



Applications of Indigenous Farming Practices and Methods for Food Security Among Rural Communities in Southern Africa: A Review

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Abstract

The world is faced with an alarming food insecurity challenge. Although various strategies associated with conventional farming are currently available to enhance food security, many people still suffer from food insecurity especially in rural communities. This review explored the role of indigenous farming practices in combating food insecurity. We explored empirical data involving indigenous land management in agriculture, soil fertilisation, planting methods, and control of pests and diseases in southern Africa. Various databases were consulted using search engines, covering data from 2010 till 2023. The literature search yielded 15 eligible studies that covered countries in southern Africa except Mozambique and Eswatini. The four land management practices identified were fallowing, shifting cultivation, zero tillage, and minimum tillage. Four materials, namely farmyard/manure, grass/crop residue, ash, and mound from termites were used by indigenous farmers in southern Africa to increase soil fertility. Five crop production cultural practices including relay planting, intercropping, crop rotation, early planting and agroforestry were identified from the eligible studies. A total of 62 plant species were documented for protecting crops from pests and diseases by local farmers. The top three mentioned plant species were *Allium cepa*, *Nicotiana tabacum*, and *Tagetes minuta*, each of them having a frequency of five (5). This review re-emphasizes the longstanding interactions between local farmers and the environment rooted in the need for sustainably managing natural resources for crop production geared towards food security.

Keywords Biodiversity · Botanical pesticides · Conservation · Indigenous knowledge · Plant pests · Sustainability

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Introduction

Population growth has caused major concerns around food security especially in developing countries. Food security is attained when all people have physical, social and economic access to sufficient, safe, nutritious and culturally acceptable food at all times which meet their dietary needs for an active and healthy life [42]. While global hunger declined from 8.7% in 2022 to 8.2% of the world population in 2024, the southern Africa region experienced a consistent rise in hunger from 10.3 to 11.4% during this same period [21]. Furthermore, more than 25% of the southern Africa population experienced “moderate or severe food insecurity” in 2024 [21]. According to the World Health Organization [84], achieving food security poses as a challenge, and efforts by the relevant sectors should be doubled to meet the United Nations Sustainable Development Goal (UN SDG) 2 targets as it is projected that 512 million people would still be facing hunger in 2030, with nearly 60% in Africa [22]. Conventionally, chemical fertilisers, fungicides, pesticides and herbicides are applied to increase agricultural productivity to feed the increasing global population. However, some of these agrochemicals threaten the environment and public health as a result of unwanted detrimental effects [37].

The current food production methods negatively affect the environment and threaten human health [82]. Considering this negative environmental impacts from conventional agriculture, the need for a global transition to farming systems that ensure food security and protect the ecosystem cannot be over-emphasized [26]. The importance of exploring alternatives that will be able to feed the increasing population while allowing the future generations to have the resources required for agricultural production remains pertinent. This includes carefully examining the methods and practices utilised in conventionally intensified agriculture from soil preparation to harvesting. Moreover, the four pillars of food security which are availability, accessibility, acceptability and adequacy should be taken into consideration not only at national levels but at household level among rural communities especially in developing countries [70, 76].

Various experts have suggested that using traditional management systems combined with agro-ecologically based management strategies may offer the only viable path to increase productivity, sustainability and resilience of agricultural production in the face of increasing population and other cross cutting factors of food insecurity [4]. While ensuring food security for the rapidly increasing population is of huge importance [17], biodiversity loss and food insecurity cannot be viewed independently as in a world of limited resources. The methods used to address biodiversity loss may involve choices affecting food security. Hence, it is

of utmost significance to explore solutions that will address both issues without compromising the other.

As an alternative to monoculture, extensive use of chemical fertilisers, fungicides and pesticides, and the use of external inputs in food production, indigenous farming methods such as mixed cropping, intercropping and the application of organic manure have been practiced by local communities for many years [55]. Through the practice of indigenous farming, humans have preserved and conserved their environment and biodiversity. Sustainable production of sufficient and safe food without compromising the soil, land, biodiversity and public health remains paramount [58]. Researchers have recently shifted their attention to indigenous farming methods and practices as they have potential to produce food without destroying or suppressing ecological systems [75]. Studies have been conducted on the use of plants to manage crop pests and diseases in the different countries of southern Africa [63]. However, these studies only focused on the use of plants for crop protection. Indigenous farming is holistic with different methods and practices complimenting each other. Therefore, the focus needs to encompass farming procedures and management, from soil preparation to plant protection strategies that are utilised by farmers for crop production. This review is aimed at appraising the utilisation of indigenous farming methods and practices for food security among the rural communities in southern Africa. Different aspects including land preparation, soil fertilisation, planting methods and the use of plants for crop protection are explored to demonstrate the element of holistic nature which is encompassed in the indigenous farming system.

Methods

Overview of Literature Selection

This review is based on studies that focused on indigenous farming methods and practices as well as the use of ethnobotanical knowledge for crop protection, from 2010 to 2023. This period was chosen so that the data retrieved shows pattern of indigenous methods and practices that has stood the test of time, and due to limited retrievable data before this period. The systematic review was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting systematic reviews and meta-analyses [45]. A thorough electronic literature search using databases such as Scopus ($n = 35$), Google Scholar ($n = 98$), Science Direct ($n = 63$) and PubMed ($n = 15$) was carried out, given their credibility and accreditation (Supplementary Figure S1). Data were extracted from various sources including published books,

articles, journals, dissertations and theses. The scientific names of the plants used to manage pests and diseases were verified using the Kew Plants of the World Online (<https://pwo.science.kew.org>).

The eligibility criteria entailed research articles, written in English and targeting how local farmers in southern Africa explore indigenous methods and practices to restore moisture, manage/fertilise soils and the various crop production cultural practices. Only articles written in English were considered because the authors are more conversant with the English language. Moreover, this was to avoid mistranslation and misinterpretation of the foreign languages not known or understood by the authors. Articles that focused on only conventional farming methods and practices as well as publications before the year 2010 were excluded. For crop protection, the focus was on the plants used to manage/control pests and diseases affecting crops. Literature that focused on synthetic pesticides, fungicides and on plants used for livestock protection were excluded.

Assessment of the Sources and Quality of the Information From the Eligible Literature

For this study, the eligible articles were obtained via a comprehensive manual and systematic search of four electronic databases: Scopus, Google scholar, Science Direct and PubMed. Search queries such as indigenous farming, indigenous farmers, medicinal plants or botanicals, and southern Africa were used individually and in various combinations to ensure comprehensive coverage of the topic. The full details of the search queries are outlined in Supplementary Table S1. The quality of the 15 eligible articles was carefully assessed to ensure their relevance to the scope of this review (Supplementary Table S2, including references such as [40, 43, 61]).

Limitations of the Study

This study incorporated 15 articles that were found eligible based on the defined inclusion and exclusion criteria as per PRISMA guidelines. The PRISMA 2009 statement comprised a checklist of 27 items recommended for reporting in systematic reviews. Such criteria include only reviewing articles written in English within the specified time period (between 2010 and 2023). However, 15 studies cannot give a conclusive result representing all the countries found in southern Africa. Only a few studies exist on indigenous farming methods and practices in southern Africa, and this could be due to less/dwindling interest in indigenous knowledge and its application, attributable to changes in lifestyle and industrialisation. Despite the limitations observed, the results obtained from this review provides a foundational

knowledge base which can be instrumental in addressing the challenges associated with food insecurity.

Results and Discussion

Overview of Eligible Literature

A total of 208 studies with publication dates from 2010 to 2023 were retrieved from various scientific databases. After careful screening based on the defined eligibility criteria, 15 studies were included in this review (Supplementary Figure S1). This review yielded sufficient research on indigenous farming systems in local communities across southern Africa.

Nine studies reported on the indigenous farming strategies for land management, soil fertilisation and planting methods (Supplementary Table S3) while the other six studies focused on the plant species used for pest and disease management (Supplementary Table S4). These studies were from 6 out of the 16 countries in the southern Africa namely, Lesotho, Malawi, Namibia, South Africa, Zambia, and Zimbabwe. The limited available information in the literature on the indigenous farming methods calls for more research documenting the agricultural systems of local communities in southern Africa. This documentation may be especially urgent before such knowledge is lost with the passing away of the aging elderly members in many communities who still practice or are the custodian of such knowledge.

Southern Africa is made up of sixteen (16) countries with populations of people from different cultures and races living in different areas with diverse ecological zones and varying socio-economic factors. Even though there are different ethnic groups in southern Africa, some ethnic groups are found across the countries, and this may be due to migration, marriage and the ‘artificial’ colonial-imposed boundaries [47]. For example, the Sotho people are found in South Africa and in Lesotho, and the Batswana are found in Botswana and in South Africa. We also have the Tsonga ethnic group who are in South Africa and in Zimbabwe. This might be a contributing factor towards the similarities in the implementation of cultural farming practices across regions in southern Africa. In addition, cultural differences play a major role in the type of food consumed and how they produce those foods. Moreover, southern Africa consists of developing countries, where most people depend on farming for their food provision and their well-being. Indigenous farming methods and practices are relatively cost effective, culturally acceptable and the associated resources for it are readily available, thus allowing for the continuity of farming in most developing countries in southern Africa [29] for household food security.

There is limited comprehensive data available, focusing specifically on the methods rather than land tenure or type of crops cultivated. Therefore, it was difficult to state a precise proportion of the total area under indigenous methods of cultivation. However, indigenous communities rely on indigenous farming systems for household food security [41]. The application of indigenous methods facilitates food production that not only meet the needs of subsistence farmers but is also capable of generating surplus yield to feed the non-growers. For instance, Africa has about 33 million small scale farms, mostly belonging to smallholders who use ‘low resource’ agricultural production practices but producing “almost all root, tuber and grain crops” and the bulk of consumed legumes in Africa [4].

Indigenous Land Management Practices in Agriculture

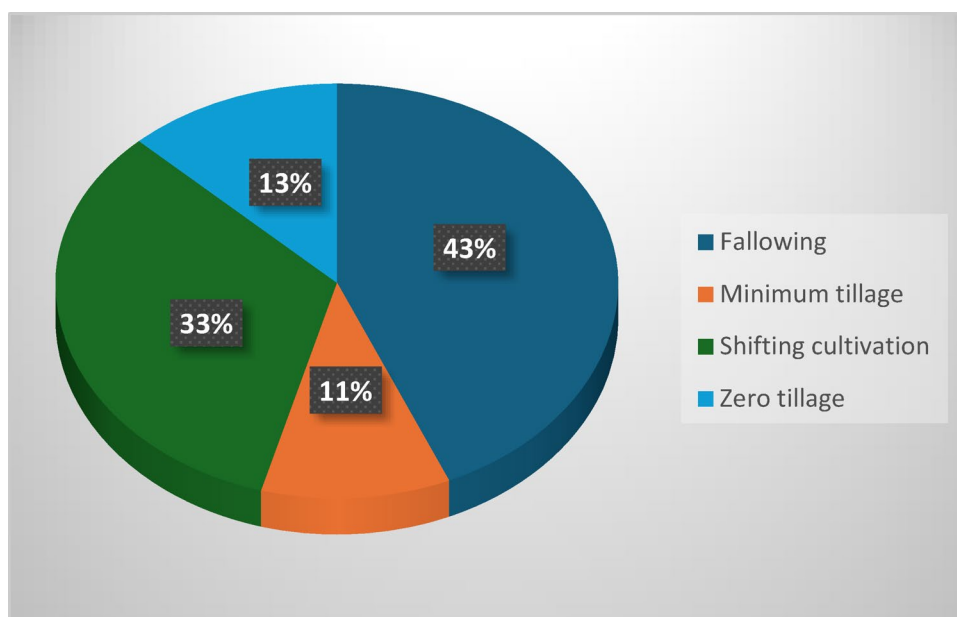
Various land management practices have been used by many farmers in communities to produce various crops. Factors relating to social, cultural, economic and demographic conditions dictate the decision to adopt indigenous practices among local farmers. These practices are also adopted because unlike science-based farming practices, it is easier to understand and apply indigenous practices with no formal education and training required [23]. The four land management methods identified were fallowing, minimum tillage, shifting cultivation, and zero tillage (Supplementary Table S3). In the different parts of southern Africa, these methods are common as they are beneficial to the soil and agricultural land [39]. Fallowing (43%) had the highest occurrence, which was followed by shifting cultivation (33%) and zero tillage (13%) (Fig. 1).

Fallowing may include an unintentional leaving of land without cultivating it for a short period of time due to social and economic reasons [15]. Planting crops after the land has been left fallow increases yields [20]. Land fallowing is an efficient agricultural management technique that is practiced in local communities. Moreover, fallowing restores soil fertility through nutrient deposits, increases organic matter, soil microbial diversity, and improves the physical properties of the soil. In local communities, fallowing is done for diverse reasons. For example, in Zambia among the Tonga ethnic group, fallowing is a notable agricultural strategy practised for soil property regeneration to improve soil health [33]. Additionally, keeping land fallow generally provides a biological means of pest control by disrupting the life cycle of pests and thereby decreasing the reliance on pesticides [16, 51].

Other land management methods that were practised were minimum and zero tillage. Generally, effective land management practices can release nutrients to the soil, reduce weeds, lead to improved soil and plant contact, and decrease the infestation of pests and diseases [39]. Ploughing, as the initial stage in crop production, and harrowing are the two most important activities which are done before planting [52].

No disturbance or minimum disturbance of the soil are two traditional methods of soil conservation that have been proven to be effective. In southern Africa, the most common practices are no tillage and minimum tillage [72]. Minimum tillage and no tillage minimise mechanical soil disturbance and conserve water in the soil profile and this is one of the main reasons why indigenous farmers have adopted and utilised them as well as the fact that the methods protect the environment and increase yields [12, 19, 66, 79]. Similarly,

Fig. 1 The frequency (%) of use for the identified indigenous land management methods in southern Africa, ($n = 15$)



in Southern Asia and in North America, local farmers utilise land management practices such as no tillage, minimum tillage and shifting cultivation [27, 49].

Mulching involves the use of materials such as grass to cover the recovering land to help with retaining moisture to the soil. This method is used to protect soil from high temperatures leading to soil deterioration. For example, in Mutoko rural village of Zimbabwe where the Buja people reside, temperatures are generally warm and temperate. Consequently, the region is associated with low rainfall and the local farmers devised various strategies to sustain their farming system. The strategies include mulching, where the seeds are planted inside a dug hole and covered with dry grass to enhance the germination and subsequent production of crops [48]. According to Thierfelder et al. [80], land rotation and no tillage with mulching resulted in better yields in smallholder farms. These two methods are utilised by the farmers to intentionally increase yields. With land rotation, crops such as maize are planted after legumes had been planted previously; this is because legumes have the nitrogen fixing capacity to enhance the quality of the soil [80]. However, it is important to understand which crops are rotated to enhance yields.

Shifting cultivation is another method that indigenous peoples use in rural communities. It is one of the main subsistence activities in small-scale farming among rural communities. This practice is based on ecological processes of forest ecosystems. The shifting cultivation system is based on three processes which are conversion, cultivation and fallowing. With this method, land is left uncultivated intentionally for a long period of time to allow for soil fertility regeneration. This system of agriculture is ecologically sound [7]. The conversion process includes the slash-and-burn of native vegetation which exposes the soil for planting, and it improves the soil fertility by leaving it less acidic.

According to Mukul and Herbohn [49], shifting cultivation is mostly practised in forests and many indigenous people around the world have depended on it for food production for years. The practice has been associated with major deforestation especially in the tropic regions; however, it has been central to the culture, livelihood and food security of local population. The burning process also temporarily restricts weeds and plant pests and pathogens allowing for no use of chemical inputs for production before planting. According to Wangpan et al. [83], shifting cultivation focuses more on the regrowth cycle than the cutting cycle. Local farmers who practice this method spend more years growing trees and crops than harvesting them. These methods have allowed farmers in indigenous communities to use their agricultural lands for longer periods of time. Indigenous communities are distinct groups of people with deep historical ties to their ancestral land, characterised by unique

indigenous cultures, values and beliefs [49]. Such communities mostly maintain their kin-based structures rather than adopting market-oriented approaches [49]. These practices have allowed farmers to be in control of their food security and maintaining it [13]. Indigenous communities depend on indigenous farming mostly because they are culturally acceptable, cost effective and eco-friendly in nature. Their criteria for choosing this type of farming is often aligned to culture, connectivity to land, spirituality sustainability, beliefs, and slightly to affordability [49].

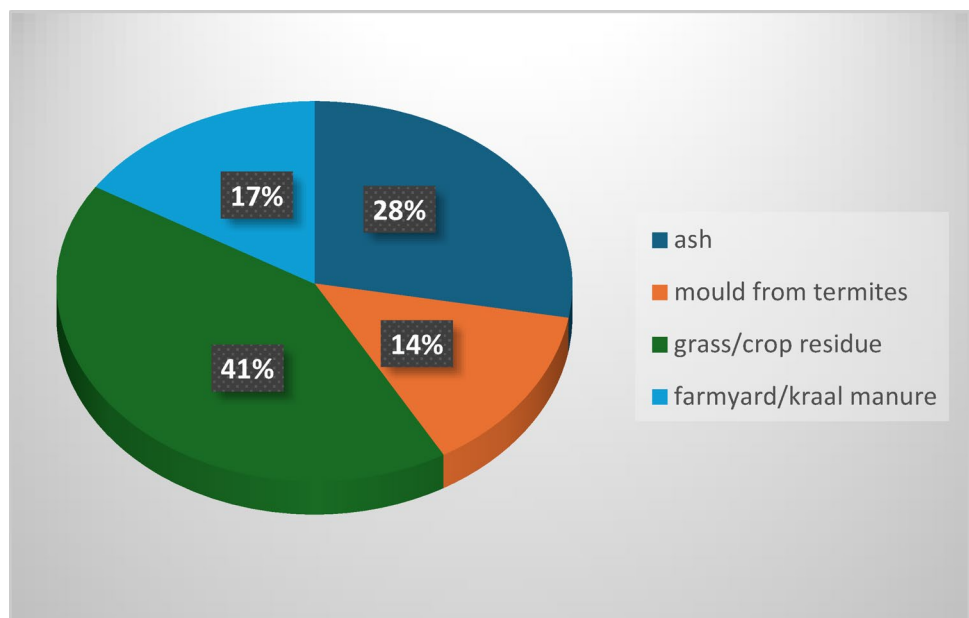
In two of the eligible studies presented in this review, local farmers in Chigaka village (Malawi) use land management practices such as shifting cultivation and minimum tillage in order to ensure that the land is prepared for cultivation [53]. Likewise, the local farmers in Tonga community (Zambia) use shifting cultivation together with fallowing and zero tillage to manage their agricultural land [33].

Shifting cultivation is implemented the same way in almost all the southern Africa regions. For example, in Angola and Zambia, shifting cultivation involves the slash-and-burn process where the field is burnt, and the ash residues are applied to the soil while the land is left uncultivated for some time. This method is implemented during the dry season in Zambia, while in Angola the method is implemented during the rainy season [34]. Similarly, tropical forest ethnic groups in South America mostly practice shifting cultivation known as the Swidden-fallow or slash and burn farming to manage their agricultural lands [64].

Indigenous Soil Fertilisation Methods

Fertile soil enhances crop growth and productivity. Soil fertility depletion has been identified as a central reason for decreasing food production in Africa [74]. Infertile soil does not produce economically significant yields or produces poor yields which impact food security. Thus, local farmers utilise their indigenous knowledge to increase soil fertility. Natural products from plant and animal waste have been utilised by farmers to fertilise their soils for decades [67]. To fertilise the soil, indigenous farmers utilise natural resources such as livestock manure e.g., cow dung, poultry manure, agricultural crop waste and food waste, which are applied before planting [19]. This review identified four materials (ash, dry grass, farmyard/kraal manure and mould from termites) that farmers utilise to fertilize their soil (Supplementary Table S3). Besides soil fertilisation, the use of ashes can control pests affecting crops [67]. The most common fertilisation material was grass/crop residue (41%) and followed by ashes (28%) (Fig. 2), which occurs in abundance and is accessible in local communities.

Fig. 2 The frequency (%) of use of the identified indigenous soil fertilisation materials in southern Africa, ($n=9$)



Local agricultural systems in southern Africa are affected by low soil fertility, a decrease in soil moisture and soil erosion [81]. A good soil structure ensures balance between soil water and air which promotes root growth, leading to good crop growth [60]. Indigenous people often possess the knowledge on ensuring that soil remains fertile for agricultural productivity and food security [62]. Various soil management systems have been explored across different communities to enrich the soil [71].

Given the longstanding interactions with their biophysical environment, indigenous people have devised various methods to prepare the soil before planting and methods to retain its fertility. Recently, increased attention is devoted to local soil knowledge due to the recognition that the knowledge of indigenous peoples who have had long interactions with their soils can offer impactful insights into sustainable soil management [25]. Indigenous farmers who practice such farming systems are often located in complex environments with different soil qualities, which result in indigenous innovation to develop a systematic knowledge [27]. This innovative systematic knowledge development has helped them to sustainably manage their soils for crop production.

As observed by Kom et al. [35], indigenous farmers in the Vhembe District in South Africa applied crop rotation, manure, as well as mixed and intercropping to improve their soil fertility. The manure was mainly from livestock and participants indicated that this method of soil fertilisation is historical and has been demonstrated to increase soil fertility and thus improve crop production. Crop rotation and multiple cropping can ensure successful crop production, improve soil fertility, maximise crop growth and provide a

variety of food which is an important component of food security.

Similar results were evident in a study conducted in KwaZulu-Natal Province of South Africa, which is dominated by the Zulu-speaking people, in areas with clay loamy and sandy soils. The local farmers used manure from livestock and applied intercropping to increase soil fertility. It is further alluded in the study that local farmers who applied these methods for soil fertility observed an increase in yield [14].

In most cases, the farms owned by local farmers in rural communities are home gardens or small-scale and the food waste is normally from their households. In local communities, most crop farmers are also livestock farmers and the animal waste is often readily available [54]. Livestock manure include waste materials such as cow dung, poultry manure, manures from sheep, goats and pigs. While cow dung is abundant in most local communities than poultry manure, poultry manure produces high amounts of magnesium and calcium than the other materials [30].

Local farmers in various communities are aware of the benefits of returning crop residues to the soil to improve its fertility. It is important to ensure that the crop residues are dry and decomposed to prevent them from competing with the main crop for nutrients which may lead to the main crop dying. However, this method is popular among farmers because these materials are also used for construction, fuel and as a source of animal feed [8]. Farmers resort to fallowing to help with soil fertility. According to Abera and Belachew [1], this method is more efficient when it is done for the period of 8 or more years and farmers cannot leave land uncultivated for that long as this may affect their food security. Understanding the significance of fallowing

in agriculture, most farmers practice seasonal fallowing so that they do not leave the land uncultivated for too long. To obtain maximum efficiency, farmers use this method with other soil preservation methods.

It is crucial for farmers to understand the dynamics of the materials they use to fertilise the soil. To improve the quality of organic manure and preserve them for the time when required, indigenous farmers gather and store the materials for the time of crop or soil nutrient demand. Organic resource storage includes piling crop residues as livestock feed during the dry season and heaping manure. When these materials are stored, it is important to protect them. In rural communities, farmers achieve this goal by putting them in sheds. The dried manure must be applied before planting to combine the manure with field operations such as tillage for maximum productivity [10].

The application of natural or organic manure to soil is associated with diverse benefits. Natural manure improves soil structure and increases the mobilisation of nutrients in the soil [32]. Chemically, the inputs of organic matter improve the stability of soil fertility and mineralisation of organic matter. Microbiologically, manure application facilitates degradation of some toxic substances, restores and controls soil diversification which provides beneficial microorganisms useful for controlling plant pathogens. Farmers in parts of southern Africa such as in Zimbabwe, use ash to fertilise their soil, and this has played an important role in enhancing soil fertility [67]. In Namibia, the local farmers in Oshikoto region use kraal manure and mound from termites to fertilise their soil [73], while in Ezigenii and Ogagweni villages (South Africa), farmers use kraal manure together with dry grass to fertilise their soil [14]. These methods are applied to achieve maximum yields [14].

Indigenous Planting Methods

The countries in southern Africa used different names and wording to describe the planting methods. However, some of them were essentially meaning the same thing. In this study, crop rotation, crop diversification, early cropping, agroforestry and relay cropping were the planting methods used by the local farmers (Supplementary Table S3). Crop diversification which was also referred to as mixed cropping and intercropping in other southern African countries was the most common planting method.

Agriculture is one of the earliest practices in many areas around the world including in rural communities. This has led to the indigenous people gaining more knowledge on the different planting methods that allow them to have diversity in diet while being able to use the land for longer periods. Practices such as agroforestry, intercropping of cereals, tubers, and legumes, diversification, and mixed farming are

not new to smallholder farmers in sub-Saharan Africa and have been used in different ways to optimise food crop production [5, 57].

The planting methods are used by farmers for various reasons. The methods they utilise promote biodiversity and reduce the spread of diseases as well as providing dietary diversity [18, 31]. Crop diversification refers to growing more than one crop in an area. Indigenous people through years of experience have mastered the method of crop diversification and they fully understand which crops to grow together on the same land simultaneously. Crop diversification increases production, results in greater use of environmental resource, provides stable and uniform yields and improves soil fertility [46]. According to Malapane et al. [41], crop diversification allows the local population to meet their food demands and produce a surplus for trade. The local farmers in the Tonga community in Zambia, for example, practice crop diversification for soil sustenance and for mitigating crop failure [33].

The methods of planting, for example mixed cropping and crop rotation involving leguminous crops and crops with high carbon content, help with soil enrichment [59]. In three of the six eligible studies on indigenous farming methods and practices, farmers use crop rotation as a planting method and mentioned that this method ensures that agricultural land is used to its maximum [14, 48, 73].

Rahman et al. [59] observed that in Bangladesh (south Asia), the practice is gradually being replaced by agroforestry which is an eco-friendlier practice that promotes biodiversity. When fully adopted, this system has the potential to improve local economies and may significantly reduce rural poverty. All planting methods mentioned above including polyculture and relay planting involve planting different crops simultaneously, which enriches the soil and limits weeds and pest attacks [36, 77].

Crop rotation and agroforestry can be a form of crop diversification as they also include growing more than one crop simultaneously. Crop rotation can be defined as a system of growing crop in a regular order one after the other on one piece of land [78]. Agroforestry includes growing trees and shrubs with other crops or livestock at the same time. These are indigenous planting methods that are often utilised by local farmers in indigenous communities for various beneficial reasons. These benefits play a significant role in their food security.

Relay planting and polyculture are two other planting methods that indigenous farmers practice; however, they are not as dominant as the others. Relay cropping refers to the simultaneous cultivation of multiple crops during a significant part of their growth cycle on a piece of land [9]. On the other hand, polyculture entails growing two or more crop

Table 1 Overview of the top ten (10) frequently cited plant species used for crop protection in the eligible articles

Scientific name	Family	Disease(s)/ pest(s) targeted	Crop(s) targeted
<i>Allium cepa</i> L.*****	Amaryllidaceae	Aphids, cutworm, stalk borer, vegetable pests	Cabbage, maize, spinach
<i>Nicotiana tabacum</i> L.*****	Solanaceae	Ants, aphids, spiders stalk borer, vegetable pests	Cabbage, maize, spinach, vegetables
<i>Tagetes minuta</i> L.*****	Asteraceae	Aphids, DBM, stalk borer, vegetable pests	Cabbage, maize, spinach, vegetables
<i>Artemisia afra</i> Jacq.***	Asteraceae	Aphids, DBM, stalk borer	Cabbage, maize
<i>Capsicum annum</i> L.***	Solanaceae	Stalk borer	Cabbage, maize, spinach
<i>Tulbaghia violacea</i> Harv.****	Alliaceae	Stalk borer	Maize
<i>Nicotiana glauca</i> Graham***	Solanaceae	Aphids, DBM, stalk borer	Cabbage, maize
<i>Pittosporum</i> <i>viridiflorum</i> ***	Pittosporaceae	Aphids, cutworm, stalk borer	Cabbage, maize
<i>Solanum giganteum</i> Jacq.***	Solanaceae	Aphids, cut- worm, DBM, stalk borer	Cabbage, maize
<i>Sonchus oleraceus</i> L.***	Asteraceae	Stalk borer	Cabbage, maize

The listed plants are ranked from the most to least mentioned. *Asterisk corresponds to the number of citations (*****=5; ****=4; and ***=3 citations)

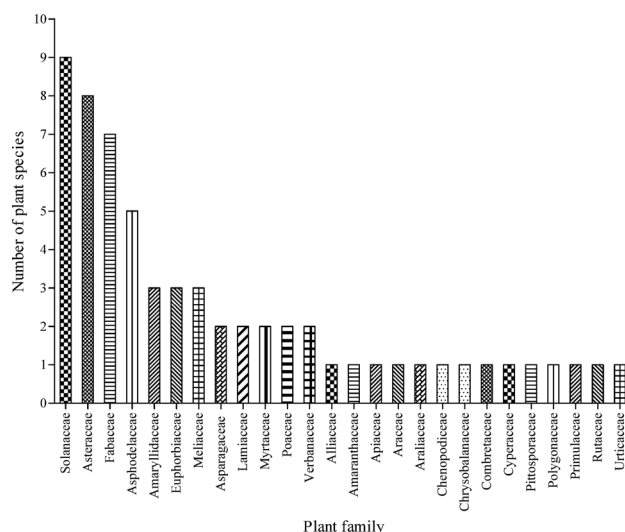
DBM diamondback moth

species and wild varieties within a specific field to mainly decrease disease transmission [38].

It is important to highlight that these practices have played a major role in the local farming systems as it allows farmers to continue producing food for a long time without depleting agricultural resources. Moreover, it is important to note that as the environment changes, local farmers are constantly developing innovative measures to sustain their farming systems without completely discarding cultural values which are an important part of indigenous methods of food production [24].

Utilisation of Plants for Pest and Disease Management

The six (6) eligible articles that focused on crop protection were from South Africa, Malawi, Zambia, and Zimbabwe (Supplementary Table S4). Notably, South Africa has the highest number of studies conducted on plants used for the

**Fig. 3** A representation of plant families used for managing crop pests and diseases in southern Africa

management of pests and diseases. Despite having only 6 articles that focused on crop protection, a total of 62 plant species were utilised by local farmers to manage pests and diseases affecting their crops. The most popular plant species were *Allium cepa*, *Nicotiana tabacum*, and *Tagetes minuta* (Table 1, Supplementary Table S5). These plant species were mentioned in five of the six eligible studies, which cut across three of the four countries namely, Malawi, South Africa and Zambia. *A. cepa* is used to manage stalk borer [44, 68], anthracnose, Cladosporium leaf spot, Sclerotinia, ring rot, Fusarium wilt, downy mildew, powdery mildew and Alternaria leaf spot [50], vegetable pests [56], aphids and cutworm [69].

N. tabacum is used to manage ants, aphids and spiders [69], stalk borer [44, 68], vegetable pests [56], anthracnose, Cladosporium leaf spot, damping off and root rot, downy mildew and Stemphylium leaf spot [50]. *T. minuta* is used to manage pests such as aphids, and diamondback moth [69], stalk borer [44, 68] as well as vegetable pests [56] and diseases such as Sclerotinia, ring rot, fusarium, downy mildew, powdery mildew, Alternaria leaf spot, bacterial spot, root rot, black rot, anthracnose, Cladosporium leaf spot, damping off and Stemphylium leaf spot [50].

Among the 26 plant families documented from the eligible studies, the dominant ones were Solanaceae and Asteraceae with 9 and 8 plant species, respectively (Fig. 3). Based on an extensive review, Solanaceae was one of the most represented plant families used for crop protection [6]. These plants were often selected based on their perceived effect against certain pathogens. This is an indication that plant species in Solanaceae family may contain important compounds that can eliminate pathogens. Plants belonging to the Asteraceae family were mentioned in all the six eligible

studies on plant protection presented in this review. Farmers used different parts of the mentioned plants depending on the type of pest or disease to be managed. In this review, the 10 plant parts documented are flower buds, leaves, roots, bulb, fruits, pods, stem, bark, stalk and the whole plant. For the plants that were identified, the leaves was the dominant (32%) part (Fig. 4). From a conservation perspective, the use of leaves contributes to sustainability, as harvesting of leaves had minimal negative impact on the regeneration potential of plants relative to other plant parts such as roots and bark.

Farmers have been using local plants to manage pests and diseases in their farms for many years before the introduction of synthetic agrochemicals. The 1940's witnessed the introduction of synthetic fungicides and pesticides which are easier to handle and last longer [3, 6]. Most local farmers have continued to use medicinal plants to manage pests and diseases [65]. This is mainly because the use of medicinal plants is arguably safe, eco-friendly, easily degradable, affordable and accessible especially to local farmers in rural communities. Moreover, the plant-based pesticides largely focus on the targeted pests or diseases and do not affect the nutrients of the crop [2]. Common plant species that are often easily accessible to farmers include onion (*A. cepa*) and garlic (*A. sativum*), which are used to manage pests and diseases [2, 28].

In southern Africa, local farmers possess vast knowledge of plants used to manage pests and diseases. The knowledge accumulated on pest and disease management is mostly around main crops that are grown in that area, allowing the farmers to be able to better manage crop production. For

example in South Africa, a survey conducted by Mwinga et al. [50] showed that subsistence farmers in OR Tambo municipality use 17 plant species to manage cabbage and spinach diseases. The farmers know exactly which plant to use and how to use it to produce effective results [69].

Significance of the Reported Indigenous Farming Methods and Practices

Indigenous farming methods and practices are usually the first set of approaches applied by indigenous farmers in local communities for food production and food security. These practices, refined over time through use, were influenced by their relationship with their surrounding environment. The environmental friendliness, adaptability to environmental changes, crop self-sufficiency and links with the local community and development of these practices allowed the continuation of their use even after the introduction of modern farming methods [37]. Indigenous farming methods are relatively cost-effective and affordable to the local farmers who mostly have low capital, allowing for sustenance in local food security. The food produced through these methods is also culturally acceptable as food is part of the identity and important spiritual ceremonies of local people [29].

A balanced and nutritious diet often incorporates more than one food crop. The practise of mixed cropping in indigenous farming as opposed to mono-cropping often practised in modern farming facilitates the availability of a variety of food crops/ food diversity towards household food security [37]. Other advantages of indigenous farming practices include biodiversity conservation, better quality

Fig. 4 Plant parts used for crop pest and disease management in southern Africa ($n=62$)

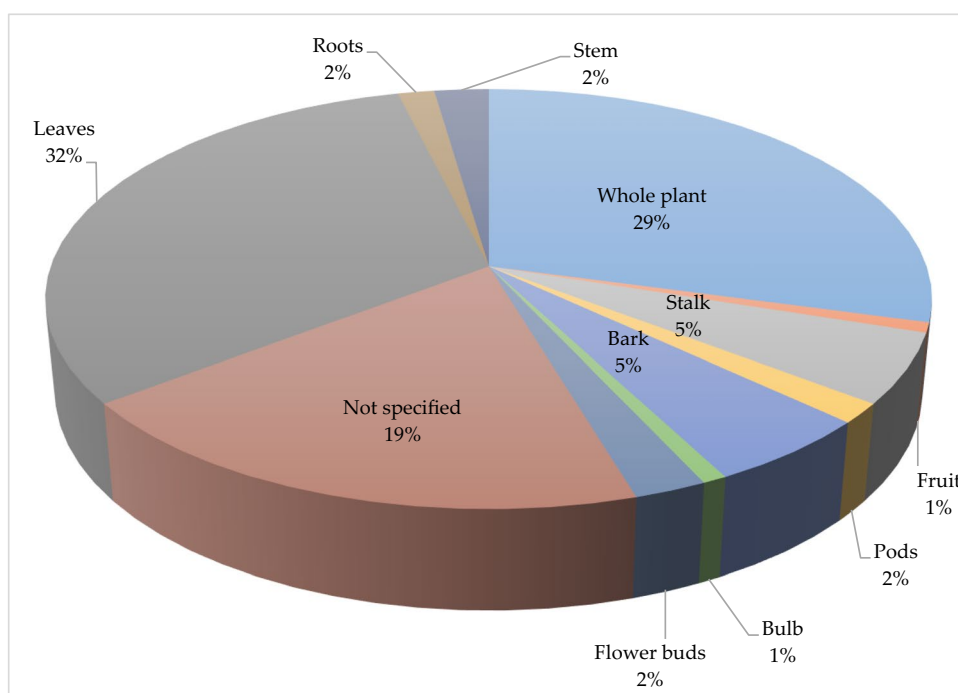


Table 2 Benefits associated with indigenous farming practices and methods for food security among rural communities in Southern Africa from 2010 to 2023

Indigenous farming methods and practices	Benefits
Land management practices	
Fallowing	Restores soil fertility, increases yield and biological means for pest control [16, 20, 51]
Minimum tillage/no-tillage	Minimises mechanical soil disturbance, conserves water in soil profile [12, 79]
Mulching	Retains soil moisture, protects the soil from high temperatures [48]
Land rotation	Increases yield [80]
Shifting cultivation	Provides soil fertility regeneration [7]
Indigenous soil fertilisation methods	
Soil fertilisation materials (ash, dry grass, farmyard/kraal manure, agricultural crop waste, food waste)	Increases soil fertility (increase yields)
Indigenous planting methods	
Crop diversification	Increases production, provides stable and uniform yields, improves soil fertility, mitigates crop failure [33, 46]
Relay planting	Minimises depletion of agricultural resources [24]
Crop pest and disease management	
Medicinal plants to manage crop pests and diseases	Safe, eco-friendly, easily degradable, affordable, accessible

of soil due to less to no use of harsh/synthetic chemical solutions, strengthening adaptation strategies and reducing greenhouse gas emissions as well as energy efficiency. Table 2 further highlights the benefits associated with indigenous farming methods.

Conclusions

This review showed that local communities in southern Africa depend on the natural environment and their indigenous knowledge for food security. Four land management methods utilised by farmers were identified. These methods allow the land to regenerate naturally with minimum disruption to the ecosystem. Farmers fertilise their soil using natural materials such as livestock waste and grasses. Some prominent planting methods that were identified include relay cropping, intercropping, crop rotation. Many indigenous farming practices allow the cultivation of several food crops on the same

field as a means of maximising land use, soil fertility and improving crop productivity for household income and food security. In this review, 62 plant species were identified as natural resources used for crop protection among local farmers in southern Africa. The continuous use of botanicals to manage plant pests and diseases shows their potential in sustainable crop pest and disease management. Indigenous farmers have significant knowledge on sustainable use of natural resources. Most of the reviewed articles lacked such information on yields/profits associated with indigenous technology. Within the time duration for review, the low number of eligible articles make it difficult to reach a conclusive generalisation for southern African as a region. Incorporation of some indigenous farming practices such as mixed cropping, and the principle behind the use of plants by local farmers to manage crops against pests and diseases into modern farming may increase agricultural production without compromising environmental integrity. It is evident that the applications of indigenous farming practices and methods remain pertinent for food security among rural communities in southern Africa. Efficient approaches aimed at incorporating community-based valuable indigenous knowledge in modern agricultural practice is recommended as a means of meeting the targets associated with UN SDG 2 (zero hunger) especially among local communities in southern Africa. Overall, the current finding can form baseline data for future studies geared toward exploring indigenous knowledge-driven farming for food security.

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Data Availability Data used for this study have been included as part of the article.

Declarations

Conflict of interest The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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Informed Consent Not applicable.

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