South African Journal of Botany 184 (2025) 1386–1401

Contents lists available at ScienceDirect

South African Journal of Botany

journal homepage: www.elsevier.com/locate/sajb

The roles, significance and sustainability of wild plant and fungal non-timber forest product use in southern Africa: a systematic review

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ARTICLE INFO

Edited by: Dr. J.S. Boatwright

Keywords:
Consumption
Culture
Non-wood forest products
Safety-nets
Trade
Values

ABSTRACT

Southern Africa is rich in cultural- and bio-diversity, which underpins the extensive use of wild plant and fungal resources for cultural, consumptive, income and safety-net purposes. The collection, use, management and knowledge of wild plant and fungal resources, commonly termed non-timber forest products (NTFPs), has been studied by multiple academic disciplines over decades, but rarely brought together across resource types and uses. Here we report on a PRISMA systematic review of the literature on such use in southern Africa (countries south of the Cunene and Zambezi rivers) to ascertain (i) the extent of research on the use of NTFPs in local livelihoods and (ii) whether it is ecologically sustainable. We conducted 13 separate searches using Scopus and Web of Science, corresponding to one on general use of NTFPs in livelihoods and 12 others for specific NTFP types (medicinal plants; fuelwood; wild fruits; wild vegetables, building timber; weaving fibres; wood for tools/crafts; thatch; oils/resins/saps; broom materials; mushrooms; wild flowers/pods/seeds). The 13 searches resulted in 435 unique articles for review, with most on medicinal plants, fuelwood, wild fruits and wild vegetables (all > 50 articles). There was a clear increasing trend in the number of publications through time. Most of the publications (62.3 %) were from South Africa, followed by 14 % from Zimbabwe, with the other five countries individually accounting for between 2.1 % and 7.4 %. We summarise the core findings per NTFP type. Generally, very few of the studies considered the ecological sustainability of the NTFPs used, and of those that did, most were based on user perceptions of changes in NTFP abundance. Formal longitudinal studies of NTFP use and availability are scarce in the region, as are those investigating cultural uses of NTFPs. Overall, we find that NTFP use is widespread for consumptive, economic, and cultural reasons with only limited evidence of declines in use in the face of multiple contextual changes over the last 2–3 decades at both local and wider scales.

1. Introduction

Approximately 5.7 billion rural and urban people the world over make use of wild biological resources to varying degrees for multiple provisioning, economic and cultural reasons (Shackleton and de Vos, 2022). Such use ranges from significant and regular reliance on these resources for everyday needs, through to less regular or ad hoc use at specific times for cultural, income or safety-net needs (Derebe et al., 2023). In fulfilling a plethora of needs, these resources include products derived from tens of thousands of plant, animal, fungal and algal species used in raw or processed forms for food, medicine, energy, construction, decoration, utensils, spirituality, culture and income generation.

A wide variety of terms have been used for these wild biological resources, but the term 'non-timber forest products' (NTFPs) has gained the most traction in the literature over the last three decades (Magry et al., 2024). NTFPs are generally regarded as largely wild (i.e. most populations, albeit not all, exist and reproduce without human agency), native or non-native biological organisms and materials, other than high value timber, collected from any landscapes and habitats (including human transformed, managed and dominated) for direct or indirect (e.g. for cultural purposes) human use and trade for local benefit (Shackleton et al., 2011). Although the concept of NTFPs includes animal products such as edible insects, honey and bushmeat, our review here deals only with plant and fungal NTFPs.

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https://doi.org/10.1016/j.sajb.2025.07.029
Received 23 April 2025; Received in revised form 12 June 2025; Accepted 21 July 2025

Due to the widespread use of and reliance on NTFPs, there is often concern about the sustainability of supply and use from both a biodiversity conservation perspective and a sustainable livelihoods and income security one. Overuse can jeopardise NTFP populations and any biota that may depend on them, as well as the wellbeing and quality of life of local communities reliant upon them. Although there are multiple examples of unsustainable use (e.g. Sampaio and dos Santos, 2015; Martins and Shackleton, 2017), unfortunately the ecological sustainability of use of specific NTFPs has been determined for only a miniscule proportion of NTFP species and contexts. The meta-reviews by Stanley et al. (2012) and de Mello (2020) indicate that most case studies show that NTFP use is ecologically sustainable (although all but a few are once-off assessments (de Mello et al. 2020)). When considering the full complexity of sustainability assessments (see Ticktin, 2015), not just the ecological dimensions, then relatively little is known globally, including in southern Africa. Moreover, the multiple dimensions of sustainability are not static, but change spatially and temporally. Thus, the use of some NTFPs may change in the face of local and larger-scale contextual changes, with the use of some increasing (such as through trade) and others decreasing (e.g. building poles) (Falayi et al., 2019). This demands the development of longer-term and more hypothesis testing studies rather than just basic inventories of species and amounts used.

Southern Africa is renowned for its cultural and biological diversity, and South Africa is the only country globally with three of the 36 recognised global biodiversity hotspots within its borders (CEPF undated), and where 77 % of higher plant species are endemic (Cornelius and van Wyk, 2024). Therefore, it is unsurprising that thousands of plant species are used by people for one or more purposes. For example, at least 3784 plant species are used for traditional medicinal purposes (Cornelius and van Wyk, 2024), at least 1740 species have been used as foods (Welcome and van Wyk, 2019) and approximately 77 % of sub-canopy forest tree and shrub species and 94 % of forest tree species in South Africa have one or more recorded uses (Geldenhuys, 1999). Individual rural households use dozens of plant species (Mulaudzi and Shackleton, 2025) and at a community level, these can total several hundred species (Shackleton et al., 2002). This equates to billions of Rands annually in direct-use (consumptive) values (Shackleton et al., 2007). Additionally, the trade in NTFPs on informal and formal markets is widespread and growing (Weyer et al., 2018), with a national survey of 1200 households in South Africa finding that 6.4 % of rural households trade in at least one NTFP (Mugido and Shackleton, 2017a). This equates to approximately 288,000 NTFP traders (almost double the number employed in the formal forestry sector) based on the assumption of there being roughly 4.5 million rural households in South Africa. However, much of the NTFP literature in southern Africa is siloed along NTFP use lines, such as studies on medicinal plants or on edible ones or on fuelwood, with relatively few studies or reviews spanning across NTFP use categories to understand the sector as a whole. Nor has there been any review of the sustainability of NTFP use in southern Africa to date. Consequently, the aim of this paper was to review the southern African literature on plant and fungal NTFPs as a whole to address the following questions: (i) what is the extent of research on southern African plant and fungal NTFPs used in local livelihoods? and (ii) is plant and fungal NTFP use ecologically sustainable? In terms of the geographic region, this review covers southern Africa, which is coarsely taken as countries south of the Cunene and Zambezi rivers, namely (in alphabetical order) Botswana, Eswatini (formerly Swaziland), Lesotho, Mozambique, Namibia, South Africa and Zimbabwe. Based on the definition of NTFPs that we used, we excluded studies that dealt with monoculture cultivation of particular NTFPs for a commercial market.

2. Forms and extent of NTFP use in Southern Africa

2.1. Approach

We adopted a PRISMA systematic review approach (Page et al., 2021) searching for and summarising the NTFP literature from southern Africa. We conducted 13 searches of English-language, peer-reviewed journal papers in both Scopus and Web of Science (WoS) in the first week of February 2025. We excluded review papers as well as modelling papers that only used existing data. Book chapters were included only if a link was available from Scopus or WoS. Each of the 13 searches in Scopus and Web of Science was composed of three elements, namely (i) the specific type of NTFP and its synonyms, (ii) the nature of use and (iii) the list of the seven southern African countries (including the former name for Eswatini, i.e. Swaziland), as outlined in Table 1. Twelve of the searches each corresponded to a specific NTFP type or use (firewood/charcoal; wild fruits; wild vegetables; medicinal plants; weaving fibres; thatching materials; materials for brooms/bushes; wood for construction; wood for crafts, artefacts and utensils; mushrooms; plant oils, resins, saps and gums; wild flowers and seeds or pods). The thirteenth one was a search of general or livelihood studies that possibly included one or more types of NTFPs, using the search terms "non-timber forest products" and synonyms (NTFPs; non-wood forest products; natural resource*; wild resource*). After each search we appraised the relevance of each article by reading the title, key words and, if necessary, the abstract and excluded those that lacked relevance to our research questions. We then removed duplicates between Scopus and WoS searches. For those that appeared suitable, we read the entire paper to gauge the content and either discarded it as inappropriate or retained it for the review and tallying of totals per NTFP type, country, and topics of interest. Lastly, we added any additional papers from our own knowledge that had not been returned by Scopus or WoS. We acknowledge that returns for Mozambique would be underestimates because we did not consider articles in Portuguese.

Botanical names follow those of SANBI's (2010) Red List of South African Plants. When considering the direct-use values of particular resources, we adjusted for price inflation using the South African inflation calculator (https://inflationcalc.co.za) from June of the year the original paper was published to Feb 2025. If the original paper reported values in US dollars we converted them to South African Rand using the mean exchange rate in June of the year/date of the publication from businesstech.co.za (https://businesstech.co.za/news/finance/11

Table 1
The three elements of the search terms and strings used in the systematic review of NTFP use in southern Africa.

Element	Search no.	Format/terms
1	1	medicinal* AND (herbal OR traditional OR "muthi")
	2	fuelwood OR firewood OR charcoal
	3	"wild fruit*" AND (edible OR traditional OR indigenous OR "wild seed* OR "edible seed*)
	4	vegetable* AND (wild OR leafy OR African OR traditional OR indigenous OR "wild tuber OR "edible flower*")
	5	(wood OR timber) AND (build* OR fence* OR roof* OR contruct*)
	6	"weave* fibre" OR reed* OR palm* OR "palm frond*" OR restio
	7	wood* AND (tool* OR craft* OR utensil OR spoon* OR handle*)
	8	thatch
	9	oil* OR sap* OR resin* OR gum* OR "home brewed" OR "alcohol" OR beverage*
	10	(*broom* OR *brush*) AND (grass OR palm OR restio OR twig)
	11	mushrooms OR fungi
	12	"wild flower*" OR seed* OR "plant pod*" OR "seed pod*"
	13	"non-timber" OR "non-wood" OR NTFP* OR "wild resource" OR "natural resource"
2	All	AND (use OR ultil* OR harvest* OR consumption OR trade OR livelihood*)
3	All	AND ("South Africa" OR Botswana OR Namibia OR Mozambique OR Zimbabwe OR Lesotho OR Swaziland OR Eswatini)

6372/rand-vs-the-dollar-1978-2016/).

2.2. Forms of NTFP use in Southern Africa

It is well-known from the global NTFPs literature and in southern Africa that the use of and benefits from NTFPs manifest in five ways (Shackleton 2015), namely (i) household consumption or subsistence provisioning, (ii) cash-savings, (iii) safety-nets in response to household shocks or adversity, (iv) income generation through the sale of raw or processed NTFPs and (v) cultural purposes. In our review, we considered all five forms of use and found that most studies on NTFPs in southern Africa do not explicitly differentiate between them. The first relates to the extensive use of a wide variety of NTFPs for direct household consumption. Most studies in our review considered this dimension. The second use relates to the cash-saving provided through the collection of NTFPs for free. For example, the collection of wild foods provides some substitute for purchased foods and hence saving the cash costs of those foods; similarly the use of firewood saves on the costs of electricity or paraffin. The value of such cash-savings can be considerable at the household level and many billions of Rands (South African currency) annually when aggregated across the region (Shackleton et al. 2007). However, there are labour costs to procure the NTFPs for household use. The cash-saving values attain greater significance in times of household shocks or hardship, such as after illness, death or retrenchment of a breadwinner, or loss of crops or livestock to drought or disease (Mugido and Shackleton, 2017b; Weyer et al., 2018). During such times the use of NTFPs as safety-nets can make the difference between survival or dissolution of a household. The fourth role is the use of NTFPs for income generation. This can range from ad hoc sales when a household is in need of additional cash, seasonal activities (e.g. marula or prickly-pear fruits) through to being a full-time occupation, such as wood carvers (Shackleton et al. 2008), medicinal plant vendors (Ah Goo and De Wit 2015), palm wine tappers (Martins and Shackleton 2018) and dozens more. Because the level of engagement in trading NTFPs is highly variable, so too are the incomes. Yet, returns per hour worked are generally higher than local wage labour rates (Mithöfer and Waibel, 2003; Shackleton et al., 2007). Last, is the important role played by many NTFPs in local cultures. Examples include ritual plants used during cultural and spiritual rites and observances (Cocks and Dold, 2006), specific woods on which the meat from sacrificial animals is served (Cocks and Wiersum, 2003), and reed mats and brushes used during traditional ceremonies (Pullanikkatil et al., 2021), amongst others.

2.3. The extent NTFPs research in southern Africa

The 13 searches resulted in 435 unique articles for our review (Table 2). The total in Table 2 is greater than 435 because there are a significant number of articles that report on more than one NTFP. The NTFP literature from the region is clearly dominated by research on medicinal plants, firewood/charcoal, wild fruits and wild vegetables, all of which have well >50 articles.

Almost two-thirds of the publications (62.3 %) were from South Africa, followed by 14 % from Zimbabwe (Fig. 1). The other five countries individually accounted for between 2.1 % and 7.4 % of the articles.

Not unexpectedly, there was a clear trend of increasing numbers of papers over time, with over a hundred papers in the five-year period from 2016 to 2020 (Fig. 2). The marked increasing trend emerged during the last half of the 1990s.

2.4. The extent and nature of NTFPs use in southern Africa

In this section we summarise the literature on NTFP use in southern Africa according to the 12 types of NTFPs in the same order as Table 2.

2.4.1. Medicinal plants

Medicinal plants are an important part of the culture and tradition of many people in southern Africa. About 3784 plant species are used as medicines, or 'magical', ritual and spiritual purposes in southern Africa (Cornelius and van Wyk, 2024; 2025). Information about species used, plant parts, preparation, dosage and medicinal applications are documented in 247 papers published between 1984 and 2024, with 24 publications highlighting species traded in herbal medicine markets and 12 papers emphasising cultural significance of medicinal plants. About

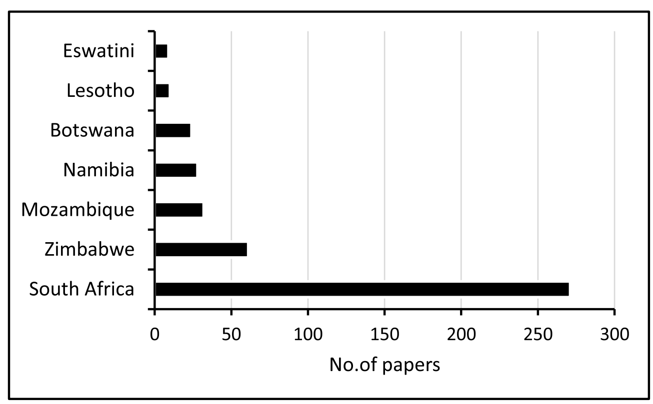

Fig. 1. Number of NTFP publications per southern African country (n = 435).

Table 2
The number of papers found and reviewed at different stages of the systematic review process.

NTFP	No. of papers						
	Listed from Scopus & WoS	Duplicates removed	Screened out on initial scan	Read full paper		Added from general studies & own knowledge	Final for review
				retained	rejected		
Medicinal plants	2145	130	1783	232	33	16	248
Firewood & charcoal	536	68	342	92	34	25	117
Wild fruits	637	73	503	61	14	16	87
Wild vegetables	581	28	486	56	11	25	81
Building wood	846	12	787	36	11	34	70
Weaving fibres	191	6	167	18	6	30	48
Wooden tools/ crafts	49	2	6	41	0	0	41
Thatch	146	13	95	16	22	14	30
Oils/resins/saps	289	4	237	25	3	0	25
Broom materials	27	9	8	10	0	12	22
Mushrooms	353	62	286	5	0	9	14
Flowers/pods/ seeds	115	5	99	11	0	0	11

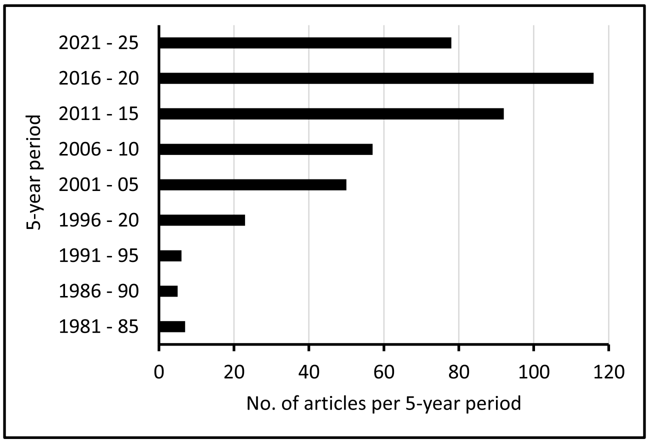

Fig. 2. Number of published papers on NTFP use and sustainability in southern Africa in five-year time periods ($n = 435$).

three-quarters of the references on medicinal plants are from South Africa (177), followed by Zimbabwe (24), Namibia (14), Mozambique (13), Botswana (12), Lesotho (8) and Eswatini (2). The top 10 species-rich medicinal plant families of southern Africa are Fabaceae, Asteraceae, Apocynaceae, Euphorbiaceae, Asphodelaceae, Malvaceae, Lamiaceae, Poaceae, Anacardiaceae, Combretaceae and Rubiaceae (Gelfand et al., 1985; Cornelius and van Wyk, 2024; Sitoe and van Wyk, 2024). Medicinal plants make an enormous contribution to primary health care in southern Africa. For example, in South Africa, a significant proportion of the urban population (72 %) still consume traditional medicines and according to Mander et al. (2007) about 27 million people relied on medicinal plants nationwide in the late 1990s (therefore likely to be more nowadays). Similarly, trading of medicinal plants has significant socio-economic benefits, enabling millions of people in southern Africa to generate some level of cash income, ranging from supplementary income in times of need through to tens of thousands of Rands per year for some fulltime traders (Mander, 1998). In South Africa, it was estimated in the early 2000s that 20,000 tonnes from 771 plant species are traded annually, contributing an estimated R2.9 billion to the national economy (Mander et al., 2007). There is growing interest in natural and traditional medicines as sources of new pharmaceutical products, with some of the commercialised or patented medicinal plants from southern Africa being *Agathosma betulina* (P.J.Bergius) Pillans, *Aloe ferox* Mill., *Artemisia afra* Jacq., *Aspalathus linearis* (Burm.f.) R.Dahlgren, *Catha edulis* (Vahl) Forssk. ex Endl., *Gunnera perpensa* L., *Harpagophytum procumbens* (Burch.) DC. ex Meisn., *Hypoxis hemerocallidea* Fisch., C.A. Mey. & AvA-Lall. and *Leonotis leonurus* (L.) R.Br. However, this growing demand for pharmaceutical products and active ingredients derived from medicinal plants raises concerns about the sustainability of some species due to indiscriminate collection and overexploitation, as well as equity in sharing of benefits with local communities (Wynberg and van Niekerk, 2014). Some medicinal plants showing signs of unsustainable harvesting in southern Africa include *Alepidea amatymbica* Eckl. & Zeyh., *A. cordifolia* B-E van Wyk, *A. macowani* Dummer, *Bowiea volubilis* Harv. ex. Hook.f., *Brackenridgea zanguebarica* Oliv., *Cassipourea flanaganii* (Schinz) Alston, *Encephalartos woodii* Sander, *Mondia whitei* (Hook.f.) Skeels, *Ocotea bullata (Burch.) Baill.*, *Prunus Africana* (Hook.f.) Kalkman, *Siphonochilus aethiopicus* (Schweinf.) B.L.Burtt and *Walburgia salutaris* (G.Bertol.) Chiov. (Raimondo et al., 2009; Williams et al., 2013).

The literature shows that the use of traditional medicines is dynamic and adaptive as several species that are exotic to southern Africa have been incorporated into the traditional *materia medica* of the region (Yessoufou et al., 2022). In South Africa, at least 528 exotic plant species are used in traditional medicine (14.0 % of utilised species) (Cornelius and van Wyk, 2024; 2025) and a similar trend was reported in Mozambique where 19 % of 731 medicinal plant species are exotic species (Sitoe and van Wyk, 2024). Research by Williams et al. (2021) showed that 301 alien taxa are traded in herbal medicine markets in South Africa.

2.4.2. Woodfuel

Across southern Africa, woodfuel (comprising both fuelwood and charcoal) is one of the most significant NTFPs in terms of economic value and ecological and societal impacts. These biomass fuels serve as primary energy sources for cooking, heating, and informal commercial activities for millions of people in the region (Sola et al., 2017). While the use of fuelwood is widespread, the production and use of charcoal is limited to Mozambique, and to a lesser degree, Zimbabwe and Eswatini (Baumert et al., 2016). We identified 117 articles reporting the use of woodfuel, the large majority of which (100) focused on fuelwood, mainly in South Africa and Zimbabwe, while only six focused on charcoal and 11 reported on both fuels, mainly in Mozambique.

Fuelwood is one of the most widely used NTFPs, with reported prevalence figures ranging from 54 % to 100 % of rural households, averaging 90 % across multiple studies. This is despite improved access to modern energy sources such as liquified petroleum gas (LPG) and electricity in much of the region over the last two decades (Shackleton et al., 2022). Indeed, a number of studies report only a modest reduction in the proportion of fuelwood-using households after electrification (Madubansi and Shackleton, 2007; Matsika et al., 2013; Falayi et al., 2019). The evidence indicates that prohibitive costs of cooking appliances and the energy they consume, rather than cultural explanations, account for the persistent use of fuelwood (Madubansi and Shackleton, 2007; Uhunamure et al., 2017). Fuelwood use also occurs among relatively wealthy households, with only modest differences in prevalence of use between wealthy and poor households (Shackleton and Shackleton, 2006; Paumgarten and Shackleton, 2009). Importantly, fuelwood use is not limited to rural areas, with an average of 57 % of households in lower income urban areas also using fuelwood (Gugushe et al., 2008; Kaoma and Shackleton, 2014) or charcoal (in Mozambique) (Chicombo and Musango, 2024). The extent of charcoal use by rural households is negligible.

Despite variation in the methods and units of measurement, we found 30 papers reporting on the use per household in kilograms, which provided an average rate of 4110 kg per rural household per year. This is only 12 % higher than the mean of 3670 kg for urban households as reviewed by Shackleton et al. (2022). In comparison, annual domestic consumption of charcoal was estimated two decades ago as 672 kg per household in urban Maputo, Mozambique (Brouwer and Falcão, 2004).

Both fuelwood and charcoal are widely traded, especially in urban areas, or in the case of fuelwood, in rural settings where local stocks have become depleted (Baumert et al., 2016; Hainduwa et al., 2016; Guild and Shackleton, 2018). The proportion of rural households purchasing fuelwood varied dramatically across studies, ranging from zero to 64 %, with an average of 26 %, while fuelwood sellers represent a smaller segment, averaging 9 % of households. Wealthier households are more likely to buy wood whereas sellers are usually from poor households (Shackleton and Shackleton, 2006; Paumgarten and Shackleton, 2009). Local fuelwood and charcoal retail prices in 2025 values averaged R1.26/kg and R1.38/kg, respectively. Although it varied widely, mean monthly income from wood sales was R2,851. This was higher than income earned by local charcoal producers (R603/month) but substantially less than that of charcoal wholesalers (R16, 904/month) (Smith et al., 2019). The annual direct use value (DUV) of fuelwood consumption across studies averages R3,174 per household, representing a mean of 39 % of the total DUV derived from NTFPs.

A broad spectrum of species is documented as being used for woodfuel, and the number of species used varies greatly between ecosystems, ranging from a handful to over 100 species, and making up between 5 % and 27 % of local woody species (e.g. Pote et al., 2006; Woollen et al., 2016; Magwede et al., 2019). However, typically only one to five species constitute the most preferred and frequently harvested fuelwood resources, generally common species with dense wood that provide slow-burning, efficient fuel. In dystrophic savannas, *Dichrosyachys cinerea* (L.) Wright & Arn., *Terminalia sericea* Burch. ex DC and *Combretum* spp. are the preferred species, while in eutrophic savannas, *Vachelia* and *Senegalia* species emerge as the dominant choice. In Mopane veld, *Colophospermum mopane* (J.Kirk ex benth.) J.Kirk ex J. Laonard is the dominant fuel species, while *Brachystegia spiciformis* Benth. and *Julbernardia globiflora* (Benth.) Troupin are the favoured species in miombo woodlands. A number of studies also document the use of non-native species such as *Acacia mearnsii* De Wild., *A. dealbata* Link, *Eucalyptus grandis* W.Hill ex Maiden and *Psidium guajava* L. (Ngorima and Shackleton, 2019; Semenya and Maroyi, 2020; Ruwanza and Thondhlana, 2022).

Much concern has been expressed about the sustainability of fuelwood harvesting, and fuelwood models have generally predicted severe fuelwood deficits in communal areas within a few decades (e.g. Banks et al., 1996). Multiple studies indicate that fuelwood users perceive diminishing local wood availability, manifested through progressively longer travel distances and increased time investment for collection (Chagumaira et al., 2016; Pelane et al., 2021). The diminishing size of harvested stems, coupled with widespread reports of harvesting culturally protected species such as *Sclerocarya birrea* (A.Rich.) Hochst. subsp. *caffra* (Sond.) Kokwaro further indicates declining supplies in some sites (Pote et al., 2006; Maroyi, 2014). However, a review of the studies that quantify wood supply and demand to assess sustainability presents a mixed picture, with wood demand exceeding local supply in some cases (e.g. Allen et al., 1988) but not in others (e.g. Nott and Thondhlana, 2017). At a national scale it is deemed that supply exceeds demand in South Africa, but with local-scale exceptions (Shackleton et al. 2022). Evidence from more recent fuelwood supply and demand models suggests that previous models significantly underestimated the contribution of coppice regeneration to meeting wood demand (Twine and Holdo, 2016). The reviewed studies also illuminate how users adapt to shortages by diversifying their harvesting strategies, such as extracting wood from non-woodland sources such as coppicing stumps in arable lands, fallows, and abandoned fields, while increasing use of exotic species (Rasethe et al., 2013; Hainduwa et al., 2016).

2.4.3. Wild fruits

The rich biodiversity of southern Africa includes at least 685 species that provide fruits that are edible to humans (Welcome and van Wyk, 2019). This is expressed in the 87 papers published between 1985 and 2024, which indicate wide use of fruits for household consumption (70 papers), income (29) and culture (8). Slightly more than half of the papers (46) were from South Africa, 15 from Zimbabwe, 10 from Botswana and five or less for each of the other four countries.

The papers ranged from studies on the household use, to trade in a specific species (e.g. *Adansonia digitata* L., *Mimusops zeyheri* Sond., *S. birrea, Strychnos spinosa* Lam., *Ziziphus mauritiana* Lam.), to general ethnobotanical inventories of species known, through to quantification of volumes used as part of livelihood valuation or climate change adaptation studies. The use of naturalised, non-native species such as *Opuntia ficus-indica* (L.) Mill. and *P. guajava* was also reported in a few studies. Two-thirds of the studies reported on the proportion of households using wild edible fruits to some degree, with the modal range reporting that 50 - 70 % of households do so. This is clearly influenced by local species richness, with Sardeshpande and Shackleton (2020) showing that the lowest use of wild fruits was amongst communities in the fynbos and grassland biomes, which harbour relatively few native fruit tree species, and the highest within the Indian Ocean Coastal Belt biome, which boasts the greatest number of native fruit species (O'Brien and Peters, 1998). However, the reported quantities consumed are highly variable, most likely a reflection of the diversity of species and the production potential of the local environment. Moreover, obtaining accurate figures of quantities consumed is complex as many fruits are consumed opportunistically when encountering a fruiting bush or tree whilst walking between locations, herding livestock or collecting other NTFPs or water (Letšela, 2003). Children consume wild fruits when playing or doing minor household chores, and this consumption is typically excluded from estimates of quantities. Nevertheless, Shackleton and S. Shackleton (2004) reported a mean across 12 sites of 104 kg/household per year, with a range of 19 to 165 kg. Most later studies are within that range (Shackleton et al., 2007; Mmopelwa et al., 2009; Falayi et al., 2019), but Woittiez et al. (2013) reported the mean household use to be 355 kg/household per year in eastern Zimbabwe, which increased to 1384 kg/household during a drought the subsequent year. The direct-use value of such use is generally in the order of several hundred Rands per household per year. Many fruit species are also culturally important (Bruschi et al., 2014), including being used for medicinal purposes (Chauke et al., 2024), but there has been no exploration of this in the literature reviewed. Cultural and other values often promote the retention of particular fruit species within agricultural fields; examples include *S. birrea* and *Uapaca kirkiana* Müll. Arg.

Considerations of the sustainability of wild fruit use have been mostly qualitative, in which local users are asked in questionnaires or focus groups, to indicate if the abundance or supply is changing through time. Some do feel that supplies are declining, but none attributed it to overuse. Suggested reasons for local declines typically include drought and deforestation for agriculture and firewood collection. More quantitative sustainability studies have been done on *S. birrea* (Emanuel et al., 2005) and *A. digitata* (Venter and Witkowski, 2013), both suggesting that fruit collection was sustainable at the study sites examined (but in the absence of high livestock densities which affect recruitment of *A. digitata*).

2.4.4. Traditional African vegetables

According to Welcome and van Wyk (2019), 659 different wild vegetable species have been recorded as used in southern Africa, with the largest contributions being from the Asteraceae, Asphodelaceae, Amaranthaceae, Apiaceae and Brassicaceae families. Following Towns and Shackleton (2018) we use the term 'Traditional African Vegetables' (TAVs). We found a rich literature on the use of TAVs, with 81 papers spanning from 1985 to 2024. Sixty-three percent (i.e. 51) were from South Africa and 14 % (11) from Zimbabwe. The remaining countries had six or fewer papers. There was a clear focus on household use (72 papers) and income (23 papers), with only eight explicitly considering cultural aspects of use, even though use is deeply embedded in dietary culture and varies markedly between ethnic groups (Welcome and van Wyk, 2019).

Most studies indicate that the majority of rural households (and many urban ones (e.g. Garekae and Shackleton (2020)) consume TAVs regularly during the rainy season (Dovie et al., 2007), and in some cultures TAVs are dried to allow use during the dry season (Ogle and Grivetti, 1985a; Nesamvuni et al., 2001; Maroyi, 2013). Most species are annuals and grow spontaneously in disturbed sites, including in cultivated fields and gardens where they are encouraged amongst staple crops such as maize or cassava (Ogle and Grivetti, 1985a; Lewu and Mavengahama, 2011). The length of the productive season of TAVs can be extended through irrigation except in areas that experience winter frosts. In some regions they are consumed daily or several times per week (e.g. Dovie et al., 2007; Paumgarten et al., 2018), but in others, consumption is less frequent. Individual households make use of several species, often mixing them, with dozens of species used at community level (Ogle and Grivetti, 1985b). The most widely used (and studied) TAVs in the region are *Amaranthus* spp., *Chenopodium album* L., *Cleome* spp. *Corchorus* spp., *Cucumis* spp. *Bidens Pilosa* L., *Momordica balsamina* L, *Solanum* spp. and *Sonchus* spp. (Shackleton, 2003; Welcome and van Wyk, 2019), but there are large regional variations in species availability and use. Some TAVs are also used as medicinal species (e.g. Lewu and Mavengahama, 2011). Cultivation and picking TAVs leaves is usually the responsibility of women and children, and hence they have greater knowledge of TAV species (Ogle and Grivetti, 1985b; Zulu et al., 2022). There are also strong cultural beliefs and taboos in some areas around gender roles in the production or preparation of TAVs and exclusion of menstruating women from handling them (Zulu et al., 2022). There may also be taboos against consumption of particular species by specific clans (e.g. Ogle and Grivetti, 1985a). Despite their widespread availability there is extensive small-scale trade in TAVs within villages, along roadsides and near commuter taxi ranks (e.g. Shackleton et al., 1998; Maroyi, 2013). This provides supplementary income alongside other goods sold.

There is a pervasive narrative that the use of TAVs is declining because they are not highly appreciated by the youth, who dislike the bitter taste of some species or that use is regarded as unmodern or unsophisticated, especially amongst the more educated (Mooketsi and Gestring, 2011; Zulu et al., 2022). However, the lack of longitudinal studies makes this difficult to test. Indeed, there are also several studies reporting that TAVs are widely appreciated due to their (i) taste, (ii) high nutrient status, (iii) healthiness, (v) ready availability and (v) being cultural foods (Lewu and Mavengahama, 2011). They are also often viewed as being more drought and pest tolerant than conventional vegetable crops, although this has not been extensively investigated other than by Oelofse and van Averbeke (2012). Additionally, there are several studies on the importance or use of TAVs as safety-nets during droughts or household shocks (e.g. Paumgarten et al., 2018), including in response to HIV/AIDS and Covid-19 (e.g. Ncube et al., 2016). This illustrates the importance of keeping alive the knowledge of which species are edible, where to find them and how to prepare them.

Twenty studies reported on the quantities used. There is wide variation, from 15 kg per user household per year (Dovie et al., 2007) to 130 kg (Shackleton et al., 2002), which is a consequence of different research methods used, household size, cultural preferences and local availability. This variation contributes to equally wide variation in direct-use values, which is compounded further by marked differences in local prices of traded TAVs. After inflation adjustment, values in 2025 terms range from several hundred rand per household per year to over R14, 000 (in Mogano village in eastern Limpopo Province). However, most fall within the range of R1,200 – R2,500 per year.

The ecological sustainability of TAV use has hardly been considered in the region. This may be in part due to many species being annuals and regarded as agricultural 'weeds' that grow spontaneously and prolifically. However, climate change will alter productivity and distributions of many species (depending on the extent of change) (Wessels et al., 2021), which will undermine the cultural sustainability of affected species, as well as their availability as safety-nets. Declines in small-scale agriculture in the communal areas (Shackleton et al., 2019) is likely to reduce the availability of many species (Njwaxu and Shackleton, 2019). However, there are nascent efforts to cultivate some of the popular TAVs.

2.4.5. *Wood for construction*

Wood is harvested from local rangelands and forests for the construction of homesteads and the fencing of fields, livestock enclosures (kraals) and home gardens. Despite the potentially large demand for construction purposes, there are relatively few studies from southern Africa that have documented how much is used per household or in aggregate. The number of relevant papers found with the initial search string through Scopus (9) and WoS (12) (with 4 in common) was low, but inclusion of NTFP valuation studies that enumerate annual household demand across various NTFP categories, and ones that we already knew of, resulted in a total of 69 papers. Most were from South Africa (42), followed by nine from both Mozambique and Zimbabwe.

The quantities of wood used in fencing and building can be considerable, but depend on local building styles, size of a dwelling, kraal or field, and the replacement rate. In one of the earliest papers, Liengme (1983) reported mean volumes of wood per unit as 1.22 ± 0.44 m^3 for round "huts" and 1.86 ± 0.6 m^3 in square ones in the Giyani district. Storage "huts" contained 1.09 ± 0.3 m^3, or 2.36 ± 1.31 m^3 depending on type. In the Eastern Cape, Cocks and Wiersum (2003) reported the annual demand for fencing as 52 ± 42 kg for kraal poles and 913 ± 1092 kg of thorn branches between the poles, with a further 168 ± 164 for fencing poles around fields. In Zimbabwe, Vermeulen et al. (1996) determined annual demand over a one-year period as 3.8 m^3 per household in roofs and buildings and an additional 0.8 m^3 for fencing. In contrast, Barnes et al. (2010) derived an aggregate of 3.5 tons of poles per household per year in Namibia just for fencing purposes. These illustrative, albeit quite dated, figures highlight that annual demand can be substantial, but it is highly variable between sites and uses. The estimated direct-use values are equally variable, ranging from close to R650 per household per year (inflation adjusted) (Shackleton and Shackleton, 2000; Shackleton et al., 2007) to over R3,000 (Herd-Hoare and Shackleton, 2022). But in many regions the use of locally harvested indigenous wood species is being replaced by commercially grown *Eucalyptus* poles because they are treated, straighter and labour is not required to harvest them (Ngorima and Shackleton, 2019). Additionally, many local authorities prohibit harvesting of large stem sizes, which are what is required for kraals, fencing and building poles.

Species selection is shaped by local availability and the particular qualities required. For fences and construction, dense woods are preferred because they last longer. Poles from non-native species are commonly used in areas where they are abundant (e.g. Ngorima and Shackleton, 2019). There is more selection around species used for wooden utensils and tools as durability may be considered against workability, wood colour and cultural norms.

The sustainability of wood demand for building and fencing has hardly been examined, and not in the last decade or more. Some early studies estimated total demand per community and considered it against assumed supply (e.g. Liengme, 1983; Vermeulen et al., 1996). They concluded that demand was well below supply and hence sustainable. But both current demand and supply (due to lower wood stocks in communal lands) are very different since those studies were done.

2.4.6. *Weaving fibres*

Plant fibres from grasses, sedges, reeds, rushes, palms and restios are used throughout southern Africa to weave various household items such as sleeping mats, baskets, beer strainers, bags, hats and crafts for tourists. According to Pullanikkatil et al. (2021), the weaving materials used are predominantly informed by culture and are dictated by locally available species. Though primarily for utilitarian purposes, these products tend to be gifted to neighbours, relatives and the elderly during traditional ceremonies to build social bonds, thus becoming ritualised over time (Cocks and Wiersum, 2003; Pereira et al., 2006; Adekola et al., 2012; Demotts, 2017; Martins and Shackleton, 2021; Pullanikkatil et al., 2021). Elders hold the knowledge of weaving and are predominantly women, with few youngsters interested in the crafting skill (Pereira et al., 2006; Mjoli and Shackleton, 2015; Adam and Shackleton, 2016).

The proportion of households using plant fibre products varies across the different regions: with 50 % household use reported in Zimbabwe (Chagumaira et al., 2016), 20 % in Botswana (Mugari et al., 2024), 68 % in Lesotho (Letšela et al., 2002), and between 0 % and 100 % in South Africa (Dovie et al., 2005; Shackleton et al., 2007; 2002; Herd-Hoare and Shackleton, 2022). Whereas in Namibia, weaving fibres ranked amongst the least used and sold NTFP (Kamwi et al., 2020). Of those households that use plant fibres, <50 % are traders, and even fewer harvest the plant fibres themselves (Shackleton et al., 2002; Chagumaira et al., 2016; Mugari et al., 2024).

The direct use and trade value for plant fibres varies between R304/yr and R2,709/yr in Botswana (Mmopelwa et al., 2009), R1,325/yr in Zimbabwe (Chagumaira et al., 2016), R7,752 in Lesotho (Letšela et al., 2002) and R8,645 in South Africa (Mugido and Shackleton, 2019). Amongst the traded NTFPs, woven products were found to have the highest returns per hour of labour (Mugido and Shackleton, 2019). The income generated from weaving fibres can contribute significantly to poorer households (Chagumaira et al., 2016; Pereira et al., 2006), and in some cases, contributes more income than wage income (Martins and Shackleton, 2022).

The sustainability of harvesting weaving fibres has been studied for some palms (e.g. *Hyphaene* spp.), sedges (e.g. *Cyperus* spp.) and reeds (e.g. *Phragmites* spp.). Most studies have assessed the perceived availability of plants and the distance to harvest sites (Adekola et al., 2012; Chagumaira et al., 2016; Demotts, 2017), whereas others have quantified the ecological impacts of harvesting (McKean, 2001; Sola et al., 2006; Kotze and Traynor, 2011; Ruwanza and Shackleton, 2015). Results from the various studies show that most harvested plants regenerate rapidly after harvesting (McKean, 2001; Foote et al., 2003; Traynor, 2008) and in some cases harvesting stimulates seedling recruitment. However, the cultivation of wetlands (Chagumaira et al., 2016), grazing livestock (Konstant et al., 1995), mining activities (Shackleton, 2020), altered fire regimes and rainfall (Mjoli and Shackleton, 2015) interact and compromise the availability of harvest sites and plant abundance at some places.

2.4.7. Wood for utensils, tools and crafts

Thirty-eight articles were found documenting the use of various woody species to make household utensils and crafts. Most were from South Africa (23), followed by eight from Zimbabwe. The remaining countries had three or fewer. Most focused on household use (23) and income (17). Only two papers mentioned how some crafts were used explicitly for cultural purposes, such as carved traditional totems used in religious and ceremonial events in Zimbabwe (Fadiman, 2008).

In the Eastern Cape, Shackleton et al. (2002) reported that 96 % of households used one or more wooden household items such as spoons, axe handles, and the like, with Dovie et al. (2005) reporting a similar proportion (98 %) in Limpopo Province. Moreover, each household typically has several such tools, such as 6.5 per household in Limpopo (Bruschi et al., 2014) and 11 in the Eastern Cape (Shackleton et al., 2007). Urban households also make use of wooden utensils, although most purchase them from vendors rather than making them for themselves (Kaoma and Shackleton 2014). However, studies report a gradual shift towards mass-produced items and a decline in use of traditional wooden ones (Mbaiwa, 2011; Garekae et al., 2020).

An amazing diversity of species are used to make crafts, ranging from 13 southern Mozambique to 93 species in the Vhembe District in Limpopo Province (Magwede et al., 2019). Thirty-eight species were recorded as being used in the Limpopo Province (Bruschi et al., 2014). In Botswana, over 90 % of Okavango Delta households were identified as reliant on NTFPs for making handicrafts (Garekae et al., 2020). In Gokwe, Zimbabwe, *Ptreocarpus angolensis* DC. and *T. sericea* were the most popular species (Shopo et al., 2022), whereas in the Sekhukuneland region of South Africa, 62 species were used for craft purposes including *C. mopane, Combretum apiculatum* Sond., *C. imberbe* Wawra, *D. cinerea, Diospyros mespiliformis* Hochst. ex A.DC. *S. birrea, Senegalia nigrescens* (Oliv.) P.J.Hunter and *T. sericea* (Mogale et al., 2019). The use of alien species, such as *A. dealbata*, has also been recorded (Ngorima and Shackleton, 2019). Knowledge of the species used and how to make wooden utensils and household items was generally reported as the domain of males. There were very few estimates of the amount of wood used to produce household crafts and utensils. For example, in the northeast of Limpopo Province, it was estimated that 0.0091 m^3 were used for a mortar and 0.003 m^3 for a pestle (Makhado et al., 2009).

Certain regions in South Africa and Zimbabwe have had well-established tourist-orientated craft industries which have received research attention. These centre on the production of figurines, spoons, sticks and bowls, often made from species with highly attractive wood, such as *Dalbergia melanoxylon* Guill. & Perr. *Phyllogeiton discolor* (Klotzsch) Herzog, *P. angolensis*, and *Spirostachys africana* Sond. in South Africa (Shackleton et al., 2008) and *A. quanzensis, C. imberbe, Kirkia acuminata* Oliv. and *P. angolensis* in Zimbabwe (Braedt and Schroeder, 2003; Standa-Gunda et al., 2007). Woodroses also have a well-developed market in the Bushbuckridge lowveld, made from the callous growth reaction to mistletoe infections by *Pedistylis galpinii* (Schinz ex Sprague) Wiens or *Erianthemum dregei* (Eckl. & Zeyh.) Tiegh (Dzerefos et al., 1999). Dovie (2003) investigated the craft industry around baobab (*A. digitata*) bark products, in which bark is harvested and processed into a fibre which is woven into various items such as blankets, baskets, bags, ropes, whips, table mats and carpets. It has been estimated that 43 % of the households between Mutare and Birchenough Bridge (Zimbabwe) were participating in the marketing of baobab bark products. Each household annually earns an amount up to US$371, translating into US$143 per participating person per annum (Dovie, 2003).

2.4.8. Thatch

The earliest article discussing the use of thatching grass and its economic value to rural livelihoods was a case study in the lowveld region of South Africa in 1996 (Shackleton, 1996). Since 2000, twenty-eight papers have reported the use of thatching grasses (amongst other NTFPs) in rural households across the region. The use of thatching grass showed high variation across space; the proportion of households using thatch ranged between 3 % (Falayi et al., 2019) and 96 % (Shackleton et al., 2007). In South Africa, many households used thatching grass for subsistence and the direct use value varied between R9 and R1,088 in 2025 value terms (Shackleton et al., 2002), whilst the direct use plus trade value varied between R3,185 and R20,677 across different villages (Herd-Hoare and Shackleton, 2022). Though traded at a small scale, the income was important for poor households (Shackleton et al., 2007). Whereas in Namibia and Botswana, the tourism industry created a thriving market for thatching grass for tourist lodges resulting in trading thatch as being a top income source for participating households (Mabuku et al., 2019; Mugari et al., 2019; Garekae et al., 2020; Kamwi et al., 2020), with the direct use and trade value ranging between R15,331 and R23,390 across different villages in Botswana (Mmopelwa et al., 2009).

The grass species used for thatching roofs vary between countries; in Botswana *Aristida congesta* Roem. & Schult., *Cymbopogon pospischilii* (K. Schum.) C.E. Hubb., *Eragrostis pallens* Hack. and *Stipagrostis uniplumis* (Licht.) DE Winter are used (Mugari et al., 2024), in Zimbabwe, *Hyparrhenia filipendula* (Hoscht.) Stapf (Woittiez et al., 2013), and in South Africa *H. filipendula, H. hirta, Hyperthelia dissoluta* (Nees ex Steud.) Clayton, *Themeda triandra* Forssk. and *Heteropogon contortus* (L.) Roem. & Schult. (Makhado et al., 2009). Thatch is commonly harvested in communal areas and in some conservation areas (Shackleton et al., 2007). Harvesters collect between 285 and 981 bundles with varying thicknesses once or twice annually, and replace thatch roofs every few years (Dovie et al., 2002; Makhado et al., 2009; Mmopelwa et al., 2009). However, over time there has been a decline in the number of structures with thatched roofs (Gaugris and van Rooyen, 2009) as they are replaced by 'modern' roofing materials. As a result, the number of skilled thatchers is also declining (Mbaiwa, 2011). Nevertheless, in some regions, it is culturally important to have at least one structure with a thatch roof (Falayi et al., 2019).

2.4.9. Beverages made from plant saps, juices and roots

Twenty-three articles documented the use and trade in non-alcoholic and alcoholic beverages from plant saps for fruit juices. Most were from South Africa (10) followed by Mozambique (5). Most focused on household use (12) and income (8). Two papers explicitly mentioned cultural significance. For example, Shackleton and Shackleton (2005) mentioned how marula beer is used by over 80 % of households in the Bushbuckridge region in South Africa during traditional and ancestral rituals. Palm wine is used in a similar fashion in southern Mozambique (Martins and Shackleton, 2021). Thirty-four species were recorded as being used to produce different beverages in Vhavenda (Magwede et al., 2019). About 9 % of households also collected roots and tubers, which were then fermented and added to different traditional alcoholic beverages to give them a distinctive flavour (Dalu et al., 2021). In

Mozambique, five species were recorded as being used to produce non-alcoholic beverages, and eight to produce distilled alcoholic beverages (Bruschi et al., 2014). Masau fruits (*Z. mauritiana*) are fermented to produce a spirit called Kachasu in Zimbabwe (Nyanga et al., 2008), whilst in Botswana, khadi (from *Grewia flava* DC) is regularly consumed as a beverage (Molapisi et al., 2024). Non-native species are also used, with Semenya and Maroyi (2020) finding that just over one-tenth of the alien plant species collected were used to make beverages.

Middle-aged to elderly men and women were recognised as having the most knowledge about which species to use and how to make the different beverages (Dovie et al., 2008). Concerns around the negative consequences of this knowledge not being transferred to the younger generation and possible reduced health impacts were raised by both Molapisi et al. (2024) and Tselaesele et al. (2023).

Some of the alcoholic beverages produced locally also have a commercial value and significantly contribute to household incomes, such as palm wine and marula beer. Studies on the commercialisation of these products have been carried out in South Africa (Cunningham, 1990; C. Shackleton, 2004; Shackleton et al., 2008; Venter and Witkowski, 2013), Zimbabwe (Foote et al., 2003) and Mozambique (Martins and Shackleton, 2018, 2021, 2022). Production and trade networks have developed to move the final product over large distances and to urban areas (Cunningham, 1990).

In southern Mozambique, palm tappers spend an average 25 ± 18 h per week on tapping activities, providing average returns to labour of R39 (±US$3) per hour. The mean annual net income from palm wine sales was R24,981 ± R12,094 (US$1878 ± 909) per tapper, which accounted for 85 % ± 22 % of their annual household income (Martins and Shackleton, 2018). However, distributors of palm wine were shown to make significantly more than the tappers (Cunningham, 1990). In contrast, the harvesting of *S. birrea* fruits for marula beer in northern South Africa and Zimbabwe is a very seasonal activity, with most beer consumed at home (Shackleton, 2004; Shackleton and Shackleton, 2005; Maroyi, 2014). Whilst there is increased marketing of marula beer along roadsides and at commuter taxi ranks, the short season means that incomes are relatively modest, approximately R500 per season (S. Shackleton, 2004), approximately R1,480 in 2025 terms. For household use, approximately 1325 ± 130 kg of fruit are collected, allowing the brewing of 200 – 400 l per season (Shackleton and Shackleton, 2005).

The harvesting of sap to produce palm wine has been shown to be unsustainable. For example, in communities where palm trees have been extensively harvested for their sap, the size class distribution of palm trees has been negatively affected, with a skewed ratio towards juvenile trees (Cunningham, 1990; Foote et al., 2003; Martins and Shackleton, 2018). To harvest sap from juvenile trees tappers have been forced to dig to access the meristem (Foote et al., 2003; Martins and Shackleton, 2018) which in many instances leads to the palm tree being damaged. In contrast, modelling of marula fruit harvests in the Bushbuckridge area indicated that they were sustainable at the time of the study in the early 2000s (Emanual et al., 2005).

2.4.10. Plant materials used for brooms and brushes

The use of traditional brooms or hand-brushes made from indigenous plant fibres is widespread and was reported in 22 studies. The large majority of studies (19) were from South Africa, with only two from Mozambique and one from Zimbabwe. The earliest reference was Liengme (1981), in a survey of plants used by the Tsonga people. Six studies focused exclusively on brooms (e.g., Cocks and Dold, 2004; Shackleton and Campbell, 2007), while the remainder included them in broader assessments of NTFP use (e.g. Paumgarten and Shackleton, 2009; Bruschi et al., 2014). Brooms were among the more commonly used NTFPs, used by well over 50 % of households in most villages in the eight studies that reported prevalence of use. "Soft" brooms for indoor use are made from grass species such as *Festuca costata* Nees or the fronds of the palm species *Phoenix reclinata* Jacq. and *Hyphaene coriacea* Gaertn. (Shackleton and Campbell, 2007; Martins and Shackleton, 2021). "Hard" brooms for outdoor use are typically made from twigs of shrubs such as *Athrixia phylicoides* DC. and *Lippia javanica* (Burm.f.) Spreng., or from the stems of Cape reed (*Restio eleocharis* Mast.) (Liengme, 1981; Shackleton and Campbell, 2007; Shackleton et al., 2009). Most studies reported higher prevalence of use of "soft" brooms than "hard" brooms. Grass and twig brooms have a lifespan of roughly 2–3 months, meaning that user households go through about four or five a year (Shackleton et al., 2002; Twine et al., 2003; Makhado et al., 2009), or two per year in the case of more hardy Cape reed brushes (Shackleton et al., 2009). Although ten studies reported demand for brooms, only three also quantified resource supply and assessed sustainability quantitatively. No consistent picture emerges, with harvesting apparently sustainable in some cases (Shackleton et al., 2009; Mjoli and Shackleton, 2015) but unsustainable in others (Gyan and Shackleton, 2005).

In most study sites, households bought brooms from local traders or traveling vendors, with relatively few households making brooms themselves (Dovie et al., 2002; Shackleton et al., 2009; Dalu et al., 2021). Eight studies reported local prices, which were in the range of R10-R40 per broom in 2025 prices, depending on the material and size (Gyan and Shackleton, 2005; Shackleton and Shackleton, 2006; Shackleton and Campbell, 2007; Dalu et al., 2021). In addition to being used by rural households, traditional brooms are also sold in urban areas, where prices are usually higher (Cocks and Dold, 2004; Makhado et al., 2009). Average annual income generated by broom producers and traders was modest and varied widely between studies, ranging from R2, 500 (Shackleton and Campbell, 2007; Mjoli and Shackleton, 2015) to over R10,000 (Gyan and Shackleton, 2005; Mugido and Shackleton, 2017). The Direct Use Value (DUV) of brooms, averaged across all households, was no more than R180/household/year, constituting <1 % of total DUV of all NTFPs used per household in all eight studies reporting these values (Dovie et al., 2002; Shackleton et al., 2002; Twine et al., 2003; Shackleton, 2020).

2.4.11. Mushrooms

The collection and use of wild mushrooms are understudied in the region. We found 14 studies (the earliest being 1995 and the latest 2024), none of which were on mushrooms specifically, but were included as one NTFP type in studies undertaking household inventories of NTFPs used. Eight were from South Africa, four from Zimbabwe and one apiece from Botswana and Namibia. These studies show high variation between sites with respect to the proportion of households using wild mushrooms, ranging from none at some sites (e.g. Paumgarten and Shackleton, 2009) to over 90 % at a site in northern KwaZulu-Natal (Shackleton et al., 2002). Whether this is a consequence of environmental variability in diversity and supply or local cultural dietary preferences is unknown.

None of the studies reported supply rates and only two studies, both from Eastern Zimbabwe reported consumption rates. Campbell et al. (1997) reported annual consumption as 47 (± 112) kg per household per year, whilst Woittiez et al. (2013) estimated it as 36 (± 11) kg per household in a "normal" rainfall year and 27 (± 11) in a drought year. Only one species was mentioned, namely *Amanita zambiana* Pegler & Piearce, whilst Guerbois and Fritz (2017) mentioned *Termitomyces* species. The sustainability of use was not directly examined in any of the studies. However, three decades ago McGregor (1995) reported on 27 mushroom ethnospecies in Zimbabwe, all of which were perceived to be declining in availability, which she attributed to deforestation in the miombo woodlands.

2.4.12. Seeds and wildflowers

Only 11 papers were found documenting the harvesting of seeds and wildflowers, spanning a twenty-four-year period from 2009 to 2020. All were from South Africa. Three articles dealt with seed use. Of the three reviewed, only one specifically mentioned the species from which the seeds were collected, namely *A. digitata* (Venter and Witkowski, 2013). Baobab seeds are collected and pressed to extract an oil used in cosmetic foundations. This demand has only emerged since the early 2000s (Venter and Witkowski, 2013) and has been driven by an increasing global demand for organic beauty products. Historically, baobab seeds were collected, roasted and pounded to be eaten. This use was not recorded in 2011 (Venter and Witkowski, 2013). In the Eastern Cape province, households from two different areas were recorded as collecting seeds from indigenous plant species (Falayi et al., 2019; Paumgarten and Shackleton, 2009). No species names were provided. It was also recorded that households in the Kat River Valley region of the East Cape collected seeds in 2000, but by 2015 a repeat survey found no households collecting seeds (Paumgarten and Shackleton, 2009).

It was estimated that the mean annual income made from the collection and sale of baobab seed equated to US$ 136 ± 14. The income generated from the seed sale was recognised as an important source of income for all who partake in the activity, approximately 22 % of the households (Venter and Witkowski, 2013).

The papers reviewed for harvesting wildflowers did not acknowledge harvesting wildflowers as an NTFP use. Attention has only been given to harvesting wildflowers in response to the local and international demand for fynbos species. A large, cut-wildflower industry has developed in the Western Cape (Blokker et al., 2015). Indigenous fynbos species are harvested from the wild and cultivated plots to meet local and international demands for fynbos flowers and foliage. However, the authors have all observed wildflower sellers along roadsides and urban crossroads in towns and cities in the Eastern and Western Cape provinces of South Africa.

2.5. NTFP harvesting and use in urban contexts

An underappreciated and researched use of NTFPs in southern Africa (and globally) relates to urban contexts. There is a pervasive perception that NTFPs are largely used by rural and remote communities. However, the global overview by Shackleton and de Vos (2022) showed that only half of NTFP users globally are in rural areas. Whilst there are no comparative estimates from southern Africa, there are several studies showing that urban dwellers also make extensive use of NTFPs, often termed “urban foraging” (Kaoma and Shackleton, 2015; Schlesinger et al., 2015; Garekae and Shackleton, 2020; Sardeshpande and Shackleton, 2023). Many urban households collect a variety of fuelwood, medicinal and edible plant species in urban parks, informal green spaces, servitudes and riparian zones. For example, Garekae and Shackleton (2020) found that 68 % of urban households in low-income neighbourhoods of two towns in northern South Africa foraged wild plants to some degree. Others buy particular NTFPs in informal markets such as for firewood (Guild and Shackleton, 2018) or medicinal plants (Rasethe et al., 2019), which may have been harvested in rural areas and transported in, or may have been collected in urban and peri-urban, public and private green spaces. Other than woodfuel, research on urban harvesting and use of NTFPs in the region is only from South Africa.

2.6. Drivers of NTFP use

The factors that underpin NTFP use are both complex and dynamic and vary according to the scale of analysis (Fig. 3). It also depends on what sort of use is being considered (see section 2.2.). For example, the factors that drive trade in NTFPs can be very different to those that drive cultural use or as safety-nets during shocks. At the national level common issues relate to the nature and strength of the national economy, with use of NTFPs increasing during economic weakness or downturns (e.g. Standa-Gunda et al., 2007; Weyer et al., 2018). In some countries (e.g. Namibia) government and non-government development agencies or NGOs play significant roles in developing market chains and markets for some NTFPs, especially those with export potential.

At the local-scale, the size, accessibility and management of NTFPs populations has a strong influence on the extent of harvesting and use. If NTFP populations are small or some distance away from where communities live, then the extent of use is less than for large populations and those in close or reasonable proximity. The same relates to the trade in NTFPs, i.e. if markets are large and in close proximity then there is a greater trade.

At the household-scale there is a large number of interacting factors that mould the nature and extent of NTFP use (Fig. 3). For example, household consumptive use is shaped by a whole range of factors, ranging from household size and poverty status through to culture and religion. The latter comes to the fore because some religious denominations discourage or prohibit the use of some NTFPs, such as medicinal plants for spiritual or cultural purposes associated with acknowledgement or appeasement of ancestors (e.g. Shackleton et al., 2002). In contrast, the use of NTFPs as safety-nets is shaped primarily by the exposure to and frequency and intensity of shocks, the poverty status of the household and the extent of local ecological knowledge around the harvesting and use of NTFPs (for home consumption or to sell) (Mugido and Shackleton, 2017b; Weyer et al., 2018).

2.7. Sustainability of NTFP use in Southern Africa

Given the millions of people in southern Africa who rely on NTFPs for some or a significant part of their livelihoods and wellbeing, it is imperative that harvests are ecologically and socially sustainable. Unsustainable extraction jeopardises local livelihoods as well as biodiversity and the broader roles that NTFPs play in plant community ecology (Shackleton et al., 2018). However, only 14 % of the studies reviewed reported some information on the local-scale ecological sustainability of the NTFPs used, often qualitative perceptions of users regarding trends in plant abundance and yields. Rates of supply or annual yields have been quantified by even fewer studies (just under 10 %), covering only a miniscule proportion of NTFP species in the region. Dynamic models of supply and demand as the basis for assessing ecological sustainability have been developed for only a few species in a few localities, such as *A. digitata* (Venter and Witkowski, 2013), *Clivia miniata* (Lindl.) Regel (Groner et al. 2022), *S. birrea* (Emanuel et al., 2005), fuelwood (multiple species) (Twine and Holdo, 2016). More often, ecological sustainability has been ‘gauged’ via once-off assessments of population structure and/or levels of damage due to harvesting, such as the extent of dead or ring-barked individuals (e.g. Tshisikhawe et al., 2011).

Over the short-term, communities mitigate ecologically unsustainable harvesting of a particular NTFP species by sourcing alternative harvesting areas or purchasing the NTFP from harvesters who transport it to areas of demand. A more medium-term response is to substitute the desired NTFP species with alternative species, as shown by Madubansi and Shackleton (2007) for fuelwood species in Limpopo Province. But the quality or efficacy of the substitute species is likely to be less than that of the initially most preferred species. Severe declines in wild stocks can catalyse the cultivation of high value species in home gardens and fields to augment supply, or in monocultures that provide large volumes, usually for export markets (e.g. *A. betulina* and *H. procumbens*).

The social sustainability of NTFP use in southern Africa has hardly been investigated to date. This relates to considerations such as equitable access to NTFPs and markets, ensuring adequate NTFP stocks for the poor and more vulnerable, fair shares in market chain values, inclusivity in NTFP governance and programmes, fair trade in export markets, and the like (Wynberg and van Niekerk, 2014).

2.8. Use of NTFPs in changing contexts

Four decades of NTFP research reveal a picture of resilience in NTFPs use in the region, but with shifting patterns and dynamics. This is supported by the few longitudinal studies (e.g. Brouwer and Falcão, 2004; Madubansi and Shackleton, 2007; Falayi et al., 2019). For example, while the prevalence of fuelwood use has hardly changed (Shackleton et al. 2019), the prevalence of buying wood and of diversifying energy sources for cooking have increased substantially (Vermeulen et al.,

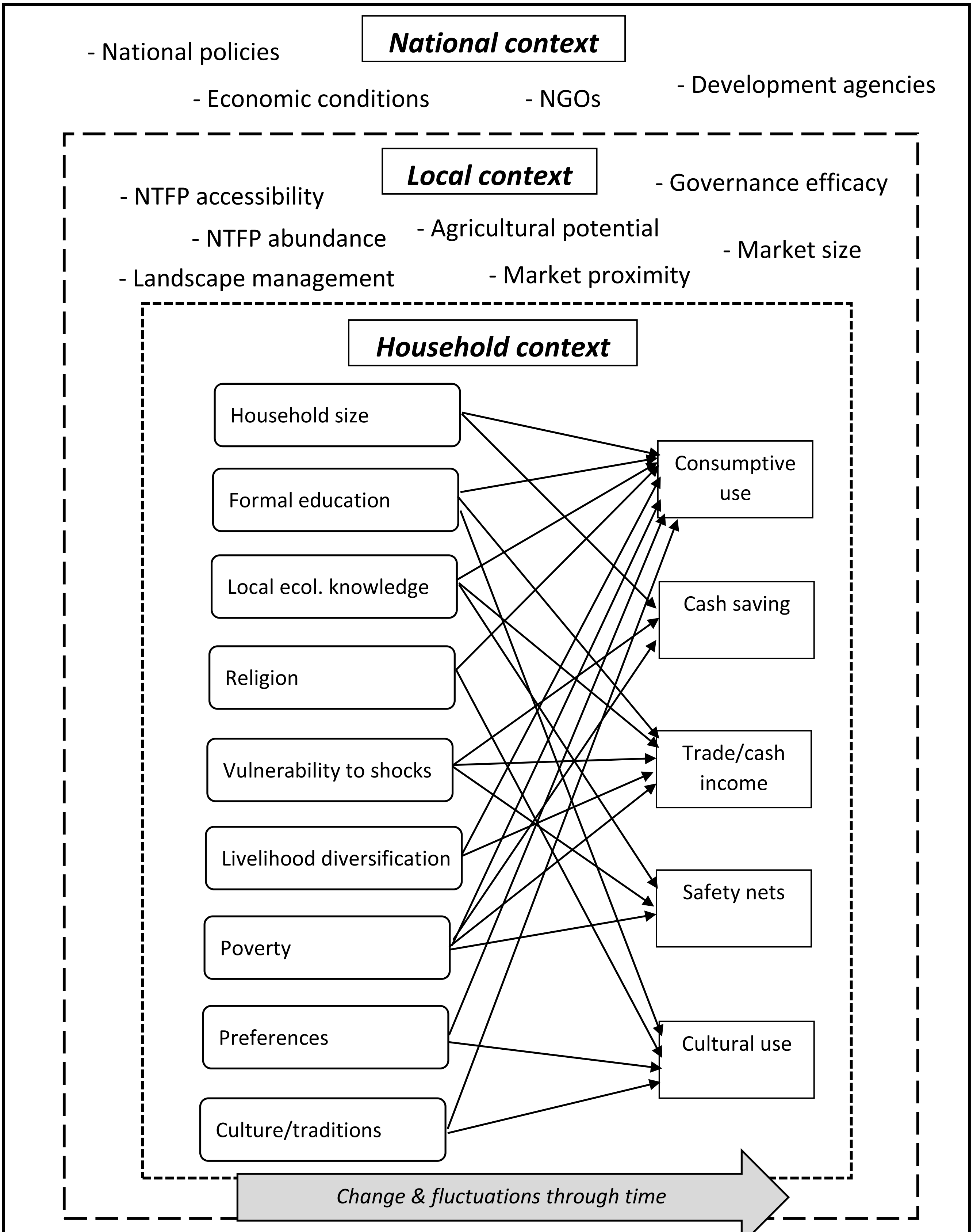

Fig. 3. Common factors that influence the extent and nature of use, reliance and trade in NTFPs in southern Africa.

2000; Madubansi and Shackleton, 2006). These shifts reflect changing environmental and socio-economic contexts in which NTFP use occurs. The key determinants of NTFP demand and supply at any point in time operate at various scales and are relatively well understood (Section 2.6). NTFP demand is determined by individual factors influencing consumer choices and behaviours, household traits and livelihoods shaping consumption patterns, and community-level factors that influence or aggregate demand at individual and household levels (Fig. 4). Additionally, demand is influenced by resource availability such as number and substitutability of used species (Section 2.6). Supply dynamics influence demand patterns through the feedback mechanisms of availability and accessibility. Supply is determined by interacting environmental factors at multiple scales: landscape- and community-level conditions, species-level demography, and individual traits (which are taxonomically constrained) (Ticktin, 2004). Supply is, of course, also influenced by harvesting pressure, which is driven by demand. However, few of the demand and supply determinants are static in time (e.g. changing macro-economies, land transformation; population densities, education and household income levels). Drivers of change in these factors are diverse, and also operate at different scales. Many of the papers comment on or mention drivers of changes in NTFPs use in southern Africa (such as loss of indigenous knowledge, deagrarianisation, increasing household incomes, demographic changes at household and population levels, population growth, urbanisation, cultural change, weakening natural resource governance, growing market integration, and the rising incidence of pandemics), but none have systematically studied responses in supply or demand in relation to one or more specific drivers. Drivers of changing resource supply, in addition to direct harvesting pressure, include land use change, climate change, ecosystem degradation, and increasing use of exotics and

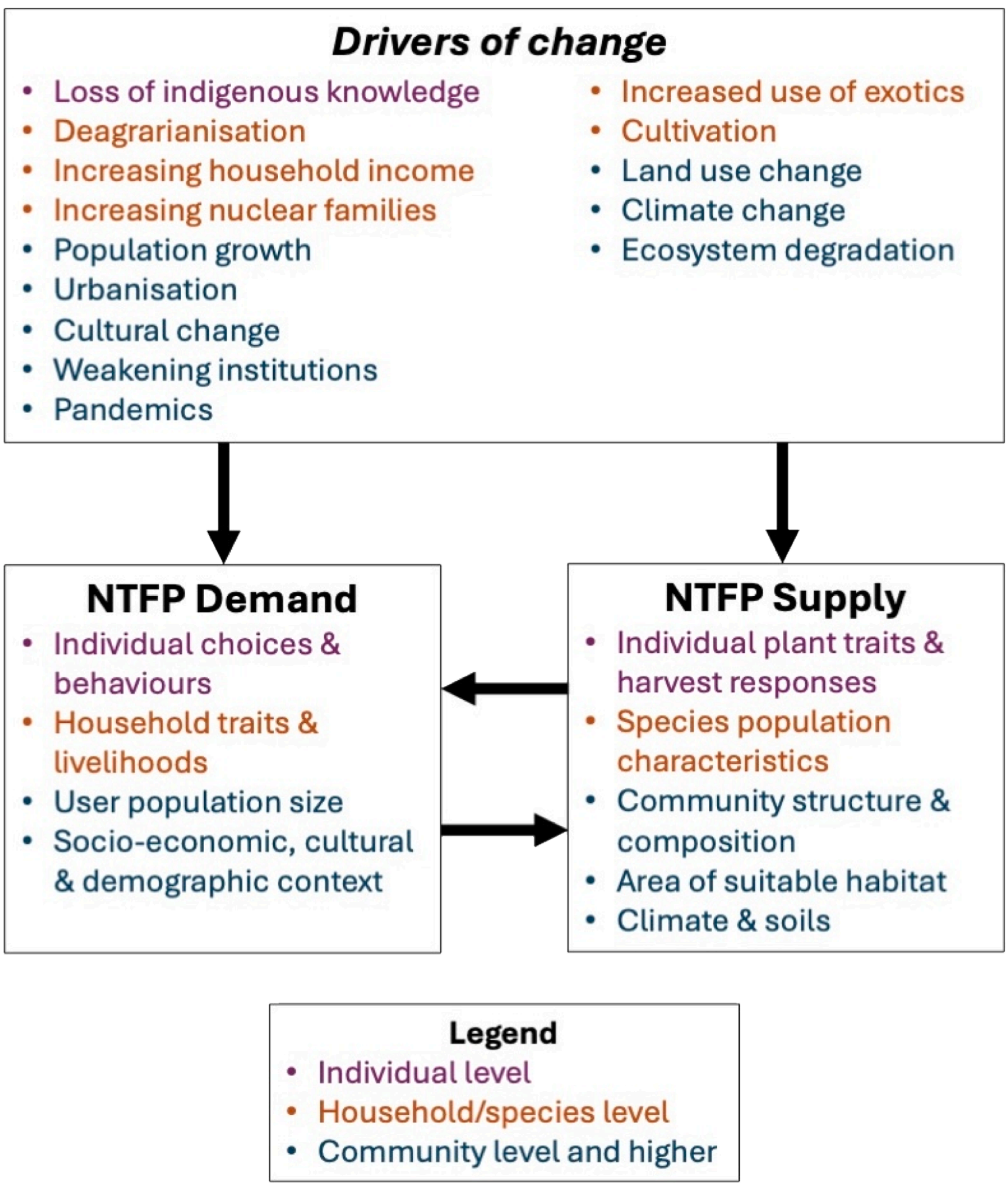

Fig. 4. Conceptual model of key drivers of change in NTFP demand and supply contexts.

cultivated species.

The effects of these drivers of change are complex for several reasons:

- Their multi-scale nature means that higher-level drivers may impact determinants at more than one level. Cultural change, for example, is a community-level trend that may shape individual preferences that influence household livelihood choices.
- They are not uni-directional. For instance, changing land use in the form of encroachment of settlements on resource use areas exacerbates diminishing NTFP availability, while revegetation of abandoned fields increases supply (Njwaxu and Shackleton, 2019).
- They may have several impact pathways. The COVID-19 pandemic is a good example, driving a surge in demand for (i) traditional medicine and (ii) for NTFPs to supplement the livelihoods of households following the loss of income due to lockdown measures (Mphekgwana et al., 2021; Krauss et al., 2022).
- Similarly, they may drive demand in complex ways beyond just influencing numbers of users. For example, urbanisation has not reduced the use of traditional medicine to the extent one might imagine, but how urban healers obtain their plant material has changed substantially, fueling the development of large urban "muthi" markets and pushing up demand for commercially harvested plant parts (Mbendana et al., 2019).
- Most drivers impact NTFPs unequally. For example, rising income has generally reduced reliance on thatch and building timber but not the demand for marula beer (Gaugris and van Rooyen, 2009; Mokgolodi et al., 2011).
- Interactions between drivers may exacerbate individual effects, such as weakening governance and increased commercialisation (Findlay and Twine, 2018).
- Positive feedback loops may occur between drivers, illustrated by the reinforcing processes of cultural change and loss of indigenous knowledge (Hlongwane et al., 2020).
- Beyond their direct effects on key determinants, some drivers can also influence others. For instance, climate change contributes to declining engagement in farming (Blair et al., 2018) and hence clearing of land for agriculture.
- These trends are not spatially uniform. The rate of field abandonment is a case in point, which varies substantially across the former apartheid homelands of South Africa (Shackleton et al., 2019).

These evolving contexts shaping NTFP use within the region necessitate a shift in NTFP research. First, the scarcity of longitudinal studies capturing these trends highlights the need for long-term data collection. This can be in the form of cohort studies designed to track individuals or households over time, or follow-up studies which revisit previous research sites using similar sampling and data collection methods (e.g. Falayi et al., 2019). Second, there is a need for more comparative studies across diverse contexts. Deeper understanding of the complex dynamics underway across the region is important for assessing sustainability of resource use. Third is the necessity to develop more hypothesis driven research with testable conceptual, dynamic and even quantitative models.

3. Conclusions

Based on our extensive experience in the NTFP sector and this review of the literature on NTFP use in southern Africa we can distill several core conclusions.

- There has been considerable research on NTFP use in southern Africa in relation to home consumption and income generation. The cultural significance of NTFP use has received markedly less attention.
- This research shows that whilst there are spatial and temporal shifts, NTFP use is highly resilient, driven by cultural, spiritual, traditional and income needs. This demands improved attention from local and national authorities in the management and conservation of NTFP stocks and biodiversity.
- Despite decades of research on NTFPs in southern Africa, it is still in its infancy, with an overwhelming focus on descriptive ethnobotanical surveys and inventories of NTFP species used by individual communities in different locations, usually at small spatial scales. There is very little research that has management relevance, develops conceptual and dynamic models of use and changes in use, or is based on hypothesis testing rather than simple description. The one exception to this is the hundreds of studies on screening for biomedical properties; nevertheless, very little of the biomedical screening has moved on to actual product development. Thus, there is a need to move beyond simplistic inventories towards conceptual and practical approaches to conserve NTFP species, the attendant knowledge of those species and the tangible and intangible benefits they provide to households and communities.
- We know very little about the ecology (habitat preferences, growth rates, yields, responses to harvesting and other stressors) of most individual NTFP species and hence the sustainability of their use. It is challenging to manage NTFPs sustainably in the absence of such knowledge. Given that there are thousands of NTFP species used in southern Africa, this is a daunting task. Therefore, priority should be given to the species where there is some evidence (qualitative or quantitative) of population declines, along with development of sustainability models by growth form that might be transferable between species to some extent.
- Since NTFPs are situated in multi-functional landscapes and use systems, sustainability is not just about supply and demand for the product. This is because NTFP populations are affected by a host of interacting factors such as fire, disease, drought, herbivory, climate change, invasive species, land use change, new or growing markets, efficacy of management institutions, and more. Consequently, population assessments must be regular and sensitive to changes in such interacting factors. Hence, there is a need for dynamic models, which, so far, are extremely rare in the research and management of NTFPs in southern Africa. Viewing NTFP use and management as part of complex adaptive systems could provide the necessary framework to move beyond simplistic surveys of species used. This would also support and drive methodological pluralism; currently many studies adopt either qualitative or quantitative approaches, with a minority that engage in mixed-methods approaches.
- A key factor influencing the local-level sustainability of NTFP use is the efficacy of local management and governance institutions. There is strong evidence that local governance of NTFPs is weak or nonexistent throughout much of the region, perhaps being most dismal in South Africa. There is a dire need for empowerment of community-based and traditional institutions.
- There are only a handful of longitudinal studies on NTFP use in southern Africa. This complicates understanding of broader-scale trajectories of change, and hence possible policy responses. Whilst there have certainly been changes in the extent or species of NTFPs used at local-scales, as yet there is no evidence of declines in NTFP use and reliance at national scales, despite changes in macro-contexts (such as in poverty levels, urbanisation rates and formal education levels).
- Indeed, a pervasive change seen throughout southern Africa is the increasing commercialisation of NTFPs. This is evident within both local markets in villages and towns, as well as more export-driven markets for higher value products. Whilst commercialisation provides employment and incomes for increasing numbers of people, it has been implicated in unsustainable harvesting practices of several species (e.g. *A. cordifolia, Cyclopia intermedia, Pelargonium sidoides, W. salutaris*). Consequently, commercialisation, especially for export markets, needs to be accompanied by adequate sustainability planning and monitoring.

Whilst we know that there is much use of NTFPs in southern Africa for cultural uses and needs, it is relatively understudied compared to the consumptive and trade uses. However, cultural uses and perspectives endure despite changes in macro-contexts and hence it is vital they are understood for development of appropriate and responsive policies and management strategies.

CRediT authorship contribution statement

Shackleton CM: Writing – review & editing, Writing – original draft, Resources, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Cocks ML:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Maroyi A:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Ntshanga N:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization. **Twine WC:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors confirm that they have no conflicts of interest in relation to the research reported in the paper.

Acknowledgments

The development of this paper was made possible with funding via the South African Research Chairs Initiative of the Dept. of Science and Innovation and the National Research Foundation (NRF) of South Africa (Grant No 84379). Any opinion, finding, conclusion, or recommendation expressed in this material is that of the authors and NRF does not accept any liability in this regard.

References

Adam, Y.O., Shackleton, C.M., 2016. Distribution and use of cash income from basket and mat crafting: implications for rural livelihoods in the Eastern Cape, South Africa. For. Trees Livelihoods 25, 199–211.
Adekola, O., Morardet, S., de Groot, R.D., Grelot, F., 2012. Contribution of provisioning services of the Ga-Mampa wetland, South Africa, to local livelihoods. Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. 8, 248–264.
Ah Goo, D.F., De Wit, A.H., 2015. The role of the informal trade in medicinal plants in sustaining livelihoods: a case study of the Nelson Mandela Bay Municipality, South Africa. S. Afr. Geogr. J. 97, 69–82.
Allen, J.A., Pimentel, D.P., Lasoie, J.P., 1988. Fuelwood production and use in rural Swaziland: a case-study of two communities. For. Ecol. Manage 25, 239–254.
Banks, D.J., Griffin, N.J., Shackleton, C.M., Shackleton, S.E., Mavrandonis, J.M., 1996. Wood supply and demand around two rural settlements in a semi-arid savanna, South Africa. Biomass Bioenergy 11, 319–331.
Barnes, J.I., MacGregor, J.J., Nhuleipo, O., Muteyauli, P.I., 2010. The value of Namibia's forest resources: preliminary economic asset and flow accounts. Dev. South. Afr. 27, 159–176.
Baumert, S., Luz, A.C., Fisher, J., Vollmer, F., Ryan, C.M., Patenaude, G., Zorrilla-Miras, P., Artur, L., Nhantumbo, I., Macqueen, D., 2016. Charcoal supply chains from Mabalane to Maputo: who benefits? Energy. Sustain. Dev. 33, 129–138.
Blair, D., Shackleton, C.M., Mograbi, P.J., 2018. Cropland abandonment in South African smallholder communal lands: land cover change (1950–2010) and farmer perceptions of contributing factors. Land. (Basel) 7, 121.
Blokker, T., Bek, D., Binns, T., 2015. Wildflower harvesting on the Agulhas Plain, South Africa: challenges in a fragmented industry. S. Afr. J. Sci. 111 (11–12), 1–7.
Braedt, O., Schroeder, J.M., 2003. Institutions governing the use of forest products: woodcraft commercialisation in southern Zimbabwe. For. Trees Livelihoods 13 (1), 59–78.
Brouwer, R., Falcão, M.P., 2004. Wood fuel consumption in Maputo, Mozambique. Biomass Bioenergy 27, 233–245.
Bruschi, P., Mancini, M., Mattioli, E., Morganti, M., Signorini, M.A., 2014. Traditional uses of plants in a rural community of Mozambique and possible links with Miombo degradation and harvesting sustainability. J. Ethnobiol. Ethnomed 10, 1–22.
Campbell, B.M., Luckert, M.K., Scoones, I., 1997. Local-level valuation of savanna resources: a case study from Zimbabwe. Econ. Bot. 51, 59–77.
CEPF (Critical Ecosystems Partnership Fund), 2025. undated. Biodiversity hotspots defined https://www.cepf.net/our-work/biodiversity-hotspots/hotspotsdefined#:~:text=The%2036%20biodiversity%20hotspots%20are,their%20livelihood%20and%20well%2Dbeing. [accessed 10 June 2025].
Chagumaira, C., Rurinda, J., Nezomba, H., Mtambanengwe, F., Mapfumo, P., 2016. Use patterns of natural resources supporting livelihoods of smallholder communities and implications for climate change adaptation in Zimbabwe. Environ. Dev. Sustain. 18, 237–255.
Chauke, S., Shelembe, B.G., Otang-Mbeng, W., Ndhlovu, P.T., 2024. Ethnobotanical appraisal of wild fruit species used in Mpumalanga Province, South Africa: a systematic review. S. Afr. J. Bot. 171, 602–633.
Chicombo, A.F., Musango, J.K., 2024. Examining urban household energy consumption patterns in Mozambique through a gendered lens. Energy. Res. Soc. Sci. 112, 103501.
Cocks, M.L., Dold, A.P., 2004. A new broom sweeps clean: the economic and cultural value of grass brooms in the Eastern Cape province, South Africa. For. Trees Livelihoods 14, 33–42.
Cocks, M.L., Dold, A.P., 2006. Cultural significance of biodiversity: the role of medicinal plants in urban African cultural practices in the Eastern Cape, South Africa. J. Ethnobiol 26, 60–81.
Cocks, M.L., Wiersum, F., 2003. The significance of plant diversity to rural households in Eastern Cape province of South Africa. For. Trees Livelihoods 13, 39–58.
Cornelius, S.F., van Wyk, B.-E., 2024. An updated inventory of medicinal and ritual plants in southern Africa. J. Ethnopharmacol 332 (5), 118361.
Cornelius, S.F., van Wyk, B.-E., 2025. Diversity and dynamics of southern African medicinal and ritual plant use. S. Afr. J. Bot. 178, 340–347.
Cunningham, A.B., 1990. The regional distribution, marketing and economic value of the palm wine trade in the Ingwavuma district, Natal, South Africa. S. Afr. J. Bot. 56, 191–198.
Dalu, M.T., Gunter, A.W., Makatu, M., Dowo, G.M., Dondofema, F., Dalu, T., 2021. Contribution of natural forest products to rural livelihoods at Mavunde and Sambandou Villages, Vhembe Biosphere Reserve, South Africa. Sustainability 13 (8), 4252.
De Mello, N.G., Gulinck, H., van den Broeck, P., Parra, C., 2020. Social-ecological sustainability of non-timber forest products: a review and theoretical considerations for future research. For. Policy Econ. 112, 102109.
Demotts, R., 2017. Weaving a living: gender, craft, and sustainable resource use in Botswana. J. Polit. Ecol. 24, 368–385.
Derebe, B., Alemu, A., Asfaw, Z., 2023. Contribution of nontimber forest products earn to livelihood in rural households and the type of use: a systematic review. Intern. J. For. Res. 2023, 9643290.
Dovie, D.B., 2003. Rural economy and livelihoods from the non-timber forest products trade. Compromising sustainability in southern Africa? Int. J. Sustain. Dev. World Ecol. 10, 247–262.
Dovie, D.B., Shackleton, C.M., Witkowski, E.T., 2002. Direct-use values of woodland resources consumed and traded in a South African village. Int. J. Sustain. Dev. World Ecol. 9, 269–283.
Dovie, D.B., Shackleton, C.M., Witkowski, E.T., 2007. Conceptualising the human use of wild edible herbs for conservation in South African communal lands. J. Env., Manage 84, 146–156.
Dovie, D.B., Witkowski, E.T., Shackleton, C.M., 2005. Monetary valuation of livelihoods for understanding the composition and complexity of rural households. Agric. Hum. Values 22, 87–103.
Dovie, D.B., Witkowski, E.T., Shackleton, C.M., 2008. Knowledge of plant resource use based on location, gender and generation. Appl. Geogr. 28, 311–322.
Dzerefos, C.M., Shackleton, C.M., Witkowski, E.T., 1999. Sustainable utilisation of woodrose-producing mistletoes (*Loranthaceae*) in South Africa. Econ. Bot. 53, 439–447.
Emanuel, P.L., Shackleton, C.M., Baxter, J.S., 2005. Modelling the sustainable harvest of *sclerocarya birrea* subsp. *Caffra* fruits in the South African lowveld. For. Ecol. Manage. 214, 91–103.
Fadiman, M., 2008. Starvation taught me art": tree poaching, gender and cultural shifts in wood curio carving in Zimbabwe. Ethnobot. Res. Appl. 6, 335–346.
Falayi, M., Shackleton, S.E., Cundill, G., Shackleton, C.M., 2019. Changes in the use and sale of local collected environmental resources over a 15-year period in a rural village, South Africa. For. Trees Livelihoods 28, 90–107.
Findlay, S.J., Twine, W.C., 2018. Chiefs in a democracy: a case study of the 'new' systems of regulating firewood harvesting in post-apartheid South Africa. Land. (Basel) 7, 35.
Foote, A.L., Krogman, N.T., Grundy, I.M., Nemarundwe, N., Campbell, B.M., Gambiza, J., Gibbs, L., 2003. Ilala palm (*Hyphaene petersiana*) use in southern Zimbabwe: social and ecological factors influencing sustainability. For. Trees Livelihoods 13, 275–296.
Garekae, H., Lepetu, J., Thakadu, O.T., 2020. Forest resource utilisation and rural livelihoods: insights from Chobe Enclave, Botswana. S. Afr. Geogr. J. 102, 22–40.
Garekae, H., Shackleton, C.M., 2020. Urban foraging of wild plants in two medium-sized South African towns: people, perceptions and practices. Urban For. Urban Green. 49, 126581.
Gaugris, J.Y., van Rooyen, M.W., 2009. Evaluating patterns of wood use for building construction in Maputaland, South Africa. Afr. J. Wildl. Res. 39, 85–86.
Geldenhuys, C.J., 1999. Requirements for improved and sustainable use of forest biodiversity: examples of multiple use forest in South Africa. In: Poker, J., Stein, I., Werder, U. (Eds.), Proceedings Forum Biodiversity Treasures in the World's Forests. Alfred Toepfer Akademie: Schneverdingen, Germany, pp. 72–82, 1999.
Gelfand, M., Drummond, R.B., Mavi, S., Ndemera, B., 1985. The Traditional Medical Practitioner in Zimbabwe: His Principles of Practice and Pharmacopoeia. Mambo Press, Gweru.
Groner, V.P., Nicholas, O., Mabhaudhi, T., Slotow, R., Akçakaya, H.R., Mace, G.M., Pearson, R.G., 2022. Climate change, land cover change, and overharvesting threaten a widely used medicinal plant in South Africa. Ecol. Appl. 34, e2545.

Guerbois, C., Fritz, H., 2017. Patterns and perceived sustainability of provisioning ecosystems services on the edge of a protected area in times of crisis. Ecosyst. Serv. 28, 196–206.
Gugushe, N., Grundy, I., Theron, F., Chirwa, P., 2008. Perceptions of forest resource use and management in two village communities in the Eastern Cape province, South Africa. South. For. 70, 247–254.
Guild, J., Shackleton, C.M., 2018. Informal urban fuelwood markets in South Africa in the context of socio-economic change. Energy Policy 117, 136–141.
Gyan, C.A., Shackleton, C.M., 2005. Abundance and commercialization of *Phoenix reclinata* in the King Williamstown area, South Africa. J. Trop. For. Sci. 17, 334–345.
Hainduwa, F.N., Ham, C., Meincken, M., 2016. Impact of fuelwood quality and quantity on the energy use of rural households in the Omusati Region, north-central Namibia. South. For. 78, 299–306.
Herd-Hoare, S., Shackleton, C.M., 2022. The use and value of wild harvested provisioning ecosystem services along a landscape heterogeneity gradient in rural South Africa. Ecosyst. People 18, 616–629.
Hlongwane, Z., Slotow, R., Munyai, T.C., 2020. Indigenous knowledge about consumption of edible insects in South Africa. Insects 12 (1), 22.
Kamwi, J.M., Endjala, J., Siyambango, N., 2020. Dependency of rural communities on non-timber forest products in the dry lands of southern Africa: a case of Mukwe Constituency, Kavango East Region, Namibia. Trees For. People 2, 100022.
Kaoma, H., Shackleton, C.M., 2014. Collection of urban tree products by households in poorer residential areas of three South African towns. Urban For. Urban Green. 13, 244–252.
Kaoma, H., Shackleton, C.M., 2015. The direct use value of urban tree non-timber forest products to household income in poorer suburbs in South African towns. For. Policy Econ. 61, 104–112.
Konstant, T.L., Sullivan, S., Cunningham, A.B., 1995. The effects of utilization by people and livestock on *Hyphaene petersiana* (Arecaceae) basketry resources in the palm savanna of North-Central Namibia. Econ. Bot. 49, 345–356.
Kotze, D.C., Traynor, C.H., 2011. Wetland plant species used for craft production in Kwazulu-Natal, South Africa: ethnobotanical knowledge and environmental sustainability. Econ. Bot. 65, 271–282.
Krauss, J.E., Artur, L., Brockington, D., Castro, E., Fernando, J., Fisher, J., Kingman, A., Moises, H.M., Mlambo, A., Nuvunga, M., Pritchard, R., Ribeiro, N., Ryan, C.M., Tembe, J., Zimudzi, C., 2022. To prevent this disease, we have to stay at home, but if we stay at home, we die of hunger': livelihoods, vulnerability and coping with Covid-19 in rural Mozambique. World Dev. 151, 105757.
Letšela, T., 2003. Plant resources used for subsistence in Tsehlanyane and Bokong in Lesotho. Econ. Bot. 57, 619–639.
Letšela, T., Witkowski, E., Balkwill, K., 2002. Direct use values of communal resources in Bokong and Tsehlanyane in Lesotho: whither the commons? Int. J. Sustain. Dev. World Ecol. 9, 351–368.
Lewu, F.B., Mavengahama, S., 2011. Utilization of wild vegetables in four districts of northern KwaZulu-Natal Province, South Africa. Afr. J. Agric. Res. 6, 4159–4165.
Liengme, C.A., 1981. Plants used by the Tsonga people of Gazankulu. Bothalia 13, 501–518.
Liengme, C.A., 1983. A study of wood use for fuel and building in an area of Gazankulu. Bothalia 14, 245–257.
Mabuku, M.P., Senzanje, A., Mudhara, M., Jewitt, G.P., Mulwafu, W.O., 2019. strategies for coping and adapting to flooding and their determinants: a comparative study of cases from Namibia and Zambia. Phys. Chem. Earth 111, 20–34.
Madubansi, M., Shackleton, C.M., 2006. Changing energy profiles and consumption patterns following electrification in five rural villages, South Africa. Energy Policy 34, 4081–4092.
Madubansi, M., Shackleton, C.M., 2007. Changes in fuelwood use and species selection following electrification in the Bushbuckridge lowveld, South Africa. J. Env. Manage. 83, 416–426.
Magry, M.A., Cahill, D., Rookes, J., Narula, S.A., 2024. Non-timber forest products: evolution, development and research. Biodiversity 25, 120–141.
Magwede, K., van Wyk, B.E., van Wyk, A.E., 2019. An inventory of Vhaveṇḓa useful plants. S. Afr. J. Bot. 122, 57–89.
Makhado, R.A., Von Maltitz, G.P., Potgieter, M.J., Wessels, D.C., 2009. Contribution of woodland products to rural livelihoods in the northeast of Limpopo Province, South Africa. S. Afr. Geogr. J. 91, 46–53.
Mander, M., 1998. Marketing of Indigenous Medicinal Plants in South Africa. A case Study in KwaZulu-Natal. Food and Agricultural Organization of the United Nations, Rome.
Mander, M., Ntuli, L., Diederichs, N., Mavundla, K., 2007. Economics of the traditional medicine trade in South Africa. In: Harrison, S., Bhana, R., Ntuli, A. (Eds.), South African Health Review. Health Systems Trust. Durban. http://www.hst.org.za/uploads/files/chap13_07.pdf.
Maroyi, A., 2013. Use of weeds as traditional vegetables in Shurugwi District, Zimbabwe. J. Ethnobiol. Ethnomed. 9 (1), 60.
Maroyi, A., 2014. Traditional and medicinal uses of essential oil producing tree *Sclerocarya birrea* in South-Central Zimbabwe. J. Essent. Oil Bear. Plants 17, 776–786.
Martins, A.R., Shackleton, C.M., 2017. Abundance, population structure and harvesting selection of two palm species (*Hyphaene coriacea* and *Phoenix reclinata*) in Zitundo area, southern Mozambique. For. Ecol. Manage. 398, 64–74.
Martins, A.R., Shackleton, C.M., 2018. The production and commercialisation of palm wine from *Hyphaene coriacea* and *Phoenix reclinata* in Zitundo area, southern Mozambique. S. Afr. J. Bot. 116, 6–15.
Martins, A.R., Shackleton, C.M., 2021. Local use and knowledge of *hyphaene coriacea* and *phoenix reclinata* in Zitundo area, southern Mozambique. S. Afr. J. Bot. 138, 65–75.
Martins, A.R., Shackleton, C.M., 2022. The contribution of wild palms to the livelihoods and diversification of rural households in southern Mozambique. For. Policy Econ. 142, 102793.
Matsika, R., Erasmus, B.F.N., Twine, W.C., 2013. Double jeopardy: the dichotomy of fuelwood use in rural South Africa. Energy Policy 52, 716–725.
Mbaiwa, J., 2011. Changes on traditional livelihood activities and lifestyles caused by tourism development in the Okavango Delta. Tour. Manage. 32, 1050–1060.
Mbendana, D., Mamabolo, K., Truter, M., Kritzinger, Q., Ndhlala, A.R., 2019. Practices at herbal (muthi) markets in Gauteng, South Africa and their impact on the health of the consumers: a case study of KwaMai-Mai and Marabastad muthi markets. S. Afr. J. Bot. 126, 30–39.
McGregor, J., 1995. Gathered produce in Zimbabwe's communal areas: changing resource availability and use. Ecol. Food. Nutr. 33, 163–193.
McKean, S.G., 2001. Productivity and sustainable use of phragmites in the Fuyeni reedbed — Hluhluwe-Umfolozi Park: management guidelines for harvest. S. Afr. J. Bot. 67, 274–280.
Mithöfer, D., Waibel, H., 2003. Income and labour productivity of collection and use of indigenous fruit tree products in Zimbabwe. Agrofor. Syst. 59, 295–305.
Mjoli, N., Shackleton, C., 2015. The trade in and household use of *Phoenix reclinata* palm frond hand brushes on the wild coast, South Africa. Econ. Bot. 69, 218–229.
Mmopelwa, G., Blignaut, J.N., Hassan, R., 2009. Direct use values of selected vegetation resources in the Okavango Delta wetland. S. Afr. J. Econ. Manag. Sci. 12, 242–255.
Mogale, M.M., Raimondo, D.C., van Wyk, B.-E., 2019. The ethnobotany of central Sekhukhuneland, South Africa. S. Afr. J. Bot. 122, 90–119.
Mokgolodi, N.C., Ding, Y., Setshogo, M.P., Ma, C., Liu, Y., 2011. The importance of an indigenous tree to southern African communities with specific relevance to its domestication and commercialization: a case of the marula tree. For. Stud. China 13, 36–44.
Molapisi, M., Tselaesele, N., Makhabu, S., Bultosa, G., Haki, G.D., Kobue-Lekalake, R., SekwatiMonang, B., Seifu, E., Phakama, T., 2024. Plant-based traditional foods of Mogoditshane, Mmopane and Metsimotlhabe villages, Botswana: nutritional and bioactive compounds potential, processing, values, and challenges. Discov. Food 4 (1), 81.
Mooketsi, K., Gestring, W.D., 2011. General knowledge and utilisation of indigenous leafy vegetables by villagers in the Mafikeng area of South Africa. Life. Sci. J. 8, 74–79 suppl. 1.
Mphekgwana, P.M., Makgahlela, M., Mothiba, T.M., 2021. Use of traditional medicines to fight COVID-19 during the South African nationwide lockdown: a prevalence study among university students and academic staff. Open Public Health J. 14, 441–445.
Mugari, E., Masundire, H., Bolaane, M., New, M., 2019. Perceptions of ecosystem services provision performance in the face of climate change among communities in Bobirwa Sub-District. Int. J. Clim. Change Strateg. Manag. 11, 265–288.
Mugari, E., Nethengwe, N.S., Gumbo, A., 2024. The utilization and contribution of timber and non-timber forest products to livelihoods under a changing climate in the Limpopo River Basin. Environ. Res. Commun. 6.
Mugido, W., Shackleton, C.M., 2017a. The contribution of NTFPs trade to rural livelihoods in different agro-ecological zones of South Africa. Int. For. Rev. 19, 306–320.
Mugido, W., Shackleton, C.M., 2017b. The safety net-function of NTFPs in different agro-ecological zones of South Africa. Popul. Env. 39, 107–125.
Mugido, W., Shackleton, C.M., 2019. The contribution of NTFPS to rural livelihoods in different agro-ecological zones of South Africa. For. Policy Econ. 109, 101983.
Mulaudzi, T., Shackleton, C.M., 2025. Scaling the numbers of non-timber forests product species used from individual to household to village levels in northern South Africa. S. Afr. J. Bot. 184, 133–141.
Ncube, K., Shackleton, C.M., Swallow, B.M., Dassanayake, W., 2016. Impacts of HIV/AIDS on food consumption and wild food use in rural South Africa. Food. Secur. 8, 1135–1151.
Nesamvuni, C., Steyn, N.P., Potgieter, M.J., 2001. Nutritional value of wild, leafy plants consumed by the Vhavenda. S. Afr. J. Sci. 97, 51–54.
Ngorima, A., Shackleton, C.M., 2019. Livelihood benefits and costs from an invasive alien tree (*Acacia dealbata*) to rural communities in the Eastern Cape, South Africa. J. Env. Manage. 229, 158–165.
Njwaxu, A., Shackleton, C.M., 2019. The availability of non-timber forest products under forest succession on abandoned fields on the Wild Coast, South Africa. Forests 10, 1093.
Nott, M., Thondhlana, G., 2017. Fuelwood preferences, use and availability in the #Khomani San resettlement farms, southern Kalahari, South Africa. For. Trees Livelihoods 26, 156–169.
Nyanga, L.K., Nout, M.J., Gadaga, T.H., Boekhout, T., Zwietering, M.H., 2008. Traditional processing of masau fruits (*Ziziphus mauritiana*) in Zimbabwe. Ecol. Food Nutr. 47, 95–107.
O'Brien, E.M., Peters, C., 1998. Wild fruit trees and shrubs of southern Africa: geographic distribution of species richness. Econ. Bot. 52, 267–278.
Oelofse, A., van Averbeke, W., 2012. Nutritional value and water use of African leafy vegetables for improved livelihoods. Water. Res. Comm. https://www.wrc.org.za/wp-content/uploads/mdocs/TT%20535-12pdf#page=94.
Ogle, B.M., Grivetti, L.E., 1985a. Legacy of the chameleon: edible wild plants in the Kingdom of Swaziland, Southern Africa. A cultural, ecological, nutritional study. Part III - cultural and ecological analysis. Ecol. Food Nutr. 17, 31–40.
Ogle, B.M., Grivetti, L.E., 1985b. Legacy of the chameleon: edible wild plants in the Kingdom of Swaziland, Southern Africa. A cultural, ecological, nutritional study. Part II - demographics, species availability and dietary use, analysis by ecological zone. Ecol. Food Nutr. 17, 1–30.

Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., et al., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. PLoS. Med. 18, e1003583.
Paumgarten, F., Locatelli, B., Witkowski, E.T., 2018. Wild foods: safety net or poverty trap? A South African case study. Hum. Ecol. 46, 183–195.
Paumgarten, F., Shackleton, C.M., 2009. Wealth differentiation in household use and trade of non-timber forest products in South Africa. Ecol. Econ. 68, 2950–2959.
Pelane, G.L., Mulalu, M.I., Mmopelwa, G., Stone, M.T., 2021. Woodland extraction rate estimation in the savanna ecosystem (case study of Foley and Makomoto in central-east Botswana). Sustainability 13 (20), 11316.
Pereira, T., Shackleton, C., Shackleton, S., 2006. Trade in reed-based craft products in rural villages in the Eastern Cape, South Africa. Dev. South. Afr. 23, 477–495.
Pote, J., Shackleton, C.M., Cocks, M., Lubke, R., 2006. Fuelwood harvesting and selection in Valley Thicket, South Africa. J. Arid Env. 67, 270–287.
Pullanikkatil, D., Thondhlana, G., Shackleton, C.M., 2021. The cultural significance of plant-fibre crafts in southern Africa: a comparative study of Eswatini, Malawi, and Zimbabwe. For. Trees Livelihoods 30, 287–303.
Raimondo, D., Von Staden, L., Foden, W., Victor, J.E., Helme, N.A., Turner, R.C., Kamundi, D.A., Manyama, P.A., 2009a. Red List of South African plants. Strelitzia. 25. South African National Biodiversity Institute, Pretoria.
Rasethe, M.T., Semenya, S.S., Maroyi, A., 2019. Medicinal plants traded in informal herbal medicine markets of the Limpopo Province, South Africa. Evid.-based. Complement. Altern. Med., 2609532, 2019.
Rasethe, M.T., Semenya, S.S., Potgieter, M.J., Maroyi, A., 2013. The utilization and management of plant resources in rural areas of the Limpopo Province, South Africa. J. Ethnobiol. Ethnomed. 9, 1–8.
Ruwanza, S., Shackleton, C.M., 2015. Density and regrowth of a forest restio (*Ischyrolepis eleocharis*) under harvest and non-harvest treatments in dune forests of Eastern Cape Province, South Africa. Econ. Bot. 69, 136–149.
Ruwanza, S., Thondhlana, G., 2022. People's perceptions and uses of invasive plant Psidium guajava in Vhembe Biosphere Reserve, Limpopo Province of South Africa. Ecosyst. People 18, 64–75.
Sampaio, M.B., dos Santos, F.A., 2015. Harvesting of palm fruits can be ecologically sustainable.: a case of buriti (Mauritia flexuosa Arecaceae) in central Brazil. In: Shackleton, C.M., Ticktin, T., Pandey, A. (Eds.), Ecological Sustainability For Non-Timber Forest products: Dynamics and Case Studies of Harvesting. Earthscan, London, pp. 73–89.
SANBI (South African National Biodiversity Institute) 2010. Red list of South African plants. redlist.sanbi.org.
Sardeshpande, M., Shackleton, C.M., 2020. Fruits of the veld: geographic and socioeconomic patterns of use of wild edible fruits, foods and non-timber forest products. Hum. Ecol. 48, 665–677.
Sardeshpande, M., Shackleton, C.M., 2023. Fruits in the city: the nature, nurture, and future of urban foraging. People Nat. 5, 213–227.
Schlesinger, J., Drescher, A., Shackleton, C.M., 2015. Socio-spatial dynamics in the use of wild natural resources: evidence from six rapidly growing medium-sized cities in Africa. Appl. Geogr. 56, 107–115.
Semenya, S., Maroyi, A., 2020. Assessment of useful alien plant species cultivated and managed in rural home gardens of Limpopo Province, South Africa. Scientifica 1, 3561306.
Shackleton, C., 1996. Potential stimulation of local rural economies by harvesting secondary products: a case study of the central Transvaal Lowveld, South Africa. Ambio 25, 33–38.
Shackleton, C.M., 2003. The prevalence of use and value of wild edible herbs in South Africa. S. Afr. J. Sci. 99, 23–25.
Shackleton, C.M., 2015. Non-timber forest products in livelihoods. In: Shackleton, C.M., Pandey, A., Ticktin, T. (Eds.), The Ecological Sustainability For Non-Timber Forest products: Dynamics and Case Studies of Harvesting. Earthscan, London, pp. 12–30.
Shackleton, C.M., de Vos, A., 2022. How many people globally actually use non-timber forest products? For. Policy Econ. 135, 102659.
Shackleton, C.M., Delang, C., Shackleton, S.E., Shanley, P., 2011. Non-timber forest products: concept and definition. In: Shackleton, S.E., Shackleton, C.M., Shanley, P. (Eds.), Non-timber Forest Products in the Global Context. Springer, Heidelberg, pp. 3–21.
Shackleton, C.M., Mograbi, P., Drimie, S., Fay, D., Hebinck, P., Hoffman, M.T., Maciejewski, K., Twine, W., 2019. Deactivation of field cultivation in communal areas of South Africa: patterns, drivers and socio-economic and ecological consequences. Land Use Policy 82, 686–699.
Shackleton, C.M., Parkin, F., Chauke, M.L., Downsborough, L., Olsen, A., Brill, G., Weideman, C., 2009. Conservation, commercialisation and confusion: harvesting of *Ischyrolepis* in a coastal forest, South Africa. Environ. Dev. Sustain. 11, 229–240.
Shackleton, C.M., Shackleton, S.E., 2000. Direct use values of savanna resources harvested from communal savannas in the Bushbuckridge lowveld, South Africa. J. Trop. For. Prod. 6, 21–40.
Shackleton, C., Shackleton, S., 2004a. The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. S. Afr. J. Sci. 100, 658–664.
Shackleton, C.M., Shackleton, S.E., 2006. Household wealth status and natural resource use in the Kat River Valley, South Africa. Ecol. Econ. 57, 306–317.
Shackleton, C.M., Shackleton, S.E., Buiten, E., Bird, N., 2007. The importance of dry forests and woodlands in rural livelihoods and poverty alleviation in South Africa. For. Policy Econ. 9, 558–577.
Shackleton, C.M., Sinasson Sanni, G., Adeyemi, O., Martins, V., 2022. Fuelwood in South Africa revisited: widespread use in a policy vacuum. Sustainability 14, 11018.
Shackleton, C.M., Ticktin, T., Cunningham, A.B., 2018. Nontimber forest products as ecological and biocultural keystone species. Ecol. Soc. 23 (4), 22.
Shackleton, R.T., 2020. Loss of land and livelihoods from mining operations: a case in the Limpopo Province, South Africa. Land Use Policy 99, 104825.
Shackleton, S., 2004b. Livelihood benefits from the local level commercialization of savanna resources: a case study of the new and expanding trade in marula (*Sclerocarya birrea*) beer in Bushbuckridge, South Africa. S. Afr. J. Sci. 100, 651–657.
Shackleton, S.E., Campbell, B.M., 2007. The traditional broom trade in Bushbuckridge, South Africa: helping poor women cope with adversity. Econ. Bot 61, 256–268.
Shackleton, S.E., Campbell, B., Lotz-Sisitka, H., Shackleton, C.M., 2008. Links between the local trade in natural products, livelihoods and poverty alleviation in a semi-arid region of South Africa. World Dev. 36, 505–526.
Shackleton, S.E., Shackleton, C.M., 2005. The contribution of marula fruits and fruit products to rural livelihoods in the Bushbuckridge district, South Africa: balancing domestic needs and commercialisation. For. Trees Livelihoods 15, 3–24.
Shackleton, S.E., Shackleton, C.M., Dzerefos, C.M., Mathabela, F.R., 1998. Use and trading of wild edible herbs in the central lowveld savanna region, South Africa. Econ. Bot. 52, 251–259.
Shackleton, S.E., Shackleton, C.M., Netshiluvhi, T.R., Geach, B.S., Balance, A., Fairbanks, D.H., 2002. Use patterns and value of savanna resources in three rural villages in South Africa. Econ. Bot 56, 130–146.
Shopo, B., Mapaya, R.J., Maroyi, A., 2022. The traditional uses of plant diversity in Gokwe South District, Zimbabwe: timber and construction, ethnoveterinary medicine, firewood and charcoal, food, tools and handicraft, religious ceremonies and rituals and other uses. Ethnobot. Res. Appl. 24, 21–23.
Sitoe, E., van Wyk, B.-E., 2024. An inventory and analysis of the medicinal plants of Mozambique. J. Ethnopharmacol 319, 117137.
Smith, H.E., Jones, D., Vollmer, F., Baumert, S., Ryan, C.M., Woollen, E., Lisboa, S.N., Carvalho, M., Fisher, J.A., Luz, A.C., Grundy, I.M., Patenaude, G., 2019. Urban energy transitions and rural income generation: sustainable opportunities for rural development through charcoal production. World Dev. 113, 237–245.
Sola, P., Cerutti, P.O., Zhou, W., Gautier, D., Iiyama, M., Schure, J., Chenevoy, A., Yila, J., Dufe, V., Nasi, R., Petrokofsky, G., Shepherd, G., 2017. The environmental, socioeconomic, and health impacts of woodfuel value chains in Sub-Saharan Africa: a systematic map. Environ. Evid. 6 (1), 4.
Sola, P., Edwards-Jones, G., Gambiza, J., 2006. Impacts of leaf harvesting and sap tapping on the ivory palm (*Hyphaene petersiana*) in south eastern Zimbabwe. For. Trees Livelihoods 16, 381–395.
Standa-Gunda, W., Bond, I., Campbell, B.M., Petheram, L., 2007. Exploring woodcarving markets to determine the potential of fiscal instruments for improving woodland management: the case of woodcarving in Southern Zimbabwe. For. Trees Livelihoods 17, 61–73.
Stanley, D., Voeks, R., Short, L., 2012. Is non-timber forest product harvest sustainable in the less developed world? A systematic review of the recent economic and ecological literature. Ethnobiol. Conserv. 1, 9.
Ticktin, T., 2004. The ecological implications of harvesting non-timber forest products. J. Appl. Ecol. 41, 11–21.
Ticktin, T., 2015. The ecological sustainability of non-timber forest product harvest: principles and methods. In: Shackleton, C.M., Pandey, A.K., Ticktin, T. (Eds.), Ecological Sustainability For Non-Timber Forest products: Dynamics and Case Studies of Harvesting. Earthscan, London, pp. 31–52.
Towns, A., Shackleton, C.M., 2018. Traditional, indigenous or leafy? A definition, typology, and way forward for African vegetables. Econ. Bot. 72, 461–477.
Traynor, C., 2008. *Juncus kraussii* harvesting in Umlalazi Nature Reserve, KwaZulu-Natal, South Africa: socio-economic aspects and sustainability. Afr. J. Aquat. Sci. 33, 27–36.
Tselaesele, N., Bultosa, G., Molapisi, M., Makhabu, S., Kobue-Lekalake, R., Haki, G.D., 2023. Plant-based traditional foods and beverages of Gumare Village. Botsw. Food Prod. Process. Nutr. 5, 1–26.
Tshisikhawe, M.P., Siaga, N.M., Bhat, R.B., 2011. Population dynamics of *Millettia stuhlmannii* Taub in Ha-Makhuvha, Vhembe district of Limpopo province, South Africa. Phyton 80, 127–132.
Twine, W., Moshe, D., Netshiluvhi, T., Siphugu, V., 2003. Consumption and direct-use values of savanna bio-resources used by rural households in Mametja, a semi-arid area of Limpopo province, South Africa. S. Afr. J. Sci. 99, 467–473.
Twine, W.C., Holdo, R.M., 2016. Fuelwood sustainability revisited: integrating size structure and resprouting into a spatially realistic fuelshed model. J. Appl. Ecol. 53, 1766–1776.
Uhunamure, S.E., Nethengwe, N.S., Musyoki, A., 2017. Driving forces for fuelwood use in households in the Thulamela municipality, South Africa. J. Energy South. Afr. 28 (1), 25.
Venter, S.M., Witkowski, E.T., 2013. Fruits of our labour: contribution of commercial baobab (*Adansonia digitata* L.) fruit harvesting to the livelihoods of marginalized people in northern Venda, South Africa. Agrofor. Syst. 87, 159–172.
Vermeulen, S.J., Campbell, B.M., Mangono, J.J., 2000. Shifting patterns of fuel and wood use by households in rural Zimbabwe. Energy Environ. 11, 233–254.
Vermeulen, S.J., Campbell, B.M., Matzke, G.E., 1996. The consumption of wood by rural households in Gokwe Communal Area. Hum. Ecol. 24, 479–491.
Welcome, A.K., van Wyk, B.-E., 2019. An inventory and analysis of the food plants of southern Africa. S. Afr. J. Bot. 122, 136–179.
Wessels, C., Merow, C., Trisos, C.H., 2021. Climate change risk to southern African wild food plants. Reg. Env. Change 21, 29.
Weyer, D., Shackleton, C.M., Adam, Y.O., 2018. HIV/AIDS and other household shocks as catalysts of local commercialisation of non-timber forest products. Dev. Policy Rev. 36, O285–O301.
Williams, V.L., Victor, J.E., Crouch, N.R., 2013. Red listed medicinal plants of South Africa: status, trends, and assessment challenges. S. Afr. J. Bot. 86, 23–35.

Williams, V.L., Wojtasik, E.M., Byrne, M.J., 2021. A chronicle of alien medicinal plants used as traditional medicine in South Africa, and their status as invasive species. S. Afr. J. Bot. 142, 63–72.
Woittiez, L.S., Rufino, M.C., Giller, K.E., Mapfumo, P., 2013. The use of woodland products to cope with climate variability in communal areas in Zimbabwe. Ecol. Soc. 18, 4.
Woollen, E., Ryan, C., Grundy, I., Baumert, S., Vollmer, F., Fernando, J., Luz, A., Ribeiro, N., Fisher, J., Lisboa, S.N., 2016. Charcoal production in the Mopane woodlands of Mozambique: what are the tradeoffs with other ecosystem services? Philos. Trans. R. Soc. B-Biol. Sci. 371, 20150315.
Wynberg, R., van Niekerk, J., 2014. Governance, equity and sustainability in non-timber forest product value chains. In: Wynberg, R., Sowman, M. (Eds.), Governance For Justice and Environmental sustainability: Lessons Across Natural Resource Sectors in Sub-Saharan Africa. Earthscan/Routledge, pp. 279–304.
Yessoufou, K., Ambani, A.E., Elansary, H.O., El-Sabrout, A.M., Shokralla, S., 2022. Time, mediated through plant versatility, is a better predictor of medicinal status of alien plants. Divers. (Basel) 14, 286.
Zulu, S.S., Ngidi, M., Ojo, T., Hlatshwayo, S.I., 2022. Determinants of consumers' acceptance of indigenous leafy vegetables in Limpopo and Mpumalanga provinces of South Africa. J. Ethn. Foods 9 (1), 13.