



Current perspectives on an emerging formal natural products sector in South Africa

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ABSTRACT

Indigenous medical plants contribute significantly to a large South African population as part of a long-standing healthcare system intimately linked to folklore and for livelihood security. For the economically marginalized, access to such plants is largely through herbal markets which are part of an informal economy. Otherwise the formal natural products economy services those with a better socio-economic standing. Recently, the latter has experienced tremendous growth which largely mirrors the global cultural trend for organic naturopathies. Commercialisation of traditional plants and their contribution to the cosmeceutical, nutraceutical and pharmaceutical industries locally and abroad is reviewed. Traditional plant knowledge of southern African people is a source of inspiration for new product development. Concomitantly, an upsurge in research activities emanating from South Africa which confirms the pharmacological efficacy of these plants is fuelling a greater trust in indigenous flora. The escalating consumption of ethnomedicinals as highly valued commodities not only presents South Africa with socio-economic opportunities but also with challenges. Sustainable utilization benefiting the commodification of ethnobotanicals, plus meeting aims of poverty alleviation and people empowerment, is a new paradigm in South Africa. The future sustainability of local ecosystems depends upon scientific conservation management practices that recognize the importance of involving local communities. Conservationists should remain aware and sensitive of socio-cultural dynamics within communities in order to manage natural resources.

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1. Introduction

There has been a cultural renaissance globally, particularly amongst developed countries, towards more natural methods of healing. As alternative and complimentary medicines in Western settings continue to gain popularity (62% of Americans used Complimentary and Alternative Medicines (CAM) therapies in 2002 contributing to a US\$ 20 billion industry), the use of traditional plant-based remedies remains entrenched in the healing practices of developing countries. This is exemplified by the pluralization of these regimes within the federal health systems in China (Traditional Chinese Medicine or TCM) and Ayurveda in India (Barnes et al., 2002). Similarly, the reliance upon herbal medicines by communities of African descent estimated at 75% by the World Health Organization (Dubey et al., 2004) continues a long-standing healthcare system intimately linked to folklore which serves as the primary source of healthcare in South Africa. The trade of indigenous

medicinal plant parts contributes to both the informal economy and the emerging more formal natural products industry. Research on traditional plants using multi-dimensional approaches emanating from national and international research institutions focused on South Africa has led to the development of several marketed phyto-medicinal products (Table 1). This is evidenced by an increasing body of scientific literature on the use and properties of medicinally important southern African plants (for details refer to: Liengme, 1983; Cunningham, 1988, 1989; Cunningham et al., 1992a,b; Van Wyk et al., 1997; Van Wyk and Gericke, 2000; Van Wyk, 2002; Fennell et al., 2004a,b; Light et al., 2005; Diederichs, 2006). The traditional medicinal plant research foci in the country are broad, serving not only to highlight the significance of medical plants to human communities but also to validate their pharmacological activity, coupled with an intention for drug discovery. Furthermore, South African researchers understand the urgency to 'systematically document indigenous knowledge' before it is 'irretrievably lost to future generations' as rightly cautioned by Van Wyk (2002).

South Africa has largely mirrored the paradigm shift towards CAM in developed countries serving a diverse range of consumers. To clarify, alternative medicine is an umbrella term referring to a

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Table 1
Indigenous South African phytomedicinals used in the formal natural products sector

Plant species	Plant part(s)	Formulation type	Geographical distribution	Therapeutical claim
<i>Agapanthus africanus</i> (L.) Hoffmanns.	Flowers	Flower essence	WC; Endemic	Spiritual and aromatherapy
<i>Agathosma betulina</i> (P.J.Bergius) Pillans <i>Agathosma crenulata</i> (L.) Pillans	Leaves and stems	Tincture, tablets, oil, loose and ground sachets	WC; Endemic	Diuretic (weight loss) and urinary tract health
<i>Aloe ferox</i> Mill.	Leaves	Tincture, health drinks, tablets, cosmetic preparations	KZN, L, WC, EC	Stomach complaints, diuretic, cosmetics
<i>Artemisia afra</i> Jacq. ex Willd.	Leaves and stems	Tincture, oil, loose and ground sachets,	N, B, LIM, NW, G, M, S, FS, KZN, L, WC,	Colds and influenza, aromatherapy
<i>Aspalathus linearis</i> (Burm.f.) R.Dahlgren	Leaves and stems	Food products, cosmetic preparations	WC; Endemic	Anti-oxidant
<i>Clivia miniata</i> (Lindl.) Regel var <i>miniata</i>	Flowers and roots	Flower essence	M, S, KZN, EC	Spiritual and aromatherapy
<i>Coleonema album</i> (Thunb.) Bartl. & H.J.Wendl.	Leaves and stems	Oil	WC; Endemic	Spiritual and aromatherapy, colds and influenza
<i>Cussonia paniculata</i> Eckl. & Zeyh. subsp. <i>paniculata</i>	Flowers, leaves and roots	Flower essence, tinctures	WC, KZN, EC	Spiritual and aromatherapy, anti-inflammatory agent
<i>Disa</i> spp.	Flowers	Flower essence	WC, KZN	Spiritual and aromatherapy
<i>Erica</i> spp.	Flowers	Flower essence	WC	Spiritual and aromatherapy
<i>Eriocephalus africanus</i> L.var. <i>paniculatus</i> (Cass.) M.A.N.Müll., P.P.J.Herman & H.H.Kolberg	Leaves and stems	Tincture, oil, loose and ground sachets, cosmetics	NC, WC; EC	Aromatherapy, colds and influenza; and stomach ailments
<i>Eriocephalus punctulatus</i> DC	Leaves and stems	Tincture, oil, loose and ground sachets, cosmetics	NC, WC; Endemic	Spiritual and aromatherapy, colds and influenza
<i>Harpagophytum procumbens</i> (Burch.) DC. ex Meisn. subsp. <i>procumbens</i> or <i>Harpagophytum procumbens</i> (Burch.) DC. ex Meisn. subsp. <i>transvaalense</i> Ihlenf. & H.E.K.Hartmann	Tubers	Tincture, tablets, oil, loose and ground sachets, cosmetic preparations	NW, FS, NC, N, B	Internally for arthritis and rheumatism; externally for skin disorders
<i>Hoodia gordonii</i> (Masson) Sweet ex Decne.	Vegetative parts	Tincture, tablets, loose and ground sachets	N, FS, NC; WC	Weight loss
<i>Hypoxis hemerocallidea</i> Fisch., C.A.Mey. & Avé-Lall. (syn. <i>Hypoxis rooperii</i> T.Moore)	Corms	Tincture, tablets, loose and ground sachets, cosmetic preparations	B, LIM, NW, G, M, S, FS, KZN, L, EC	Immune booster
<i>Ixia</i> spp.	Flowers	Flower essence	WC	Spiritual and aromatherapy
<i>Kigelia africana</i> (Lam.) Benth.	Fruit	Tincture, gel	N, B, LIM, G, M, S, KZN	Internal microbial infections and skin disorders
<i>Leonotis leonurus</i> (L.) R.Br.	Leaves and stems	Tablets, loose and ground sachets	LIM, M, KZN, WC, EC	Colds and influenza, stomach ailments
<i>Lippia javanica</i> (Burm.f.) Spreng	Leaves, stems and roots	Oil	B, LIM, NW, G, M, S, FS, KZN, EC	Respiratory infections, colds and influenza, skin disorders
<i>Oxalis incarnata</i> L.	Flowers	Flower essence	WC, EC; Endemic	Spiritual and aromatherapy
<i>Pelargonium graveolens</i> L'Hér.	Leaves and stems	Oil, cosmetic preparations	LIM, EC, M	Aromatherapy, cosmetic preparations, respiratory infections
<i>Pelargonium reniforme</i> Curtis subsp. <i>reniforme</i> <i>Pelargonium reniforme</i> Curtis subsp. <i>velutinum</i> (Eckl. & Zeyh.) Dreyer	Leaves and stems	Tincture	EC; Endemic	Stomach ailments
<i>Pelargonium sidoides</i> DC.	Leaves, stems and tubers	Tincture	NW, M, S, FS, KZN, L, EC	Respiratory infections and immune booster
<i>Salvia stenophylla</i> Burch. ex Benth.	Stems and leaves	Oil	N, B, LIM, NW, G, M, FS, KZN, L, NC, WC, EC	Anti-inflammatory, skin ailments, cosmetic preparations
<i>Sceletium tortuosum</i> (L.) N.E.Br.	Stems and leaves	Tincture, tablets	NC, WC, EC; Endemic	Psychiatric disorders (depression)
<i>Siphonochilus aethiopicus</i> (Schweinf.) B.L.Burttt	Rhizome	Tincture, tablets, oil	LIM, M, S, KZN, EC	Colds and influenza
<i>Sutherlandia (Lessertia) frutescens</i> (L.) R.Br.	Stems and leaves	Tincture, tablets, oil, loose and ground sachets	N, B, M, FS, KZN, L, NC, WC, EC	Multipurpose
<i>Warburgia salutaris</i> (G.Bertol.) Chiov.	Bark	Tablets	LIM, M, S, KZN	Respiratory infections, anti-malarial
<i>Watsonia</i> spp.	Flowers	Flower essence	WC	Spiritual and aromatherapy
<i>Xysmalobium undulatum</i> (L.) Ainton f. var. <i>ensifolium</i> Burch. ex Scott-Elliot <i>Xysmalobium undulatum</i> (L.) Ainton f. var. <i>undulatum</i>	Roots	Tincture	N, B, LIM, NW, G, M, S, FS, KZN, L, NC, WC, EC	Diarrhea and dysentery

This list is not necessarily exhaustive as it has been compiled from natural plant products that are being retailed in South African health shops, pharmacies, supermarkets and/or using Internet-based ordering systems. Information on the distribution is taken from Germishuizen et al. (2006). Abbreviations: N—Namibia, B—Botswana, LIM—Limpopo, NW, North West Province, G—Gauteng, M—Mpumalanga, FS—Free State, KZN—KwaZulu-Natal; L—Lesotho, NC—Northern Cape, WC—Western Cape, EC—Eastern Cape.

broad spectrum of healthcare practices which include homeopathy, naturopathy, acupuncture, chiropractic and herbalism. Complementary medicine refers to the use of treatments drawn from alternative medicine to complement allopathic medicine. The term 'complementary and alternative medicine' (CAM) implies the use of both allopathic and alternative medical systems including those linked to indigenous traditional knowledge systems (McClure, 2002). The dual use of allopathic and alternative ways of healing has become popular in many Western countries as it is perceived as a more holistic approach to healing. "Botanical drugs are defined by the Food and Drug Administration as those containing ingredients from fresh or dried plants, plant parts, isolated or combined chemical components of plant origin, algae, macroscopic fungi or combinations thereof" (Goldman, 2001; Liu and Wang, 2008). For purposes of this review, we use the term 'natural products' to refer to those products originating from plants even though it is conventionally accepted as a term that describes 'products of natural origins' from a variety of sources including animal or micro-organisms (Sarker et al., 2006). Here, use of this term further excludes other plant-derived products such as wood-crafted materials or ornamental/functional art products. The natural products sector in South Africa reflects the global trend towards contemporary lifestyle changes but has a dual system of healing. This involves the use of local flora and internationally exploited botanical knowledge systems. The government is endorsing pride in South African Products, led by the 'Proudly South African' campaign (www.proudlysa.co.za/ accessed 2 April 2008) inculcating an ideology that locally made products are of a high-quality. This patriotism is also dictating the heterogeneous mix of local and international herbal products, now available for retail. South African is a 'land of contrast' with a mixture of westernized, more educated people and those that are less privileged with limited education and socio-economic resources. This contrast refers also to the physical landscape including the range of biodiversity offered by the multiple climates and topographic regions in South Africa (Goldblatt, 1997). The educated more affluent members of the South African population are the principal users of natural products from the formal sector. These members are largely from the white population but also include middle-to-upper income earners from the black, coloured and Indian population groups. Those with a higher socio-economic status have access to private healthcare and the means to choose. Natural products are increasingly representing the front line as a form of over-the-counter therapies chosen for self-medication (Cocks and Dold, 2000). The international trend towards CAM is used to supplement conventional medicine rather than as a replacement (Barnes et al., 2002), of concern is the interaction of this 'medical pluralism' (Stevenson et al., 2003) but this is perhaps beyond the scope of this particular review. The formal industry is thus composed of local consumers interested in purchasing finished products and exporters of raw or value-added materials to manufacturers and processors (Mander and Le Breton, 2006).

This review attempts to assess the impact of indigenous plant knowledge on the commodification of the associated biodiversity and consequently its effects on a growing formalised herbal medicines industry. This industry services the cosmeceutical, nutraceutical and pharmaceutical industries in South Africa and more recently the world. We focus on developments that have taken place in the past decade regarding the imminent commercialisation of South African plants. The formal medicinal plant industry is contrasted to the informal sector which is well-established but remains an 'underground economy'. Finally, current achievements are discussed with future challenges and opportunities for creating an environment for sustainable exploitation of medicinal plant resources.

2. Traditional medicine in South Africa: historical account and present status

The sector that comprises local African medicines representing a 'hidden economy' (Cunningham, 1991) mainly runs concurrent to the recognized herbal sector. In the past, the more formal natural products industry was based on the developed worlds' model comprised solely of internationally renowned species, for example: *Echinacea purpurea* (L.) Moench, *Panax ginseng* C.A Mey., *Ginkgo biloba* L., *Hypericum perforatum* L. and *Serenoa repens* f. *glauca* Moldenke. Nowadays, due to the dynamic nature of this industry there are points of convergence between the formal and the informal herbal industries. The formal sector now draws from indigenous knowledge systems to meet international appetites for innovation and new product development. Furthermore, this is aligned with the national government's drive to increase the entrepreneurial spirit in the country building the mainstream South African economy. Sustainable utilisation programmes, which benefit the commoditisation of traditionally relevant medicinal plants creates a new South African prototype. Furthermore these programmes must also meet aims of poverty alleviation and empowerment of historically and economically marginalised population groups. As the impact on conservation remains poorly understood, fears from conservation managers of South African wild flora are justified. Historically, conservation of biodiversity in South Africa primarily used a law enforcement approach (Wiersum et al., 2006). Recently, participatory schemes which involve the conservationists and user groups of medicinal plants (local communities) are beginning to consider gender, cultural, ethnic and other social values in managing biodiversity. For successful medicinal plant resource management, Hamilton (2004) reiterated the benefits of an 'appreciation of cultures, economies, social structures and dynamics of local societies'. This, together with a deep knowledge of the biology and the ecology of plants by conservationists, is essential for establishing conservation strategies that are successful and sustainable. Several successful community-based programs have recently been implemented in South Africa. As a result of socio-cultural influences and regional biodiversity threats, there are differences in conservation and commercialisation priorities of medical plants within South Africa. In KwaZulu-Natal, conservation of forest species is one of the key priorities as unsustainable bark stripping is common practice (for example: *Warbugia salutaris* (G.Bertol.) Chiov. and *Ocotea bullata* (Burch.) Baill.). Species such as *Bowiea volubilis* Harv. ex Hook.f. subsp. *volubilis* and *Siphonochilus aethiopicus* (Schweinf.) B.L. Burt are part of the priority list for KwaZulu-Natal whereas the effect of over-harvesting of *Pelargonium* species in the Eastern Cape is a major concern. The conservation programmes in the Western Cape, focus on fynbos and other Cape Floristic Region (CFR) species, including those of medicinal value. Cape Action for People and Environment (CAPE) was established to monitor regional biodiversity in the Western Cape. Community-based conservation programmes initiated after 1994 engage both South African conservation agencies and traditional healers. In the Western Cape the traditional healers are composed of mainly Xhosa and Rastafarian 'bossies-dokters' (bush-doctors) with different ideologies and knowledge of plants of the Western Cape. In other provinces, traditional healers may be composed of four different ethnic groups (for example: the people of the Lowveld represent four different ethnic groups; Tsonga, Swazi, Venda and Pedi, Botha et al., 2004) with differences in culture. Awareness social and cultural issues related to medicinal plants is thus important for developing conservation strategies that serve a diverse group of users.

The 'pluralization' of traditional African plant-based remedies with a 'western' style of medical administration, amalgamating customs, can be traced back to colonial times with European

style tinctures of locally collected medicinal plants. Adoption of 'Dutch' Remedies or 'drupples,' tinctures incorporating popular plants (such as *Agathosma betulina* (P.J. Bergius) Pillans or 'buchu' and *Aspalathus linearis* (Burm.f.) R.Dahlgren or 'rooibos') in the late 1800s led to the establishment of general stores along commercial trade routes, inciting large scale harvesting of medicinal plants during the mid-1900s (Digby, 2005). The use of these species continues to flourish in modernized Africa where traditional medical practices are being incorporated and accepted into the current medical doctrine. Urban migration has exacerbated the demand for traditional medicines used for healing, therapeutic and spiritual purposes thereby boosting the informal trade as the use of traditional medicines continues in urban settings (Cocks and Dold, 2006). Current estimates of both renewable (leaves, flowers, fruits, and stems) and non-renewable resources (bark, bulbs, and rhizomes) predict the traffic of 35,000–70,000 tonnes of materials within this hidden economy between 50 and 100 million consumers (Mander and Le Breton, 2006). This trade of herbal products within the informal sector was valued at US\$ 75–150 million (Mander and Le Breton, 2006). Mander (1998) estimated that there are about 200,000–300,000 people along a value chain from collectors, traders, healers and wholesalers who are involved with the trade of medicinal plants. The majority of these people come from disadvantaged socio-economic backgrounds and receive relative little wage earning from this trade (Mander, 1998). In 1998, it was estimated that about 20,000 tonnes of material was being traded in South African markets (Mander, 1998), while more recent estimates suggest that 700,000 tonnes of plant material of medicinal value is extracted from the wild (Spring, 2004). About 1000 plant species are exchanged in the informal sector for a value of US\$ 50–100 million per annum (Mander and McKenzie, 2005). These figures are largely based from analysing the informal herbal markets of KwaZulu-Natal. Important studies documenting the medicinal plant trade in KwaZulu-Natal include publications by Cunningham (1988), Mander (1998), Mander et al. (1998) and the recent report by Mander and McKenzie (2005). Dauskardt (1990, 1991) examined the significance of herbal products in the urban setting of the Witwatersrand (Gauteng Province). This was subsequently followed by an analysis of the trade of medicinal plants and plant parts at the Johannesburg medicinal market (Williams et al., 1997). Some of these studies are summarized in sections that follow.

The study of Dold and Cocks (2002) estimated about 525 tonnes of medicinal plants were being traded in medicinal markets around the Eastern Cape (Port Elizabeth/Uitenhage, King Williamstown, East London, Umtata and Queenstown) and these medicinal plants were valued at R 27 million annually (approximately US\$ 6 million at the time of the investigation). *Hypoxis hemerocallidea* Fisch., C.A.Mey. & Avé-Lall. was the most frequently traded species in this region. The trade of plants in the Lowveld (a region with low lying plains situated east of the Drakensberg mountain range) is significantly lower compared to the vending of plants in urban centres of Durban and the Witwatersrand (Johannesburg) (Botha et al., 2004). Even though trade in rural centres is less, harvesting is on the increase to meet urban demands (Williams et al., 2000). In Durban 400–500 traders were recorded by Mander (1998) whereas Williams et al. (2000) recorded 166 traders that were selling medicinal plants and/or plant parts at the Witwatersrand market. Cunningham (1992) recorded over 420 species that were available for trade in the Durban area. Generating trade statistics is difficult as volumes of materials traded in the informal herbal sector are difficult to quantify at regional markets (Mander and Le Breton, 2006) and this may lead to inaccurate national estimates.

To summarize, a keystone study of the herbal trade in KwaZulu-Natal (KZN) was conducted in the mid 1980s by Cunningham (1989, 1992) followed by a study of the Durban markets by Mander

(1998). The latter documented the amount of plant materials traded and the consequential reliance upon this economy by disadvantaged socio-economic groups for livelihood security. More recent research is focusing on other markets (apart from KZN), for example: the Witwatersrand in the Gauteng Province (Williams et al., 1997, 2000). Williams et al. (2006) concluded that species utilization is proportional to availability and geographical location. In the Eastern Cape, the trade is dominated by middle-aged poorly educated black women and is estimated at US\$ 4 million per year (Cocks et al., 2004). This is further reiterated by Botha (2004) who conducted studies in the northern parts of the country in rural areas close to Kruger National Park. Little attention has been paid to the medicinal trade in the Western Cape, specifically a paucity of information concerning the fynbos biome. The fynbos is defined as a shrub-like evergreen, fire prone vegetation with hard-edged leaves that persists on rocky, sandy and nutrient poor soils in a Mediterranean climate (Marshall, 1998). As the Western Cape has a growing migrant population (48,000 annually) from other provinces and surrounding countries with an annual growth rate of approximately 3.5% (Bekker, 2002), the true extent of the trade in this region remains unknown. Therefore conservation concerns regarding future risk to this biodiversity exist. Even so herbal medicines and preparations based on Cape Floristic Region (CFR) endemics are evident in both formal and informal natural products sectors.

Variables challenging the sustainable utilization of natural plant resources include concerns associated with urban sprawl such as high population growth rates, restricted access to alternative medicines, poverty, and high unemployment rates (Cunningham, 1989; Winter and Botha, 1994; Hamilton, 2004). While it has been stated that migrants to urban areas are more likely to lose traditional knowledge and values (Cunningham, 1989), unsustainably harvested products sold at marginal prices remain a revenue generator which many rely upon for subsistence (Cocks and Wiersum, 2003). This coupled with the relatively slow growth of many medicinal plant species endangers local biodiversity (Spring, 2004) and directly impinges upon the health security of neighbouring communities (Hamilton, 2004). These variables present both a challenge and an opportunity for South Africa to create sustainable employment based on the management of culturally significant natural products. Other literature which is relevant with respect to ethnobotanical and ethnopharmacological research in South Africa include studies by Hutchings (1989a,b), Van Wyk (2002), Fennell et al. (2004a,b), amongst others.

3. The formal natural products sector reviewed

The natural plant products and organic sector is considered the fastest growing in the entire agribusiness industry. Worldwide sales of nutrition products totaled about US\$ 128.5 billion in 1999 and this continuing trend is reflected by a growth in sales in the US from US\$ 15 billion in 1999 to US\$ 23 billion in 2002 (Kelly et al., 2005). Increasing awareness and changes in lifestyles, in preference for natural and organic products in Europe and the United States are highly significant in fast tracking this growth. Approximately 85,000 plant species world-wide are reported as being medicinally useful (Liu and Wang, 2008), with the United States leading the market with a 35% market share, closely followed by Europe (33%), Germany, France, UK, Italy, Scandinavia, and Japan (18%), while Africa contributes to less than 1% of this market (US\$ 520 million) (De Kock, 2004).

3.1. A global perspective

In 1998, the World Health Organization estimated that 14 countries had regulated the sale of botanical drugs whereas current

Table 2
Global sales figures of natural plant products

Natural plant product	Global sales (billion US\$)
Dietary supplements, includes herbals and botanicals	47.1
Functional foods	47.7
Natural and organic foods	22.7
Natural personal care products	11.0

Source: Natural Food Products Merchandiser, January 2002.

statistics have added 50 more countries to that list, with the market value estimated at US\$ 60 billion per annum (Barnes et al., 2002). The status of ethnoherbals in the natural products sector is constantly changing. Table 2 indicates estimated revenue generated worldwide by the natural products industry in 2002. In the past, drugs from medicinal plants were regarded as dietary supplements but their status has been elevated to registered herbal remedies circumventing identification of a single active compound prior to registration in the United States.

In the United Kingdom, complimentary medicines are also an important approach to healthcare. Retail supported a US\$ 230 million industry in 2002, reflecting a 23% growth from 1998. Over half of the sales of complimentary medicines are of an herbal nature indicating 50% growth for the period of 1995–2000 (Barnes, 2003). Comparing the United States where regulation has been amended, in the United Kingdom herbal medicinal products are still regarded as dietary supplements without compulsory registration under the Medicines Act of 1968. They remain regulated under food and not pharmaceutical legislation (Barnes et al., 2002; Barnes, 2003). “Dissatisfaction with conventional medicine in terms of effectiveness and or safety” concomitant with psycho-cultural beliefs and/or philosophies on life and health (Barnes, 2003) cannot be underestimated as an influence on global trends. As a result, a continued need for novel products is on the rise, and countries with high levels of biodiversity, such as South Africa, are thus positioned well to meet such demands.

3.2. A South African perspective

The structure of the botanical market in southern Africa is vertically oriented with direction of flow only to the supply and marketing of the products. Ultimately there is little to no value-addition. Quantitative analyses on the natural products sector in South Africa and statistically valid data are difficult to acquire, making it improbable to accurately define the fiscal contribution of the burgeoning natural products sector on the South African economy. This criticism refers also to the impact of the local market internationally as many companies are guarded with their trade data, fearing competitors becoming conscious of investment opportunities. However, current worldwide estimates allude to a growth rate of 10% per annum over the last five to ten years, with nutraceuticals alone generating US\$ 50 million from African plants. The exponential demand for phytotherapies encompassing a whole range of products (organics, herbal teas, oils, phytocosmetics, phytomedicinals, herbs and spices) are saturating different outlets such as health shops, conventional pharmacies plus are becoming more available for consumers at supermarket chains (Agribusiness in Sustainable Natural African Plant Products, 2008). Mander and McKenzie (2005) suggest that about 5000–10,000 tonnes of raw material are traded in the formal sector generating an income of US\$ 25 million per annum. These data include plants that are used for herbal remedies, phytomedicines, nutraceuticals and cosmeceuticals. Raw material is wild harvested by rural harvesters (35,000–70,000 tonnes) as well as commercially farmed (50,000–70,000 tonnes). These authors include a supply chain network for the formal industry.

Natural products are also available for the middle-upper class consumer at unconventional outlets or specialist shops (health spas, food shops and curios shops). In spite of the formal retailers stocking plant therapeutic products largely dominated by exotic plants, a growing number of southern African endemics are starting to feature in preparations (Table 1). This list is compiled from visits to regional and national retailers carrying ‘natural products’ comprised of indigenous plant materials. It is by no means complete but it serves to indicate indigenous plant species of medical value that are becoming increasingly important as phytomedicinals. These are being manufactured by about 40–50 national small to medium enterprises, a conservative estimate. There is a continual state of flux within the market involving farmers/collectors, agents, manufacturers, distributors and exporters. Due to the lack of policed and reinforced regulations, the amounts and parts of plants used in preparations are typically poorly documented but many claim to use good manufacturing practice (GMP). Price of the products decrease along the supply chain and farmers receive 30–40% of export price. Unfortunately minimum value adding takes place in South Africa, and that is where the biggest mind shift must occur, with the establishment of new steps in the production chain, where prepared or processed products make an entry onto the market, locally and internationally.

Due to limited cultivation/domestication of non-agriculturally important plant species, future stresses on medically relevant plant resources remain unpredictable. This is further exacerbated by a rising population rate and pronounced interest in natural products from the middle- to upper-income earning brackets. However it is likely to exacerbate biodiversity concerns as users are anticipated to escalate. As the traditional medicines sector is also highly dynamic, the South African National Biodiversity Institute (SANBI) who monitor biodiversity in South Africa caution that the provision of a ‘complete checklist is inherently ethereal’ (Crouch, 2006) regarding the absolute use and possible threats to medical plant populations in the wild. Several species of bioregional importance are currently being elevated to a more national platform in the natural products sector. Not surprisingly, some plants are also achieving greater international status as their trade outside South Africa is becoming more prominent (examples are *Aspalathus linearis* (Burm.f.) R.Dahlgren (commonly known as ‘rooibos’), *Hoodia gordonii* (Masson) Sweet ex Decne., *Pelargonium* spp., *Aloe ferox* Mill., *Agathosma betulina* (P.J.Bergius) Pillans (commonly referred to as ‘buchu’), *Harpagophytum procumbens* (Burch.) DC. ex Meisn. subsp. *procumbens* or *Harpagophytum procumbens* (Burch.) DC. ex Meisn. subsp. *transvaalense* Ihlenf. & H.E.K.Hartmann (common name being ‘devil’s claw’) and *Lessertia frutescens* (L.) P.Goldblatt & J.C.Manning (syn. *Sutherlandia frutescens* (L.) R.Br.) (otherwise known as ‘cancerbush’) Table 1).

Products incorporating extracts of *Siphonochilus aethiopicus* (Schweinf.) B.L.Burt or wild ginger, *Leonotis leonurus* (L.) R.Br. or wild dagga, *Artemisia afra* Jacq. ex Willd. or ‘wildeals’, *Hypoxis hemerocallidea* Fisch., C.A.Mey. & Avé-Lall. (syn. *Hypoxis rooperii* T.Moore) or African potato are becoming more commercialized but were originally used solely in traditional medicines. These indigenous plants are being largely utilised in formulations by a growing number of South African venture companies. Many of these companies came into operation in the early to mid-1990s. An interesting example indicating the sophisticated nature of the formal industry is the use of flower essences, a rare phenomenon in the informal market. Here, indigenous CFR taxa are represented by *Disa* spp. (orchids), *Erica* spp. (fynbos), *Watsonia* spp. (geophytes) and *Oxalis* spp. (geophytes) (Table 1). Flower essences are used for ‘aura-cleansing’ and this is documented as spiritual use in Table 1. Companies producing such extracts do not document plants used to the species level. The formal industry is a fraction of the informal

trade regarding the movement of traded plants where approximately 50 plants are being traded in the formal sector (Mander and Le Breton, 2006) compared to more than 4000 documented ethnomedicinal species (Arnold et al., 2000). The largest formal sector revenue is generated from local and international herbal tea trade with rooibos production exceeding 9000 tonnes a year. The movement of *Harpagophytum procumbens* and *Aloe ferox* is noteworthy with over 800 tonnes and 700 tonnes being traded, respectively (Mander and Le Breton, 2006). Importance in the trade today is preceded by a history of commercialisation of these two plant species with *Aloe ferox* being developed for medicinal properties for stomach ailments. It is predominantly important for skin and hair care industries at local and international levels. The sustainable harvesting of *Harpagophytum procumbens* has played a role in the up-liftment of poor rural communities where it is harvested for the international market to make extracts for the relief of arthritis (Donaldson, 2006). In general cultivation of medicinal plants is in its infancy. In comparison, the large-scale cultivation of *Hoodia gordonii* has commenced to support an international market which has mushroomed. Hoodia-hype perpetuated by huge media attention as the new revolutionary 'weight loss' product is also closely linked to bioprospecting and 'biopiracy' controversy which culminated in a benefit-sharing agreement between the Khoi-San people and the Council for Scientific and Industrial Research (CSIR) and PhytoPharm (Wynberg, 2004).

Marketing and advertising in the formal sector is achieved through a variety of means including formalised mail-order, wholesalers and middle-men negotiators and directly from manufacturer to buyer (Mander and Le Breton, 2006). The amount of Internet-based ordering systems is on the rise with many South African companies using this modern resource as a utility to reach international consumers. Some choose to solely retail via cyberspace. The influence of modern technology is comparable to the evolution of the formal trade in colonial Africa as the collection, packaging, and processing of 'free' local natural resources was further exacerbated by the advent of the postal service in Africa. Mail advertisements and mail order medicines, printed in a variety of African languages, were used to distribute large amounts of traditional and culturally related paraphernalia as well as plant remedies (Digby, 2005). These advertisements including claims to "stop evil spirits, win court cases and obtain the desirability of the opposite sex" are still popular today and have contributed to the notion that traditional medicines are a form of witchcraft and/or quackery (Devenish, 2005). Exaggerated claims by Internet-based companies, particularly on psychoactive herbs (for example *Sceletium tortuosum* (L.) N.E.Br.) generate undesired scepticism in the industry.

The formal sector still faces challenges which include a lack of public and private sector investment, minimal product development and supply chains with fragmented networks (Mander and Le Breton, 2006). For the large-scale and substantial growth of the industry in South Africa which is on a par with the international natural product industries in developed countries, cultivation of plants using agricultural systems is recommended. This would make this industry sustainable. This necessitates greater efforts in developing propagation systems and understanding medicinal plants as crops being implemented.

4. Dynamics influencing sustainable medicinal plant use

The use of traditional medicines and healing is deeply woven into the cultural and spiritual ideology in South African societies; such indigenous knowledge systems are perceived as being (1) dynamic and continually evolving, (2) orally transmitted and shared amongst communities and (3) drivers for the procurement of medicinal plant products. It should be noted that the contin-

uation of this type of knowledge and the mode of knowledge transmission creates a deeper appreciation of nature. In this case it may provide a platform for balancing possible financial gains from botanical product development while empowering communities both culturally and economically. The richness of cultures and biodiversity in South Africa implicates that there is an opportunity for South Africans to combine healthcare concerns with conservation initiatives. The continuity or transmission of local traditional ecological knowledge is a source of cultural identity preservation during times of great social and political change. The fall of Apartheid created an impetus for a petitioning for formal recognition of traditional healing which led to the formation of hundreds of herbalist organizations (Devenish, 2005). Previous legislation, such as the Medicines and Regulated Substances Control Act (Act 101 of 1965) set regulations for african traditional medicines which were not policed or enforced. The Health Act of 1974 actually banned traditional healers. The post-Apartheid era has made access to biomedicine a national priority (Digby, 2005) with national governments concerned about meeting the Millennium Development Goals. As a result the South African government now recognizes the value of traditional healers within the healthcare system. The Traditional Health Practitioners Act passed in 2004 provides a 'regulatory framework to ensure the efficacy, safety, and quality of traditional healthcare services' and 'for control over the registration, training, and conduct' of traditional health practitioners (Medical Research Council, 2005). This formal recognition of traditional healing is intimately connected to the practice of illegal harvesting of natural populations.

The Biodiversity Act No. 10 of 2004 aims to manage and prevent pillaging of natural resources while ensuring sustainable use of biological diversity. After its promulgation in 2004 the chapters on bioprospecting and benefit sharing came into effect in 2006. This part of the act was written in order to curb biopiracy. Recent amendments to the South African Patents Act deal with the compensation of indigenous South African communities.

The paradoxical nature of these recent regulations creates a conundrum for law enforcement. For example, uprooting of *Siphonochilus aethiopicus* rhizomes for multipurpose medicinal use (Zschocke et al., 2000) has resulted in this species being rare in the wild and it now faces extinction in unprotected areas (Scott and Springfield, 2004). As a consequence, its cultivation became a priority to fulfil demands of the traditional and commercial trades. Both tissue culture propagation and field cultivation have been used for this particular species. *In vitro*-derived seedlings of *Siphonochilus aethiopicus* may be transplanted and cultivated in the field (Mander et al., 2006). The adoption of *in vitro* culture and field cultivation strategies is useful for conservation of medicinal flora to alleviate wild harvesting pressures and to save others from extinction. Other plants that may benefit from this type of approach include: *Asclepias cucullata* (Schltr.) Schltr., *Alepidea amatymbica* Eckl. & Zeyh. var. *amatymbica*, *Plectranthus grallatus* Briq., *Bowiea volubilis* Harv. ex Hook.f., *Warburgia salutaris* (G.Bertol.) Chiov.; to name a few. These are some of the species that are of high demand in the ethnoherbal trade. The plants listed above include those whose *in vitro* propagation has also been considered successful (reviewed by Nigro et al. (2004)). Local conservation initiatives (such as small scale indigenous plant cultivation) on a countrywide scale have incorporated social concerns that are potentially significant in stabilizing the delicate status of medicinal plant species. Knowledge-based (encompassing community-based) approaches are a unique mode of transforming political agendas of conservation to include more socio-cultural considerations creating more sustainable initiatives. Wiersum et al. (2006) reiterated the value of an *in domo* conservation regimen in poverty relief and for human capacity building while preserving remaining botanical knowledge from traditional

cultures. Projected increases in demand for vulnerable medicinal plants necessitate interaction between cultural empowerment, conservation and poverty alleviation through employment creation. Although the study by Shackleton et al. (2008) focuses on non-medicinal natural products, it serves to further endorse the non-financial benefits derived from linking trade in natural products as a vehicle for ameliorating poverty.

In the South African context, there are several examples of the marriage of social and biological conservation initiatives:

- (1) Community-based natural resource management projects: Projects initiated by a national conservation institution, CapeNature, hold workshops which introduce local users to sustainable harvesting techniques. CapeNature has recently produced a policy on the consumptive utilization of biological resources from protected areas and surrounds in the Western Cape Province, creating a guide for sustainable harvesting practices (CapeNature, 2008).
- (2) Educational training on medicinal plant propagation: South African National Parks (SANPARKS), a governmental agency, has created a forum in which groups of healers (Rastafarian bush-doctors and Xhosa healers) share traditional knowledge of herbal medicines while learning how to produce their own plant materials.
- (3) Provision of arable lands for cultivation: Vetfontein Medicinal Plant Garden in Knysna is managed solely by women and combines both knowledge sharing practices and utilization of communal growing lands which are available at the Silverglen Medicinal Plants Nursery (Donaldson, 2006).
- (4) Display teaching gardens for *in situ* and *ex situ* germplasm resource management: The Natal National Botanic Garden and Kirstenbosch Botanic Garden (SANBI) display the indigenous and alien medicinal plants commonly used by the healers in the area (Crouch and Hutchings, 1999).
- (5) Processing, packaging and storing techniques: eThekweni Municipality in Durban has supported the cultivation and subsequent production, processing and packaging of indigenous medicinals (McKenzie, 2006). This includes the drying, milling, value-adding, storage and packaging of medicinal plant products. This has created a form of standardization of products as well as employment creation.

These community-based conservation projects serve as a platform for the interaction between scientists and healers; and, amongst healers themselves (Shukla and Gardner, 2006). These projects often are able to identify species under the threat of being endangered. One challenge faced by such economic development of particular products is that economically disadvantaged individuals also recognize the potential of such products and are rapidly harvesting naturally occurring populations, not for medicinal use but for export. This further contributes to the endangerment of plant species (Toman, 1992). The severe indiscriminate harvesting of *Pelargonium sidoides* DC tubers (which is frequently confused with the related species, *Pelargonium reniforme* CURT) for the German-produced herbal extract (Umckaloabo®; Schwabe Pharmaceuticals) in the Eastern Cape clearly illustrates this relationship. Wild harvesting of tubers causes concerns as this may lead to this species becoming endangered (Lewu et al., 2007).

Community-based conservation programs concerning the modification of medicinal plants are dependent upon the extent of the trade, the differences amongst regions of trade, and the nature of the traded plants (Botha et al., 2004). These researchers suggest that plants with a larger distribution range should represent increased resilience to collection. They also suspect that community-based initiatives may have a wider ranging impact to

resource users given the extensive social nature within market networks. Many community-based programs are in their fledgling stages and their future success remains unpredictable. However, traditional healers are becoming more aware of the importance of conservation for future supply security of medicinal plants. For example, a commonly held belief by healers is that cultivated medicinal plants do not have the same efficacy as wild-harvested materials. However, with the advent of price increases and scarcity of materials, conservation initiatives involving medicinal plant cultivation have begun to be accepted and are being employed (Dold and Cocks, 2001; Fennell et al., 2004a).

5. Cultivation and economic development: from farmer to market

5.1. South Africa

Generally there has been a lack of understanding in terms of the value of domesticating medicinal plants in South Africa by the private and public sectors (Mander et al., 1998). The cultivation of medicinal plants is recognized as being important for the development of the formal medicinal plant industry. The dual character of the agricultural economy has resulted in a commercial sector and a resource poor small-scale farming sector. Small-scale farmers are regarded as those that emanate from rural communal lands who have not historically focused on farming medicinal plants (Mander et al., 1998). Through our observation we have noted that these farmers generally plant a quarter to one hectare of medicinal plants but this is dependent on the crop that is being planted. These farmers typically come from disadvantaged communities in the Western Cape and the Northern Cape. They are the descendants of the Khoi-San. Farming cooperatives have been established in the past decade. For example: the Genadenberg agricultural project was involved in planting 3 ha of rooibos and 0.25 ha of buchu seedlings in 2004 (People Project Annual Report, 2004). In 2005, a total of 10 ha of rooibos and buchu were planted. In Aurora, 8 people shared 18 ha of land planting rooibos and vegetables (People Project Annual Report, 2005). On the other hand, commercial growers are generally white land owners. They cultivate five hectares or more, have access to financial support but often are opposed to sharing agricultural practices with each other and poorer communities. Entry into the agricultural economy by resource poor small-scale farmers is constrained by a myriad of factors, for example: the lack of productive resources, access to land and water resources, and the structure of the industry, particularly the knowledge economy of agriculture. Those that are growing medicinal plants at the 'homestead level' (Mander et al., 1998) may be regarded as subsistence farmers. Rastafarian herbalists are an example of subsistence farmers who may cultivate some of their plants but remain heavily reliant upon wild collection.

In South Africa, a niche exists for small-scale growers, with cultivation of alternative crops with a higher value per hectare than agricultural crops. Alternative crops are usually medicinal, cosmetic, specialty foods or industrial crops which receive a higher price in the market if grown in an environmentally friendly manner or as certified organic. Fair Trade and organic certification is another option for small-scale growers, where farmers receive a premium for products sold overseas. Additionally farmers have the opportunity to cultivate alternative crops through partnership creation with local communities thereby accessing indigenous knowledge, potentially realizing economic potential of plants long before they are commercialized.

To reiterate, the majority of South African medicinal plants are harvested from the wild and commercial cultivation is essential

to reduce the imminent decline of wild stocks. The first challenge faced when establishing commercial cultivation is the selection of genetic material. A prime example is reflected by the field production of *Agathosma betulina* and *Agathosma crenulata* (L.) Pillans. For decades, producers struggled to produce seedlings successfully to establish commercial plantations. Of the two species, *Agathosma betulina* yields better quality oil, while *Agathosma crenulata* oil is lower in quality fetching lower prices. Through increased research and development culminating in highly prolific cultivation protocols, sufficient stocks of *Agathosma betulina* are readily available. Therefore *Agathosma crenulata* has been suffocated out of the market. Other indigenous aromatic plants have potential for domestication and production of novel oils. Moreover, research to understand the biology and horticultural requirements of those plants is ongoing (consult other papers in this issue).

Most established African products are wildcrafted and exported out of South Africa as bulk raw materials with little to no value adding taking place. Exporters end up reaping all the profits. Recently South Africa has embraced the opportunity to embark on value adding opportunities and a number of processing facilities exist. The tragedy of this is that most of the processors are to a large extent, cultivating their own raw materials resulting in competition between producers and processors, leaving little opportunity for the cultivation of new unexploited crops. Processors are being driven to cultivate their own plants as they are assured of the quality of the plant material they are using and the history of the agricultural practices used is also known. This is particularly important as regulations on the production of medicinal plants require use of good agricultural practice particularly for the international markets. Supply security is also a driver for processors to cultivate their own medicinal plants particularly for the export markets. This may result in the formal medicinal plant industry being exclusive as small scale growers may not be able to sell their cultivated products to processors. This also leads to the exploitation of only a few species that are traded internationally. Little attention in terms of cultivation is being paid on other medicinal plants that are relevant for the South African industry. Small scale farmers are often unable to afford processing equipment and as a result may be excluded from the industry.

5.2. Western Cape case study

One of the most daunting tasks is to guide a new field crop into commercial production. Pharmacologically active secondary metabolite components require stress conditions in the field, leading to lower crop yields. Often provision of conditions increasing plant vigour negatively affects secondary metabolism. Research and technology transfer is therefore needed to assist natural products producers to optimize cultivation systems. Additionally, access to infrastructure and costs for phytochemical analysis of cultivated plant materials for the active ingredients is often prohibitive. Finally, the establishment of legal seller-buyer contractual commitments will streamline the supply. This is essential for supply security to intermediaries who buy products and produce a higher value added and standardized product.

There are a number of companies based in the Western Cape, involved in the manufacture of phytomedicines. The majority of these companies cultivate large quantities of raw materials used in their operations, conduct research and development, plant breeding and formulations of products. They do not only use South African plant species in their manufacturing process, but source from other parts of Africa and worldwide. Most of the South African and Western Cape pharmaceutical companies produce their own branded products, but some specialize in formulation and contract manufacturing. At least three companies in the Western Cape

focus primarily on 'buchu' as their sole supply of raw material, specializing in the blending and distillation of fresh leaves. Although they do buy some raw material from producers, they mainly rely upon their own production as sustainable supply of raw materials. This is a worrying trend as processors are moving away from their core business of processing as they expand to cultivation. This does not address issues raised above where it will be preferable for the owners or descendants of owners of the indigenous knowledge (small-scale farmers) who are suppliers of raw materials. The revenue earned from the sales of 'buchu' annually is more than US\$ 25 million and 'buchu' production is important in the creation of employment in the province (Williams, 2005).

Trends in natural products change drastically with time, it is predicted that the major opportunities for growth are in the following areas: fitness; well being through natural weight loss; health (physical and mental) products; pleasure-foodstuffs; ethics-products addressing environmental, economic and social issues (De Kock, 2004). Forecasts for the natural products sector by the Western Cape Investment and Trade Promotion Agency (WESGRO, 2005/2006) report that exports of natural products from the province will increase by more than 400 tonnes (www.wesgro.co.za). Wesgro estimates that the Aloe industry will grow by 10% per annum over the next 5 years, partly due to new export contracts. They are also forecasting a growth in exports of fynbos products. Income earned through fynbos exports is currently US\$ 6.5 million per year, but it is predicted to grow to US\$ 23 million over the next ten years.

6. Traditional medicine and natural products sector: a balancing act

Several difficulties arise when considering the self-prescribed use of non-allopathic plant remedies including: the interaction between herbal products with pharmaceutical drugs reviewed by Izzo and Ernst (2001); multiple use of natural products leading to synergistic interactions with cytotoxic and mutagenic effects; failure of patients to disclose their use of alternative medicines with allopathic practitioners and forensic experts (Stewart and Steenkamp, 2000; Steenkamp et al., 2006), and finally the toxicity of medicinal plant treatments (Barnes, 2003; Fennell et al., 2004b). Other hazards encountered when ingesting plant materials are related to horticultural techniques utilised (such as fungicide and pesticide use); and, post-harvest agricultural practices and storage of perishable materials (Fennell et al., 2004a). Lack of regulation regarding the distribution and use of herbal materials may be the most dangerous element, involving a lack of proper labelling of materials sold in formal and informal markets. The insurgence of individuals, attempting to secure a livelihood, who pose as collectors and healers is also concerning as this endangers the lives of patients.

Nowadays, South Africa is also faced with an increased prevalence of epidemiological lifestyle diseases which are a direct product of adopting westernised habits. Botanical drugs relevant for treatment of central nervous system, cardiovascular, and metabolic diseases (diabetes) are sought after (Barnes, 2008). In Sub-Saharan countries, which have been more severely affected by the HIV/AIDS epidemic (Fabricant and Farnsworth, 2001), the exploring of 'plant-based pharmaceutical platforms' is regarded as important for developing countries with well-established technological capacity (Ma et al., 2005). The combined natural asset biodiversity (representing about 10% of the Earth's flora), a large technical skills and infrastructural base compared to other African countries positions South Africa favourably towards exploring global trends of complimentary and alternative natural products. Modern diseases are also being addressed by traditional healers and

the search for leads from traditionally used medicines by a range of scientists including systems biologists and discovery chemists continues. Striking a balance in terms of future scientific discovery and growing the formal natural products industry with South African flora as the template requires multidirectional and extensive collaborative networks to ensure an overall holistic approach towards sustainable use of natural resources. Such networks are being established in the country amongst national research institutions, universities and conservation management organizations as well as with international research partners for added expertise.

It is predicted that the development of a 'green' industry where plant-derived substances are recycled requires greater collaboration amongst plant scientists, pharmacists, organic chemists, process engineers and microbiologists (Inze, 2007). Development of such an industry requires not only effective manipulation of metabolic pathways for production of important plant derived products but also environmentally friendly downstream processing methods (Inze, 2007). Use of new technological approaches or even use of combinatorial chemistry (Lam, 2007) rather than chemical synthesis alone is important for drug discovery in the future. Significant advances in chemical techniques (purification, separation techniques, structure elucidation) are thus predicted to expedite drug discovery from natural products. At present, such technologies are being utilised to gain a better understanding of the chemistry of South African flora. A range of spectroscopic techniques, microplate assays and other *in vitro* assays together with *in vivo* testing are routinely employed in South African institutions.

The utilisation of advanced technologies is advantageous for the commercialisation of medicinal plants. Powerful phytochemical techniques are used to test for artefacts and contaminants of natural products to ensure product quality; for chemotaxonomy; metabolite profiling and toxicity analysis; amongst others (Mulholland, 2005). Benefits of incorporating biotechnological solutions for studying medicinal plants are well-known but it remains difficult to predict whether consumers regard these as 'natural' (Canter et al., 2005). Even so, *in vitro* propagation may facilitate the conservation of medicinal taxa preventing their extinction whereas one of the advantages of molecular biological approaches is an increase in our fundamental understanding of secondary metabolism. This is advantageous for new product discovery and economic development. The utilisation of biotechnology to study South African species was recently reviewed by Nigro et al. (2004). Fennell et al. (2006) focused on the relevance of both 'low-level' and 'high-level' biotechnology strategies to the medicinal plant industry. With a proven research record and investment in technology South Africa appears to be prepared to exploit the natural products renaissance.

7. Conclusion and future considerations

There has been a marked increase in the use of indigenous medicinal flora in South Africa creating opportunities for economic growth, consequentially presenting a growing number of challenges. The investment in plant-derived products by small to medium scale commercial enterprises has thus significantly increased. The Western Cape presents a prime example of the benefits of value adding to medicinal flora ('rooibos' and 'buchu' industries) and how this can lead to sustainable economic growth. However the commercialization of medicinal plants is highly dynamic in nature and as an emergent economy it is often poorly addressed by government agencies in terms of the viability of the market in South Africa; the role of the players from both the informal (traditional healers and collectors) to the formal (small scale

farmers and distributors) markets; and finally through to the standardization and safety of natural products. It is also apparent that the delicate balance of cultivation, collection and production of new products requires careful consideration with greater investment in infrastructure to provide a larger skills base for the conservation aspects of this trade. For future sustainability, this communication strongly endorses as a requisite a concerted input into research and development implemented at a greater scale for agronomic and product development. This needs to be linked to extension services where plant extracts used in the production of phytomedicines are tested for efficacy and safety. South Africa is at an advantage regarding a well-developed research ethos, technical know-how and infrastructure. However this needs to be brought closer to those intimately involved with medicinal plants in the value adding pipeline. The impact of the informal trade on medical plants, including the influence on future biodiversity is well-documented as it is under the scrutiny of conservationists. Biodiversity monitoring programmes are essential for threatened species identification and the management of indigenous resources. Such programmes are likely to be even more important as the formal natural products sector grows. It is also commendable that conservation initiatives are beginning to incorporate social aspects, promoting increased awareness regarding the importance of cultivation of traditionally significant plants. Continued sharing of (traditional and horticultural) knowledge between the formal and informal sectors should include indigenous populations to find sustainable alternatives for new product development. There is an opportunity for fledgling business ventures to succeed in terms of value adding at different levels of the pipeline. Biodiversity conservation incentives, commercial cultivation, value-addition to plants and economic development for traditional plant resource exploitation are concerns that require a delicate balance. Even so, with the advent of the revitalization of natural medicines, organic farming and awareness of food miles, South Africa is presented with many opportunities. Increasing scientific pharmacological research and formal economic ventures using indigenous flora for phytotherapeutic products serve to highlight the benefits of preserving indigenous knowledge.

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