the germplasm needed for improved seed. When it comes to field days, the ministry conducts field days for both hybrid maize and maize landraces signifying the importance we attach to maize landraces as a ministry." Technocrats also recognize the cultural significance of maize landraces, especially in regions where they have been cultivated for generations. They advocate for the preservation of landraces as part of cultural heritage and traditional agricultural practices. Technocrats view maize landraces from a point of it being a valuable genetic resource for understanding the genetic basis of traits such as disease resistance, drought tolerance, and nutritional content. In this regard, they support efforts to collect, preserve, and study landrace diversity to harness its potential for crop improvement. In contrast, technocrats

Table 5: Farmer Period of Hybrid and Landraces Cultivation

	Mean	Median	Mode	Standard Deviation	Range	Minimum	Maximum
Hybrid	7.7	5	3	5.4	21	1	22
Landraces	11.8	11	5	6.9	26	2	28

that are focused on maximizing agricultural productivity and efficiency tend to prioritize modern, high-yielding maize varieties over landraces and look at landraces as less productive than improved hybrids. Technocrats involved in agricultural policy and regulation consider the role of maize landraces in seed systems and food security. They advocate for policies that promote both the conservation of landrace diversity and the adoption of improved varieties to meet the diverse needs of farmers and consumers as explained by key informant KI.

We do distribute maize landraces to farmers for in-situ conservation but most importantly for food security for our poor rural farmers. We also display them to farmers during Agriculture and Commercial Shows. We have promoted these maize landraces in Lusaka, Mansa, Kassama, Monze, Kaoma, Rufunsa, and Mumbwa districts." From the technocrat point of view above, the perception of maize landraces is likely

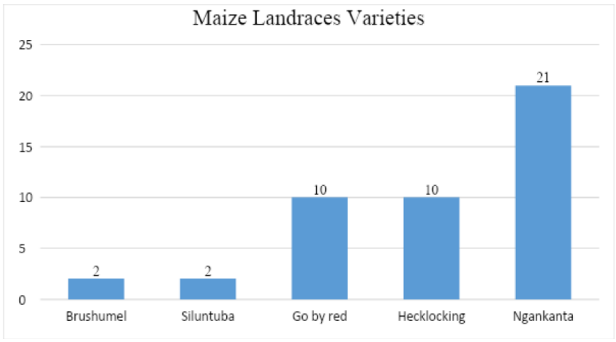

Figure 7: Most Grown Maize Landraces Varieties

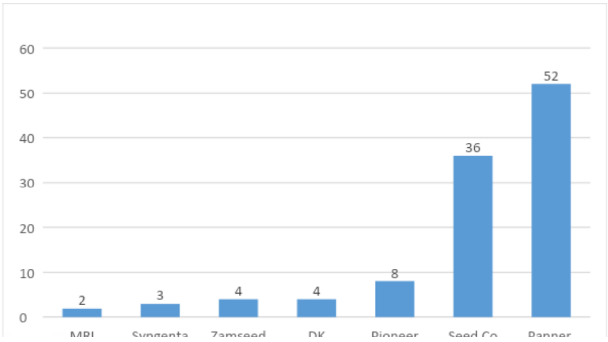

Figure 8: Most Grown Maize Landraces Varieties

to vary based on their specific expertise, interests, and objectives related to agriculture, genetics, biodiversity, and food security.

On the other hand, the view of smallholder farmers in as far as maize landraces are concerned is not so different from that of technocrats. Like technocrats, smallholder farmers view landraces as a source of household food security and a cheaper way to farming as the seed can be recycled and still maintain stable yield. Cultivating landraces helps farmers to eliminate the cost of seed, chemicals as commercial farmers can afford synthetic fertilizers, post-harvest handling among others. Smallholder farmers also view landraces as having small investment demand while hybrids have big investment demand, and without chemicals some hybrid varieties start to rot or being attacked by weevils while standing in the field. Discussants from all the three (3) focus group discussions conducted argued that maize landraces were more resistant to pests and weevils as explained below.

"Maize landraces are not very susceptible to weevils as compared to hybrid maize which require chemicals for its preservation. Maize landraces have a longer shelf life compared to hybrid varieties and have (landraces) hard shells that are not easily attacked."

Smallholder farmers also view maize landraces as God given, a source of freedom, and a symbol of cultural heritage. Maize landraces are often deeply embedded in the cultural heritage of farming communities. They may have been passed down through generations and hold symbolic value as a link to traditional farming practices and cultural identity as elaborated by farmers during the focus group discussions:

"This seed [maize landraces] was given to us by God. We have a sovereign right to this seed. It is a symbol of our freedom. To be who we are, and to grow what we want to grow. To eat what we want to eat. To share what we want to share. It is a birth-right and it is a symbol of our cultural heritage."

The fact that maize landraces have evolved over time to thrive in local environments gives smallholder farmers the impetus to grow it more in different agro-ecological

conditions unlike hybrid varieties that are bred in controlled conditions or environment to realize high yields. Smallholder farmers also view landraces from a position of cost saving as farmers practice seed saving with maize landraces, meaning that farmers are able to replant seeds from each harvest, reducing the need to purchase new seeds each season. While all these good things might be said about landraces, there are challenges associated with maize landraces, and range from lower yields for some landraces compared to modern hybrids, resulting in them being viewed as less economically viable for some farmers.

Study Discussion

Prevalence of Maize Landraces Versus Hybrid Cultivation Among Small-scale Farmers

The study aimed at investigating the prevalence of hybrid maize seeds and maize landraces cultivation among small-scale farmers in Pemba District of Southern Province in Zambia. The study revealed that hybrid maize is by far the most cultivated maize seed among small-scale farmers, both in terms of prevalence (the number of farmers cultivating it) and intensity (the quantity of area cultivated). The number of farmers who cultivated maize landraces only (4 percent) was approximately 13 times smaller than those who cultivated hybrid maize only (50 percent). Even worse, the proportion of farmers who dedicated more area to maize landraces (1.3 percent) was 17 times lower than that of hybrids (22.4 percent). These findings were comparable with those reported by Smale *et al.,* [29], who found that hybrid maize accounted for more than 55% of the total acreage of land cultivated with maize in Zambia. Furthermore, the results also revealed that 96 percent of the small-scale farmers cultivated maize hybrid (i.e. 50% maize only and 46 percent, combined with maize landraces). The results were also in line with what Smale [30] and Waldman *et al*., [31] who found the cultivation of hybrid maize to be at 68 percent and over 80%, respectively. In addition, the study interrogated the rate of adoption and abandonment of maize seed cultivation among small-scale farmers in the study area for economic impact and sustainability efforts. This result showed that there was rapid adoption of hybrid maize cultivation over the last years due to aggressive marketing strategies mainly by the government and seed companies. The results showed that the more farmers (54 percent) had adopted hybrid maize than maize landraces (43 percent). A deeper analysis showed that farmers that were cultivating hybrids for less than five (5) years were higher (44%) compared to landraces (13 percent) within the same period. Thus, more hybrid adoptions are likely to be recorded in the near future giving hybrid a further upper hand. The findings are in line with what Baidu-Forson *et al*., 2014 found that the widespread adoption of hybrid maize cultivation had seen an unprecedented decline in the cultivation of maize landraces. In terms of the rate of abandonment, results showed that over 50 percent of the farmers who cultivated hybrid maize had abandoned maize landraces while others switched from cultivating maize landraces to hybrid maize in the last five years. However, there was no incident of a farmer abandoning hybrids for landraces. This is indicative enough of the fact that hybrid cultivation is rapidly replacing maize landraces cultivation. As a result, the future of maize landraces agriculture appears bleak unless purposeful action is taken by strategic actors such as the government, non-governmental organizations and farmers. It is also gratifying to note that a sizable portion of farmers (46.1%) continued to grow maize landraces while also cultivating hybrid varieties. The challenges of food security is increasing the demand for new crops amongst small scale farmers away from the maize landraces [32]. Though most of these farmers allocated more land to hybrid, they remained very loyal to maize landraces. According to the farmers, maize landraces complemented hybrid maize and to be specific, hybrid acted as the main source of income, while maize landraces acted as the main source of household food. Culture also contributes to the relationship between maize Landraces and women. Most cultures regard women as custodians of family diets, influencing their priorities [33] towards a focus on food security and/or local varieties that are both palatable and nutritious and that further meet processing and storing requirements.

Conclusion

The general objective of the study was to investigate how hybrid maize seed impacted the cultivation of maize landraces and the potential risks it has on small-scale farmers' household food security. The study specifically focussed on the effects of hybrid maize seed on the prevalence of maize landraces cultivation among small-scale farmers. The study was informed by Sustainable Development Goal (SDG) number two which aims to achieve Zero Hunger, achieve food security, improve nutrition, and promote sustainable agriculture and food systems. It was established that there were low levels of maize landraces cultivation among small-scale farmers in Pemba District which only accounted for 3.9% and was evident enough that hybrid maize had significantly replaced maize landraces cultivation. This could be attributed to the highly marketed hybrid maize seed by the private seed companies, and lack of a deliberate policy to promote maize landraces by the government. It is also a missed opportunity by the government to increase the

staple food and end hunger among rural small-scale farmers, as well as a missed opportunity for the country to eliminate the cost of hybrid seed from poor rural small-scale farmers in their farming systems as landraces can be recycled for many years without any reduction in yield, especially if the country promotes landraces varieties that weigh and yield almost or better than hybrid seed. It is therefore recommended to the government (s) to embark on promoting maize landraces as they have the advantage of being recycled to help farmers achieve household food security at a minimal cost.

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