AN ASSESSMENT OF THE OCCURRENCE AND UTILISATION OF CROP WILD RELATIVES AMONG SMALLHOLDER FARMERS OF LUKOLONGO AGRICULTURAL CAMP IN KAFUE DISTRICT OF ZAMBIA

Masiye Tembo[1], Prof. Chansa Chomba[2], Eng. Francis Sichilima[3]

[1] Climate change scientist, National Plant Genetic Resources Centre of Zambia, ZARI, Chilanga
[2] Deputy Vice Chancellor and Senior Lecturer, Mulungushi University, Kabwe
[3] Senior Lecturer, Mulungushi Univeristy, Kabwe

ABSTRACT

This research, conducted in the Lukolongo area of Kafue district within Agro-ecological region I, addresses the critical issues of drought, and food shortages. By targeting the occurrence and utilization of crop wild relatives (CWRs), which are often drought-resistant and serve as alternative food sources, the study aims to enhance agricultural resilience in Lukolongo. Conducted between January 28 and February 20, 2024, the study's objectives were to document the presence of CWRs, evaluate smallholder famers' knowledge and utilization patterns, and propose strategies for their sustainable use. The study thus, addresses critical aspects of conservation, food security, knowledge dissemination and sustainable practices in relation to crop wild relatives in the agricultural space. Its outcomes will not only benefit the smallholder farmers of Lukolongo agricultural camp but also contribute to broader goals of sustainable development and resilience in the face of environmental challenges.

The study employed a mixed-method research design, combining qualitative and quantitative data collection methods, including field surveys, observations, and literature reviews. Data were collected from 103 respondents using structured questionnaires, and analysed using descriptive statistics and frequency analysis with Microsoft Office Excel, version 2019 (Pro Plus). This approach facilitated a comprehensive understanding of CWR occurrence and utilization in the study area.

Key findings reveal a diverse presence of CWRs in Lukolongo, particularly during the rainy season, highlighting their adaptability and potential to enhance agricultural resilience.

Despite high familiarity with CWRs among farmers, significant gaps in traditional knowledge and gender disparities were noted. The study also identified a complex landscape where CWRs are valued for their multifunctional benefits but are not widely integrated into agricultural practices. The predominant use of CWRs for combined food and medicinal purposes underscores their importance in local livelihoods.

The study identified several factors influencing CWR utilization, including legal, socio-cultural, and infrastructural challenges. Proposed strategies for enhancing sustainable utilization include community-led conservation initiatives, educational programs, community seed banks, and

sustainable farming methodologies. Government policies, research investment, and infrastructure development are also noted as being essential for creating an enabling environment.

The findings and recommendations of this study emphasise the need for comprehensive and integrated approaches to enhance the sustainable utilization of CWRs. By addressing gaps in knowledge, promoting sustainable practices, and fostering community and government support, the study aims to contribute to agricultural resilience and food security in Lukolongo and similar regions.

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

CWR	Crop wild relatives.
GIS	Geographical information systems
GRZ	Government of the Republic of Zambia
NSAP	National strategic action plan
PGRC	Plant genetic resources centre
R&D	Research and development
SADC	Southern Africa Development Community
ZARI	Zambia Agriculture Research Institute

CHAPTER ONE

INTRODUCTION

1.1 Background

This research assessed the occurrence and utilisation of crop wild relatives (CWRs) among smallholder farmers of Lukolongo Agricultural Camp in Kafue District of Zambia.

Crop wild relatives (CWRs) are wild plant species closely related to cultivated crops (Hajjar & Hodgkin, 2007). They possess valuable genetic traits that can be utilised to improve the productivity, adaptability and sustainability of agricultural systems (Altieri, 2018). With the increasing challenges posed by climate change, such as pests, diseases and drought, harnessing the potential of CWRs can provide a vital solution to enhance food and nutrition security and livelihoods for rural farming communities (Maxted, 2012).

Additionally, the use of CWRs can contribute to sustainable agriculture by reducing reliance on external inputs such as fertilisers, pesticides, and water (Dempewolf & Tyack, 2015). This can lead to improved environmental sustainability and reduced production costs for farmers, ultimately enhancing their economic well-being.

The importance of this research topic therefore, lies in its potential to address the pressing challenges faced by rural farming households in Lukolongo Agricultural Camp of Kafue District and similar areas. These challenges include climate variability, land degradation, limited crop diversity, and vulnerability to pests, diseases and drought. By exploring the utilisation of CWRs, this research offers an innovative approach to building resilience in food production systems.

Despite the potential benefits of CWR utilisation, there is a significant research gap in appreciating their occurrences in space, and understanding their practical application and integration into the food production systems of rural farming households. Existing studies often focus on the conservation and characterisation of CWRs, but there is limited knowledge on how to effectively utilise them for enhancing resilience in agricultural systems at the local level (Dempewolf, et al., 2017).

The research intended to address this gap by assessing the occurrence and utilisation of CWR species in the study area. Factors such as farmer knowledge and attitudes towards CWRs, the availability and accessibility of CWR genetic resources, and the potential barriers to CWRs adoption were also explored during this study.

By identifying and understanding these factors, the research served to provide valuable insights into how CWRs can be effectively integrated into the farming practices of rural households in Lukolongo, and similar areas. This knowledge will not only contribute to building resilience in local food production systems but also offer a basis for policy recommendations and practical guidelines for sustainable agricultural development in similar contexts.

Unfortunately, CWRs are also a threatened resource (Dempewolf, et al, 2017). Therefore, studies such as this may also contribute to their protection and conservation, both in the wild and in the gene banks.

1.2 Problem statement

Lukolongo agricultural camp, a vital contributor to the agricultural output for Kafue town and Lusaka city, confronts significant adversities, including climate variability, land degradation and limited crop diversity. These challenges exacerbate the community's vulnerability to pests, diseases, and drought, severely undermining food & nutrition security and threatening livelihoods.

Given the urgent need for sustainable agricultural practices, this study aims to assess the occurrence and utilization of crop wild relatives (CWR) in Lukolongo. By leveraging the genetic diversity inherent in CWR, we can explore innovative solutions to enhance food security and resilience against climate change, thereby safeguarding the community's future (Maxted, et al., 2012).

1.3 Aim of the study

The aim of this study was to assess the occurrence and utilisation patterns of crop wild relatives (CWRs) among smallholder farmers in Lukolongo Agricultural Camp of Kafue District of Zambia, with a focus on understanding their significance and potential contributions to agricultural practices in the area.

1.4 Research objectives

The study was guided by the following research objectives:

i. Determine the occurrence of crop wild relatives (CWRs)
ii. Evaluate smallholder farmers' knowledge of crop wild relatives
iii. Assess the utilization patterns of crop wild relatives by smallholder farmers
iv. Investigate factors influencing the utilization of crop wild relatives
v. Propose strategies for enhancing the sustainable utilization of crop wild relatives

1.5 Research questions

The following research questions therefore, suffice:

i. What is the extent of occurrence of crop wild relatives among smallholder farmers in Kafue's Lukolongo agricultural camp?
ii. How knowledgeable are smallholder farmers in Kafue's Lukolongo agricultural camp about crop wild relatives?
iii. In what ways do smallholder farmers in Kafue's Lukolongo agricultural camp utilize crop wild relatives in their agricultural practices?
iv. What factors influence the utilization of crop wild relatives by smallholder farmers in Kafue's Lukolongo agricultural camp?
v. What strategies can be proposed to enhance the sustainable utilization of crop wild relatives among smallholder farmers in Kafue's Lukolongo agricultural camp?

1.6 Significance of the research problem

The research findings of this study hold several significant implications and potential impacts. These include: Food security and resilience – by exploring the occurrence and utilisation of CWRs, the research endeavoured to contribute to improving the resilience of food production systems in rural farming households. This could result in increased food security, reduced vulnerability to environmental stresses, and enhanced adaptability to changing climatic conditions. Diversification of agriculture – the study would promote the diversification of agricultural systems by incorporating CWRs, which could enhance the sustainability and stability of farming practices. This diversification could reduce the dependence on a limited number of crop species, making farming systems more robust and less susceptible to crop failure. Climate change adaptation – given the predicted impacts of climate change on agricultural productivity, the research findings would support adaptation efforts by identifying and utilizing CWRs that possess traits enabling them to withstand extreme weather conditions, pests, and diseases. This could enable farmers to adapt to changing climatic patterns and protect their livelihoods.

Indigenous knowledge and cultural preservation – the study would acknowledge and document the traditional knowledge and practices of rural farming households, ensuring their preservation and recognition. By integrating this knowledge with the utilisation of CWRs, this research could strengthen the cultural identity and heritage of the local communities. Sustainable agriculture and conservation – the research would contribute to sustainable agriculture practices by highlighting the importance of conserving CWRs, which are valuable genetic resources. The findings could inform conservation strategies and policy frameworks aimed at preserving biodiversity and promoting sustainable use of plant genetic resources.

1.7 Conceptual and theoretical frameworks

The conceptual and theoretical frameworks underlying this study to assess the occurrence and utilisation of crop wild relatives (CWRs) among smallholder farmers of Lukolongo Agricultural Camp in Kafue District of Zambia are as follows:

1.7.1 Conceptual framework

The conceptual framework for this study involves understanding the interconnected elements of biodiversity, local agricultural practices, and socio-economic factors (Berkes & Turner, 2006). It also encompasses the relationship between smallholder farmers and CWRs, considering factors such as ecological diversity, farmers' knowledge, and cultural influences (Pretty & Smith, 2004). The framework also considers the impact of agricultural practices on the occurrence and utilization of CWRs.

In the framework, the ecological diversity, farmers' knowledge as well as cultural influences are the independent factors influencing the occurrence and utilization of CWRs (dependent variable). The diagrammatic representation is as shown below:

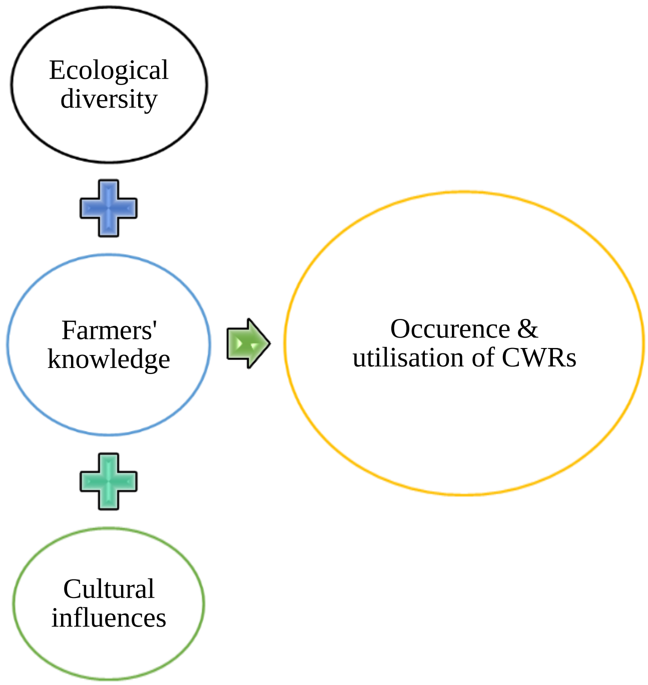


Fig 1.1 Conceptual Framework on the occurrence & utilisation of CWRs; adapted from Petty & Smith, 2004

1.7.2 Theoretical framework

Agrobiodiversity theory

This framework, which focusses on the variety and variability of plants, animals, and micro-organisms that are used directly or indirectly for food and agriculture, emphasizes the importance of biodiversity for food security, ecosystem services, and sustainability in agricultural systems (Zimmerer & De Haan, 2017).

The agrobiodiversity theoretical framework is crucial for assessing CWRs in Lukolongo agricultural camp as it highlights the significance of biodiversity in food security and ecosystem sustainability.

The framework also emphasizes the direct and indirect roles of diverse species in agriculture, which can enhance resilience against pests and climate change. By evaluating the occurrence and utilization of CWRs, researchers can identify genetic resources that contribute to local agricultural practices, improve crop resilience, and promote sustainable farming systems, ultimately supporting food and nutrition security in the region.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Crop wild relatives (CWRs) play a crucial role in maintaining biodiversity and in enhancing the resilience of agricultural ecosystems (Sharma & Gupta, 2020). They are essential components of agroecosystems, and represent a valuable genetic resource for crop improvement and adaptation. In the context of Kafue's Lukolongo agricultural camp where small scale agriculture predominates, understanding the occurrence and utilisation of CWRs among smallholder farmers is essential for sustainable agriculture in the face of climate change.

This literature review therefore, aims to provide insights into the key themes related to CWRs, their significance in agriculture, the methodologies for assessing their occurrence and utilization, the importance of studying their occurrence in space, the potential benefits of their utilization, as well as the relevant case studies and findings from similar regions.

2.2. Crop wild relatives and their significance

Crop wild relatives are wild plant species that are genetically related to cultivated crops. They are crucial for agricultural biodiversity as they possess a wide range of genetic traits that can be harnessed for crop improvement, such as resistance to pests and diseases, drought tolerance, and enhanced nutritional profiles, which can be introduced into cultivated varieties to improve crop resilience and productivity (Maxted et al., 2012). The utilization of CWRs among smallholder farmers in areas such as Lukolongo agricultural camp, can thus contribute to crop diversity, increased resilience, and enhanced food security (Hajjar & Hodgkin, 2007).

2.3 Global and regional Context

CWRs are distributed globally, with significant occurrences in regions with rich biodiversity. Africa, in particular, hosts numerous CWRs due to its diverse ecosystems and long history of agriculture (Jarvis et al., 2008).

While specific findings from Lukolongo Agricultural Camp are limited, general trends indicate that CWRs in similar regions contribute significantly to local agricultural practices. For example, wild relatives of maize and sorghum are commonly used by farmers for their resilience to environmental stressors (Chivunga, 2016). Indeed, other findings indicate that local farmers rely on these wild relatives for resilience against climate change and pests (Ngúni et al., 2017).

2.4 Biodiversity and agricultural resilience

Numerous studies emphasize the significance of CWRs in contributing to the genetic diversity of crops, which is pivotal for developing new varieties with increased resistance to pests, diseases, and environmental stresses (Castaneda-Alvarez, et al., 2016; Nair, 2019). They are the potential source of novel traits and genetic variation in food crops with narrow genetic base (Choudhary, et al., 2017).

The study of CWRs in Lukolongo agricultural camp however, also has implications for biodiversity conservation. Conserving these wild relatives ensures the preservation of genetic diversity within the plant kingdom, which is vital for breeding programs and adapting crops to changing environmental conditions (Maxted, et al., 2008).

2.5 Assessment approaches

The assessment of CWRs often involves a combination of field surveys, genetic analyses, herbarium records, geographical information systems (GIS) mapping and community engagement (Hodgkin & Meilleur, 2004). These methods help in comprehensively understanding the distribution and potential uses of wild relatives in local agriculture and livelihoods.

2.6 Case studies on CWRs

Studies in various African regions have documented the presence of CWRs. For instance, a study in Ethiopia identified significant populations of wild relatives of teff and barley, highlighting their potential for breeding programs (Dempewolf et al., 2017).

2.7 Local knowledge and utilization of CWRs among smallholder farmers

Research indicates that smallholder farmers often possess valuable traditional knowledge of CWRs and their use (Goettsch, B., et al., 2021). This knowledge includes identifying CWR species, their ecological niches, and methods for incorporating them into farming systems. Incorporating this local wisdom into assessments can also provide a holistic perspective on the interaction between farmers and crop wild relatives in Lukolongo agricultural camp and similar areas.

Studies have also shown that integrating CWRs into agricultural practices can lead to increased crop yields, pest resistance, and climate resilience (Heywood & Zohary, 1995).

2.8 Utilization of CWRs in Agriculture

Crop wild relatives are often used in breeding programs to introduce desirable traits into cultivated crops. This process involves crossing wild relatives with domesticated varieties to develop new cultivars with improved characteristics (Hajjar & Hodgkin, 2007).

2.9 CWR Conservation efforts

In-situ and ex-situ conservation strategies are employed to preserve CWRs. In-situ conservation involves protecting CWRs in their natural habitats, while ex-situ conservation includes gene banks and seed storage facilities (Maxted & Kell, 2009). Zambia's national gene bank (the national plant genetic resources centre) is located about 35km north of Kafue town, and 20km north-west of the study area.

The study also aligns with Zambia's National Strategic Action Plan (NSAP) for the Conservation and Sustainable Use of CWR, emphasizing the need for conservation efforts and farmer education in order to enhance agricultural practices and food security in Kafue district (Ngúni et al., 2017).

2.10 Challenges and conservation concerns

Despite their importance, CWRs face several threats and challenges in their utilization among smallholder farmers. These threats and challenges include habitat loss, climate change, lack of awareness regarding their importance, limited access to CWR germplasm, and the need for capacity building. Collaborative efforts between researchers, local communities, and agricultural institutions are essential to overcome these barriers (Dempewolf, et al., 2017). Understanding these challenges is also critical for designing effective conservation strategies to ensure the continued availability and utilisation of CWRs.

2.11 Policy implications

Several studies emphasize the need for integrating CWRs conservation into agricultural policies (Riordan & Nabhan, 2019; Heywood, 2008; Banks, 2004). Acknowledging the importance of CWRs at the policy level can facilitate the sustainable management of agricultural biodiversity in Lukolongo agricultural camp, and beyond.

There are however, institutional and policy barriers that hinder the integration of CWRs into mainstream agriculture (FAO, 2010).

2.12 Literature gaps

Current literature is silent on how the ecological dynamics like biodiversity, climate resilience, and their role in maintaining ecosystem services affect the occurrence and utilization of crop wild relatives in the study area and similar regions. There is also a gap in literature regarding conservation strategies for CWRs (such as community-based approaches, in-situ conservation efforts and policies) in the study area, or indeed in the entire Kafue district. Other literature gaps are also apparent in how modern agricultural practices such as the use of agrochemicals, land-use changes, or other anthropogenic factors influence the occurrence and utilization of crop wild relatives in Lukolongo agricultural camp.

2.13 Opportunities

Enhanced awareness and training programs for farmers, coupled with supportive policies, can facilitate better utilization of CWRs. Additionally, advances in biotechnology and molecular breeding offer new avenues for harnessing the potential of CWRs (Dempewolf et al., 2017).

2.14 Conclusion

In conclusion, the assessment of the occurrence and utilization of CWRs among smallholder farmers in Lukolongo agricultural camp is a topic of great importance, as it holds the potential to enhance agricultural resilience and sustainability, increase food security, and contribute to biodiversity conservation. Integrating local knowledge, employing diverse assessment approaches, and addressing conservation challenges are crucial components in ensuring the sustainable coexistence of farmers and CWRs not only in Lukolongo agricultural camp, but in the entire Kafue district. This collaborative research and engagement with local communities are key to unlocking the benefits of CWRs in this region of Kafue, and beyond.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter provides a roadmap for the study on the occurrence and utilization of CWRs in Lukolongo agricultural camp of Kafue district. The materials employed as well as the methodologies implemented will be discussed. Also to be discussed are the processes, designs and resources instrumental in shaping the outcomes of this study.

3.2 Study area location and description

3.2.1 Study area location

Lukolongo agricultural camp is located approximately 12 km north-east of Kafue town, and extends up to 10 km off the Kafue-Lusaka highway (Great North Road). The area is bordered by Chilanga district in the north and north-west, and consists of Shimabala, Lukolongo and Chipongwe settlements. The area is however, sub-divided into eight zones, namely; Kasamu, Muchini, Katyoka, Chipongwe, Chitalo, Chilembela, Muteba and Lishiko.

For administrative purposes, the camp falls under Chipapa Agricultural Block, alongside Chipapa, Mphande and Kapongo agricultural camps.

Map of Lukolongo Agricultural Camp, Kafue

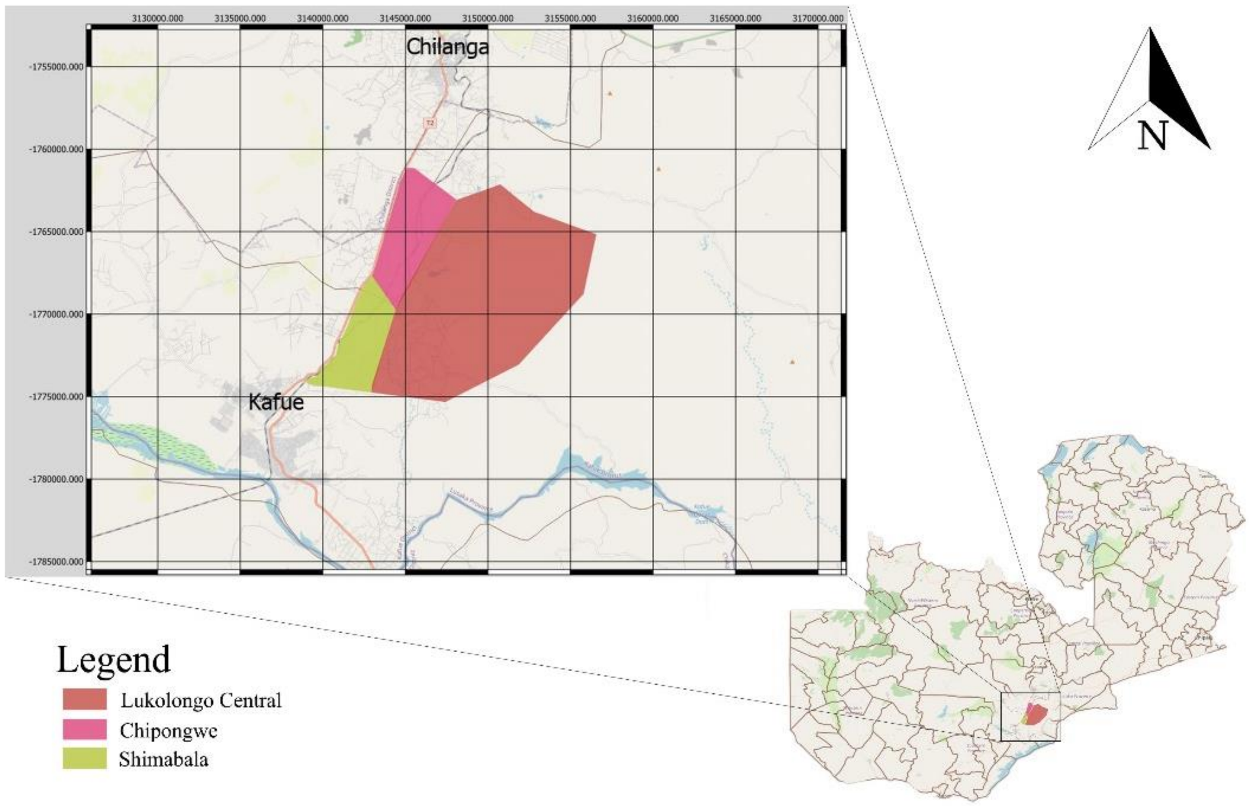


Fig 3.1 Locational map of study area **Source**: Soil Survey Unit (SSU), ZARI

Map of Lukolongo Agricultural Camp, Kafue

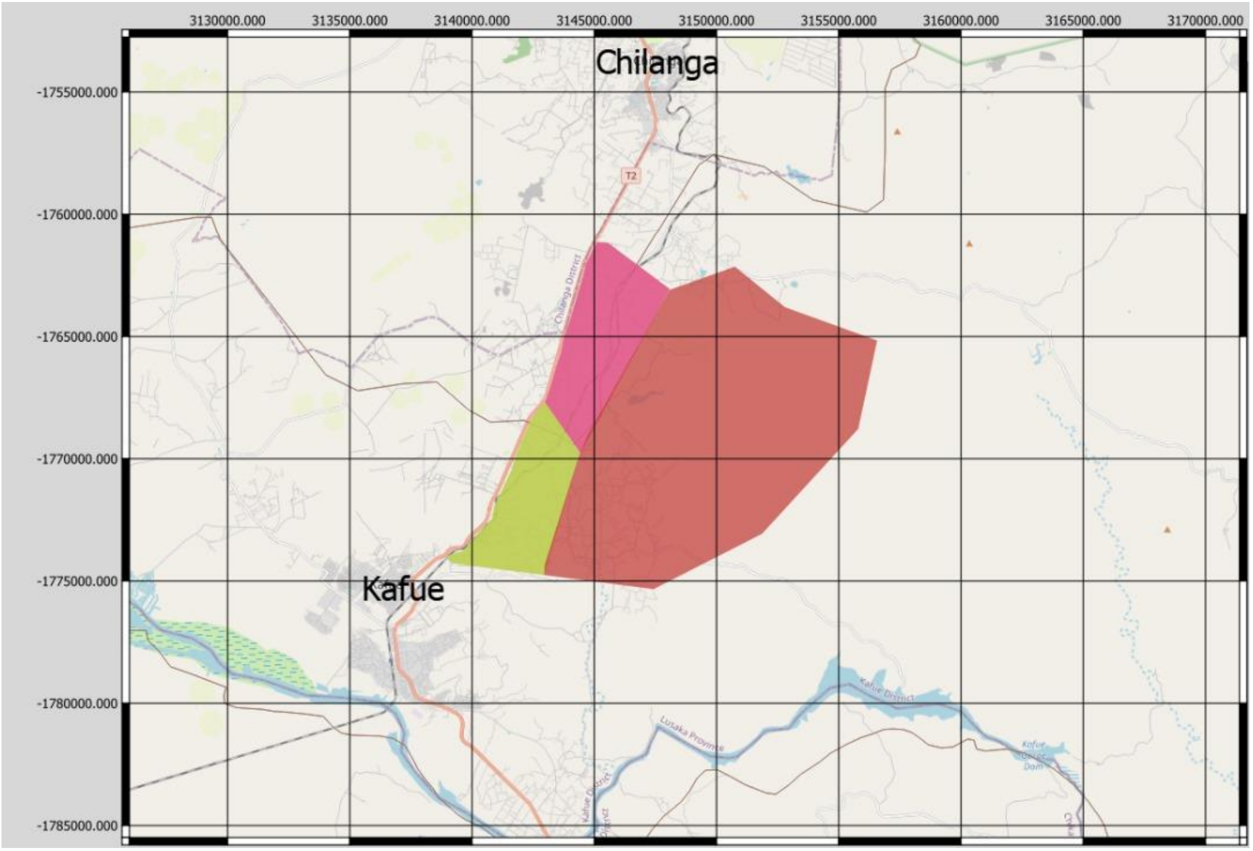


Fig 3.2 Locational map of study area [Expanded view] **Source**: Soil Survey Unit (SSU), ZARI

3.2.2 Study area description

Kafue's Lukolongo agricultural camp has an estimated total population of 2,540, with 1,783 being registered farmers (GRZ, 2023).

The area falls under agro-ecological region II, receiving rainfall of between 800 mm and 1000 mm annually. The soil is excessively drained to well-drained, shallow to moderately shallow, dark-brown, friable, stony, gravelly, coarse to fine loamy orthi-eutric Leptosols (GRZ, 2011), which supports a variety of agrarian occupations.

Lukolongo agricultural camp is traditionally an agricultural area, with the majority of the inhabitants being smallholder farmers who depend on rain-fed agriculture. In the recent past however, rain-fed agriculture has suffered frequent droughts, a shortened rainy season, and an increase in pest and disease incidences.

3.3 Research design

This study employed the mixed-method research design. The design facilitated the provision of a detailed account of the occurrence and utilization of crop wild relatives in the study area, through direct observation, documentation of phenomena and through a survey. Thus, the study involved a combination of both qualitative and quantitative methods of data collection.

3.4 Population

An overview of the demographic characteristics of the study area was conducted, with particular emphasis on the sampling frame and the sample size. This approach was designed to provide a refined understanding of the study's findings within the specific context of the population of the area under investigation.

3.4.1 Sampling frame

As the study area has 1,783 registered farmers (GRZ, 2023), this figure was used a sampling frame from which the final sample was drawn.

The stratified random sampling technique was employed to divide the population of Lukolongo agricultural camp into strata based on settlement zone, i.e. Shimabala, Lukolongo central and Chipongwe.

Random sampling was then used within each stratum, to select a representative sample. This served to ensure that various subgroups within the camp were adequately represented in the study.

The camp extension staff (Agriculture Assistant and Block Supervisor), in collaboration with the Kafue District Extension Methodologist, were on hand to assist with the sampling.

3.4.2 Sample size

A sample size of 103 respondents was considered. This figure was calculated using a Sample Size Calculator (https:www.calculator.net/sample-size-calculator.html? type/…) based on the total number of registered farmers in the area, a Confidence Level of 70 % and the Margin of Error of 5 %.

Thus, 103 respondents were interviewed in this study.

3.5 Data collection methods

A combination of both primary and secondary data collection methods were utilized to effectively address the study's objectives and enhance the reliability of the findings. This was anticipated to contribute to a robust understanding of the occurrence and utilization of CWRs species in the study area.

3.5.1 Primary data collection

This involved gathering data by conducting interviews and making field observations. Interviews were conducted using a structured questionnaire (see Appendix I).

3.5.1.1 Field observations

Phenomena were observed in their natural environments using a digital camera. Pictures of various CWR species were captured, and the associated data and information were subsequently recorded in a field notebook, for later analysis.

3.5.2 Secondary data collection

Additional data and information was collected from existing research studies, articles, and publications related to CWRs, thereby enhancing the study's context.

3.5.3 Ascertaining the occurrence of CWRs in Lukolongo Area

A comprehensive survey involving a structured questionnaire was administered to selected farming households in Kafue's Lukolongo Agricultural Camp, to identify and document different CWR species, in order to assess their occurrence and abundance in space.

3.5.4 Evaluating smallholder farmers' knowledge of CWRs

A questionnaire (as above) was also used to investigate Lukolongo smallholder farmers' awareness and understanding of CWRs, exploring traditional knowledge and practices related to their identification and use.

3.5.5 Integration of CWRs into agricultural practices

The questionnaire was equally used to examine how farmers integrate CWRs into their agricultural practices, and if there was any associated cultural significance to this practice.

3.5.6 Factors influencing the utilization of CWRs and proposed strategies for sustainable utilization.

Socio-economic factors, agricultural practices, and environmental conditions that influence the utilization or neglect of CWRs by smallholder farmers were explored. Barriers or challenges faced by farmers in integrating CWRs into their farming systems were equally examined.

The survey also explored recommendations for promoting the sustainable use of CWRs among smallholder farmers. Potential interventions, conservation measures, or awareness programs to enhance the conservation and utilization of CWRs in the Lukolongo Agricultural Camp were also suggested.

3.5.7 Questionnaire administration

The structured questionnaire was administered through face-to-face interviews.

3.6 Data analysis methods

Data analysis methods involved a combination of descriptive statistics and frequency analysis.

3.6.1 Descriptive Statistics

Descriptive statistics were employed to summarize and present the data effectively. Graphs and tables were primarily used to visually represent the findings, making it easier to identify trends and patterns in the data. Frequencies, proportions, and percentages were calculated to provide a clear and comprehensive picture of the occurrence, knowledge, and utilisation patterns of CWRs among the respondents.

3.6.2 Frequency Analysis

In examining the occurrence and utilization patterns of specific CWRs species in the area the frequency of occurrence of species was also calculated to add to the body of knowledge obtained.

The above statistical methods were conducted through the Microsoft Office Excel, version 2019 (Pro Plus).

3.7 Ethical considerations

The following are some ethical considerations deployed in this study:

3.7.1 Informed consent

In this study, informed consent was obtained from all participants, explaining the study's purpose, procedures, and any potential risks or benefits. Voluntariness in participation was highly emphasized.

3.7.2 Confidentiality

The privacy of participants was safeguarded by ensuring that their personal information remained confidential. Codes and pseudonyms were used wherever possible, instead of revealing their identities.

3.7.3 Respect for local knowledge

This assessment also endeavored to acknowledge and respect local knowledge, practices, and traditions, as are practiced in the study area.

3.7.4 Community involvement

The community was engaged for much of the research process, to seek feedback, input and approval.

3.7.5 Minimisation of harm

Measures were also taken to minimize any potential harm to participants, wildlife and the environment.

3.7.6 Benefit sharing

The potential benefits of the research undertaking were discussed with the respondents and the results shared with them, whenever it became practicable**.**

3.7.7 Compliance with regulations

The study also ensured a strict adherence to ethical guidelines and regulations established by relevant institutions and authorities (traditional structures, etc) to ensure the study met ethical standards and legal requirements.

CHAPTER FOUR

RESEARCH FINDINGS

4.1 Introduction

This chapter presents key findings of the study to assess the occurrence and utilisation patterns of crop wild relatives (CWRs) among smallholder farmers in Lukolongo Agricultural Camp of Kafue District of Zambia, following a comprehensive survey undertaken between 28th January and 9th February, 2024. The data was obtained through interviews and field observations.

4.2 Presentation of Findings

4.2.1 Occurrence of crop wild relatives

The occurrence of CWR species in Lukolongo agricultural camp was found to be as follows: Fabaceae (5.82%; n=6), Poaceae (30.1%; n=31), various vegetable taxa (42.72%; n=44), Root & tubers (16.5%; n=17), Arboreal species (0.98%; n =1) and none (3.88%; n=4), as depicted in Figure 4.1 below.

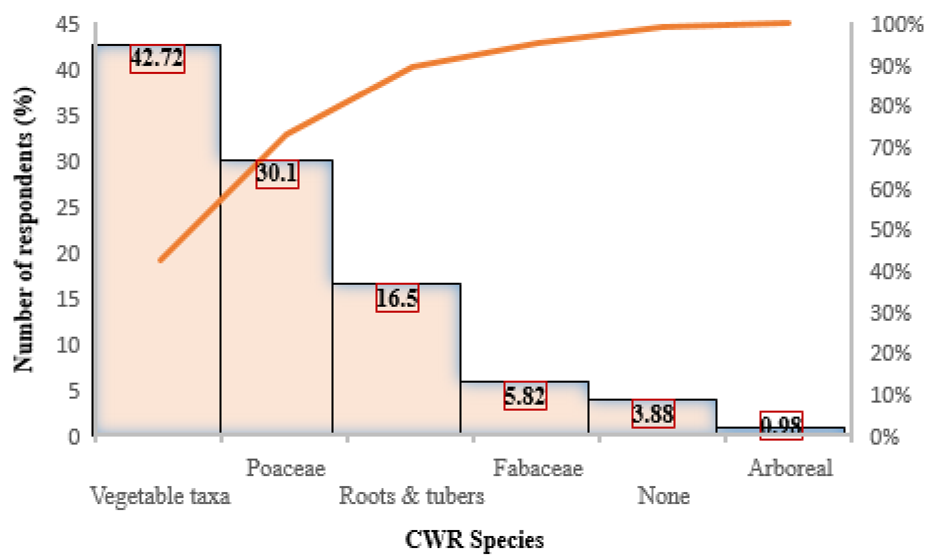
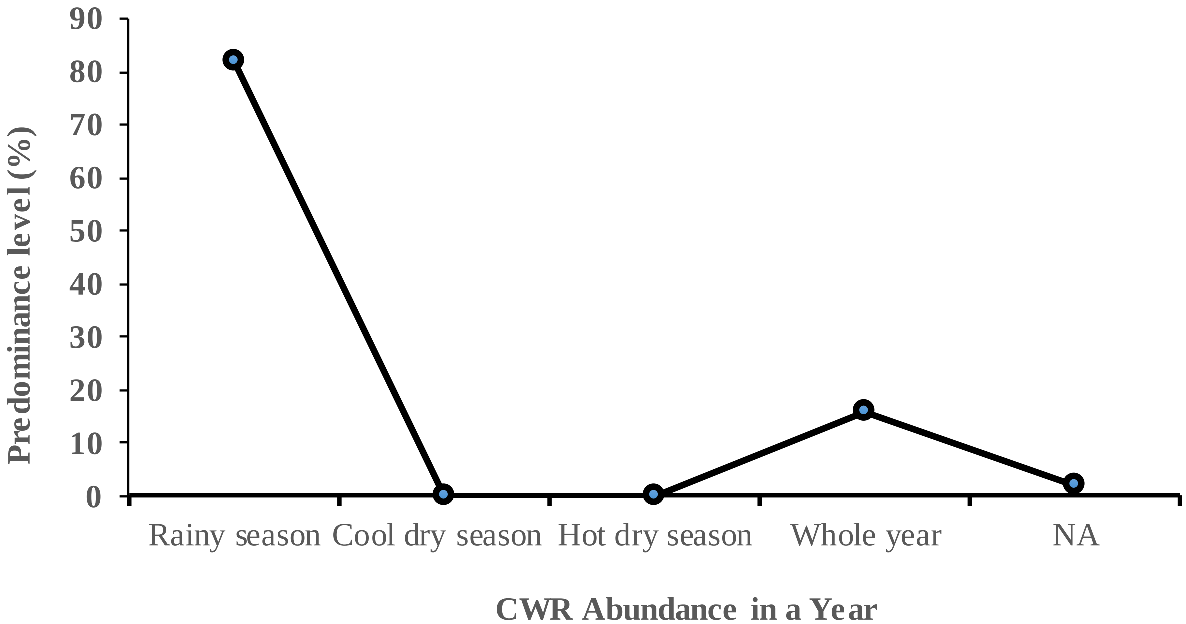


Fig 4.1 Occurrence of CWR species in Lukolongo Agricultural Camp

The distribution of CWR abundance in Lukolongo exhibited a predominance during the rainy season (82%; n=84), with no significant occurrences during the cool dry season (0%) or hot dry season (0%). There was a minor presence throughout the year (16%; n=16), with a small percentage classified as not applicable (2%; n=3), as indicated in the data below.

Fig 4.2 Distribution of CWR abundance in a typical year



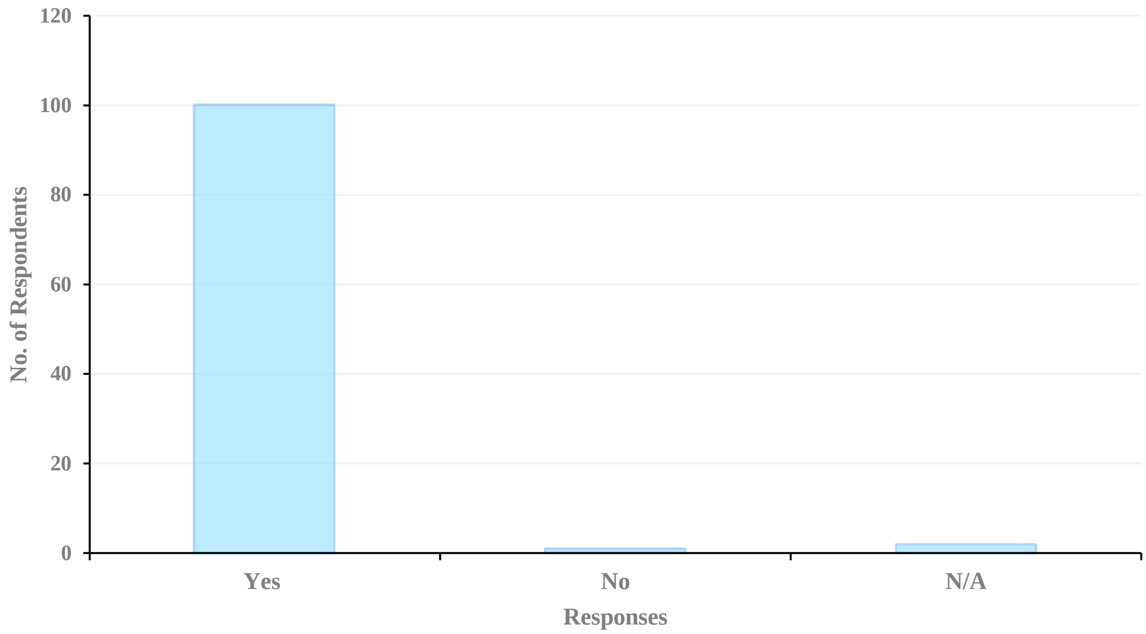


Fig 4.3 Availability of areas with high CWR diversity in Lukolongo Camp

The inquiry into whether the Lukolongo Agricultural Camp encompassed areas exhibiting higher diversity of crop wild relatives (CWRs) yielded the following results: Yes (97.08%; n=100), No (0.97%; n=1), Not applicable (1.94%; n=2), as is shown in Figure 4.3 above.

Regions within Lukolongo camp exhibiting varied levels of crop wild relatives (CWRs) diversity were as follows: Shimabala (0%), Lukolongo Central (76%; n=78), Chipongwe (21%; n=22), Uncertain (3%; n=3), as illustrated in figure 4.4 below:

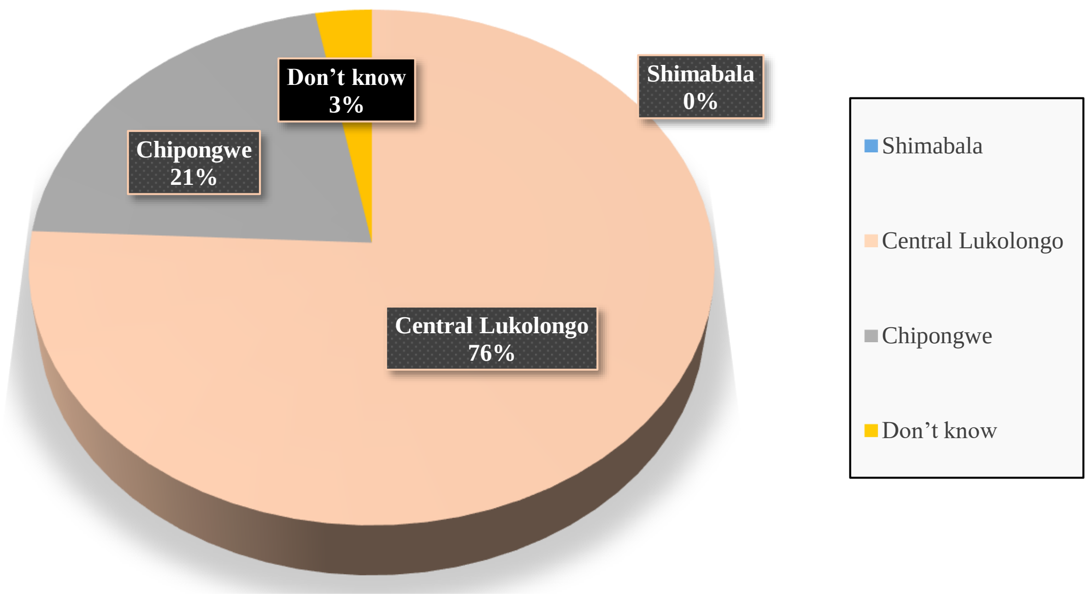


Fig 4.4 Regional variation of CWR diversity in Lukolongo Agricultural Camp.

4.2.2 Smallholder farmers' knowledge of crop wild relatives

The level of familiarity respondents had with CWRs within the Lukolongo Agricultural Camp is delineated as follows: familiar (62%; n=64), Very familiar (36%; n=37), Not familiar (2%; n=2), as depicted below.

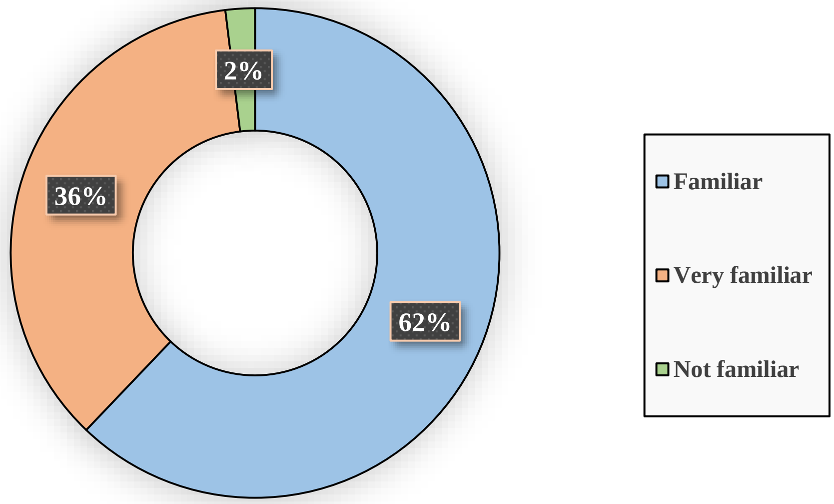


Fig 4.5 Delineation of Lukolongo farmers' familiarity with CWRs

Comparative analysis results of familiarity with CWR show that slightly more female respondents (18.45%; n=19) were *very familiar* with CWR than their male counterparts (17.48%; n=18).

The specific species of CWR identified within the Lukolongo Agricultural Camp include: Aerial yams (*Misepo*); *Dioscorea bulbifera* (6%; n=6), Bush yams (*Mupama*); *Dioscorea praehensilis* (11%; n=12), Wild Sorghum (*Masaka*); *Sorghum verticilliflorum* (3%; n=3), Wild Cucumber (*Amankolobwe*); *Cucumis africanus* (44%; n=45), Wild Finger millet; *Eleusine coracana africana* (4%; n=4), Wild Faba beans (*Nkhasi*); *Vigna reflex-sublobata* (3%; n=3), Wild Peas (*Kankhoma*); *Vigna unguiculata subspecies dekindtiana* (4%; n=4), Bitter Tomato (*uMutuntulwa*); *Solanum incanum* (15%; n=16), Wild Onion (*Bulanyenje*); *Allium spp*. (1%; n=1), Wild Cassava (*Chiphira*); *Manihot spp*. (1%; n=1), Wild corchorus (*Tindingoma*); *Corchorus spp.* (5%; n=5), with a category marked as Not Applicable (N/A) accounting for 3% (n=3), as illustrated below.

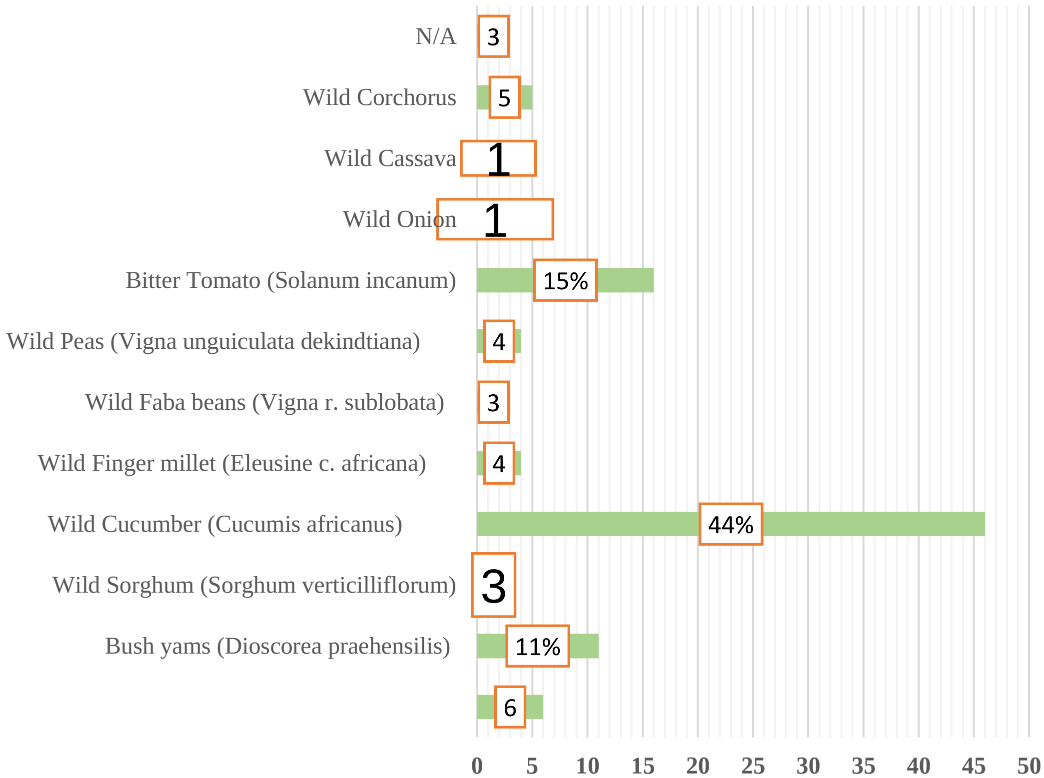


Fig 4.6 Specific CWR species identified in Lukolongo Camp

Following the percentage distribution for each of the species above, the *frequency analysis* results of the species found in Lukolongo camp indicated that wild cucumber (Cucumis africanus) is the most prevalent CWR species in the area, accounting for 44% (n=45) of the identified species. This is followed by bitter tomato (Solanum incanum) at 15% (n=16) and bush yams (Dioscorea praehensilis) at 11% (n=11).

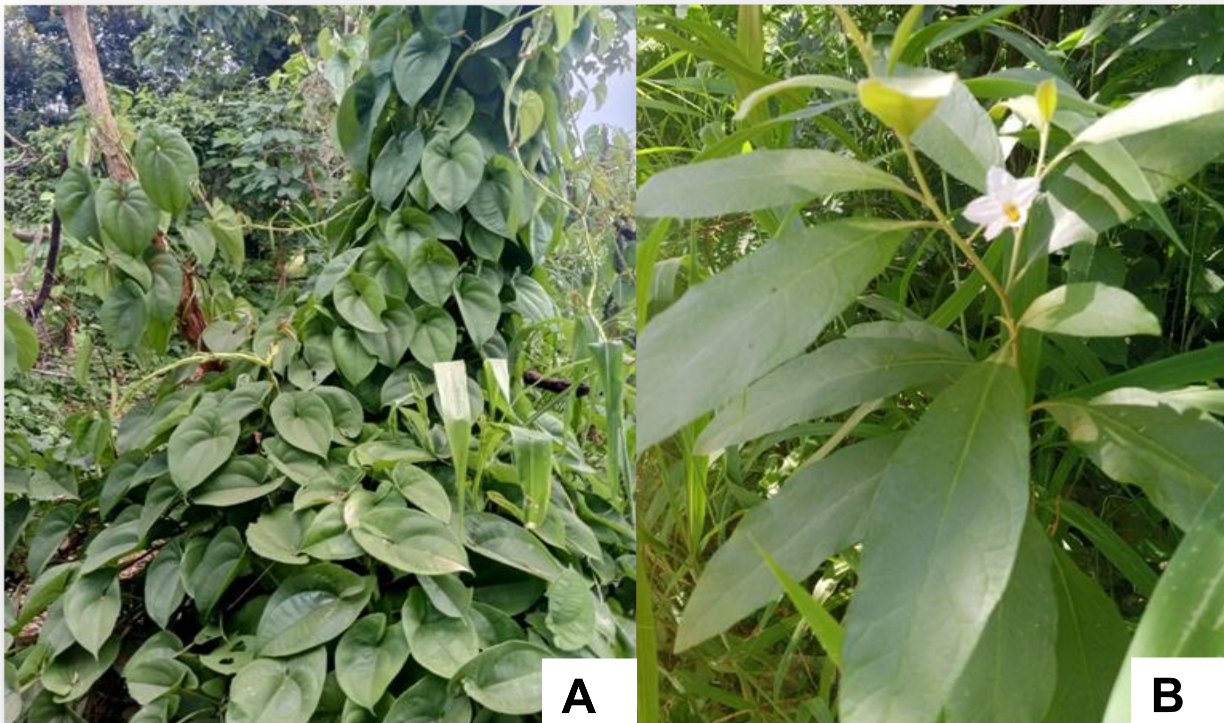


Fig 4.7A Bush yams (*Mupama*); *Dioscorea praehensilis* species [left] mainly encountered in central Lukolongo area and Bitter tomato (*uMutuntulwa*); *Solanum incanum* at flowering stage in **Fig 4.7 B** [right] found across the entire agricultural camp landscape.

Fig 4.8A [Left]: A mature Bitter lemon plant (*Solanum incanum*) is a wild relative of the African eggplant (*Solanum aethiopicum*). **Fig 4.8B** [Right]: Eleusine spp. plant is a wild relative of finger millet (*Eleusine coracana*) also commonly encountered across Lukolongo Agricultural Camp.

Fig 4.9A Pennisetum spp. [Left] are wild relatives of pearl millet (Pennisetum glaucum) also found in some parts of Chipongwe area of Lukolongo Camp. **Fig 4.9B** [Right]: Wild relative species of Sorghum (Sorghum spp.) spotted in Lukolongo's Chipongwe area.

Fig 4.10 Left: *Eleusine coracana* (cultivated finger millet) grown alongside its wild relative (*Dulu*); *Eleusine spp*. on the right, at the Southern Africa Development Community (SADC) Plant Genetic Resources Centre (PGRC) in Silverest, Chongwe.

The traditional knowledge pertaining to CWR identification within Lukolongo camp encompassed various aspects: capability in observing specific plant characteristics (13%; n=13), understanding of the distribution across different locations, seasons and environmental conditions (1%; n=1), and expertise in seed preservation techniques (19%; n=20). The majority of respondents reported a lack of traditional knowledge in this area (67%; n=69).

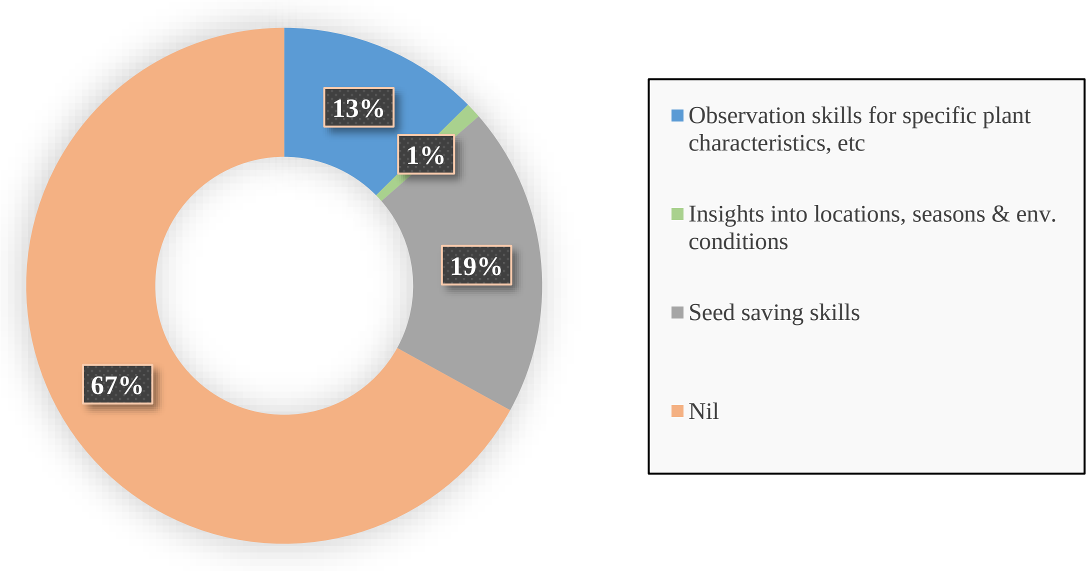


Fig 4.11 Aspects of traditional knowledge regarding CWR identification in Lukolongo Camp

The traditional knowledge concerning the utilization of CWR within Lukolongo camp comprised diverse applications: food preparation (17%; n=17), medicinal purposes (25%; n=26), recognition of potential hazards linked to their utilisation (3%; n=3), integration into intercropping practices with cultivated crops (1%; n=1). A significant percentage of respondents indicated a lack of traditional knowledge in this regard (54%; n=56), as depicted in figure 4.12:

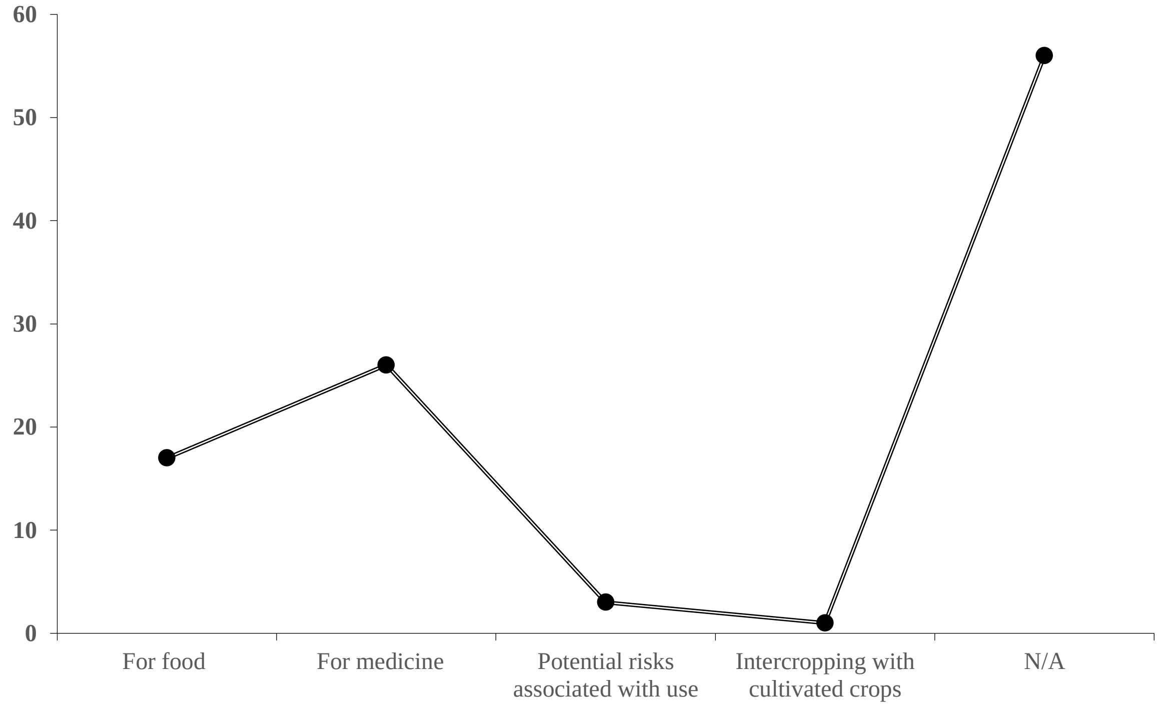


Fig 4.12 Traditional knowledge regarding the utilisation of CWRs within Lukolongo camp.

Comparative analysis results of traditional knowledge possessed with respect to gender, on the identification and use of CWR, show that more females (41%; n=42) possessed knowledge in this regard than male respondents (33%; n=34).

The origins of traditional knowledge concerning the utilisation of Crop Wild Relatives (CWR) was derived from various sources within Lukolongo community. These included hereditary transmission (13%; n=13), guidance from community leaders (4%; n=4), personal empirical understanding (0%), literature (0%), and internet resources (0%). The majority of respondents however, indicated a total lack of any traditional knowledge (83%; n=86).

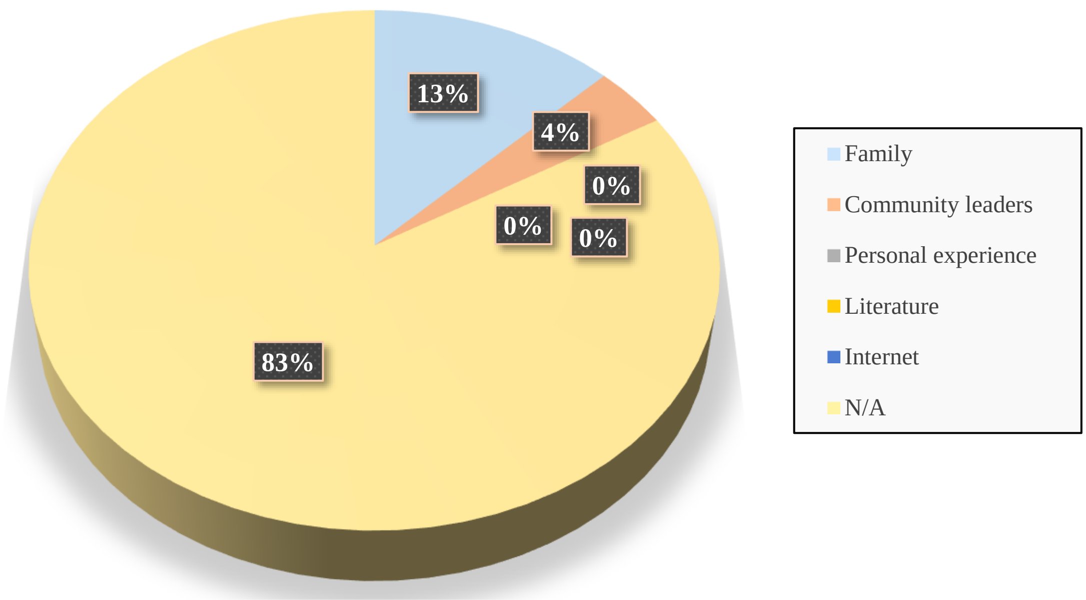


Fig 4.13 Sources of traditional knowledge regarding CWR utilisation in Lukolongo.

The level of understanding among respondents regarding the potential benefits of CWR in agricultural or farming practices was as follows: mildly knowledgeable (25%; n=26), very knowledgeable (0%), and lacking awareness (73%; n=75). A negligible percentage indicated no applicable response (2%; n=2):

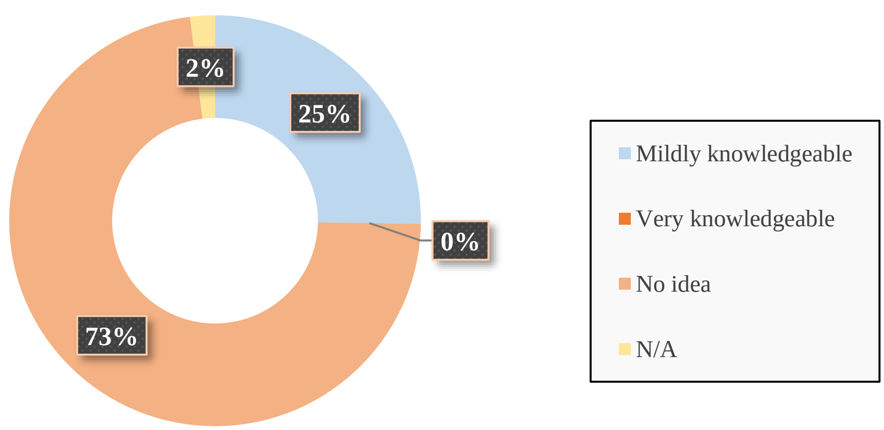


Fig 4.14 Knowledge of potential benefits of CWRs in farming practices.

4.2.3 Utilization patterns of crop wild relatives by smallholder farmers

The utilisation of CWRs within the residential farm yards of the Lukolongo Agricultural Camp includes various purposes: food consumption (31%; n=32), aesthetic and ornamental value including flowers (2%; n=2), medicinal applications (13%; n=13), combined use for both food and medicine (50%; n=52), with a minor proportion reporting no utilisation (4%; n=4), as illustrated in Figure 4.15 below:

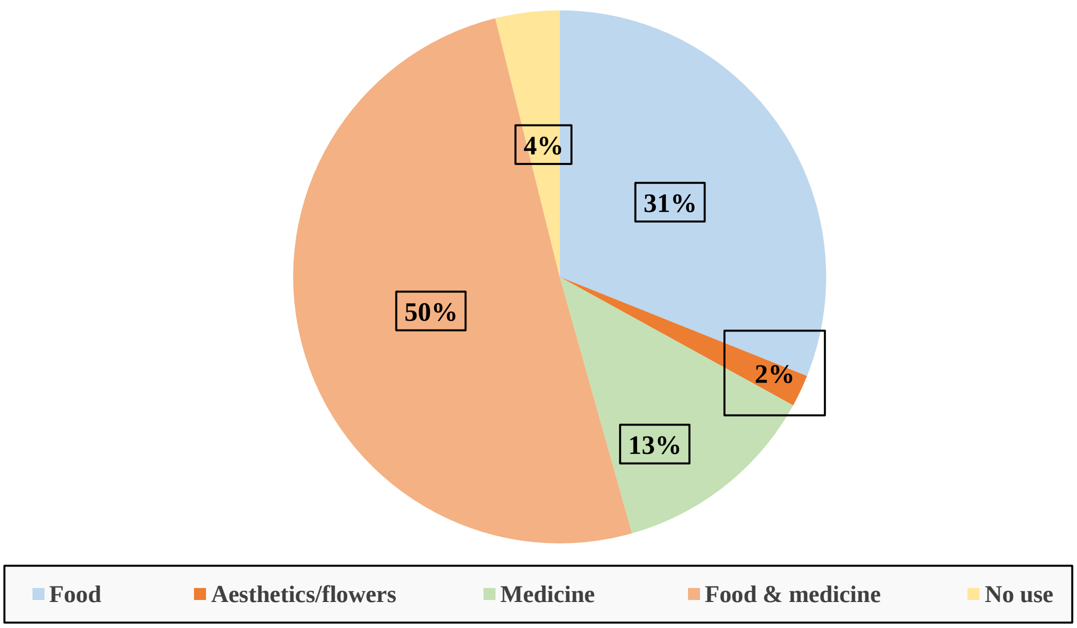


Fig 4.15 Utilisation of CWRs within Lukolongo Camp farm yards.

The utilisation of Crop Wild Relatives among neighboring residents, as determined by respondents, exhibits various dimensions: food consumption (24%; n=25), absence of utilisation for aesthetics/flowers (0%), medicinal applications (14%; n=14), concurrent utilisation for both food and medicinal purposes (56%; n=58), with a minority indicating non-utilization (6%; n=6):

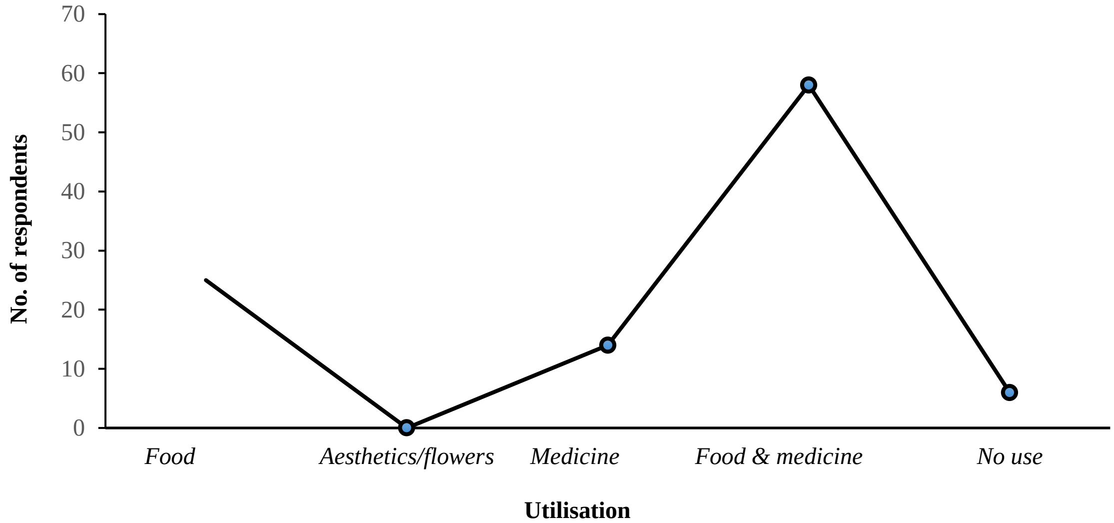


Fig 4.16 Utilisation of CWR by neighboring residents as discerned by respondents.

The utilisation of CWRs within the agricultural activities of Lukolongo camp was established as follows: affirmative (17%; n=18), negative (81%; n=83), with a negligible percentage marked as Not Applicable (N/A) (2%; n=2):

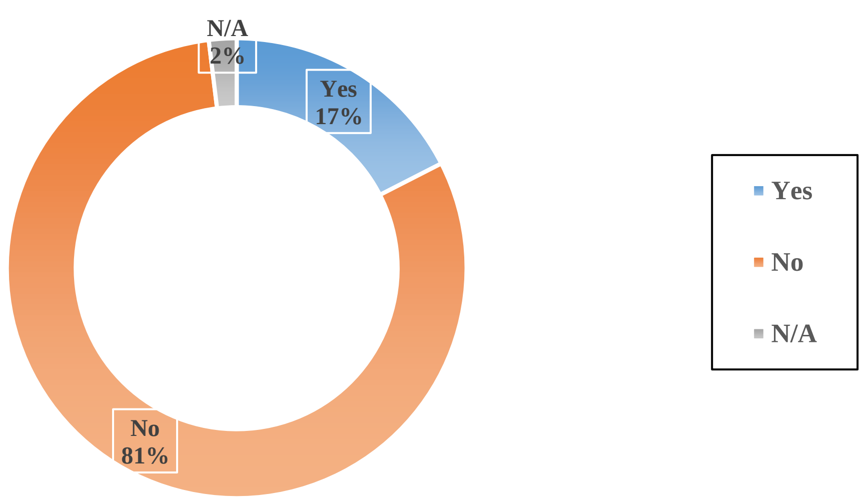


Fig 4.17 Utilisation of CWRs within the farming practices of Lukolongo camp.

The manner in which CWRs are integrated into farming practices within the Lukolongo agricultural camp was delineated as follows: breeding with cultivated crops (0%), utilisation as green manures (3%; n=3), incorporation through intercropping techniques (15%; n=15), while the majority were categorized as Not Applicable (N/A) (82%; n=85).

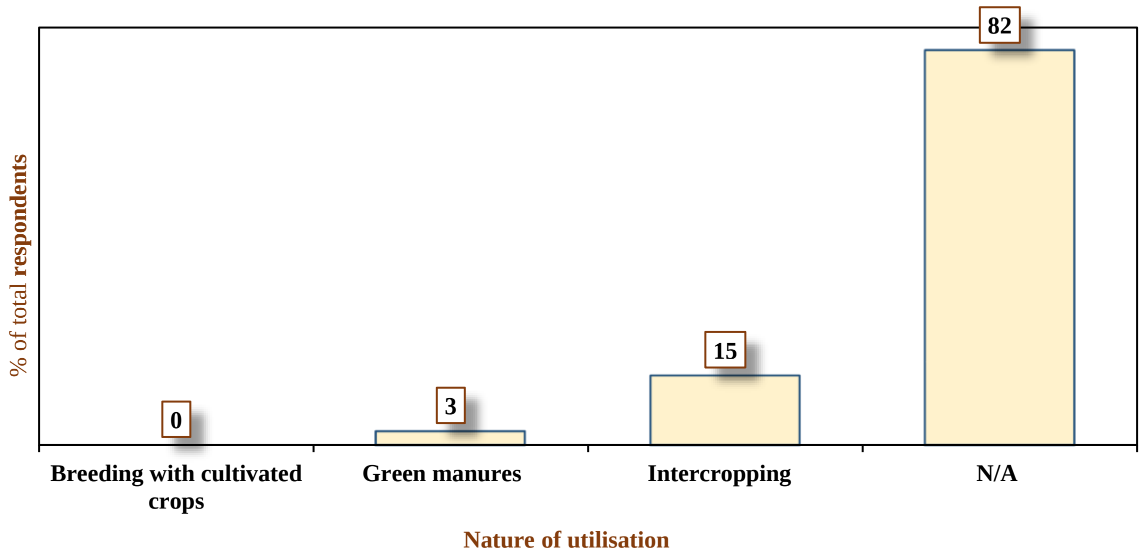


Fig 4.18 Nature of CWR utilisation in farming practices.

An analysis of the significant changes in the utilization patterns of CWRs in the agricultural context of Lukolongo showed a 94% (n=97) approval rate, with a minority reporting negative feedback at 4% (n=4). A nominal fraction reported non-applicability at 2% (n=2):

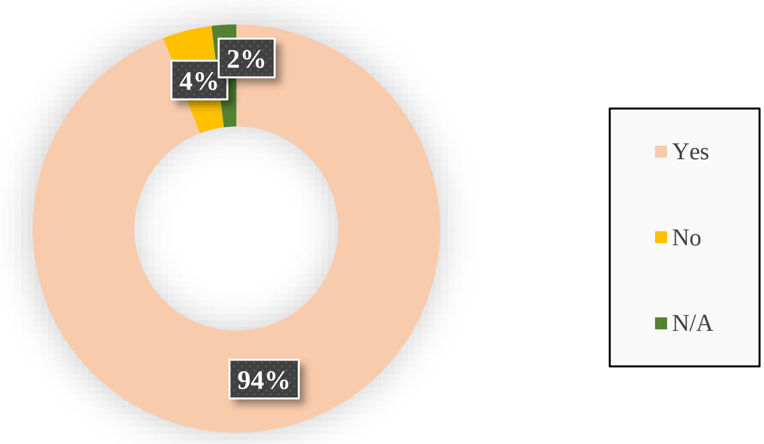


Fig 4.19 Observation of noticeable changes in the utilization patterns of CWRs in Lukolongo camp.

The analysis of temporal dynamics in the utilization patterns of crop wild relatives in the farming domains in Lukolongo showed the following specific trends: increasing in importance (0%), decreasing in importance (34%; n=35), increasing in abundance (0%), declining in abundance (59%; n=61), no increased utility (0%), no decreased utility (1%; n=1), expressions of uncertainty (4%; n=4), absence of observation (1%; n=1), no change at all (1%; n=1), as depicted in the subsequent figure.

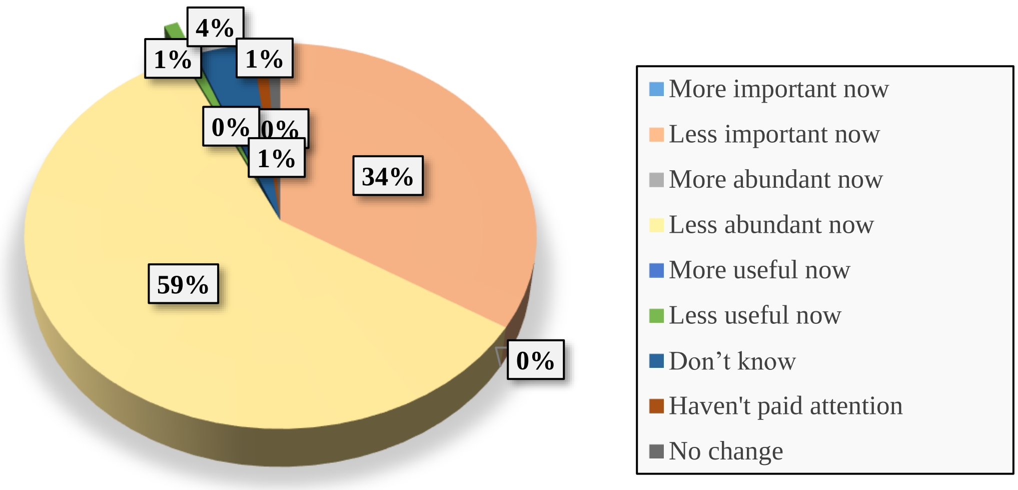


Fig 4.20 Specific trends in CWR utilization over time.

4.2.4 Factors influencing the utilization of crop wild relatives

According to the agricultural community of Lukolongo, impediments hindering the access and effective utilization of CWRs in agricultural practices include: legal constraints (0%), challenges in identification and collection (10%; n=10), inadequacy of specialized expertise for the incorporation of CWR into traditional farming methodologies (49%; n=51), deficiency in adaptation to evolving environmental dynamics (1%; n=1), absence of noticeable challenges (38%; n=39), and instances of non-applicability (2%; n=2), as shown:

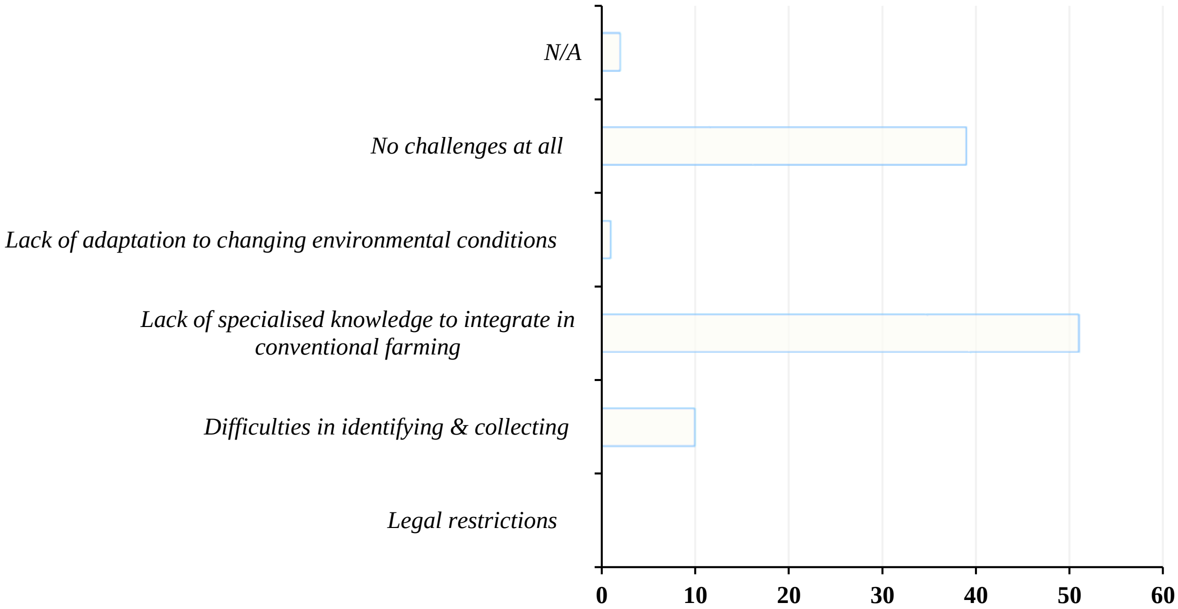


Fig 4.21 Impediments to access and effective utilization of CWR in agricultural practices

The analysis into the socio-cultural determinants shaping the acceptance and integration of CWR within the confines of Lukolongo camp revealed distinctive features: perceptions of risks and uncertainties (1%; n=1), association with established traditional agricultural practices (1%; n=1), prevalent unfamiliarity regarding potential benefits (79%; n=81), limited access to essential resources including seeds and technologies (2%; n=2), considerations of market demand & acceptance (10%; n=10), peer dynamics exerting influence (3%; n=3), absence of knowledge concerning CWR (4%; n=4), as illustrated in Figure 4.22 below.

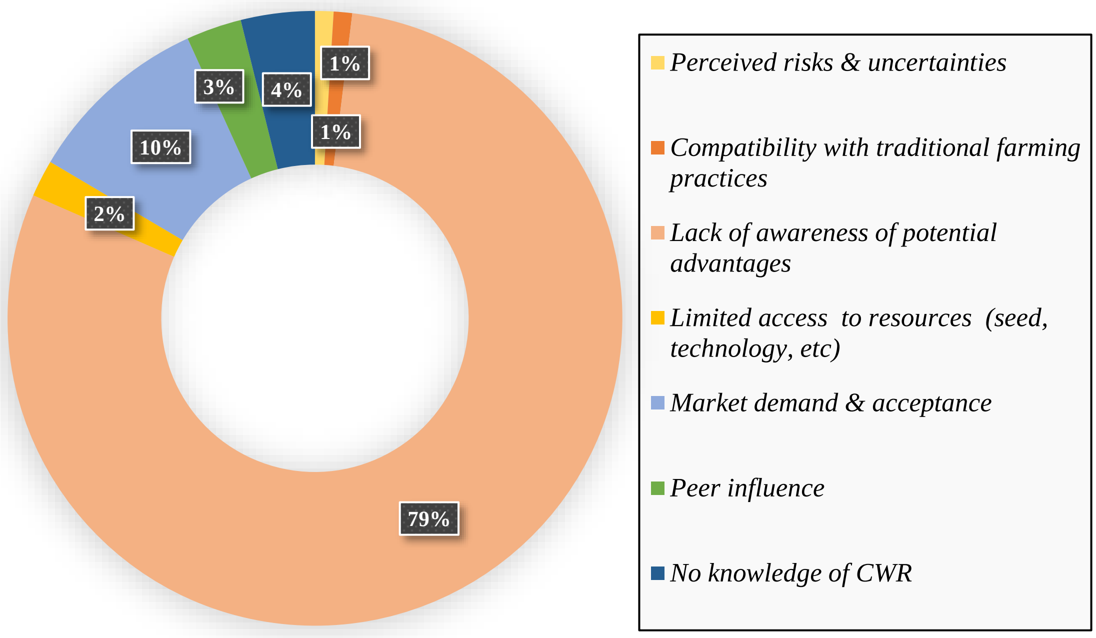


Fig 4.22 Socio-cultural determinants shaping the acceptance and integration of CWR within Lukolongo Camp

The analysis of the effects of pests, diseases and environmental factors on the use of CWR in Lukolongo showed significant results which included decreased crop yields (9%; n=9), decreased crop quality at harvest (7%; n=7), restrictions on growth & distribution (36%; n=37), habitat loss (11%; n=12), loss of genetic diversity (23%; n=24), decreased adaptability and resilience (12%; n=12), and cases of non-use (2%; n=2):

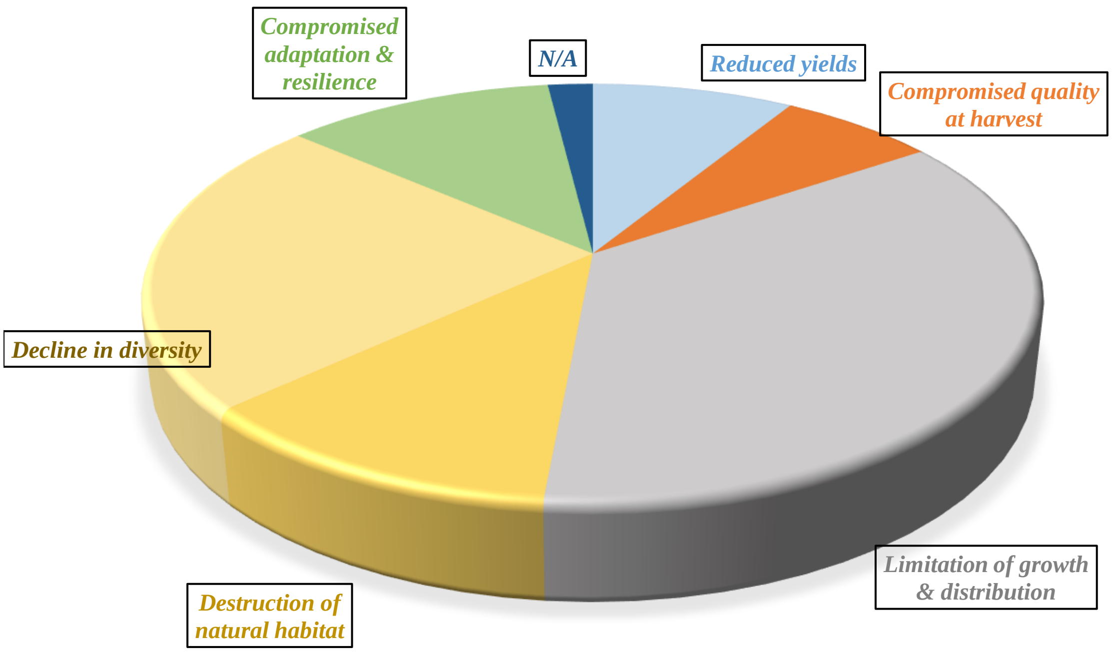


Fig 4.23 Influence of pests, diseases and environmental variables on the use of CWR in Lukolongo.

An inquiry into the infrastructural barriers affecting the integration of CWR in agriculture within Lukolongo camp revealed significant challenges such as: absence of storage facilities (4%; n=4), lack of processing facilities (1%; n=1), dysfunctional transportation networks (1%; n=1), inadequacies or lack of research laboratories (29%; n=30), inadequacies or absence of market structures (22%; n=23), insufficient or lack of irrigation facilities (41%; n=42), and non-applicable (2%; n=2), as illustrated in Figure 4.24 below.

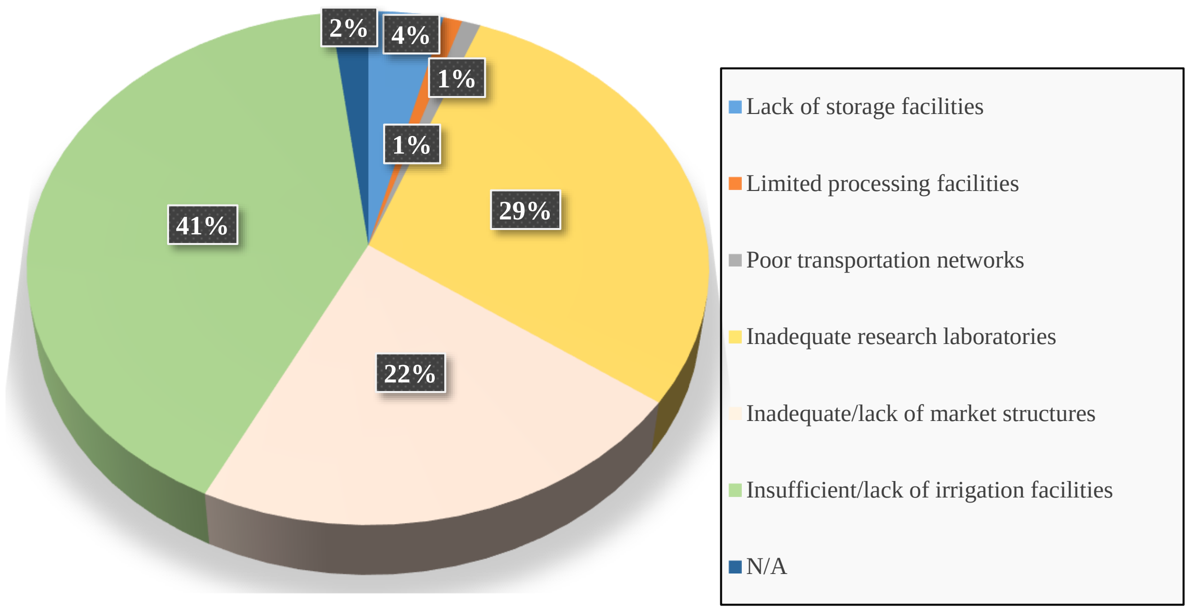


Fig 4.24 Infrastructural impediments influencing the utilization of CWR in agriculture within Lukolongo camp

4.2.5 Proposed strategies for enhancing the sustainable utilization of crop wild relatives

Proposed strategies to ensure the long-term conservation and use of CWR in the agricultural area of Lukolongo include: initiation of community-led conservation initiatives (34%; n=35), education to raise and enhance awareness (49%; n=51), establishment of seed banks or repositories (3%; n=3), promotion of sustainable farming methodologies to integrate CWR cultivation and use (5%; n=5), support policies to encourage sustainable agricultural practices amongst farmers (7%; n=7), and non-applicability (2%; n=2), as shown in the figure below:

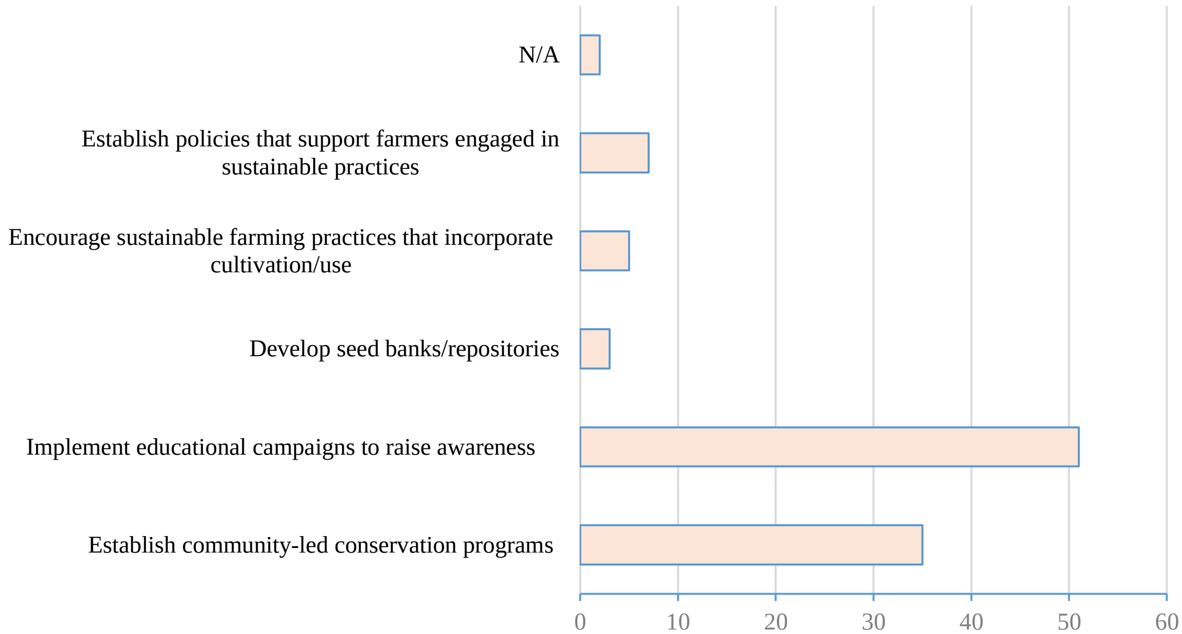


Fig 4.25 Strategies for long-term conservation and use of CWRs in Lukolongo agricultural camp.

The study revealed that incorporating CWRs into sustainable farming practices offers various significant benefits. Notable findings include the assertion that the genetic diversity inherent in CWRs enhances the resilience of cultivated crops, accounting for 3% (n=3) of the identified benefits. Additionally, the respondents attributed 26% (n=27) of the benefits to the potential for CWRs to facilitate the development of improved crop varieties. Moreover, the recognition of CWRs' capacity to support ecosystem services highlights their manifold usefulness, although the precise measurement in this regard was not specified (0%). Of paramount importance is the fact that respondents identified the substantial advantage, representing 37% (n=38), of utilizing CWRs in crop improvement for resilience to climate change. Furthermore, the study findings emphasise CWR's potential to broaden available food options, representing 32% (n=33) of the enumerated benefits. A small proportion of benefits (2%; n=2) was classified as not applicable, suggesting the need for further research or refinement in this area, as the Figure below demonstrates:

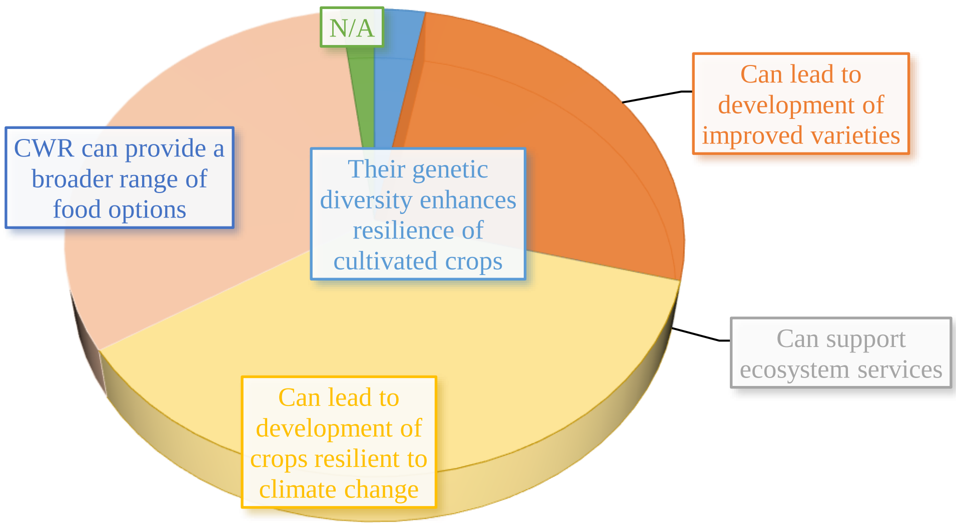


Fig 4.26 Key benefits of integrating CWR into sustainable agricultural practices.

The research findings pertaining to the presence of personal efforts aimed at the sustainable utilization of CWR in Lukolongo agriculture camp showed a significant lack of such initiatives. Only 4% (n=4) of the responses were positive, while 94% (n=97) indicated no such efforts. Additionally, a small segment of the dataset (2%; n=2) found the question not relevant, as shown below:

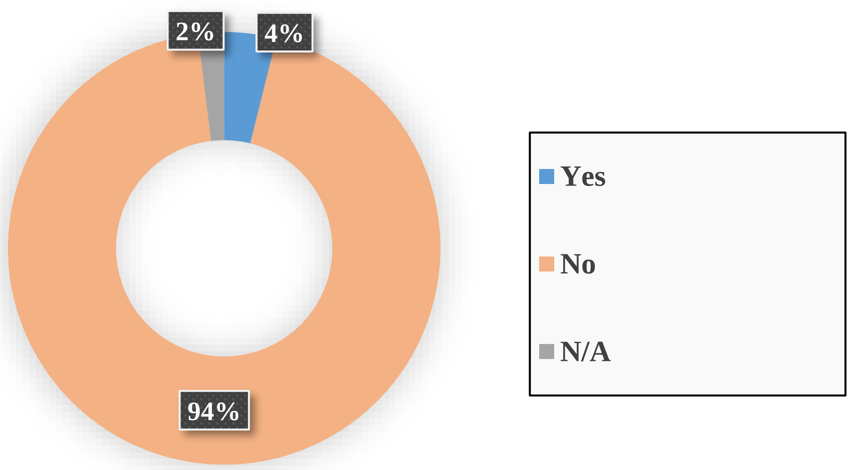
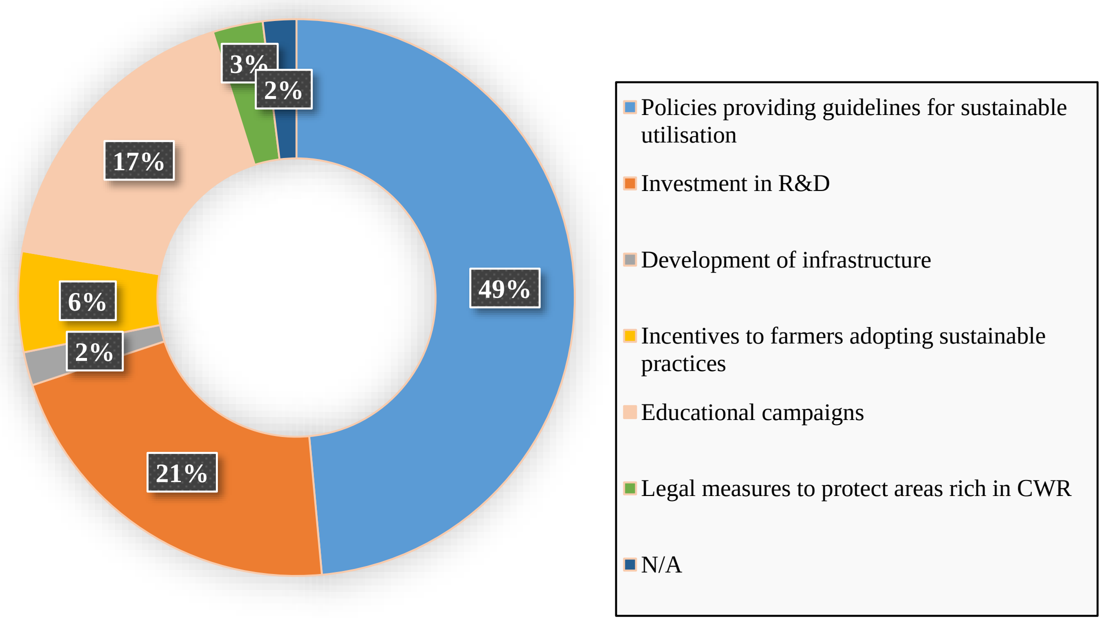


Fig 4.27 Availability of personal initiatives aimed at sustainable utilization of CWRs in Lukolongo camp

Proposed governmental efforts to promote the sustainable utilization of CWR in Lukolongo Agricultural Camp include various strategies. The majority of the respondents suggested creating and enforcing policies to guide sustainable CWR use, making up 49% (n=50) of the proposed actions. Additionally, 21% (n=22) proposed government investment in research and development (R&D) to improve knowledge and innovation in this area. Infrastructural development was seen as important by 2% (n=2) of the respondents. Incentives to encourage farmers to adopt sustainable practices make up 6% (n=6) of the suggestions. Educational campaigns are emphasized by 17% (n=18) of the respondents in order to increase understanding and support for sustainable CWR utilization. Moreover, legal protection for areas rich in CWRs were recommended by 3% (n=3) of the respondents. A small portion of respondents (2%; n=2) considered the inquiry irrelevant, suggesting areas for further inquiry. The figure below illustrates these findings:

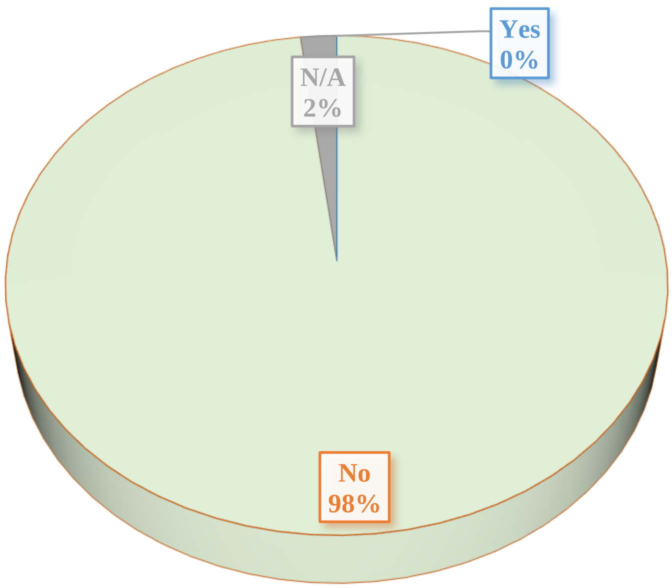
Fig 4.28 Proposed government interventions aimed at fostering the sustainable use of CWRs in Lukolongo



Agricultural Camp

The inquiry into community-led initiatives to promote the sustainable utilization of CWRs in Lukolongo agricultural camp revealed a notable lack of such efforts. None of the responses indicated the presence of such initiatives, accounting for 0% of the responses. Instead, 98% (n=101) of the respondents indicated the absence of community-driven efforts in this area. A minor proportion of the respondents (2%; n=2) considered the investigation irrelevant, as depicted below:

Fig 4.29 Availability of community-driven initiatives focused on fostering the sustainable utilization of CWRs in



Lukolongo agricultural camp

4.2.6 Demographic characteristics of the respondents: gender distribution and age composition

The demographic outlook of the study area reveals a predominance of female respondents over male respondents, as illustrated in Fig 4.30 below:

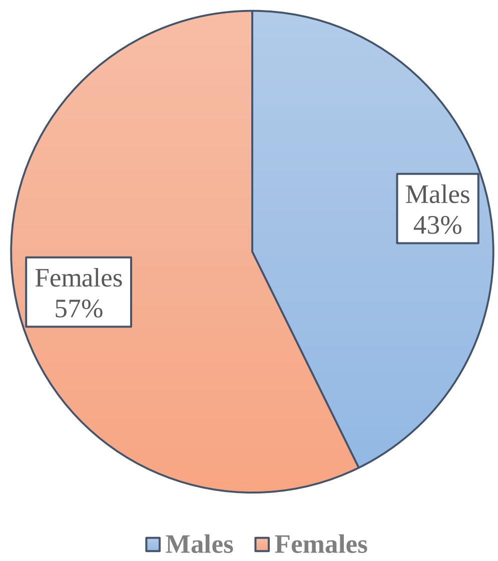


Fig 4.30 Gender distribution of the respondents in Lukolongo agricultural camp

The age distribution of respondents is categorized as follows, with youthful respondents constituting 31.1% (n= 32) of the total:

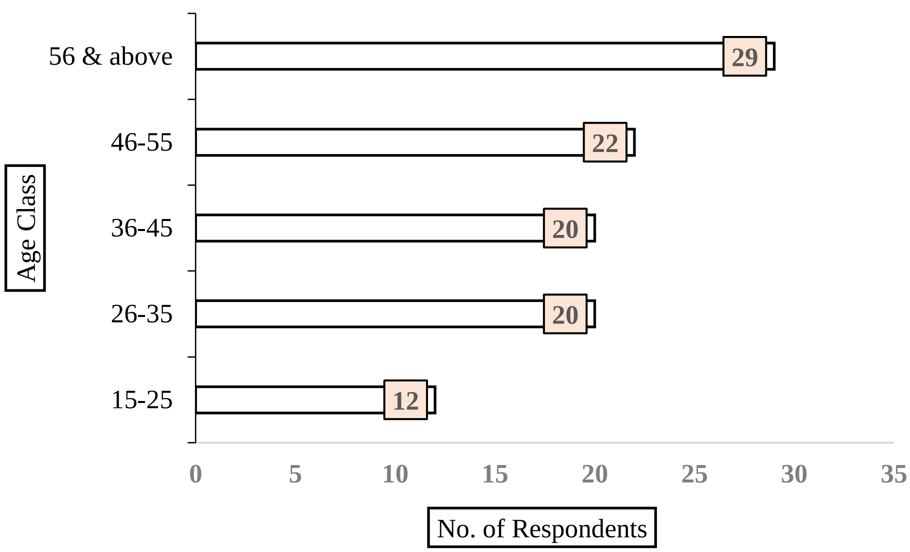


Fig 4.31 Age distribution of the respondents in Lukolongo agricultural camp

CHAPTER FIVE

DISCUSSION OF THE FINDINGS

5.1 Introduction

In this chapter, the findings of the study assessing the occurrence and utilization of crop wild relatives (CWRs) among smallholder farmers in Lukolongo agricultural camp, Kafue district, will be examined in relation to existing literature on the subject matter.

5.2 Discussion of results

The assessment of the occurrence and utilization of crop wild relatives (CWRs) in Lukolongo agricultural camp has provided valuable insights into the area's biodiversity and its potential for agricultural enhancement in the wake of climate change. The findings indicate a rich diversity of CWRs across various plant categories, with notable seasonal abundance and regional variations in their distribution. These results underscore the importance of targeted conservation efforts and highlight the critical role of CWRs in promoting agricultural resilience and sustainability in Lukolongo.

5.2.1 Occurrence of crop wild relatives (CWRs)

The study conducted in Lukolongo agricultural camp has revealed a diverse presence of CWRs, with specific emphasis on their occurrence across different plant categories. The distribution of these CWRs highlights the significant biodiversity within the agricultural camp, which is crucial for agricultural sustainability and potential breeding programs.

Fabaceae (legume) species represent 5.82% of the CWRs identified in the area. The relatively lower occurrence of legumes compared to other categories could suggest either a lesser abundance of wild leguminous plants in the camp or perhaps a higher preference and management of domesticated varieties by local farmers. This finding stresses the need for targeted conservation efforts to preserve the genetic diversity of Fabaceae species, which are vital for improving legume crop resilience to diseases and environmental stresses (Maxted, Ford-Lloyd & Hawkes, 1997).

Poceaea (cereals) account for 30.1% of the CWRs encountered in the area. This significant proportion indicates the importance of wild cereal relatives in Lukolongo. These species provide essential genetic resources for enhancing the yield, nutritional value, and stress tolerance of cultivated cereals. The high occurrence of wild cereals also suggests their adaptability to local environmental conditions, making them invaluable for future crop improvement strategies. This also collaborates with recent research (Guzzon, et al., 2022) emphasizing the importance of conserving and utilizing these genetic resources to maintain crop resilience and productivity in a changing climate.

With 42.72% being various vegetable taxa, the category shows the highest representation. The dominance of vegetable CWRs highlights their ecological adaptability and potential utility in diversifying the agricultural output of the area.

Root and tuber species comprise 16.5% of the CWRs found in the area. This significant presence underscores the importance of wild relatives in maintaining the genetic diversity necessary for the improvement of root and tuber crops. These species are essential for food security, especially in regions where root and tuber crops are staple foods. The relatively high occurrence suggests a rich genetic reservoir that can be tapped into for enhancing crop resilience and productivity.

Arboreal (tree) species represent only 0.98% of the CWR. The minimal occurrence of tree CWRs may be attributed to the specific ecological requirements and longer life cycles of tree species.

The remaining 3.88% of the survey reported no presence of CWRs, suggesting areas where either the natural habitat has been significantly altered, or where certain CWR are inherently less prevalent.

The study also indicates that 82% of the CWR are abundant during the rainy season. This finding is consistent with the ecological patterns of many wild plant species that thrive in wetter conditions due to increased water availability, which supports growth and reproduction. The seasonal abundance underscores the importance of protecting these habitats during the rainy season to ensure the continued survival and propagation of CWRs.

Conversely, 16% of the CWRs were found throughout the year, demonstrating the presence of perennial species or those adapted to a wide range of environmental conditions. These species are particularly valuable for agricultural resilience, providing genetic traits that enable crops to withstand varying climatic conditions.

The 2% of respondents classified as not applicable might include areas with little to no vegetation or respondents who were unsure of the seasonal patterns of CWRs.

A substantial majority (97.08%) of respondents indicated that Lukolongo agricultural camp has areas with high CWR diversity. This overwhelming consensus highlights the recognition of the area's rich biodiversity among the local population, which is crucial for promoting conservation efforts. Only 0.97% of the respondents disagreed, possibly reflecting a lack of awareness or exposure to the diverse plant species in certain parts of the camp. The 1.94% not applicable might include respondents unfamiliar with CWRs.

The Lukolongo central region was reported by 76% of respondents as having the highest diversity of CWRs, followed by Chipongwe region with 21%. The central region's prominence could be due to favourable ecological conditions that support a wide variety of wild plants. The significant representation in Chipongwe suggests localized biodiversity hotspots that contribute to the overall genetic diversity of the area. The absence of CWRs diversity in Shimabala (0%) indicates either ecological limitations or extensive agricultural activities that have reduced the natural habitat for wild relatives. The 3% of uncertain respondents might reflect a lack of detailed knowledge or variability in the perception of CWR diversity across different regions.

5.2.2 Smallholder farmers' knowledge of crop wild relatives

The study indicates that a significant majority of respondents (98%) are familiar with CWRs, and with 36% being very familiar and 62% familiar. This high level of familiarity is indicative of the importance of CWRs in the local agricultural context, possibly reflecting the reliance on these wild species for various purposes. The minimal 2% who are not familiar with CWRs suggest areas where awareness-raising efforts could be targeted to achieve comprehensive community knowledge of CWRs.

A notable gender difference emerges in the familiarity with CWRs, with slightly more female respondents (18.45%) being very familiar compared to their male counterparts (17.48%). This gender disparity highlights the critical role women play in the local knowledge and utilization of CWRs, which may be linked to their traditional roles in food preparation and household food security. Recognizing and supporting the knowledge of female farmers could enhance the conservation and utilization of CWRs in sustainable agricultural practices.

The identification of specific CWR species in Lukolongo highlights the biodiversity present in the area. Wild cucumber (Cucumis africanus) is the most prevalent species, accounting for 44% of the identified CWRs, followed by bitter tomato (Solanum incanum) at 15% and bush yams (Dioscorea praehensilis) at 11%. These findings suggest that certain CWRs are more prominent or easily identifiable by the local farmers, potentially due to their abundance, utility, or distinctive characteristics.

The presence of a wide variety of CWRs, including Dioscorea bulbifera, Sorghum verticilliflorum, Vigna spp., Eleusine coracana africana, and others, indicates a rich genetic reservoir that can be leveraged for crop improvement and resilience. The relatively low percentage of species like Allium spp. and Manihot spp (1% each) highlights the need for further exploitation and documentation of these less common CWRs to fully understand their potential benefits.

Traditional knowledge related to CWRs identification is limited, with only 13% of respondents capable of observing specific plant characteristics and a mere 1% understanding the distribution across different locations and seasons. Expertise in seed preservation techniques is slightly higher at 19%. However, a majority (67%) reported a lack of traditional knowledge in this area, which emphasizes the need for educational programs to enhance the community's skills in identifying and preserving CWRs.

The utilization of CWRs for food preparation (17%) and medicinal purposes (25%) demonstrates the practical importance of these species in local livelihoods. The recognition of potential hazards linked to CWRs utilization (3%) and their integration into cropping practices (1%) are also noted, although these areas are less commonly understood. The significant proportion of respondents (54%) lacking traditional knowledge on CWRs utilization points to a critical gap that needs to be addressed through knowledge-sharing initiatives and training programs.

Gender differences are also evident in traditional knowledge regarding the utilization of CWRs, with more female respondents (41%) possessing this knowledge compared to their male counterparts (33%). This finding reinforces the role of women as custodians of traditional agricultural knowledge and their potential contribution to sustainable CWR utilization.

Younger age groups (10-0 years) tend to identify fewer plant species compared to older age classes (Ayantunde, et al., 2008). There appears to be a curvilinear relationship between respondent age and the number of recognized plant species. Older generations often hold more extensive traditional knowledge, while younger generations may lack opportunities to develop these skills as culturally significant environments degrade. This observation may account for the limited ability of many respondents in the study area to accurately identify CWR species, as a significant proportion of respondents were relatively young.

The origins of traditional knowledge regarding CWR utilization predominantly stem from hereditary transmission (13%) and guidance from community leaders (4%). The absence of knowledge derived from personal empirical understanding, literature, or internet sources (0% each) suggests a reliance on oral traditions and communal practices. The overwhelming majority (83%) reporting a lack of any traditional knowledge highlights the urgent need for systematic documentation and dissemination of traditional practices to prevent the loss of invaluable cultural and agricultural knowledge.

The respondents' understanding of the potential benefits of CWRs in agricultural practice is alarmingly low, with 73% lacking awareness and 25% being mildly knowledgeable about CWRs benefits. This indicates a significant gap in education and awareness. Addressing this gap is crucial for promoting the integration of CWRs into sustainable agricultural practices, and ensuring food security.

5.2.3 Utilization patterns of crop wild relatives by smallholder farmers

The study reveals that the primary purpose of CWRs consumption within residential farm yards is for combined food and medicinal use, accounting for 50% of the reported utilization. This dual purpose utilization reveals the multifunctional value of CWRs in local households, providing both nutritional and health benefits. Food consumption alone accounts for 31%, highlighting the role of CWRs as a supplementary food source, potentially contributing to food security and dietary diversity. Medicinal applications are significant, representing 13% of the utilization, which reflects the reliance on traditional medicine in the community. The minimal use for aesthetic and ornamental value (2%) suggests that the primary focus of CWR use is functional rather than decorative. A small proportion (4%) reported no utilization, indicating areas where awareness or accessibility to CWRs might be limited.

The utilization patterns among neighbouring residents show a similar trend, with a predominant combined use for food and medicinal purposes (56%). This consistency in utilization patterns across different households underscores the widespread recognition of the benefits of CWRs. Food consumption alone accounts for 24%, while, medicinal applications are slightly higher than within residential yards at 14%. The absence of use for aesthetic purposes (0%) further emphasizes the functional importance of CWRs. Non-utilisation is slightly higher at 6%, suggesting that some households may not recognize or have access to CWR resources.

The utilization of CWRs within the broader agricultural landscape of the camp is marked low, with only 17% affirmatively reporting their use, while a significant 81% indicated negative utilization. This disparity suggests a gap between the recognition of CWR benefits at the household level and their practical integration into agricultural practices. The 2% reporting non-applicability may reflect areas where CWRs are not present or where specific farming practices preclude their use.

The integration of CWRs into farming practices within the agricultural camp is limited. No respondents reported using CWRs for breeding with cultivated crops (0%), indicating a lack of awareness or capacity for using CWRs in crop improvement programs. Utilisation for green manure is minimal (3%), suggesting that the potential soil fertility benefits of CWRs are not widely recognized or implemented. Intercropping techniques account for 15% of the integration, highlighting some awareness and practice of using CWRs to enhance biodiversity and possibly pest management. However, the majority (82%) reported non-applicability, reflecting a significant gap in the adoption of CWR-based farming practices.

An overwhelming majority (94%) of respondents reported significant changes over time, in the utilization patterns of CWRs in the agricultural context of Lukolongo camp, indicating a recognition of the evolving role of these resources. However, 4% reported negative feedback, possibly reflecting challenges or barriers to integrating CWRs effectively. The 2% non-applicability may pertain to respondents who did not observe any changes or were not engaged in practices involving CWRs.

The analysis of temporal dynamics shows a concerning trend, with 34% of respondents indicating a decrease in the importance of CWRs over time. This decline could be attributed to factors such as changing agricultural practices, increased reliance on commercial crops, or loss of traditional knowledge. No respondents reported an increase in the importance of CWRs (0%), highlighting a potential area for intervention to promote the benefits of CWRs. The negligible percentages for no increased utility (0%), no decreased utility (1%), uncertainty (4%), and no change at all (1%) suggests that the majority of the community perceives a downward trend or is uncertain about the role of CWRs. This finding correlates with other studies indicating that the reduced emphasis on CWRs can be linked to modernization in agriculture, which often prioritizes high-yield commercial varieties over diverse traditional crops. Additionally, the intensification of agriculture and urbanization contributes to habitat loss, further threatening the existence of many CWRs. For instance, over 70 wild relatives of key crops are currently threatened with extinction due to habitat conversion and the shift from traditional farming systems to mechanized agriculture (IUCN, 2021)

5.2.4 Factors influencing the utilization of crop wild relatives

The primary impediments hindering the access and effective utilization of CWRs in Lukolongo camp include challenges regarding identification and collection (10%) and a significant inadequacy of specialized expertise for incorporating CWRs into traditional farming methodologies (49%). This finding highlights a critical gap in knowledge and skills necessary for the effective use of CWRs. The lack of specialized expertise suggests a need for targeted training programs and educational initiatives to enhance farmers' capacities to identify, collect, and integrate CWRs into their practices.

The absence of noticeable challenges reported by 38% of respondents indicates that a substantial portion of the community may not perceive barriers to CWR utilization, possibly due to a lack of awareness or engagement with these resources. The minimal impact of legal constraints (0%) suggests that regulatory frameworks are not a significant barrier in this context. The deficiency in adaptation to evolving environmental dynamics (1%) and non-applicable responses (2%) further highlight the need for adaptive strategies to address emerging environmental challenges.

Socio-cultural determinants play a pivotal role in shaping the acceptance and integration of CWRs within Lukolongo agricultural camp. The prevalent unfamiliarity regarding potential benefits (79%) is the most significant socio-cultural barrier, indicating a widespread lack of awareness and understanding of the advantages that CWRs can offer. This unfamiliarity hampers the community's ability to leverage these resources for agricultural improvement.

Perceptions of risks and uncertainties (1%) and the association with established traditional agricultural practices (1%) suggests that some farmers may be cautious about integrating new or unfamiliar resources into their well-established farming systems. Limited access to essential resources, including seeds and technologies (2%), and considerations of market demand and acceptance (10%) further constrain the utilization of CWRs. Peer dynamics exerting influence (3%) and the absence of knowledge concerning CWRs (4%) highlight the importance of community networks and information dissemination in promoting CWR utilization.

The use of CWRs is significantly affected by various biotic and abiotic factors. Decreased crop yields (9%) and decreased crop quality at harvest (7%) indicate that pests, diseases and environmental stressors negatively impact the productivity and quality of crops derived from or incorporating CWRs. Restrictions on growth and distribution (36%) and habitat loss (11%) underscore the ecological challenges that limit the availability and accessibility of CWRs in their natural habitats.

The loss of genetic diversity (23%) and decreased adaptability and resilience (12%) reflect the broader consequences of environmental degradation and climate change on the genetic resources available to farmers. These findings highlight the critical need for conservation efforts to preserve the genetic diversity and adaptability of CWRs, ensuring their continued availability for future agricultural use. Cases of non-use (2%) may indicate areas where CWRs are not currently relevant or accessible to farmers.

Infrastructural barriers present significant challenges to the integration of CWRs in agriculture within Lukolongo camp. The absence of storage facilities (4%), lack of processing facilities (1%), and dysfunctional transportation networks (1%) indicate logistical constraints that hinder the effective management and utilization of CWRs. These infrastructural deficiencies impact the ability of farmers to store, process, and transport CWR-derived products, limiting their marketability and utility.

The inadequacies or lack of research laboratories (29%) and market strictures (22%) further constrain the development and commercialization of CWRs. The absence of research facilities hampers the ability to conduct necessary studies on CWRs properties, breeding potential, and agronomic practices. Similarly, insufficient market structures limit the economic incentives for farmers to cultivate and sell CWR-derived products.

The most significant infrastructural barrier is the insufficient or lack of irrigation facilities (41%). This deficiency critically impacts the cultivation of CWRs, particularly in areas prone to water scarcity or irregular rainfall. The provision of adequate irrigation infrastructure is essential to support the growth and integration of CWRs into local agricultural systems. Non-applicable responses (2%) suggest that some respondents do not perceive these infrastructural barriers as relevant to their context.

5.2.5 Proposed strategies for enhancing the sustainable utilization of crop wild relatives

The study identifies several key strategies for the long-term conservation and use of CWRs, with a significant emphasis on community-led conservation initiatives (34%) and education to raise and enhance awareness (49%). These findings underscore the critical role of community involvement and education in fostering sustainable CWR practices. Community-led initiatives are essential as they leverage local knowledge and engagement, ensuring that conservation efforts are culturally relevant and locally supported.

The establishment of community seed banks or repositories (3%) is identified as a potential strategy, although it is under-reported. Seed banks play a crucial role in preserving genetic diversity and providing a resource for future agricultural development. The promotion of sustainable farming methodologies to integrate CWR cultivation and use (5%) is also highlighted, but its low percentage indicates a need for greater emphasis on practical farming techniques that incorporate CWRs.

Support policies to encourage sustainable agricultural practices (7%) are seen as vital for creating an enabling environment for CWR utilization. However, the relatively low percentage suggests that policy initiatives need to be more robust and widespread. The non-applicability (2%) response highlights areas where more research and tailored strategies might be necessary to address specific local conditions and needs.

Incorporating CWRs into sustainable farming practices offers numerous benefits, as indicated by the study. A small percentage (3%) of the respondents acknowledge the genetic diversity inherent in CWRs as enhancing the resilience of cultivated crops. This benefit is critical for developing crops that can withstand pests, diseases, and climate change. The potential for CWRs to facilitate the development of improved crop varieties is recognized by 26% of the respondents, highlighting the importance of CWRs in agricultural innovation and crop improvement programs.

A significant finding is that 37% of the respondents see the utilization of CWRs in crop improvement as crucial for resilience to climate change. This underscores the urgent need to integrate CWRs into breeding programs to develop crops that can adapt to changing climatic conditions. Additionally, 32% of the respondents identify the potential of CWRs to broaden available food options, which is essential for food security and dietary diversity. The non-applicability (2%) response indicates that further research may be needed to fully understand and communicate the benefits of CWRs.

The findings reveal a significant lack of personal and community efforts aimed at the sustainable utilization of CWRs. Only 4% of responses indicate personal efforts, while a vast majority (94%) report no such initiatives. Similarly, there are no community-led initiatives reported (0%), with 98% indicating the absence of such efforts. These findings suggest a critical gap in local engagement and action towards CWR conservation and utilization.

The lack of personal and community initiatives highlights the need for targeted awareness campaigns and capacity-building programs to encourage individual and collective actions. The minor proportion of respondents considering the question irrelevant (2%) suggest a disconnect or lack of awareness about the importance of CWRs, which need to be addressed through education and outreach.

The study identifies several governmental strategies to promote the sustainable utilization of CWRs, with strong emphasis on creating and enforcing policies (49%) and government investment in research and development (21%). These strategies are crucial for providing the necessary regulatory and financial support to foster innovation and sustainable practices.

Infrastructure development (2%) and incentives to encourage farmers to adopt sustainable practices (6%) are also recognized, although their low percentages indicate that more efforts are needed in these areas. Educational campaigns (17%) are essential for increasing understanding and support for CWR utilization, while legal protection for areas rich in CWRs (3%) is necessary to safeguard these valuable genetic resources.

The small proportion of respondents considering the inquiry irrelevant (2%) highlights the need for further investigation into specific local contexts and tailored governmental interventions to address unique challenges and opportunities in Lukolongo agricultural camp.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter consolidates the main findings of the study assessing the occurrence and utilisation of CWRs among smallholder farmers in Lukolongo agricultural camp. By synthesizing the analysis of CWR presence, farmers' awareness, utilization behaviours, and influencing factors, this chapter offers actionable recommendations to stakeholders. The aim is to provide practicable guidance for policymakers, agricultural practitioners, and local communities to enhance biodiversity conservation, augment food security, and promote resilient agricultural practices in Lukolongo and similar settings.

6.2 Conclusion

The findings from Lukolongo agricultural camp underscore the critical importance of preserving CWRs across various plant categories. The diverse presence of CWRs, particularly during the rainy season, highlights their adaptability and potential utility in enhancing agricultural resilience. The recognition of high CWR diversity by the majority of respondents points to the need for targeted conservation and utilization strategies, ensuring that these genetic resources are safeguarded for future crop improvement efforts. The regional variations in CWR diversity further emphasize the importance of localized conservation initiatives to protect these invaluable plant resources.

The findings also reveal a high level of familiarity with CWRs among smallholder farmers but also highlight significant gaps in traditional knowledge and awareness of their benefits. The gender differences in knowledge and the reliance on hereditary transmission for traditional practices underscore the need for targeted educational initiatives and knowledge-sharing platforms. Enhancing the community's understanding and utilization of CWRs can contribute to sustainable agricultural development and the conservation of these valuable genetic resources.

The study also reveals a complex landscape where these genetic resources are valued for their multifunctional benefits but are not widely integrated into agricultural practices. The predominant use for combined food and medicinal purposes emphasizes their importance in local livelihoods, while the limited use within the agricultural landscape and farming practices highlights significant gaps in knowledge and application. The observed decline in the importance of CWRs over time calls for targeted interventions to promote their conservation and utilization, ensuring that the community can fully benefit from these valuable resources. Addressing these gaps through education, awareness programs, and practical demonstrations could enhance the sustainable use of CWRs, contributing to agricultural resilience and food security in the area.

The findings on the factors influencing the utilization of CWRs in Lukolongo camp reveal a complex interplay of impediments, socio-cultural determinants, biotic and abiotic challenges, and infrastructural barriers. Addressing these challenges requires a multifaceted approach that includes enhancing knowledge and skills, promoting awareness of CWR benefits, conserving genetic diversity, and improving infrastructural support. By tackling these issues, the community can better integrate CWRs into their agricultural practices, enhancing resilience, productivity, and sustainability in the face of evolving environmental and socio-economic conditions.

The findings on proposed strategies for enhancing the sustainable utilization of CWRs in Lukolongo agricultural camp reveal significant opportunities and challenges. Community involvement and education are paramount for fostering sustainable practices, while government support through policies, research, and infrastructure is essential for creating an enabling environment. The perceived benefits of CWR integration, particularly for climate resilience and food security highlight the critical role of these resources in sustainable agriculture. However, the lack of personal and community initiatives underscores the need for targeted interventions to raise awareness and build capacity at the local level. Addressing these gaps through a comprehensive and integrated approach can enhance the sustainable utilization of CWRs, contributing to agricultural resilience and food security in Lukolongo agricultural camp.

6.3 Recommendations

Based on the comprehensive analysis of the findings related to the occurrence, knowledge, utilization patterns, influencing factors, and proposed strategies for the sustainable utilization of CWRs in Lukolongo agricultural camp, the following recommendations are proposed:

Implement targeted educational programs - there will be need to develop and deliver educational programs aimed at increasing farmers' familiarity with CWRs. These programs should focus on the identification, benefits, and sustainable use of CWRs, leveraging both traditional knowledge and scientific insights.

Enhance gender-sensitive training – there will also be need to ensure that educational initiatives are gender-sensitive, recognizing the slightly higher familiarity among female respondents, and aim to bridge any knowledge gaps between male and female farmers.

Document and disseminate traditional knowledge – the need to systematically document traditional knowledge related to CWRs and disseminate this information through workshops, community meetings, and printed materials cannot be overemphasized.

Encourage multi-purpose utilization of CWRs - the diverse uses of CWRs, including for food, medicinal purposes, and combined uses, will need to be promoted through community-led initiatives and farmer educational programs. The benefits of integrating CWRs into existing farming practices will also need to be highlighted.

Integrate CWRs into agricultural practices – there will be need to develop and promote sustainable farming methodologies that incorporate CWRs, such as intercropping, green manure use, and other agro-ecological practices. Training and resources to support these practices will need to be provided.

Monitor and evaluate utilization trends – there will also be need to establish a monitoring and evaluation framework to track changes in CWR utilization patterns over time. This data can be used to inform future strategies and ensure continuous improvement.

Develop adaptive strategies for environmental challenges – There will also be need to formulate and implement adaptive strategies in order to address environmental challenges, such as habitat loss and climate change, in the area. Promoting the conservation of genetic diversity and resilience of CWRs through community-based conservation programs will suffice, in this regard.

Fostering community-led conservation initiatives - the formation of community-led conservation groups focused on the preservation and sustainable use of CWRs should be encouraged, by providing training and resources to support these initiatives and ensuring their sustainability.

Establish community seed banks - community seed banks or repositories to preserve the genetic diversity of CWRs can also be established in order to provide a resource for future agricultural use. These seed banks will however, need to be well-managed and accessible to all local farmers in the area.

Formulate supportive policies and incentives – there will be need to advocate for the development and enforcement of policies that promote the sustainable use of CWRs in the area. Similarly, farmers will need to be provided with incentives to allow them adopt sustainable agricultural practices, including financial support, technical assistance and market access.

Promote research and development - government and the private sector should be encouraged to invest in research and development (R&D) in order to improve knowledge and innovation related to CWRs. This R&D should focus on breeding programs, ecological studies, and the development of sustainable farming techniques.

Protect critical habitats – government should also endeavor to implement legal protection for areas rich in CWRs in order to prevent habitat loss and ensure the conservation of these valuable genetic resources.

By adopting these recommendations, Lukolongo agricultural camp can enhance the sustainable utilization of CWRs, thereby contributing to agricultural resilience, food security, and the preservation of biodiversity. These efforts will require coordinated action among community members, government agencies, and other stakeholders to achieve long-term success.

REFERENCES

Altieri, M.A. (2018). Enhancing crop resilience via wild relatives. Science, 362(6414), 832-833.

Ayantunde, A.A., Briejer, M., Hiernaux, P., Udo, H.M.J., Tabo, R. (2008). Botanical knowledge and its differentiation by age, gender and ethnicity in southwestern Niger. Human Ecology. 36(6):881-889

Banks, J.E. (2004). Divided Culture: Integrating Agriculture and Conservation Biology. Frontiers in Ecology and the Environment 2 (10), 537-545

Berkes, F., & Turner, N. J. (2006). Knowledge, learning and the evolution of conservation practice for social-ecological system resilience. Human Ecology, 34(4), 497-494

Castaneda-Alvarez, N. P., Khoury, C.K., Achicanoy, A.H., Bernau, V., Dempewolf, H., Eastwood, R.J., Guarino, L., Harker, R.H., Jarvis, A., Maxted, N., Muller, V.J., Ramirez-Villegas, J., Sosa, C.C., Struik, P.C., Vincent, H. & Toll, J. (2016). Global Conservation Priorities for Crop Wild Relatives. Nature Plants 2 (4), 1-6.

Chivunga, E. (2016). "Wild Crop Relatives: Indigenous Knowledge and Sustainable Agriculture in Zambia." Journal of Agricultural Research and Development, 5(2), 101-114.

Choudhary, M., Signh, V., Muthusamy, V., & Wani, S.H. (2017). Harnessing Crop Wild Relatives for Crop Improvement. IndianJournals.com 6 (2), 73-85.

Dempewolf, H., Baute, G., Anderson, J., Kilian, B., Smith, C., & Guarino, L. (2017). Past and future use of wild relatives in crop breeding. Crop Science, 57(3), 1070-1082

Dempewolf, H., Eastwood, R. J, Guarino, L., Khoury, C.K., Muller, J.V., & Toll, J. (2017). Adapting agriculture to climate change: a global initiative to collect, conserve and use crop wild relatives. Agroecology and Sustainable Food Systems, 41(6), 606-623

Dempewolf, H., & Tyack, N., (2015). The economics of crop wild relatives under climate change. Crop wild relatives and climate change, 281-291. Wiley-Blackwell.

FAO. (2010). "The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture." Food and Agriculture Organization of the United Nations.

Goettsch, B., Urquiza-Haas, T., Koleff, P., et al. (2021). Extinction Risk of Mesoamerican Crop Wild Relatives. Plants, People, Planet 3 (6), 775-795.

Guzzon, F., Gianella, M, Giovannini, P., & Payne, T.S. Conserving Wheat Genetic Resources BT – Wheat Improvement: Food Security in a Changing Climate. In: Reynolds, M.P., & Braun, H.J, Editors (2022). Cham: Springer International Publishing; p. 299-318.

GRZ, February, (2023). Ministry of Agriculture., Department of Agriculture HQ, Mulungushi House, Lusaka.

GRZ (2011). Ministry of Agriculture. Exploratory Soil map of Zambia. Zambia Agriculture Research Institute, Mount Makulu Soil Survey Unit.

Hajjar, R., & Hodgkin, T. (2007). The use of wild relatives in crop improvement: A survey of developments over the last 20 years. Euphytica, 156 (1-2), 1-13.

Heywood, V.H. (2008). Challenges of In Situ Conservation of Crop Wild Relatives. Turkish Journal of Botany 32 (6), 421-432.

Heywood, V. H., & Zohary, D. (1995). A catalogue of the wild relatives of cultivated plants native to Europe. Flora Mediterranea, 5, 375-415.

Hickey, S & Mohan, G. (2002). Participation in development: perspectives from the comprehensive development paradigm. Review of Development Economics 6(2):163-82. DOI: 10.1111/1467-9361.00148

Hodgkin, T., & Meilleur, B.A. (2004). In Situ Conservation of Crop Wild Relatives: Status and Trends. Biodiversity & Conservation 13, 663-684.

IUCN, (2021). Threats to Crop Wild Relatives Compromising Food Security and Livelihoods. https://www.iucn.org/news/species/202109/threats-crop-wild-relatives-compromising-food-security-and-livelihoods

Jarvis, A., Lane, A., & Hijmans, R.J (2008). "The Effect of Climate Change on Crop Wild Relatives." Agriculture, Ecosystems & Environment, 126(1-2), 13-23.

Maxted, N., Ford-Lloyd, B.V., & Hawkes, J.G (1997). Plant Genetic Conservation: The In Situ Approach. Chapman & Hall.

Maxted, N., & Kell, S.P. (2009). "Establishment of a Global Network for the In Situ Conservation of Crop Wild Relatives: Status and Needs." FAO Commission on Genetic Resources for Food and Agriculture.

Maxted, N., Kell, S., Toledo, A., Dullo, E., Heywood, V., & Hodgkin, T. (2012). A global approach to crop wild relative conservation: Securing the gene pool for food and agriculture. Kew Publishing. Maxted, N., Ford-Lloyd, B.V., Jury, S.L, Kell, S. P, & Scholten, M.A. (2008). Towards a definition of a crop wild relative. Biodiversity & conservation 31 (4), 3593-3607

Nair, K.P. (2019). Utilising Crop Wild Relatives to Combat Global Warming. Advances in Agronomy 153, 175-258.

Ngúni, D., Thormann, I., Gaisberger, H., Maxted, N., Brehm, J.M., Kell, S., Munkombwe, G., Mwila, G., Dulloo, E. M (2017). National Strategic Action Plan for the Conservation and Sustainable Use of Crop Wild Relatives in Zambia – Technical background document ii. DOI. 10.7910/DVN/VYZZFF

Pretty, J. & Smith, D. (2004). Social capital in biodiversity conservation and management. Conservation Biology, 18(3), 631-638.

Riordan, E.C., & Nabhan, G.P. (2019). Trans situ Conservation of Crop Wild Relatives. Crop Science 59 (6), 2387-2403.

Sharma, M.P., & Gupta, B.B. (2020). Role of Wild Relatives for Development of Climate-resilient Varieties. Rediscovery of Genetic and Genomic Resources for Future Food Security, 303-314.

Zimmerer, K.S. & De Haan, S. (2017). Agrobiodiversity and a sustainable food future. Nature Plants. International Centre for Tropical Agriculture 3:17047. https://hdl.handle.net/10568/81385