FINAL DOCUMENT

WILD FOODPLANTS AS 'SUPERFOODS': ARE THERE SPECIES THAT CAN BE SUSTAINABLEY HARVESTED AND USED TO SUPORT COMMUNITY CONSERVATION ON THE WILD COAST, SOUTH AFRICA?

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Report to

THE WILDLANDS CONSERVATION TRUST

CEPF INVESTMENT IN THE MAPUTALAND-PONDOLAND-ALBANY HOTSPOT

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Abstract

This report identifies traditionally used wild foods eaten in the communal areas of the Wild Coast. The aim of the study was to identify plants and plant parts that show potential as sustainably harvested 'superfoods'. Two complementary methods were used to identify candidate plants; these were: collating available information on wild plants utilized in the communal areas of the Eastern Cape (literature review and personal observations), and an analysis of the macro and micro nutritional content of these foods (a database of wild plants was specifically developed for this study).Two aggregated nutritional indices were uses to rank wild food plants, these were the % Complete Food Index and the Nutritional Density Indices.

This report develops a definition of a 'superfoods' based on number of criteria. Species that have been successfully commercialized, marketed as nutritional supplements, and that provide direct benefits to communities, such as Maroela and Baobab, serve as role models for the development of wild foods enterprises in the communal areas of the Wild Coast.

Selection criteria used to identify potential superfood plants, include: occurrence in study area, abundance (plant occurs in relatively high densities) and history of traditional use as a wild food. A second set of criteria were then used that ranked species according to nutritional profiles for macro and micro nutrients (where available). In addition, the potential for the commercialization of a wild food to promote positive conservation spin-offs, have been discussed and is seen as essential to the establishment of such an enterprise.

The results of this study show that there are a significant number of wild food plants have exceptionally high nutritional profiles and could qualify as a 'superfood'. Food plants were grouped according to the plant part used, these included: wild leafy vegetables, fruits, and seeds and nuts. The wild leafy vegetables, commonly known as 'wild spinach', are cosmopolitan weeds that have been part of the traditional diets of many Africans. Of these, a number of *Amaranth* species have been identified that fit the nutritional profile of a 'superfood'. Commonly used wild foods are often tree fruits, this study identified the following wild fruits as having high potential for commercial harvesting, these include: Wild plum (*Harpephyllum caffrum*), two Red-milkwoods, (*Mimisops Cafra* and *M. obvata*), Num-num (*Carissa Macrocarpa*), Dune myrtle (Eugenia Capensis) and two Kei Apples (*Dovyalis caffra*, and *D. rhamnoides*. The third category of wild foods considered are seeds and nuts: trees identified for this group included the pods of Boer-bean trees (*Schotia afra*, and *S. brachypetala),* and the valuable oils of the Natal and forest mahogany (*Trichilia emetic*a, and *T. dregiana*) as well as the high oleic oil contained in the Coastal Red-milkwood (*Mimusops caffra*).

There are a number of distinct advantages of a wild foods enterprise over commercial or even subsistence agricultural production; these include the possibility for positive biodiversity conservation spinoffs, due to the need to keep natural habitat intact to ensure future productivity of target species. A wild foods harvesting enterprise can provide economic benefits and employment directly to local communities, on whose land the wild plants grow, and unlike commercial agriculture, input costs and labour requirements are low.

Most areas with wild food plant resources are also valuable for the protection of biodiversity. The commercial exploitation of wild products can provide economic opportunities as well as incentives to poor communities, (in areas such as the Wild Coast) to conserve sections of tribal

land as formal sustainable-use-protected areas. This report proves a strong and substantiated argument for the development of small scale commercial enterprises based on the use of a number of wild food products occurring within, the forested habitats of the Wild Coast. These wild food products can be marketed to the growing urban demand for 'superfoods'. In addition, this report argues that the potential conservation spin- offs associated with such an enterprise, as well as the likelihood of qualifying for 'fair trade' certification, provides attractive marketing opportunities.

The rapidly degrading dune and scarp forests, near Mdumbi, Bulungula and many other areas of the Wild Coast still have good resource of many wild food plants discussed in this report. Community based enterprises could be the critical incentive to prevent complete forest loss in these areas.

Possible marketable products, obtained from several tree species that are common in these forests, include various forms of fruit (dried, dehydrated and powdered, jams, jellies and juice beverages) as well as oils from the fruit nuts (used for nutritional supplements, cooking oil, cosmetic products).

Management plans will be required to ensure that the harvesting pressure is relatively thinly dispersed within a targeted area, and that potential impacts are reduced. The harvesting of wild foods that re-grow seasonally on the plant (i.e. leaves and fruit), unlike roots, corms or bulb, can be sustainable harvested.

Future planning and research are needed that includes: detailed laboratory analysis of the nutritional profiles of target species; mapping and estimation of availability and seasonality of stocks; harvesting methods and levels (for example no more than 30 % of the available standing crop is harvested at any one season); mitigation strategies to ensure continued productivity, such as a reforestation program to restore degraded forests; business plans and models of scales of profitability, evaluation of potential markets, and drawing up of joint management agreement between communities and key stakeholders.

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1 Introduction

1.1 Context

The broad context of this project is to support efforts to identify suitable economic activities that can be linked to conservation areas, and that will provide direct economic and employment opportunities to communities living in or around proposed Wild Coast protected areas. One of the key threats to conservation in communal areas such as the Wild Coast is the lack of economic benefits associated with the creation of protected areas on the Wild Coast (Berliner, & Desmet, 2007; Berliner 2009) This project aims to provide information to support effective decision making around the potential sustainability of harvesting wild foods. The project does this by firstly, reviewing the current knowledge regarding edible wild foods within the study area, secondly, by development of a searchable database, and thirdly, applying multiple criteria to assess the suitability of plants for commercialization.

Considerable efforts have been made concerning commercializing of the cosmetic and medicinal uses of indigenous plants, however the investigation into the commercial potential of wild foods is still relatively unexplored. The rapid growth in the health and organic food markets should provide an incentive to this avenue of research.

This is primarily a pilot/desktop study to evaluate the potential of using wild harvested foods for conservation-related economic activities.

1.2 Project aims

- Identify wild plant species used traditionally as foods, and that occur naturally on the Wild Coast, Eastern Cape, South Africa.
- Where available (from literature sources), provide an indication of the nutritional value of these foods.
- Development of a wild foods searchable database
- Consider harvesting strategies, ecological impacts and mitigation strategies
- Identify possible conservation benefits or /spinoffs that may be associated with harvesting wild foods for commercialization.
- Identify potential wild plant species that could be sustainable harvested for a superfood.
- Identify potential products.
- Identify areas for further work

1.3 Description of study area

The project study area is the Wild Coast, (Kei river to the Umtanvuna river), and running for approximately 30 km inland. The area forms part of the Maputuland-Pondoland-Albany hotspot, as identified by Conservation International. The Pondoland center of botanical diversity (Van Wyke,1990) has also been prioritized as part of South Africa's national protected area expansion strategy (NPAS, 2008).

There is a specific focus on the priority biodiversity hot spot areas as identified by systematic conservation planning. Within these areas, a number of protected areas have been proposed (Berliner, 2010), see map below. The development of these areas as registered protected areas will require close cooperation between communities trusts, land managers (Department of Agriculture, fisheries and Forests) as well as the conservation authorities (Eastern Cape Parks and Tourism board). The GEF funded, Wild Coast Project has set up a number of job creation activities associated with these proposed protected area, including bee-keeping, alien clearing and forest rangers. (Peter Tyldesley, pers. coms.)

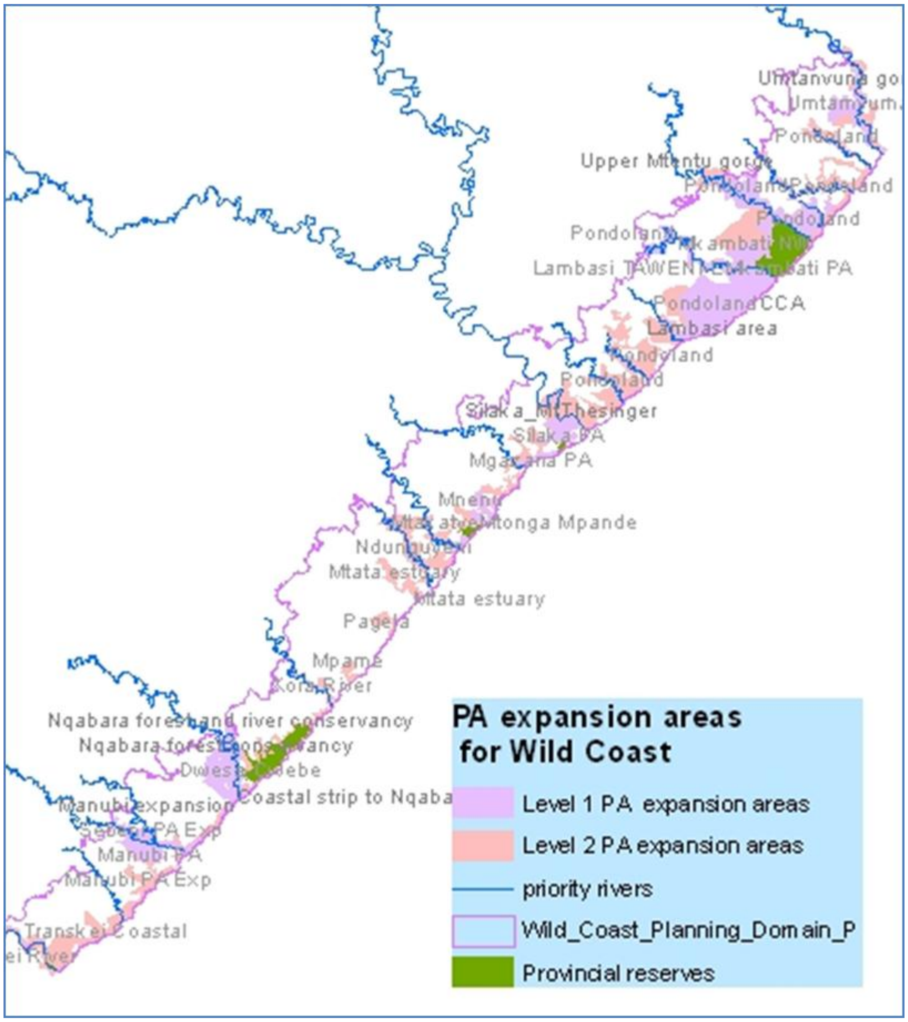

Figure 1. Priority protected area expansion regions for Wild Coast. Level 1 areas are considered as either top priorities and/ or where communities have indicated willingness to establish reserves. Level 2 are additional priority conservation areas, earmarked for future work (Berliner, 2010)

1.4 Wild foods, indigenous knowledge and botanical diversity

Wild foods have been used as a supplement or ‘fallback’ to cultivated crops as sources of food and nutrition for indigenous communities since time immemorial. They therefore play an essential role in food security for local people. However, with the introduction of modern cash crops, and a cash economy, their value as food sources has declined. This has been accompanied by the stigmatization of traditional wild foods as 'food for the poor' (Fox, et al 1983, Shava, 2000).

Wild foods play a particularly important role in the nutritional supplementation of vulnerable and poor children in the Eastern Cape. McGarrya and Shackleton, (2009), found that 62% of the children surveyed were supplementing their diets with wild foods; and 30% with over half their diet supplemented in this way.

The extent of use of wild indigenous food plant species, varies widely between different rural populations, tribal groups and geographical area, however there is also a surprising degree of overlap in species utilized. A number of recent studies have confirmed the importance and extent to which wild plants are utilized in the diet of rural populations. For example, Shava (2000), for the Peddie District of the Eastern Cape found that 80 species of edible wild plants were regularly used in the village. These were broadly categorized into: 41 species of wild fruits, 21 species of wild spinach (Marog or imifino)**,** seven species of edible roots/tubers, and seven beverage plants. Other edible plants eaten included edible gums/resins, bark or other vegetable parts (seven species).

A number of authors, (Wehmeyer & Rose, 1983, van Wyke & Gericke, 2000, Shava, 2000, Fearon, 2010, Dold & Cocks, 2012) have commented on the importance of wild indigenous plants, (and hence biodiversity), in the diet and cultural practices of rural communities. Dold & Cocks (2012) have made a particularly strong case for the importance of linking cultural preservation to biodiversity conservation. The knowledge and use of wild food plants varies between communities, tribal groups, gender and age. Typically, tribal groups where cultural customs are still relatively intact, living in areas surrounded by natural vegetation, and amongst the older generation (often woman), will still have remarkably high levels of knowledge and use of indigenous plants. However, knowledge of wild plant use is currently being eroded (Shava, 2000, Kepe, 2001 Shava, 2005, Voster, 2003, Dold & Cocks, 2012). Efforts need to be made to preserve this indigenous knowledge within communities by education of younger generations of the value of biodiversity and traditional plant use.

In Africa, until well into the 19th century, indigenous food plants played an important role in the traditional diets of African people (Flueret, 1979, Fox *et. al*, 1982). Most African communities have traditionally relied on a very broad food base, comprising of mainly wild food plants, which were nutritionally excellent (Gelfand *et al*, 1985). However in recent times, for a number of reasons, there has been a shift away from the use of wild food plants in the diet.

Studies of indigenous use of Wild food plants could contribute towards ecologically sustainable use of botanical biodiversity and community health. Shava (2005) makes the point that research on indigenous knowledge should go beyond documenting and interpreting it. Rather, it should stimulate inquiry into its application in present day community development and education settings. In other words, the study of indigenous knowledge should steer research towards practical application initiatives, in particular where communities can benefit from this knowledge. It is hoped that this project can contribute towards this aim.

There is an incredible diversity of wild food plants that have been documented for Southern Africa. Wehmeyer (1986) has documented and analyzed over 300 edible plants from Southern Africa, Shava (2005) documents over 206 edible food plants from Zimbabwe, while Fox and Norwood Young (1982) recorded more than 1000 indigenous food plants in southern Africa alone. A wide range of plant parts are used, for example edible roots (roots, tubers, rhizomes and corms), edible bulbs, edible leaves (leaves, stems, stalks and inflorescences), edible fruits (berries, drupes, aggregates and pods), edible grains (grasses),edible seeds and edible gum.

Numerous studies have been done documenting wild food plant and other plant use in Southern Africa (for example Fox et. al, 1982; Wehmeyer & Rose; 1983; Palgrave, 1977; Tredgold, 1986; Peters et. al, 1992; Chigumira et. al,1999; van Wyke & Gericke, 2000; Shava, 2000; Fearon, 2010; Dold & Cocks, 2012).

1.5 Wild food plants and potential domestication

A common situation is where plants grow wild in ecosystems that have themselves been "domesticated". For example, in many parts of Africa "farm trees" are found scattered through areas of cultivated land within and near farm fields. These trees are managed, protected and harvested by farmers to provide fuel wood, fodder, poles for construction and edible fruits and nuts. In the Sahel, with its sandy soils of low fertility, scattered *Acacia albida* trees in millet or sorghum fields increase crop yields up to two and a half times over those obtained in open fields (FAO, 1999). Similarly wild Maroela trees are left standing within maze fields, in many parts of South Africa. Wild plants may be transferred from forests or other ecosystems to gardens or close to human habitations as well as into fields so that they are readily available and easily collected, this is usually the first stage of domestication. The stages in the process of co-domestication of forests and tree species that has resulted from interactions between local communities and forests are illustrated in the figure, below.

Many species that have been domesticated escape from cultivation and have become naturalized. Weedy forms, cultivated and semi-cultivated plants exist side by side. Thus there is a whole range of different situations ranging from completely wild, to semi-domesticated through selection, to fully domesticated through selection and breeding, to escape from cultivation, to naturalized. Many of the Amaranth species fall within this category.

The useful series of publications ‘The Lost Crops of Africa, vollumes1 to 3 (National Research Council, 1996, 2006, 2008) discusses and identifies the most important wild food plants that would be suitable to cultivation as food plants across Africa .This report emphasizes 24 cultivated and wild fruit trees; eight seed and grain plants; and 18 vegetables that currently are either casually cultivated or still grow wild and that seem useful for diversifying food supplies and improving nutrition across the hungriest continents.

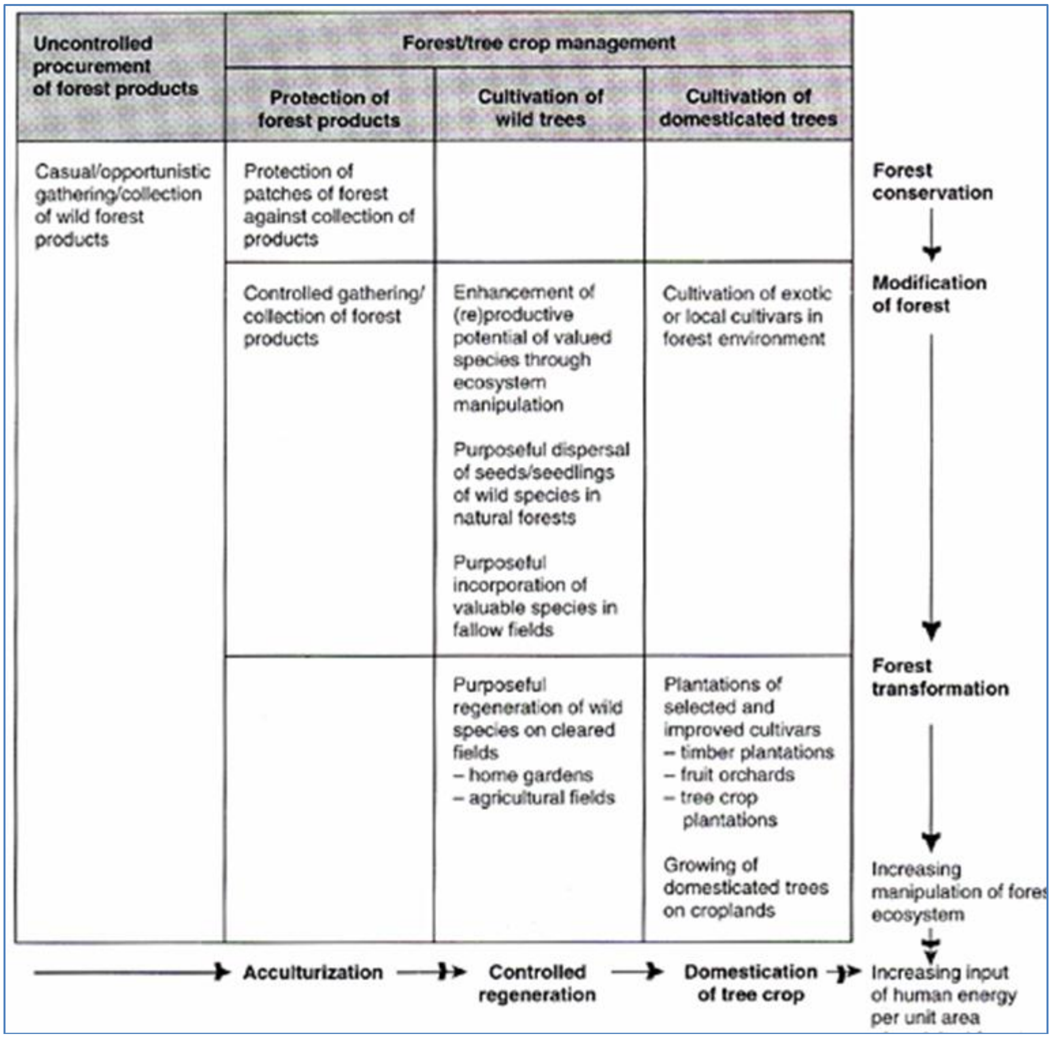

Figure 2 Stages in the domestication of wild forest plants (after Weirsum, 1996)

1.6 Commercial success stories

A number of wild plants have been successfully commercialized in South Africa, mostly for medicinal or cosmetic products), and few for their value as a food (see table below). There are really only two good examples of a Southern African wild plant that has been commercially marketed, as a ‘superfood’, that is *Baobab fruit powder*, and *Marula nut oil*. Both are wild grown, sustainable harvested and benefit local communities. The *Cape Aloe* is another wild food product with high commercial potential, although its status as a wild superfood is debatable,as it is mostly cultivated.

Table 1 Examples of Wild southern African plants that have been used for commercial products.

Species	Part/products	Use	Commercialized by
Baobab products *(Adensonia digitata)*	Fruit Powder, oil, leaves bark	Food /cosmetics/fiber	Phytotrade Africa http://www.phytotradeafrica.com/products
Marula *(Sclerocaria birea)*	Oil, nut	Food/ cosmetics	Phytotrade, Marula Natural Products (Pty) Ltd http://www.marula.org.za Moyahabo (www. OpenAfrica.org) AfriGetics Botanicals (http://afrigetics.co.za)
Devils claw	tuber	Herbal medicine	Phytotrade
Kalahari Melon Oil	oil	cosmetics	Phytotrade
Kigelia Fruit Extract *(Kigelia Africana)*	oil	Cosmetics, Anti-ageing and regenerating skin care products.	Phytotrade
Trichilia Oil (*Trichilia emetic*)	oil	cosmetics	Phytotrade
Ximenia seed Oil *(Ximenia cafra)*	oil	cosmetics	Phytotrade
Cape Aloe (*Aloe ferox*)	Aloe Juice, aloe-based jams, pickles and relishes	Food preserves /cosmetics	Totally wild http://www.totallywild.co.za/background
Hoodia (*Hoodia gordonia*)	Stem	Originally used as food fruit by Nama probably incorrectly marketed as an appetite suppressant	Various
Rooibos and Honey bush tea		Leaves/Tea	Heiveld Co-operative. Rooibos Ltd.
Pelargonium sidoides	Oil extract from leaves	Flue medication	Natura Homeopathic Laboratory
Marogo) *Amaranthus* spp.	leaves	Food	Sold in cans (e.g. 'Green Gold' and 'Gold Crest Traditional Morogo)
Masau *Ziziphus mauritiana*	fruit	Eastern fresh, dried, made into bread or into alcoholic drink	Global Facilitation Unit for Underutilized Species, marketed commercially in Mozambique

1.7 What are superfoods?

There is no single agreed definition of what constitutes a 'superfood'. Ultimately the term has been exploited as a marketing strategy by trendy health food outlets. Experts estimate that the global market for these foods will *reach* $177 billion by 2013 (smallfootprintfamily.com). With so much money at stake, the 'superfood' trend has been co-opted to sell everything from broccoli to vitamin supplements.

Many foods are labeled as ‘superfoods’ due to claims of extraordinary health benefits. The foods are generally whole, natural foods and preferable raw (not cooked or heated above 45 degrees). Other definitions may focus on specific groups of nutrients other than vitamins or proteins, such as foods that contain a high concentration of phytonutrients, long chain carbohydrates (low GI index) and essential oils (in particular omega 3’s).

Those who tout them, suggest that by incorporating a variety of these exceptionally healthy foods, one's overall physical health can improve. Typical examples, sold in expensive health shops in South Africa include Goji Berries, Raw Cacao, Maca Powder, Hemp Seed Powder, and Spirulina. Important to this work is that all of these superfoods are all imported products, and thus incur a high carbon footprints.

The definition of a ‘superfood’ becomes somewhat fuzzy when seen in the broader context of the term *nutraceutical* (a term closely related to ‘phytonutrients’). Dillard & German, (2000) define a nutraceutical as ‘any non-toxic food extract supplement that has scientifically proven health benefits for both disease treatment and prevention’. Dlamini (2010) lists the major plant-derived chemical groups recognized as having potential health promoting effects, to include certain flavonoids, alkaloids, carotenoids, phytosterols, tannins, terpenoids, saponins, soluble and insoluble dietary fibres. Examples of Southern African plants that meet this definition include Buchu tea (*Agathosmabetulina*), Honeybush tea (*Cyclopiagenistoides*), *Aloe ferox, Hoodia and Sceletium.*

So while the distinction between a superfood and a nutraceutical is not always clear, superfoods tend to provide high concentrations of essential nutrients, while a nutraceutical may be a whole plant or a plant extract that contains natural chemicals with health and medicinal properties.

2 Approach

2.1 Defining grades of superfood

Superfoods have become a marketing handle increasingly used by the health foods industry to sell expensive imported food concentrates. The definition of superfoods is vague. For the purposes of this work, I have tightened the definition to imply *foods with an exceptional health benefit and that are produced and sold with a low ecological footprints and positive social benefits to local rural populations* (and ideally, with positive conservation spinoffs, such as promoting natural habitat conservation). See figure below.

Table 2. Grades of the definition of ecologically sustainable superfoods

Grades of the definition of 'Superfoods '	Criteria	
High density of essential nutrients (vitamin and mineral)	Nutrional definition	'nutrional foods'
High in phytonutrients, micronutrients, trace minerals and antioxidants		
The right combination of nutrients, and in highly absorbable forms (e.g. favorable ratio of minerals, vitamin & co factors)		
High in essential nutrients that are typically low in modern diets (e.g. certain amino acids, like Lysine, Methionine**)**		
Organically produced		
Raw and unprocessed		
Wild Grown	Ecological footprint definition	
Ecologically sustainable (no or low harvest impact, and low carbon footprint from source to point of consumption)		
Provides tangible biodiversity conservation spinoffs		'true superfoods'
Communities benefit directly (fare trade certification)	Social footprint definition	

Currently almost all the superfoods sold in developing countries are exotic plant products that have been imported (goji berries from China and Tibet; açai, maca, chia, and quinoa from South America; coconut, nonifruit and durian from Southeast Asia; mesquite, agave, and spirulina from Mexico; and chlorella from Japan). While many of these foreign foods are very nutritious, they carry a heavy environmental and social footprint. Transporting food is one of the fastest-growing sources of greenhouse gas emissions (World Watch Institute, 2012).

Most products sold as superfoods in South African health shops, typically, meet the nutritional criteria, but fall short of the social and ecological criteria; this is because many are not harvested from the wild, or may not be organically certified, and are usually imported from South America or Asia, incurring high carbon footprints. The benefits accrued to local communities are also unknown. Currently this author is only aware of two superfoods that meet all these criteria, and that are commercially marketed in South Africa, these are *baobab seed powder* and *Maroela nut oil.*

An additional concept that has recently crept into the health food industry is the term '*beyond organic'*– meaning that the plant grows wild in its natural habitat and is sustainably harvested at its peak. This apparently, develops a superior nutritional profile as the soils in which wild crafted plants grow are abundant in minerals and co-factors that are often lacking even in organic growing operations.

The underlying motivation of this study is as follows: given the high botanical diversity of the Wild Coast and the strong traditional of use of wild plants (for foods, medicine etc.), there is a good likelihood that there are edible plants that could meet the market standards of a 'superfood' (as defined in table 2). The increased interest in the use of superfoods provides a marketing opportunity that can lead to significant benefits to local communities.

2.2 Search methodology

As this study is a desktop study, no laboratory analysis was budgeted for. Reliance is made on available existing information sources, and these include: direct observations; communication with specialists in the field of nutritional analysis of wild plants and a review of available literature. These are briefly discussed below.

2.2.1 Personal observation and interviews

After three years of working on conservation issues on the wild coast, of which a significant portion has been spent in the field, I have had the opportunity to observe and record the use of indigenous wild plants, in particular the fruits eaten by children, or vegetables collected by elderly woman.

2.2.2 Direct communication with specialists

I have been in contact with a number of specialists in the field, who have mostly been forthcoming in providing me with their relevant and latest research papers; these are listed in the table below.

Table 3 Specialist consulted thus far for this study

Specialists	Position and contact
Dr. Gerda Botha (PhD) Pr.Sci.Nat	Business Area Leader: Food Science Biosciences CSIR Tel: (+12) 841 3147 gbotha@csir.co.za
Dr.Vinesh Maharaj	Biosciences CSIR Tel: (+12) 841 3147 VMaharaj@csir.co.za
Professor Marthinus Horak	Dr Marthinus Horak Manager: Essential Oils and Medicinal Plants Enterprise Creation for Development CSIR Pretoria tel +27 (0)12 841 2670 fax +27 (0)86 558 2489 RMHorak@csir.co.za
Professor Hettie Schönfeldt	School of Agricultural and Food Sciences University of Pretoria South Africa Tel: + 27 (0) 12 348 6649 Fax: + 27 (0) 12 361 2333 Cell: +27 (0)83 458 2757 hettie.schonfeldt@up.ac.za
Dr Beulah Pretorius	ARC-Irene Analytical Services, Animal Production Institute, Agricultural Research Council, Irene, Republic of South Africa beulah.pretorius@gmail.com

Dr. Priscilla Burgoyne	Botanical Scientist, National Herbarium South African National Biodiversity Institute Private Bag X 101, Pretoria, 0001,RSA. Research Fellow UNISA, Department of Environmental SciencePhone: +27 12 843 5000 Fax: +27 12 804 3211 E-mail: P.Burgoyne@sanbi.org.za URL: www.sanbi.org
Dr. Soul Shava	University of South Africa Department of Educational Studies, P.O. Box 392, UNISA 0003, Pretoria, South Africa Cell: 00 27 78 695 4153 Fax: 00 27 86 695 6865 Email: soul.shava@gmail.com
Dr Janice Golding	Programme Manager at Swiss Economic Cooperation (SECO) Honorary Research Associate at University of Cape Town Business & Environment Adviser at SADC-Transfers janice.golding@eda.admin.ch

2.2.3 Review of key literature sources

Although a relatively large body of literature has been collected and consulted concerning wild edible foods from southern Africa, a number have been particularly useful for this project, these include:

Table 4. Key literature sources used.

Author(s)	Title	How used
Wehmeyer, A. S. 1986	Edible wild plants of southern Africa: data on nutrient contents of over 300 species. Council for Scientific and Industrial Research, Pretoria	Provides the most comprehensive data on nutritional content of wild foods. This project has converted lists of tables into a digital searchable database format
Fox, F.W., Norwood Young, M.E. (1982).	Food From the Veld. Edible Wild Plants of Southern Africa. Craighall: Delta Books	Seminal work on over 1000 edible wild plants from Southern Africa , not much data on nutritional status
National Research Council, Washington DC	Lost Crops of Africa 1996. Volume I: Grains 2006 Volume 11: Vegetabels 2008 Volume 111: Fruits	Most interesting volumes that identify and shortlist about 10 to 20 plants for each of the most important fruits, grains and vegetables growing wild in Africa and that have been used in the past, and that show potential for diversifying and improving nutrition, and could be cultivated
Chivandi, et al 2010	Proximate, mineral, amino acid, fatty acid, vitamin E, phytate phosphate and fibre composition of Mimusops zeyheri (Red-milkwood) seed International Journal of Food Science and Technology 2011, 46, 555–560	Ground breaking research on nutritional value of Transvaal Red-milkwood seeds, used to extrapolate nutritional value of other members of the sapotacea (e.g. Coastal Red-milkwood)
Shava, S. 2000.	The use of Indigenous Plants as food, by	Provides a useful list of plants used

	a rural community in the Eastern Cape: An educational exploration A thesis submitted in partial fulfillment of the requirements for the degree of Masters of Education Rhodes University	for food in Eastern Cape , most also used in Wild Coast
Shackleton et al 2007	Direst-use value of non-timber forest products from two areas on the Transkei Wild Coast. Agrekon **46**: 135-155	Confirms importance of number of forest fruit trees as dietary supplements
Fearon, J.J. 2010	Population assessments of priority plant species used by local communities in and around three Wild Coast reserves, Eastern Cape, South Africa. of Masters of Science. Department of Environmental Science, Rhodes University	Useful in determining availability and abundance of some of the commonly used wild foods on Wild Coast
Van Wyke B & Gerieke, 2000	Peoples plants: A guide to Useful Plants of Southern Africa.	Provides a broad southern African perspective to the range of wild plants utilized by a cross-section of South African cultures
Boon R, 2010	Pooleys Trees of Eastern South Africa: A complete guide	Essential in confirming distributions of species, as well as on information concerning edibility of fruit from certain trees

2.2.4 Conservation criteria

Because this project is part of a broader conservation funding strategy for the Maputuland-Pondoland-Albany Hotspot, it is important that not only are considerations of sustainability be included within the project framework, but also that the project be used to promote explicit incentives amongst communities for the conservation of natural habitat (referred to in this report as ‘ positive conservation spin-offs’).

Conservation related criteria include:

- The plant occurs in the study area in significant abundance and density

  (This is the most basic criteria, as low density of plants will lead to high harvesting effort, for low returns).

- Plants should not be listed as a red data or threatened

- Should be possible to harvest sustainably, and negligible ecological impacts.

The removal of any plant parts in significant amounts is never going to be without some ecological impacts. For example, the removal of tree fruits is likely to reduce available feed for frugivoures, however some these impacts can be mitigated (for example by harvesting only below a certain height or only picking fallen fruits etc. In addition impacts need to be seen in the broader context of ongoing habitat destruction from cultivation or from poor livestock management.

- Use should result in overall net positive conservation spin-offs. These may be:
    - Direct, as for example harvesting of fallen fruits, removes a potential source of attraction for goats that enter the forest to feed on fallen fruits.
    - Indirect, economic benefits realized by local populations from harvesting of non-timber forest products, will provide incentives to ensure that others do not illegally harvest 'their forests'

2.2.5 Multi-criteria analysis

Selection criteria are divided into essential criteria and scoring criteria. The former are essential conditions that needed to be met for a candidate plant to be selected, while the later are preference criteria that contribute to an overall higher sore and ranking in the multi-criteria evaluation.

Essential criteria

- Occurrence in study area
- Abundance
- Has been used traditionally as a food plant
- Can be sustainably harvested

Scoring criteria

- High nutritional profile
- Commercial potential (safety, palatability, shelf life, processing, packaging, marketing etc)
- Positive conservation spin offs
- High in certain key nutrients

The first set of criteria provide a preliminary 'long list' of plant species that have some commercial potential to be sustainably harvested from wild stocks, these are the lists of plants presented in this progress report. Further refinement of this selection will be presented later in this report, where the second set of scoring criteria will be used to select a 'short list' of species with commercial viability for wild harvesting.

2.3 Database on nutritional values

Available nutritional data on South African wild food plants has been integrated into a single searchable data base for the purpose of this project. In itself, this database will be a useful product. Apparently no such database currently exists. This will enable complex quarries to be made such as finding potential food plants high in specific minerals or vitamins, or with favorable combinations of nutrients, etc.

The seminal work of Wehmeyer (1986) who analyzed over 300 southern African wild food plants for a wide range of nutrients has never been digitized into a database format. (Professors Hettie Schönfeldt and Marthinus Horak, pers. coms.). For this project, this work has been scanned in, (with some help from optical character recognition software), and manually entered into an M.S. Access database (consisting of well over 300 x 20 data entries). This data has then been linked to additional data sources, including some more recent analysis (in particular on wild vegetables and on the seed content of some plants) as well as the forest species database developed by (Berliner, 2009) which provides data on the occurrence and conservation status of the species.

An example of a section of the database developed for this project is given in table 5 below. A sort has been made for high vitamin C containing plant foods, (but not according to any other conditional criteria such as occurrence or abundance). It has been horizontally transposed to fit into the page.

Table 5 Extract from database under development showing a section of high vitamin C containing wild food plants from the families Anacardiaceae and Amaranthacea

GENUS	Sclerocarya	Amaranthus	Rhus	Harpephyllum	Gethyllis	Sclerocarya
SPECIES	birrea	hybridus_var_hybridus	lancea	caffrum	ciliaris	birrea
FAMILY	ANACARDIACEAE	AMARANTHACEA	ANACARDIACEAE	ANACARDIACEAE	AMARLLIDACEAE	ANACARDIACEAE
PART_USED	berries	leaves	leaves	fruit_flesh	fruit_flesh	beer
MOISTURE_g_100g	85	84.9	86.4	*87.5*	86.4	97.3
ASH_g_100g	1	*2*	1.1	*0.8*	0.7	0.1
PROTEIN_g_100g	0.5	3.5	1.8	0.7	2.7	0.2
FAT_g_100g	0.4	0.3	0.3	0.2	0.3	
CRUDE_FIBER_g_100g	1.2	1.5	1.7	1.7	0.9	
CARBOHYDRATE_g_100g	12.0	6.9	8.7	9	9	2.4
ENERGY_kj_100g	225	186	187	172	208	
Ca_mg_100g	20.1	306	149	47.0	7.16	4.1
Mg_mg_100g	25.3	182	44.4	23.7	19.7	0.65
Fe_mg_100g	0.5	6.0	0.10	0.6	0.61	0.66
Na_mg_100g	2.24	3.62	4.60	5.73	15.4	5.19
K_mg_100g	317	760	148	254	279	45.2
Cu_mg_100g	0.07	0.23	0.12	0.14	0.17	0.06
Znm_g_100g	0.1	0.63	0.22	0.14	0.51	0.19
Mn_g_100g						
P_g_100g		64.2	42.4	13.3	55.9	0.77
Thiamin_g_100g	0.03	0.01		0.12	0.18	
Riboflavin_g_100g	0.02	0.15	0.09		0.12	
Nicotinic_acid_g_100g	0.27	1	0.26		1.44	
Vit_C_g_100g	194	126	108	70.7	52.4	49
Occurrence in Wild Coast	no	Yes	Yes	Yes	no	No

Limited analysis of what has been developed in the database thus far, reveals that a number of families have a significant number of highly nutritious and edible fruits. For example, the family Sapotocea (the Milkwoods) has many edible and nutritive fruit trees. See the table below

Table 6. Nutritional content of some edible fruit trees from the family Sapotocea

Family : Sapotocea									
COMMON_NAMES	Transvaal milkplum	Fluted milkwood	Zulu milkberry	Forest milkberry	Lowveld milkberry	red milkwood	Red milkwood Tree	Transvaal red milkwood	white milkwood
GENUS	Bequaertiodendron	Chrysophyllum	Manilkara	Manilkara	Manilkara	Mimusops	Mimusops	Mimusops	Sideroxylon
SPECIES	magalismontanum	viridifolium	concolor	discolor	mochisia	caffra	obovata	zeyheri	inerme
PART_USED	fruit_flesh	fruit_flesh	fruit_flesh	fruit_flesh	fruit_flesh	fruit_flesh	fruit_flesh	fruit_flesh	fruit_flesh
MOISTURE_g_100g	74.3	58.2	71.4	71	70.4	69.7	70.2	66.4	70.2
ASH_g_100g	0.7	1.1		1.3		1.3	1.7	1.4	2.3
PROTEIN_g_100g	0.9	*2.7*		2.1		0.8	1.9	1.2	4.3
FAT_g_100g	0.6	3.5		1.9		0.6	0.3	0.6	4.4
CRUDE_FIBER_g_100g	2	1.9		2.1		1.9	3	3.9	1.5
CARBOHYDRATE_g_100g	21.5	32		21.6		25.7	22.9	26.3	17.3
ENERGY_kj_100g	399	715		470		468	428	484	529
Ca_mg_100g	14.5			81.9			43.9	40.4	46.4
Mg_mg_100g	20.6			26.5			51.5	22.1	41.7
Fe_mg_100g	0.76			0.75			0.88	0.68	1.18
Na_mg_100g	5.25			4.97			51.6	10.5	
K_mg_100g	268			474			489	392	482
Cu_mg_100g	0.23			0.13			39	0.15	0.1
Znm_g_100g	0.29			0.25			0.21	0.16	0.2
Mn_g_100g				1.98					
P_g_100g	15.9			23.6			26	15.8	17
Thiamin_g_100g	0.05			0.04					0.06
Riboflavin_g_100g	0.08			0.4				0.01	0.09
Nicotinic_acid_g_100g	1.38			0.35				0.36	0.55
Vit_C_g_100g	13.1		21.1	12.4	45		60	28.6	14.8
Carotene_g_100g	0.98		0.0031	0.002					

2.4 Description of database and limitations

The work of Wehmeyer (1986), assessed over 350 southern African wild food plants for macro nutrients (protein, fiber, carbohydrates, energy) and micro nutrients (minerals and vitamins). This was digitized into a relation database (using MS excel). In addition to this, results from a number of more recent studies have been included; specifically those relating to the recent interest in the various species of wild African leafy vegetables (in particular the work of Odhava, et al 2007) as well as the work done on the nutritional value of the seeds of the Transvaal Red Millwood (Chivandi et. al, 2007).

For a wild plant to be considered as a superfood it would need to stand out as being nutritionally superior to other wild foods, not just within a limited region such as the Eastern Cape, Wild Coast but also across the southern African sub region. For this reason a broader selection analysis was conducted on all available data for Southern African Wild food plants, and not just those occurring within the Eastern Cape.

In cases where important plant species are suspected of being nutritionally superior, data from the closest relative has been used to infer probable nutritional values. For example, the nutritional values of the seed/nut of the Transvaal Red Millwood, *Mimusops zeyheri,* done by Chivandi et. al, 2007 (a species that does not occur in the Eastern Cape) was used to infer possible values of the Coastal Red-milkwood, *Mimusops Cafra*, a species that occurs in abundance on the Wild Coast, and holds considerable promise as a superfood plant.

An additional important limitation is that the data of Wehmeyer (1986) does not consider all of the trace minerals (such as selenium), nor any of the phytonutrient compounds such as antioxidants.

The data of Wehmeyer(1986), although reliable and asses according the standard scientific methods, is still subject to unavoidable variations, in particular those relating to variation in the total moisture content, and values given cannot be considered as absolute but rather indicative.

All results are relative to initial moisture content. The higher the moisture content the larger its influence on the results. So where moisture has been lost before laboratory analysis, results may be affected. In addition certain nutrients such as Vitamin C and carotene loose value very quickly after collecting and analysis needs to be done on fresh material. Because of these and other possible distortion factors Wehmeyer(1986) is clear to point out, that these values need to be considered as possible indications of the nutrient status and not necessary as absolutes.

2.5 Indicators used to rank nutritional quality of wild foods

The term nutrient density has several meanings. Most commonly, nutrient density is defined as a ratio of nutrient content (in grams) to the total energy content (in kilocalories or joules). Nutrient-dense food is opposite to energy-dense food (also called "empty calorie" food). According to the Dietary Guidelines for Americans 2005, nutrient-dense foods are those foods that provide substantial amounts of vitamins and minerals and relatively few calories. Fruits and vegetables are the nutrient-dense foods, while products containing added sugars, processed cereals, and alcohol are not. Second, nutrient density is defined as a ratio of food energy from carbohydrate, protein or fat to the total food energy. To calculate nutrient density (in percent), divide the food energy (in calories or joules) from one particular nutrient by the total food energy in the given food.

The sum of all nutrients divided by the energy value per 100mg, gives a general nutritional density rating, but because not all of the fields for vitamins and minerals are available for all plants analyzed, a corrected approximated version of nutritional density index was developed. This considers how many data fields are available and divides this by the sum of all nutrients. This is then divided by the energy value. It should be remembered that these indices are relative values to rank the nutritional values of wild plants within the table; they cannot be used in any absolute value.

Some foods may be very high in certain nutrients but low in others, while other may not have any exceptionally high nutrients, but may have a good general levels of a combination of a wide spread of different nutrients required by the human body.

Because of this difficulty of comparing one food against another I have developed two indicators that can be used to measure the *relative value* of a food plant part; these are discussed in the sections below.

2 5.1 Approximate Nutrient density

The first indicator developed here is the' approximate nutrient density'. The term *approximate* is used to show that their values are relative and limited to the availability of information in the database. I will hence forth refer to this indicator as the '*nutrient density'*; this is a measure of the total nutrients provided in a food relative to its energy value. For example, foods that are high in energy but low in nutrients (e.g. starches) will have a low nutritional density, as large amounts of the food need to be eaten before basic nutrient requirement can be satisfied. Nutrient density indicator is a relative value with no units and can only be used to rank plant foods within this database.

Nutrient density = (sum of macro nutrients /energy + sum of micro nutrients/energy)/2
Macro nutrients are measured in g/100g dry weight; Micro nutrients are measure in mg/100g dry weight

2.5.2 Percentage Complete Food index (% CFI)

The second indicator is used to evaluate the nutritive content of a food relative to how well it meets recommended daily allowances (RDA) for each of the nutrients measured. This is considered to be a more reliable indicator of nutritional value. It is calculated as follows:

Mean of sum of all nutrients (Value of nutrient /RDA for nutrient) , expressed as a percentage of RDA, with maximum value of 100% (in cases where the nutrient exceed the RDA)

It is important to point out that firstly these indicators should be seen as relative values, and can therefore only be used to compare *within this database* of values derived from the same analysis methods. Secondly, not all of the data fields for macro and micro nutrients were calculated for all plants, a significant number of nutrients were not evaluated. For this reason, I have added the additional indicator of the *confidence factor***,** (not always shown in the tables due to limited space). This indicates how many of the nutrients have been analyzed. For some plants, for example , where only half of the nutrients are evaluated the confidence factor will be 50 %. It is also not always clear if some of the values are zero or just absent from the analysis, in all cases they are considered as 'missing' and contribute to a lower confidence factor (%CF).

An example of the indicators used has been extracted from the database and shown in the table below

Table 7 Example of the evaluation indicators used: N*utrient Density* and %C*omplete Food Index. Table shows indicators for* six wild fruits. The RDA is the recommended daily allowances as given by World Health Organization. See text for methods

GENUS	Eugenia	Harpephyllum	Sideroxylon	Phoenix	Carissa	Podocarpus	RDA
SPECIES	capensis	caffrum	inerme	reclinata	bispinosa	falcatus	
ASH_g_100g	1	0.8	2.3	3.9	0.7	1.2	
PROTEIN_g_100g	0.9	0.7	4.3	3.2	0.7	3	50
FAT_g_100g	0.4	0.2	4.4	0.7	1.2	0.3	65
CARBOHYDRATE_g_100g	27.7	9.1	17.3	46.3	14	17.6	300
CRUDE_FIBER_g_100g	1.4	1.7	1.5	9.8	1.8	5.2	25
Ca_mg_100g		47	46.4	50.6	20.6	46	1000
Mg_mg_100g	26.7	23.7	41.7	79.2	19.8	20.1	400
Fe_mg_100g	1.67	0.6	1.18	182	0.81	1.6	18
Na_mg_100g	66.5	5.73		67	10.3	11.5	2400
K_mg_100g	209	254	482	1329	261	460	3500
Cu_mg_100g	0.14	0.14	0.1	0.33	0.23	0.98	2
Zn_mg_100g	0.04	0.14	0.2	0.76	0.43	0.2	15
Mn_mg_100g				0.81			400
P_mg_100g	31.8	13.3	17	33	25.9	10.3	1000
Thiamin_mg_100g	0.11	0.12	0.06	0.03	0.05	0.04	1.5
Riboflavin_mg_100g	0.03		0.09	0.02	0.08		1.7
Nicotinic_acid_mg_100g	0.39		0.55	1.16	0.32	1.13	20
Vit_C_mg_100g	107	70.7	14.8		10.6		60
sum	474.78	427.93	633.88	1807.81	368.52	579.15	
ENERGY_kj_100g	496	172	529	858	292	357	
Nut density index	1.0	2.5	1.2	2.1	1.3	1.6	
Complete food index %	15	10	10	2	7	10	
Confidence factor (%)	90	85	90	95	90	90	

2.6 Summary of research methodology

The research methodology used in in this report has been summarized in the figure below

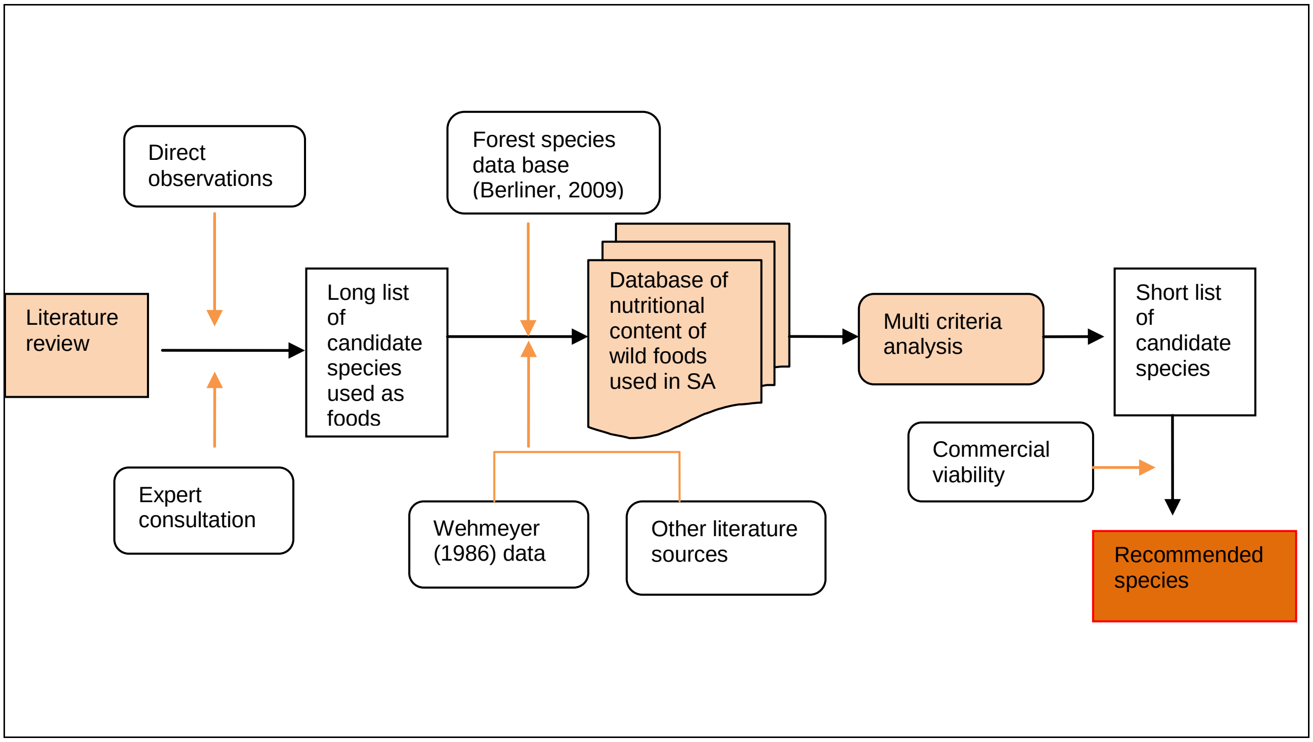

Figure 3. Summary of research methodology used.

3. Important considerations in the selection of a wild plant food

3.1 Non nutritional components of wild foods with potential health benefits

Phytonutrients

Plant foods contain thousands of natural chemicals. These are called phytonutrients or phytochemicals. These chemicals help protect plants from germs, fungi, bugs, and other threats.Phytonutrients aren't essential for keeping you alive, unlike the vitamins and minerals that plant foods contain. But when you eat or drink phytonutrients, they may help prevent disease and keep your body working properly. More than 25,000 phytonutrients are found in plant foods. Six important phytonutrients with potential health effects include: Carotenoids; Ellagic acid, Flavonoids, Resveratrol, Glucosinolates, Phytoestrogens.

Carotenoids.
More than 600 carotenoids provide yellow, orange, and red colors in fruits and vegetables. Carotenoids act as antioxidants in your body. This means they tackle harmful free radicals that damage. They include Alpha-carotene, beta-carotene, and beta-cryptoxanthin. Your body can convert all of these to vitamin A. Yellow and orange foods like pumpkins and carrots are good sources of alpha- and beta-carotene. These also contain beta-cryptoxanthin, as do sweet red peppers.

Lycopene.
This gives red or pink colour to tomatoes, watermelon, pink grapefruit, lycopene has been linked to a lower risk of prostate cancer.

*Lutein and zeaxanthin***.**
These may help protect you from cataracts and age-related macular degeneration, which are two types of eye problems. Good sources of these phytonutrients are greens such as Spinach, Kale, Collards.

Ellagic Acid.
This is another phytonutrient found in a number of berries and other plant foods, especially in Strawberries, Raspberries, Pomegranates. Ellagic acid may help protect against cancer through several different ways.

Flavonoids.
A large number of phytonutrients fall into the flavonoid category. They are found in a variety of plant foods. The types of flavonoids include: Catechins. Green tea is an especially good source of catechins. The drink may help prevent certain types of cancer. Hesperidin. Found in citrus fruits, this flavonoid works as an antioxidant. It can reduce inflammation in the body. It may also help reduce the risk of cancer. Quercetin is a well-studied type of flavonol. It is found in Apples, Berries and Grapes.

Phenolic compounds

Plants are a storehouse of chemical substances. Certain parts of plants may be toxic, while other parts of the same plant are harmless. Many wild foods are rich sources of bioactive compounds many with beneficial effects on health. The most important are discussed below.

Polyphenols are quantitatively the main dietary antioxidants and possess higher in vitro antioxidant capacity than vitamins and carotenoids (Gardner et al., 2000). Plant phenolics include phenolic acids, coumarins, flavonoids, stilbenes, hydrolysable and condensed tannins, lignans and lignins. Generally, plant extracts that contain a high amount of polyphenols also exhibit high antioxidant activity.The Wild leafy vegetables such as *Amaranthus sp*., and *Solanum macrocarpon* have high antioxidant activity (Nangula, 2010).

Dillard & German, 2000 defines Nutraceutical as “any non-toxic food extract supplement that has scientifically proven health benefits for both disease treatment and prevention”. In the global marketplace nutraceuticals and functional foods have become a multi-billion dollar industry and tremendous growth is projectected. Nutrceuticals include anti-cancer and disease agents, such as canthaxanthin (reported to be an antitumor agent) and lutein, (which is reported to slow down the development of age-related eye diseases), found in *Amaranthus* spp.

The analysis to find a wild super food is limited to the available information on the nutritive compounds in wild foods. Unfortunately few wild foods have been fully essayed for many of the phytonutrient compounds beyond the macro and micro nutrient of vitamins and minerals.

3.2 Health risks and safety considerations

Some wild foods, in particular leafy vegetables may however also contain dietary components that compromise digestion and absorption of vital nutrients. These components occur in combinations and may act synergistically or may have contradicting effects with each other.

Anti-nutrients are found at some level in almost all foods for a variety of reasons. However, their levels are reduced in modern crops, probably as an outcome of the process of domestication. The most important of these include:

Tannins
Tannins interact with proteins, starches and digestive enzymes, thereby reducing the nutritional value of foods (Chung et al., 1998), in particular. Tannins interfere with protein absorption and reduce iron availability.

Oxalic acid
Calcium oxalate is the most common component of kidney stones. Early investigators isolated oxalic acid from wood-sorrel (Oxalis). Its presence makes it dangerous to eat unripe carambola or monstera fruits. Members of the spinach family are high in oxalates, as is sorrel, Rhubarb leaves contain about 0.5% oxalic acid. Depending on species, oxalate can occur as soluble salts of potassium and sodium salts and as insoluble salts of calcium, magnesium and iron or as a combination of the two forms (Noonan and Savage, 1999).

Insoluble oxalate is excreted in the faeces while the soluble oxalate is absorbed by the body. Soluble oxalate forms strong chelates with dietary calcium, rendering it unavailable for absorption and assimilation (Radek and Savage, 2008). High dietary intake of soluble oxalate can lead to the formation of kidney stones (Radek and Savage, 2008). Addition of a source of calcium to vegetables containing high levels of soluble oxalate has been shown to reduce the intestinal available oxalate content in such food (Radek and Savage, 2008). Common foods containing oxalic acid include orange, spinach, rhubarb, tea and coffee, banana, ginger, almond, sweet potato, bell pepper.

Phytic acid
Phytic acid is the major phosphorus storage compound in many wild leafy vegetables. Although phytic acid is an antioxidant, it has been shown to inhibit absorption of minerals. Phytic acid chelates multivalent metal ions such as zinc, calcium and iron, thus it is a strong inhibitor of iron mediated free radical generation (Rackis, & Joseph, 980). The disadvantage of this is that a diet high in phytate content reduces the bioavailability of zinc, iron and calcium and has adverse effects on the digestion of proteins and starches (Reddy and Pierson,1994). The beneficial effects of phytic acid are related to its metal chelating abilities. Phosphates can act as antioxidants by inhibiting iron-mediated oxidative reactions, enhancing immunity by increasing Natural Killer cell function and activity and stimulating bacterial killing by neutrophils (Bohn et al., 2008)

Common foods containing Phytic acid (inositol hexaphosphate), include cereals, nuts, sesame seeds, soybeans, wheat, pumpkin, beans, almonds. Phytic acid not only grabs on to or chelates important minerals, but also inhibits enzymes that we need to digest our food, including pepsin, needed for the breakdown of proteins in the stomach, and amylase, needed for the breakdown of starch into sugar. Trypsin, needed for protein digestion in the small intestine, is also inhibited by phytates. High-phytate diets result in mineral deficiencies. In populations where cereal grains provide a major source of calories, rickets and osteoporosis are common.

Various food preparation methods can be used, such as soaking overnight that activates the enzyme, phytase, that breaks down phytic acids. Soaking grains and flour in an acid medium at very warm temperatures, as in the sourdough process, also activates phytase and reduces or even eliminates phytic acid (Nagel, 2010).

Alkaloids

The bitterness of some wild plants often indicates the presence of alkaloids, which invariably influence the consumer acceptability of such vegetables (Wallace et al., 1998). The two groups of alkaloids that have been well studied are the pyrrolizidine and the quinolizidine. Pyrrolizidine are frequently found in members of Asteraceae and in the Boraginaceae families, rendering these plants toxic, while, quinolizidines occur primarily in the genus Lupinus, Amaranth and Portulaca. Naturally occurring pyrrolizidine alkaloids are harmless but become highly toxic when transformed by cytochrome P450 monooxygenases in the liver (Croteau et al.,2000). These compounds also possess medicinal properties.

Protease inhibitors

Some African wild leafy vegetables contain trypsin and chymotrypsin inhibitors that impairs the utilization of proteins and the amino acids present, by interacting with proteolytic enzymes rendering them unavailable for protein digestion (Mosha and Gaga, 1999). Presence of protease inhibitors have been reported in Maerua crassifolia, Brassica sp. and Boscia senegalensis, amongst others. The activity of trypsin and chymotrypsin inhibitors is strongly influenced by the presence of water, the temperature and the length of cooking (Mosha and Gaga, 1999).

Aflotoxins

These mycotoxins are often found in legumes and nuts that have been contaminated. Dry storage can reduce this risk significantly.

Hormone analogs

Certain plants contain oestrins and goitrogens that occure in some legumes, yams and sweet potatoes and beets.

Enzyme inhibitors, vitamin and amino acid antagonist

These may occur in certain legumes and cereals, and in the tomato family (Fox & Noorwood Young, 1982)

3.3 Reduction of anti-nutritional factors through processing

Heat treatment is a reliable method of reducing anti-nutritional factors in leafy vegetables (Mosha and Gaga, 1999), although this could lead to leaching of nutrients (Mepba et al., 2007). Blanching and cooking causes the rupture of the plant cell walls resulting in the leaching of soluble anti-nutritional factors into the blanching medium. Blanching and cooking significantly reduce the levels of oxalic and phytic acid in leafy vegetables (Oboh et al., 2005), while drying and storage has little effect on these anti-nutritional factors (Yadav and Sehgal, 2003). Conventional blanching was found to be more effective in reducing trypsin and chymotrypsin inhibitor activities than microwave blanching (Mosha and Gaga, 1999). Although Vanderjagt et al. (2000) found that in most ALVs, the trypsin inhibitory activity was heat-stable after 5 min of boiling, which may lead to poor protein utilization in humans.

There is a significant interaction between plant age and growth temperature, with respect to antioxidant activity of boiled *Amaranthus*. Modi (2007) found that boiled amaranth that was harvested 60 days after sowing displayed higher antioxidant activity compared with those harvested at either 20 or 40 days after sowing. Therefore, the stage of plant development should be considered during harvesting for optimum antioxidant activity.

Many traditional methods of food preparation such as fermentation, cooking, and malting (sprouting), and soaking, increase the nutritive quality of plant foods through reducing certain anti-nutrients such as phytic acid, polyphenols, and oxalic acid. Such processing methods are widely-used in societies where cereals and legumes form a major part of the diet. An important example of such processing is the fermentation of cassava to produce cassava flour: this fermentation reduces the levels of both toxins and anti-nutrients in the tuber.

3.4 Evaluation of nutritional status of natural foods

Nutritional rating systems are methods of ranking or rating food products or food categories to communicate the nutritional value of food in a simplified manner to a target audience. Rating systems are developed by governments, nonprofit organizations, or private institutions and companies.

The methods may use point systems to rank or rate foods for general nutritional value or they may rate specific food attributes such as cholesterol content. Graphics or other symbols may be used to communicate the ratings to the target audience.

Nutritional rating systems differ from nutritional labeling in that they attempt to simplify food choices, rather than listing specific amounts of nutrients or ingredients.

Three rating systems commonly used, are briefly discussed, as they will form the basis of a simplified method used in this report. Importantly the methods used for the evaluation of wild foods will need to be adapted to the availability of information. Currently the only data source that provides a measure of consistence for some, but not all of the long listed species is that of Wehmeyer (1986).

Nutripoints (Vartabedian, 2010)
This is a system for rating foods on a numerical scale for their overall nutritional value. The method is based on an analysis of 26 positive (such as vitamins, minerals, protein, fiber) and negative factors (such as cholesterol, saturated fat, sugar, sodium) compared to the calories in the food. The overall Nutripoint score of the food is the result. The higher the value, the more nutrition per calorie (nutrient density) and the least negative factors in the food. Thus, the higher the Nutripoint score, the better the food for overall health. The system rates 3600+ foods including basic foods like apples and oranges, fast-foods, and brand-name foods.

Nutripoints was developed by Dr. Roy E. Vartabedian (a Doctor of Public Health) in the 1980s and was released to the general public in 1990 with his book, "Nutripoints," published in 13 countries and 10 languages worldwide. The food rating system is part of an overall program designed to help people measure, balance, and upgrade their diet's nutritional quality for overall health improvement and well-being.

Naturally Nutrient Rich (NNR), Drewnowski, (2012)
This indicator is based on mean percentage daily values (DVs) for 14 nutrients in 2000 kcal food, can be used to assign nutrient density values to foods within and across food groups. Use of the NNR score allows consumers to identify and select nutrient-dense foods while permitting some flexibility where the discretionary calories are concerned.

The Aggregate Nutrient Density Index (ANDI)
This is a score assigned to whole foods that contain the highest nutrients per calorie. Each of these whole foods is given a score based on the equation H=N/C, which is that the health of a food is equal to the nutrients it delivers per calorie.

The ANDI of any given food is determined by taking its aggregated content of micronutrients -- such as vitamins and minerals and phytochemicals -- and dividing it by the food's aggregated content of the macronutrients protein, carbohydrate and fat. Because different nutrients are measured in different units of measurement, their aggregated content is determined by their recommended daily intake (RDI) or, when unavailable, their estimated daily value (DV) as a percentage of one's total daily diet.

The resulting values are then factored by a common multiplier to produce a value on an index ranging from 0 to 1,000; the higher the number, the more nutrient dense the food, and the lower the number, the less nutrient dense. A person can then add up the ANDI values of all the foods in any given meal to determine its overall nutritional density.

The nutrient balance indicator provided a visual representation of how complete a food is in terms of providing recommended daily amounts across all essential nutrients, as well as quantities of unhealthy components (such as saturated fats, sodium and cholesterol) . The diagram can quickly shows which nutrients are in short supply and how well balanced a food is (see diagram below)

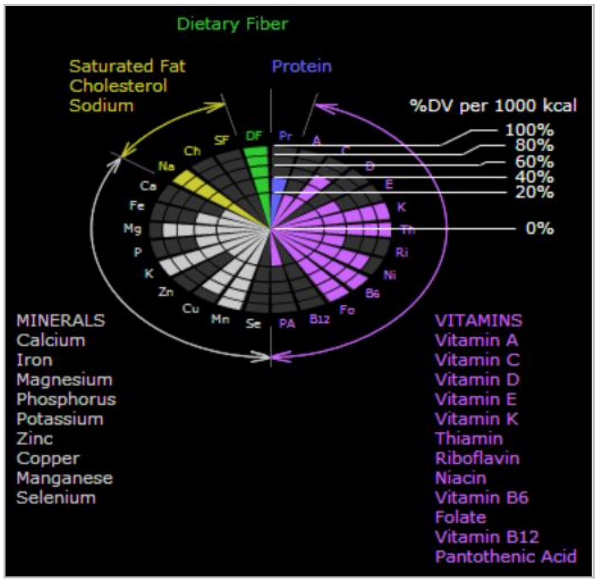

Figure 4. The nutrient balance indicator provided a visual representation of how complete a food is in terms of providing recommended daily amounts across all essential nutrients

The above graph has spokes that represent different essential nutrients and are grouped into one of the color coded categories: green for dietary fiber, blue for protein, purple for vitamins, white for minerals, and yellow for potentially troublesome nutrients. The nutrient densities used are derived from the % of the recommended daily values that are contained in a 1000 calorie portion of the food. If the 1000 calorie portion contains less than 10 % of the daily recommended value for a nutrient, or if no data is available for that nutrient, the nutrients spoke is grey. The main purpose of this is to display the foods strengths and weakness. For example in the diagram above it can be seen that this food is a poor source of vitamin D, B12 and selenium, but that the food does contain abundant amounts of dietary fiber, vitamin k, thiamin, vitamin b6, foliate, manganese, potassium and sodium.

The Reference Daily Intake or Recommended Daily Intake (RDI) is the daily intake level of a nutrient that is considered to be sufficient to meet the requirements of 97–98% of healthy individuals in every demographic in the United States (where it was developed, but has since been used in other places).

The RDI is used to determine the Daily Value (DV) of foods, which is printed on nutrition facts labels in the United States and Canada, which is regulated by the Food and Drug Administration (FDA), and Health Canada. The table (see appendix X) lists the DVs based on a calorific intake of 2,000 calories, for adults and children four or more years of age.

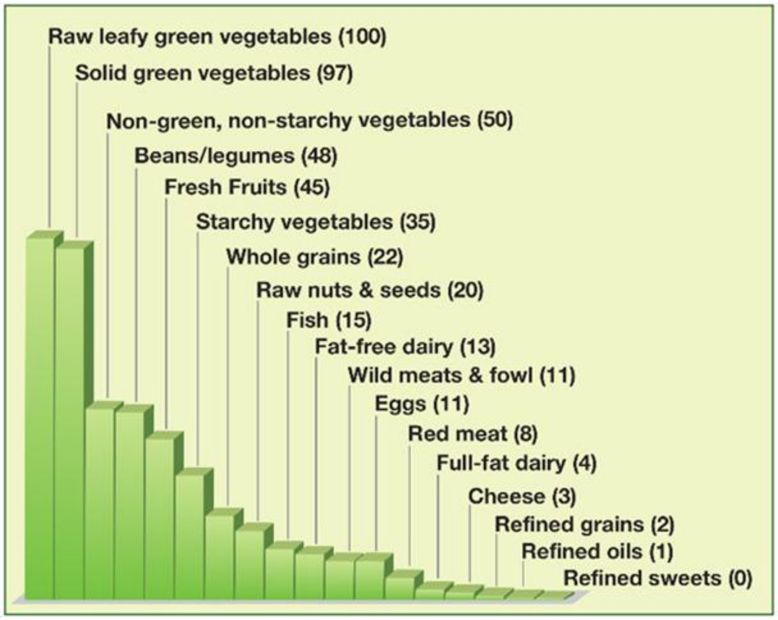

Figure 5. Nutrient density scores of common foods (after Fuhrman, 2010)

3.4.1 Problems with nutritional food ranking

Because phytochemicals are largely unnamed and unmeasured, these rankings underestimate the healthful properties of colorful natural plant foods compared to processed foods and animal products. One thing we do know is that the foods that contain the highest amount of known nutrients are the same foods that contain the most unknown nutrients too. So even though these rankings may not consider the phytochemical number sufficiently they are still a reasonable measurement of phytochemical content.

The value of RDA/RDIs is disputed among nutritionists. Indeed, even the "definition of RDAs and their relevance to health" is disputed (Pellett, 1988).For example, the daily maximum for some nutrients, like sodium are higher in the U.S. than in other parts of the developed world, and are far above established safe minimums. For instance, the National Research Council has found that 500 mg of sodium per day (approximately the amount in a quarter-teaspoon of table salt) is a safe level. In Great Britain, the daily allowance for salt is 6g (approximately 1 tablespoon, about the upper limit in the U.S., but are still considered too high . Similar DV for certain vitamins and minerals may indicate minimal amount to prevent diseases a as result of deficiencies, but these may be many times lower than optimum values for health. Vitamin C is a good example where RDA is low, at about 60 mg, but optimum health benefits may result at levels more than 10 times the RDA!

3.4.2 What about food interactions and ratios of nutrients?

Most ranking methods fail to consider either dangerous high level of certain compounds that may occur in association with highly nutritious foods; a good example, being oxalic acid that occurs in the amaranths. In addition there are so called anti-nutritional factors that affect the absorption of minerals, vitamins and proteins. Besides this certain rations of minerals notably Ca to Mg can lead to poor absorption of one or the other. A diet high in phytate content reduces the bioavailability of zinc, iron and calcium and has adverse effects on the digestion of proteins and starches.

3.4.3 Interaction between nutrients effecting absorption

There are 94 basic mineral elements in the body, these are required in the diet, not only in sufficient amounts, but also in optimal ratios. Proper mineral ratios are the key to effective utilization of minerals. Too much calcium, for example, leads to magnesium deficiencies, even if adequate magnesium levels exist in the bloodstream. Calcium and magnesium are antagonists to each other (and must coexist in a specific ratio to be most effective). The same is true of almost all other minerals. They depend on each other according to very exact ratios, ratios which will vary from person to person, from plant to plant, from soil to soil (making prescriptive rules tricky). Nature knows best when it comes to designing the proper ratios. Whole mineral sources, unheated and unaltered, are the most trustworthy sources of complete mineral nutrition. Clays, seaweeds, full spectrum mineral, mineral rich herbs (nettles, alfalfa, horsetail, etc.), coral,blue-green algae, chlorella, spirulina, alfalfa, barley and kumut grass juices, etc.)

Not all minerals and vitamins in a food can be absorbed. The bioavailability for some nutrients is determined by both the absorption ability and its biological effectiveness. This is because the nutrient sources are typically in chemically different forms, resulting in differences in nutrient activity .Vitamin and mineral bioavailability for dietary supplements also lacks a standard scientific and regulatory definition. Hoag and Hussain (2001) identified 2 categories of factors that affect bioavailability: factors that affect release from the food form into the blood, and factors affecting nutrient stability, absorption, and metabolic processes.. Different chemical forms of nutrients and nutrient-nutrient interactions may affect bioavailability, e.g., different forms of inorganic iron or zinc vary in bioavailability, and vitamin C interacting with inorganic iron may enhance bioavailability of the iron, and decreasing the levels of magnesium and calcium increases the bioavailability of iron.

A number of interactions between micronutrients could take place when high doses of a single nutrient is given or when the supply of an individual micronutrient is inadequate. The interactions between iron, zinc and copper appear to be especially important. In populations where the major reason for iron deficiency is a poor availability of iron from the diet

Because calcium, iron, zinc and magnesium share the same transporter within the intestine excessive consumption of one of these minerals can lead to saturation of the transport system and reduced absorption of the other minerals.

Some of the issues with calcium absorption can be related to low stomach acid, not enough healthy fat in your diet (calcium depends on healthy fats for proper absorption), poorly functioning hormones and parathyroid gland, low intake of vitamin D, a few more things, and not enough magnesium.

Most Calcium / Magnesium (Cal/Mag) supplements are offered in a ratio of 2:1, while recommendations by nutritional practitioners can vary from a 4:1 to a1:1 calcium to magnesium ratio. Some sources claim that calcium and magnesium oppose each other at the intracellular level, thus low magnesium intake causes high calcium storage, or calcification. Other sources maintain that magnesium is needed for proper calcium absorption, and that low magnesium intake can be responsible for low calcium levels.

If calcium is above-normal, but magnesium is even higher than calcium, then there is a good chance that an individual will eventually experience symptoms of a calcium deficiency

Another issue that is quite often forgotten is the Calcium/Phosphorus ratio in blood. This may indicate deficiencies. Recommended ratio of these minerals by most dietitians, are in the following ranges: Calcium is 9.5-10.2 and best at 10; Phosphorus is 3.8-4.2, best at 4; The Ca/P Ratio is 10:4, and Magnesium is 2.3-3.

When increasing manganese, phosphorus, zinc, Vitamin C, or stomach acid to normal levels, calcium uptake is generally optimized to normal levels as well, and usually no calcification takes place. However, increasing these same co-factors to above-normal levels will increase the risk for calcium loss, with all its undesirable consequence.

Some of the more important mineral to mineral and mineral to vitamin interactions that may affect the quality of a wild food are provided in the table below. From these a section rule/criteria is suggested that can be used to identify superior foods or superfoods from wild plants.

Table 8. Table of mineral-mineral and mineral –vitamin interaction that can affect the rating of a food.

Mineral/vitamin	Interaction	Wild food selection rule
Ca-Zn-Phytic acid	In the absence of phytic acid, the effect of calcium on zinc absorption is low. However, when phytic acid is present, calcium significantly inhibits zinc absorption. (Cheryan & Joseph, 1980).	Prefer to select wild foods with low Phytic acid levels
Ca- Oxalic acid	Soluble oxalate forms strong chelates with dietary calcium, rendering it unavailable for absorption and assimilation	Prefer to select wild foods with low Oxalic acid levels
Tanins-Fe, Zn, Protien	Tannins, found in many plants chelate metals such as iron and zinc and reduce the absorption of these nutrients, but they also inhibit digestive enzymes and may also precipitate proteins (Gilani et al , 2005)	Select plants low in tannins
Trypsin inhibitors and lectins	Trypsin inhibitors and lectins (found in most legumes), are enzyme inhibitors that interfere with digestion and absorption of many minerals and vitamins (Gilani et al , 2005)	Avoid wild legumes that have not been tested for enzyme inhibitors
Ca-Fe	Calcium has an inhibitory effect on iron absorption (Nelson, et al 2000).	Where plant is selected for high iron, Ca should be low
Fe- Vit. C	Ascorbic acid has a strong iron absorption promoting potential and in iron deficient populations ascorbic acid supplementation improves iron status.	When selecting for high Fe, prefer to have high Vit C as well
Zn- Fe	Zinc supplementation in adult females reduced indices of iron and copper absorption	Avoid plant with too high Zn
Ca-Mg	Magnesium is required to keep calcium in solution. When the ratio is imbalanced, it may reflect a relative magnesium deficiency.	Select plants where Ca is 2 to 4 times higher than Mg
Vit D-Ca, Mn, P	Vitamin D increases calcium, magnesium, and phosphorus absorption.	Where plant has high Ca, P, Mn select plant with high Vit D as well

4 Results: Literature review of the most commonly used wild foods for the Eastern Cape

This section is a review of the most commonly used wild foods used in the Eastern Cape, with special reference to the Wild Coast. This analysis forms an initial selection step towards finding candidate superfoods. Based on those species commonly reported in the scientific literature as wild plant food; as well as from discussions with experts, and from my own direct field observations, a list of possible wild superfood species was drawn up.

The most commonly used wild foods for each of the groups of: wild fruits, nuts/seeds and vegetables are listed.

Key Literature sources used include:; Fox et al ,1982; Wehmeyer & Rose, 1983; Peters et al.1992; National Research Council, 1996; Kruger, et al 1998;Shava, 2000; Van Wyke & Gerieke, 2000; Kepe, 2002; Modi et al, 2006; Shackleton et al. 2007; Voster , 2007; Afolayan & Jimoh, 2009; Fearon, 2010; Boon, 2010; Dold,& Cocks, 2012.

4.1 Fruits

. Abundance in the wild may indicate suitability for commercialization
The most commonly utilized wild fruit trees on the Wild Coast are presented in the table below.

Table 9 Selection of candidate fruit trees or shrubs based on usage, as cited in the literature.

Fruit tree/shrub species	Common name	Comment	Abundance
Harpephyllum caffrum	Wild Plum	Large seed , small fruit , very palatable used for juice and jam	V High
Rubus rigidus[1]	Bramble	Can be confused with alien species and hybrids of	High
Scutia myrtina [2]	Cat thorn	May be more medical than food, stringent but edibles fruit	Low
Mimisops Cafra	Coastal Red-milkwood	Large seed , small fruit , very palatable	High
Mimisops Obvata	Red-milkwood	Exceptionally high vit. C content	Medium
Dovyalis caffra	Kei Apple	Tasty fruit, high vit C	Low
Dovyalis rhamnoides	Sour kei apple	As above, but does not fruit every year	Medium
Carissa Macrocarpa	Num-num, Amathugulu	Large fruit, very palatable, high vit. C. , used for juice and jam	High
Carissa bispinosa	Small num-num	Smaller version of above	High
Salicia gerrardii	Forest lemon-rope		low
Cantheium spp	Turkey berry		low
Pachystigma bowkeri,	Forest Crowned -medlar		low
Pachystigma macrocalyx	Rock Crowned -medlar	Very palatable	low
Ficus sp.	Wild figs	Fruit mostly stung by wasps	Medium
Eugenia Capensis	Dune myrtle	Used to stabilize dunes, slow growing	Medium
Vangueria infausta	Velvet Wild-medlar (Umvili)	Sweet sour fruit, high in vit. C and potassium	Medium
Englerophytum natalensis	Natal Milkplum		Medium

Rhoiciccus tomentosa	Common forest grape	Fruit makes tasty jam, vinegar and wine	high
Gardenia amoena	Thorny gardenia		Low
Burchelia bubalina	Wild pomegranate		Low

Notes:[1] Rubus rigidus is indigenous to South Africa, however, R. cuneifolius and Rubus x proteus (American bramble, Amerikaanse braam) are declared Category 1 invasive plants and Rubus fruticosus (European blackberry) is a declared Category 2 invasive plant in South Africa.[2]Ethnol extracts of *Scutia myrtina* exhibited significant antitumor and antioxidant effects by reducing the formation of free radicals in hepatocellular carcinoma, they asls show shows hepato-protective effects.(Kumar et all 20011)

4.2 Seeds/nuts

Recent work has shown that the nuts of many wild fruit trees can have a high nutritional content. For example the nut of the Marula tree fruit, Sclerocarya *birrea is a* traditional food plant in Africa. The nuts of the fruit of this tree are, are high in protein and essential oils (28.3% protein, 57.3% oil, high in minerals, especially magnesium, iron, copper, zinc and phosphorus). The marula tree has been described by NRC, (2008), as ‘having the potential to improve nutrition, boost food security, foster rural development and support sustainable land-care’.

The nutritional content of the seeds/nuts of most of the fruit trees listed in the table above are largely unknown, however recent research on the nuts of the fruit of the Transvaal Red-milkwood (*Mimusops zeyheri*) are very promising. Chivandie *et. al* (2011) found the *M. zeyheri* seed to be high in number of amino acids (e.g. Glutamic acid), high in Ca, Vitamin E and rich source of oils (in particular oleic acid). They concluded that this seed could be exploited as a dietary energy supplement and an oil source rich in oleic acid. Oleic oil can be used as an essential oil nutritional supplement or as an olive oil type substitute.

Melville (1947) has, noted that there is a good correlation in nutritive values between species within a genus or family, particularly of seeds and nuts. While the Transvaal Red-milkwood does not occur in the Wild Coast, two close relatives do (*Mimusops Cafra* and *Mimusops obvata*). It is therefore a reasonable assumption to make that these two species may also have high nutritional value as *M. zeheri*. Two other species have seeds that have been historically used for food, include the two boer-boen, or *Schotia* species, (data on nutritional content still required). A third species, *Harpephyllum caffrum* (Wild Plum), is a very commonly occurring tree, very popular for its fruit, however to date no research could be found on the potential use of the large nut within the fruit. However, given that it is part of a family with many species of edible nuts, it is well worth investigating. Trees, occurring in the study area, with fruits that may contain nutritionally valuable nuts, are listed in the table below.

Table 10. Tree species occurring on Wild Coast that are likely to have nutritious seeds/nuts.

Tree species	Common name
Mimisops Cafra	Coastal Red-milkwood
Mimisops Obvata	Red-milkwood
Schotia brachypetala	Weeping boer-bean
Schotia myrtina	boer-bean
Schotia latifolia	Forest boer bean)
Harpephyllum caffrum	Wild Plum
Trichilia emetica/dregiana	Natal/Forest mahogany

Of these the most well-known seed product is from *Trichilia emetic*a (natal Mohogany). Oil from these seeds forms a solid butter at room temperature and melts at 30˚C. The butter is rich in essential fatty acids (palmitic, stearic, oleic and linoleic) and has been shown to have antimicrobial and anti-inflammatory activity due to the presence of also been shown to scavenge free radicals more effectively than many other oils on the market. Although the oil it has been mostly used as a skin and hair conditioner, it has also used medicinally to treat rheumatism and heal wounds Grundy & Campbell (1993). The research of Grundy & Campbell (1993) implies that both the Natal Mahogany (Trichilia emetic), and it is closely related forest species the forest Mahogany (Trichilia dregiana), that is more common on the Wild Coast, have very similar properties. Trichelia oil has already been successfully used as an agroforestry crop in Mozambique to uplift local communities who grow, manufacture and sell the oil, known locally as Mafura, (FAO, 2005). The seed of Trichilia emetica yields two kinds of oil: 'mafura oil' from the fleshy seed envelope (sarcotesta) and 'mafura butter', also called 'mafura tallow', from the kernel. The oil is edible, but the butter is les so due to its bitter taste. The by-products have other uses such as animal feed and fertilizer.

In addition to this, there are number of families and genera that have large numbers of species that are utilized for their nuts, (most that do not occur in the Wild Coast, but that may have close relatives that do). I have listed a few families and genre that may provide useful leads to investigate potential nut sources (also see FAO, 1995)

Table 11 Species occurring in Eastern Cape belonging to families with large numbers of species used for nuts worldwide.

Family	Species occurring in Eastern Cape	Comment
Anacardiacea	Harpephyllum caffrum	Wild Plum is very common in and around forests
Combreatacea	Terminalia phanerophlebia	Not very widespread
Rutaceae	*Calodendrum capensis*	Cape Chestnut is wide spread nuts eaten; seeds source of an oil used in cosmetics
Sapotacea	*Vitellariopsis marginata*	forest bush milkwood fruits eaten by locals
Cucurbitacea	Acanthosicyos horrida	Seeds of various melons used
Lauracea	*Cryptocarya latifolia*	*Ntonga nuts* , occurrence in study area uncertain (nuts widely used in Africa)
Leguminosae	*Tylosema esculentum*	Maramba bean. Uncertain occurrence in study area (beans used in many parts of Africa)

The most promising leads derived from the analysis in the above table, and that require further investigation into use onwild coast are the *Wild Plum* and the *Cape Chestnut, and the forest Mahogani*.

4.3 Vegetables

The leaves of a number of wild and cultivated plants are used as wild spinach, (‘*imifino’ in Xhosa and Zulu or ‘morogo’* in Tswana, meaning wild vegetables). Most of the imifino plants in the Eastern Cape are cosmopolitan weeds that have been part of the traditional diets of Africans for a long time. Indeed, use of pigweed (*Amaranthus hybridus)* has been recorded as being used instead of spinach as early as 1680 (Dold & Cocks, 2012).

Shava (2000), records 21 species of plant that he groups as ‘wild spinach’. Nutritional evaluation showed that many of these wild vegetables commonly utilized by many indigenous populations in South Africa are more nutritious than the popular exotic vegetables i.e., cabbage and swiss chard (Kruger, et al 1998, Modi, et al 2006, Voster , 2007**)** . It was found that among the wild vegetables, *Amaranthus*, black jack, and water navel are more valuable sources of vitamins C, vitamins A and E, and iron and zinc, respectively, compared with cabbage and swiss chard.

In South Africa the *Amaranthus* species are widely used spinach. Commercial farming of these plants is becoming popular with the leaves, processed and caned. The leaves are valuable source of protein and vitamin A. There protein content is high, varying between 26 and 30 %. The iron content may be as high as five times the recommended daily allowance, the calcium content at least double, and the vitamin A content, 20 times (Van Wyke & Gerieke, 2000). Amaranth species also bear edible, protein rich seeds. Flour ground from these seeds mixes well with cereal flours and increases the protein content.

Amaranthus (one or more of its species or cultivars) is clearly a good candidate for a ‘superfood’, indeed one of the most important South American grains commonly marketed as superfood is quinoa, or inca wheat is an *Amaranthus*. In addition, the seeds of other *Amaranthus* species can be found in some health shops as a cultivated product from India.

Table 12 Wild and cultivated plants used as wild spinach (moroga or imifino) in the Eastern Cape. Ssources: Shava, 2000, Kruger, et al 1998, Modi, et al 2006, Voster , 2007.

Species	Common name
Amaranthus hybridus	Pigweed, Marogo
Amaranthus thunbergii	Cape pigweed,poor-man’s spinach
Amaranthus cruentus	Purple grain *Amaranthus*
Amaranthus gracilus	
Biden pilosa	Black jack
Centella asiatica,	Marsh pepperwort
Chenopodium album	White goose-foot, fat-hen
Cucurbita pepo	Pumpkin
Hypochoeris radicata	
Rumex spp.	Dock
Sonchus oleraceus	Sow thistle, wild thistle
Solanum nigrum	Black nightshade
Sonchus oleraceus,	Sow thistle
Sonchus asper	
Taraxacum officinale	
*Urtica urens***,**	Stinging nettle
Portulacaria affra	Pork bush
Galinsoga parviflora	gallant soldier
Physalis peruviana	Cape gooseberry

Imifino is also dried to increase shelf life to several months. The dried leaves can then be rehydrated and added to any dish. The leaves of some of the higher protein containing *Amaranthus* species (i.e.30 %) could possible qualify as a superfood protein and mineral (in particular iron) powder supplement. (Typical protein supplements such as hemp seed powder, contain about 40-50 % protein)

The objectives of this project were to: 'identify wild naturally grown plants that may qualify as superfoods, and that the commercialization of them may lead to positive conservation spin-offs' With this in mind it is arguable if any of the 'wild spinach' species mentioned in the list above will qualify. This is because most of these 'wild spinach' plants are grown either deliberately or by default in fallow or cultivated lands, implying that the conservation of natural habitat is not necessary for their production; commercialization therefore, is unlikely to yield any positive conservation spin-offs.

5 Results: Species selected based on indices calculated from the wild foods nutritional database

5.1 Top ranking foods- all parts

A database for over of 342 records was developed for this study, primarily based on the work of Wehmeyer(1986), but also other researchers. This enabled the calculation of two nutritional indices that could be used for ranking the quality if wild foods and to make comparisons between species. Most of the species presented are indigenous to southern Africa and have been used by various communities at some stage as a food source. There are a number of exotic species that have either become naturalized (like the *Amaranthus* species) or that are an invasive problem (like *Lantana camara*), a number of others that are in common use (such as Hibiscus rosa-sinensis) are also given. *Lantana camara*, is of particular interest as it is one of the biggest invasive alien problem plants in the Wild Coast. It is most surprising that it has been tested by Vehemeyer (1986) and the twigs considered as a wild food. No records of the twigs being used as a wild food in the Eastern Cape could be found, although there are numerous reports that the fruit is used as food, certainly by birds, but also by humans. The leaves are toxic, causing photosensitivity in livestock. It is uncertain if these toxic compounds are found in the twigs, but further research is needed to investigate the possible use of this as an animal feed.

Species that occur in high abundance on the Wild Coast and that were selected in the top 18 include the fruits of the raisin bush (Grewia spp). In the table below the C*omplete Food Index* (see section 3.4) has been used to rank the most nutritional top 18 wild foods, irrespective of the plant part used (i.e. leaves, fruit, tubers, seeds, nuts). In addition, no section has been made according to the occurrence of the species within the Eastern Cape. All of the top four plants are Wild spinaches (or leaves of *Amaranthus* species). This is not surprising given the recent attention in the literature to these plants. Without doubt these plants can be considered as superfoods, all of them occur within the Eastern Cape. The next most nutritious plant, somewhat surprisingly, is the fruit of the white raisin bush, *Grewia bicolor*, it has a good general spread of both macro and micro nutrients, and relatively high protein content for a fruit. Following this are the nuts from the baobab tree , *Adasonia digitata*, and the two *Parinari* trees, the well-known, Mobolo plum, none of the species occurs in the Eastern Cape in any numbers, but do although occur in the northern parts of the Muputu land. The fruits of these trees are widely used in Zimbabwe and Mozambique. Other valuable species identified are the fruits of the Wild date palm, (*Phoenix reclinata*), and the Forest red-milkwood, *Mimusops obvata*, both occurring on the Wild Coast.

5.2 Top ranking fruit-trees occurring in the Eastern Cape

The top ranking wild fruit trees, for which data was available, and that occur within the Eastern Cape, shown in table 12, in the appendix.

5.3 Top priority fruit-trees with high palatability and occurrence

Wild fruits commonly utilized as food by rural communities, and hence most likely to be palatable (see review section under results) and that have high occurrence (i.e. can be harvest in relative bulk) include the following species, in order of importance:

- Coastal Red-milkwood (*Mimusops Cafra*)
- Forest Red-milkwood (*Mimusops obovata*)
- White milkwood (*Sideroxylon inerme*)
- Natal plum (*Carissa macrocarpa*)
- Cape ash (*Ekebergia capensis*)
- Wild date palm (*Phoenix reclinata*)
- Wildplum (*Harpephyllum caffrum)*
- Dovyalis caffra (*Kei apple*)
- Bastard Currant (*Allophylus decipiens*)
- Dune false Curent (*Allophylus dregeanus*)
- Yellowood (*Podocarpus falcatus*)
- Trema oreintalis (*Pigeon wood*)

Note that the fruit of the Coastal Red-milkwood (*Mimusops Cafra*) was not analyzed by Vehermyer (1986), but it is likely to have very similar nutritional content as the closely related Forest Red Milk wood *(Mimusops obovata*). It has been included here because it occurs in abundance but also due to its exceptional conservation benefits that could be potentially realized by harvesting this species and providing a direct economic benefit for surrounding communities from the rapidly degrading dune forests of the Wild coast (see section 6)

5.4 Top ranking seed and nut producing plants occurring in Eastern Cape

The top ranking seed plants, as can be expected are all grasses, with relatively good spread of nutrients and protein content between 9 and 14 %. These include:

- Egyptian crowfoot (*Dactyloctenium aegyptium*) ;
- African brislegrass (*Setaria sphacelata*)
- Foxtail millet (*Setaria italic*)
- Finger millet (*Eleusine oracanna)*

There are a number of important trees that have highly nutritious seeds or nuts these are

- Boer-bean (*Schotia afra*)

- Weeping Boer-bean (*Schotia brachypetala*)
- Natal mahogany (*Trichilia emetic*)
- Forest mahogany (*Trichilia dregiana*)
- Natal wild banana (*Strelitzia nicolai)*
- Coastal Red-milkwood (*Mimusops caffra*)

Some of the most valuable nutrients in these wild tree nuts are the fatty acids and essential oils, typically found in nuts, however there is little or no data available for many of these species. The oils of Natal mahogany seeds, *Trichilia emetica*, are already commercially available, and suggestion have been made by some researcher that other such as the Red-milkwood also have potential in this regard.

5.5 Top ranking nut trees that do not occur in the Eastern Cape

A number of wild trees are receiving increased attention for their value as superfoods (high in protein, vitamin c and essential fatty acids). The nuts of Marola and baobab have been successfully commercialized and are providing much needed income to poor rural communities in the northern parts of the country and in neighboring states.

Of particular interest is the work Chivandi *et al* (2010) done on the Transvaal Red-milkwood (*Mimusops zeheri*). This is due to the likelihood that two of its Eastern Cape occurring relatives (*Mimusops caffra* and *M. obvata*) may have similar properties that may indicate commercial potential

5.6. Top ranking wild foods for specific nutrients

Under-nutrition can be divided into protein-energy-malnutrition and micronutrient deficiencies. Globally, the most important micronutrient deficiencies are iron, vitamin A, iodine and zinc. Micronutrient malnutrition is also called ‘hidden hunger’ as the consequences thereof often go unnoticed. At national level, in South Africa, 33.3% of preschool children are vitamin A deficient, 21.4% are anemic and 5.0% suffer from iron deficiency anemia. South African children consume a maize based diet that is inadequate in energy and of low nutrient density (Faber& Wenhold, 2006).

The availability of a greater variety of nutritious foods at community and household level can be increased through mixed cropping, the introduction of new crops, the promotion of underexploited traditional food crops, and the use of wild grown foods.

The improved understanding and sustainable use of wild foods can promote community livelihoods and health by supplementing existing nutrient poor diets, and could also provide sustainable forms of income if wild products can be successfully developed and marketed.

This section reviews the wild foods database for wild foods that are exceptionally high in a number of selected nutrients. Not all nutrients were reviewed, rather those that are typically low in rural children’s diets or those that have high marketability as superfood supplements (protein and Vit C are good examples). Nutrients typically low in rural African diets include protein, iron, ca,, zinc, vit A and Vit C). Certain essential amino acids are low or absent in maize staples *and* wild foods high in protein could supplement a predominately maize based diets.

Maize protein is deficient in lysine and tryptophan but has fair amounts of sulphur-containing amino acids (methionine and cystine). On the other hand, the protein of food legumes is a relatively rich source of lysine and tryptophan but is low in sulphur amino acids (Bressani and Elías, 1974). It can be assumed that the protein of beans or food legumes will complement the protein of maize best, Bressani and Elías, (1974) recommend the proportion of 30 parts beans to 70 parts maize. There are number of wild food legumes that can serve this role

Unfortunately there is limited availability of amino acid composition data for wild foods.

The tables below, also provides the Complete Food Index (%CFI) scores that gives an approximate of the overall nutritional value of the food.

5.6.1 Protein

There are a number of wild foods with very high protein content, but most do not occur within the Eastern Cape (see table12). Most tend to be leguminous plants with acacia gums and seed being particularly high in protein. The Mobolo plum (Parinaria curatelifolia) is one of the fruits with a nut that is well known and utilized (and sold commercially) in Zimbabwe and Mozambique. The nut of the baobab and Maroela, are two wild trees that have recently become particularly popular as a food but also as an additive to cosmetic products, in particular, but also for their sought after oils used in body products.

The leaves of a number of the *Amaranthus* species, utilized as wild spinach (maroga) in the Eastern Cape, have high protein and mineral contents, as well as have high nutrient densities (*Amaranthus gracilus* has one of the highest nutritional densities of any wild food at, 49 % complete food index). The *Amaranthus* species show potential as a superfood supplement that can be stored and marketed in a dry powdered form. One of the drawbacks of some of the species used as wild spinach is the high levels of oxalates. It is not clear if drying and reconstituting in water has the same effect that cooking and draining off of the water has to make them more acceptable. Although oxalates are not highly toxic, they can interfere with mineral absorption and lead to kidney stones

It is also interesting to note that the *seeds* of a number of *Amaranthus* species are particularly high in protein and can be bought in certain health food stores in South Africa, they are imported from India. There is no reason why they cannot be commercially produced by communities in South Africa.

Table 13. Southern African Wild foods ranked according to protein content, only some occur within the Eastern Cape, indicated in last column

COMMON_NAMES	GENUS	SPECIES	PART_USED	PROTEIN_g_ 100g	% CFI	Occ in EC
Nyala tree	Xantriocercis	zambesiaca	seed_without_te	112	33	n
Camel Thorn	Acacia	erioloba	gum	43	22	n
baobab	Adasonia	digitata	nut	33.7	36	n
Gemsbuck bean	Tylosema	esculentum	seed_without_te	32.9	33	n
Slender amaranth	Amaranthus	gracilis	leaves	31.2	49	y
	Acanthosicyos	horrida	seed_without_te	30.7	31	n
Love-lies-bleeding	Amaranthus	caudatus	leaves	28.8	46	y
Mobolo plum	Parinari	curatellifolia	nut	28.7	32	n
Marula	Sclerocarya	birrea	nut	28.3	29	n
Flower of an hour	Hibiscus	trionum	leaves	26.7	29	n
Mongongo tree	Ricinodendron	rautanenii	nut	26.3	33	n
Dwarf Mobola-plum	Parinari	capensis	nut	26.3	31	n

Table 14. Top wild foods occurring in the Eastern Cape, ranked by protein content, with % CFI (Complete food index)

COMMON_NAMES	GENUS	SPECIES	PART_USE	PROTEIN_	% CFI_me
Slender amaranth	Amaranthus	gracilis	leaves	31.2	49
Love-lies-bleeding	Amaranthus	caudatus	leaves	28.8	46
Tumbleweed	Amaranthus	graecizans	leaves	26.1	43
African brislegrass	Setaria	sphacelata	seed_with	11.1	28
Egyptian crowfoot	Dactylocteniu	aegyptium	seed_with	9.8	29
Wormwood	Artemisia	afra	leaves	9.4	39
Travsvaal red milkwood	Mimusops	zeyheri	seed	9.3	9
morning glory	Ipomoea	obscura	leaves	8.8	25
Wild mint	Mentha	longifolia	leaves	8.4	37

5.6.1 Vitamin C

Vitamin C is a popular nutritional supplement widely used for its multiple health benefits, and in particular as an antioxidant and immune system booster. Many wild fruits and pods have exceptionally high vitamin C content with a number having many times the vitamin C concentration of oranges. Baobab seed powder is increasingly sold worldwide as a vitamin C and calcium superfood supplement. Interestingly one of the milkwood relatives, the milk pear tree (*Inhambanella henriquesii*) has almost double the Vitamin C concentration of baobab seeds and seven and a half times that of oranges. They occur in northern natal and Mozambique but not in the Eastern Cape.

Table 15. Southern African Wild food plants ranked according to vitamin C content. The typical vitamin C content of oranges is about 54 mg per 100g. Most of these plants have a vitamin C content many time higher than this, (see third last column).

COMMON_NAMES	GENUS	SPECIES	PART_USED	Vit_C_mg_100g	X orange	Occ in EC	% CFI
Swallow-wort	Cynanchum	zeyheri	pods	398	7.5	n	12
Milkpear	Inhambanella	henriquesii	fruit_flesh	238	4.5	n	14
Baobab	Adasonia	digitata	fruit_flesh	209	3.9	n	27
Tortoise berry	Nylandtia	spinosa	fruit_flesh	206	3.9	n	8
Marula	Sclerocarya	birrea	Fruit	194	3.7	n	11
Namaqua firesticks	Diospyros	ramulosa	fruit_flesh	162	3.1	n	18
Rough Pigweed	Amaranthus	hybridus	leaves	126	2.4	y	18
Kei apple	Dovyalis	caffra	fruit_flesh	117	2.2	y	11
Carrion flower, Aasl	Orbea	namaquensis	pods	116	2.2	n	11
Wild Apricot	Landolphia	capensis	fruit_flesh	112	2.1	n	14
African Sumac Karee	Rhus/searsia	lancea	leaves	108	2.0	n	11
Dune myrtle	Eugenia	capensis	fruit_flesh	107	2.0	y	15

The top wild foods with high vitamin C content and that occur in the Eastern Cape are ranked in table 15 below

Table 16 Top Vitamin C containing wild foods occurring in the Eastern Cape

COMMON_NAMES	FAMILY	GENUS	SPECIES	PART_USED	Vit_C_mg_	% CFI
Rough Pigweed	AMARANTHACEA	Amaranthus	hybridus	leaves	126	18
Kei apple	FLACOURTIACEAE	Dovyalis	caffra	fruit_flesh	117	11
Dune myrtle	MYRTACEAE	Eugenia	capensis	fruit_flesh	107	15
Sourberry	FLACOURTIACEAE	Dovyalis	rhamnoid	fruit_flesh	71	6
Wildplum	ANACARDIACEAE	Harpephyllum	caffrum	fruit_flesh	71	10
Red milkwood	SAPOTACEAE	Mimusops	obovata	fruit_flesh	60	20
Natal plum	APOCYNACEAE	Carissa	macrocarp	whole_fruit	52	12
Coastal bladdernut	EBENACEAE	Diospyros	scabrida	fruit_flesh	97	17
Sourplum	OLACACEAE	Ximenia	caffra	fruit_flesh	68	14

A number of these fruits are found in significant quantities and could be marketed in the form of fruit juices or jam and jelly preserves. The Natal plum (*Carissa macrocarpa*) is one of the fruits that is widely eaten in the Eastern Cape and KwaZulu Natal and can sometimes be found sold at local markets. Two other fruits that are highly palatable are the Wild plum and Kei apple. Less well-known but with commercial potential are the fruits of the Red-milkwoods and the Dune myrtle (the late being very high in vitamin C). The added advantage of harvesting the Red-milkwood fruits is the potential to use the nuts as sources of oleic oil (see section 6.3 of this document)

5.6.2 Iron

Iron has been listed as one of the minerals that is often deficient in African children (Faber& Wenhold, 2006) and is the main cause of anemia. A number of wild foods can provide valuable sources of iron. In the Eastern Cape the fruits of the Wild date palm and some of the wild spinach (in particular *Amaranthus gracilis* leaves). Interestingly, rooibos tea, has a high iron content of.

Table 17. Wild food plants high in mineral iron (in mg/100g).

COMMON_NAMES	GENUS	SPECIES	PART_USED	Fe_mg_10	% CFI_me	Occ in EC
Rooibos	Aspalathus	linearis	leaves_and_twigs	243	25	n
Wild date palm	Phoenix	reclinata	fruit_flesh	182	18	y
Slender amaranth	Amaranthus	gracilis	leaves	82.5	49	y
Flannel weed	Sida	cordifolia	leaves	79.8	41	n
	Helichrysum	nudifoliur	leaves	49.9	31	y
Wormwood	Artemisia	afra	leaves	46.3	39	y
	Jatropha	zeyheri	leaves	31.4	39	n
morning glory	Ipomoea	obscura	leaves	28.8	25	y
Baboon Root	Babiana	curviscapa	bulb_peeled	28.7	30	n
common wild mustard	SisYmbrium	thellungii	leaves	27.1	19	n
	Anacampsero	papyracea	leaves	23.4	23	n
Love-lies-bleeding	Amaranthus	caudatus	leaves	23.2	46	y

5.6.3 Calcium and Magnesim

The two minerals calcium and magnesium are often deficient in many modern diets and have become a popular supplement in particular for mothers and athletes. Again the *Amaranthus* leaves come out top ranking for these mineral. The Milkwoods also are high in Ca. The ratio of Ca to Mg is important for absorption. The opinions in the literature on the optimal ration of Ca to Mg, differs between experts, but there seems to be a general consensus of a 2:1 ratio. The baobab fruit powder, already sold as a vitamin C and Ca supplement, as well as the *Amaranthus* species have this desired ratio. Baobab fruit powder has the distinct advantage of having high vitamin C content as well.

Table 18. Wild food plants high in Ca and Mg. Also shown are Vitamin C and CFI index as well as the ratio of Ca to Mg (in mg/100g)

COMMON_NAMES	GENUS	SPECIES	PART_USE	Ca_mg_10	Mg_mg_1	Vit_C_mg	% CFI_me	Occ in EC	Ca/mg ratio
Love-lies-bleeding	Amaranthus	caudatus	leaves	3348	1589	5.6	46	y	2
Slender amaranth	Amaranthus	gracilis	leaves	2350	1506	3.4	49	y	2
Flannel weed	Sida	cordifolia	leaves	2299	667		41	n	3
Tumbleweed	Amaranthus	graecizans	leaves	1850	1450	13.8	43	y	1
Wild mint	Mentha	longifolia	leaves	1815	258		37	y	7
Spanish Flag	Lantana	camara	twigs	1527	357		41	y(a)	4
leadwood	Combretum	imberbe	gum	1176	165		22	n	7
Wormwood	Artemisia	afra	leaves	1167	127		39	y	9
Umga	Acacia	karroo	gum	963	111		23	y	9
Travsvaal red milkw	Mimusops	zeyheri	seed	587.4	107.3		9	y	5
Baobab	Adasonia	digitata	fruit_flesh	335	167	209	27	n	2

6 Potential conservation benefits associated with wild food utilization: Case study for Coast Red -milkwood dune forests on Wild Coast

6.1 Introduction

This project aimed to identify a wild foods harvesting enterprise that would also have positive conservation spin-offs.

Most products identified in this report that show commercial potential, may require some form of mitigation to minimize negative biodiversity impacts. For example, harvesting of wild fruits such as *Carissa macrocarpa*, will reduce the food source for many birds, monkeys and other animals that feed on these fruits. However, associated with harvesting of some of these species, in particular the forest fruits such as Red-milkwoods and Wild Plum, are potential conservation benefits, in the form of community awareness and economic incentives to maintain forests in natural, and hence a productive state.

In this section I discuss a case study for two locations on the Wild Coast (Mdumbi and Bulungula), both of which are currently experiencing extreme degradation of their coastal dune forests. This degradation is caused by a number of factors (see figure 7), but one of the key drivers are goats. Goats are brought into the forest to feed on young shoots and fallen fruits of the Red-milkwood trees. By paying communities to collect these fruits before the goats get in, you will be both reducing the attraction for goats to enter the forests, but also provide an economic incentive to the communities to conserve the forests.

6.2 Case study: Belungula and Mdumbi dune forests

My attention was recently brought to the state of two Red-milkwood dune forest situated close to the Belungula and Mdumbi estuary areas, on the Eastern Cape's Wild Coast. Despite the small sizes of these forest (less 15 ha), both play significant roles in dune stabilization and biodiversity conservation. They are also an integral part of the aesthetically pleasing landscape for these popular eco-tourism destinations.

The forest degradation is indicated by the following observations:

- a significant number of dead or dying mature Red-milkwoods(>20 % of standing trees);
- little or no ground cover, with evidence of recent windblown sand;
- many trees buried a few meters in sand, evidently caused by shifting sands;
- no signs of any Milkwood regeneration, either from coppicing or seedlings;
- plenty evidence of goat browsing and trampling
- alien invasive plants that rapidly colonize degraded forest areas

Discussion with local resort managers/owners showed that they appeared to be aware of the problem, but not the full extent, nor that many trees were showing signs of a dye off. They also pointed to the unusually high seas associated with equinox coinciding storm events between 2007 and 2008 that caused significant damage along the south Coast of South Africa. This was verified by inspecting satellite imagery for these two areas between the uears 2005 and 2009.From these observations I have pieced together a likely causative model of the degradation, see figures 7, below.

My attention was also brought to apparently similar degradation of the coastal dune forests around Cinsa and between Cinsa and East London. Unlike the Mdumbi and Bulungula Dune forests discussed above, (that have >90 % Red-milkwood Canopy) , these forest are lower in height and with a mixed canopy composition. They are classified as Eastern Cape Dune forest (Von Matitz et al, 2002). On inspection of the Cinsa dunes, it is apparent that the leading edge, up to 10 meters in some places, had been washed away by high seas (possibly associated with the equinox storm events of 2007). However, what is also clear is that in most areas, the dunes have stabilised, with good vegetation re-growth on the leading dune edges, and tree seedling regeneration. This is in stark contrast to the Mdumbi and Belungula dune forest where the dunes have not stabilised, are shifting and are significantly invaded by alien plants (notable Lantana, and ink berry). Although these are slightly different systems, this clearly points to the different disturbance regimes acting on these dunes. Notably the Cinsa forests are devoid of goat browsing, invasive plants and wood harvesting and have thus stabilized and are recovering. This apparently confirms my original hypothesis of the causes of the Wild Coast Red-milkwood forest degradation. Verbaly the model can be stated as : high seas (equinox storm events, possible climate change) cause initial destabilization of dune leading edges of forests, already under stress from goats (who eat tree seedlings and loosen ground cover, by browsing and hoof action). This combination of disturbances promotes the spread of pioneer invader alien plants that colonize the leading edges and advance inside the dunes. These plants rapidly outcompete indigenous dune vegetation (they are also less palatable to goats) that would otherwise stabilise the dunes after storm events. However, the alien plants are ineffective in stabilizing the dunes leading edges, as they do not survive winter storms, being ill adapted to salt spray, as most leading edges have remnants of alien hedges (see figures below)

Figure 4. Mdumbi Red-milkwoods. Top left , moving clock wise. Goats, are brought into forage under shade of Milkwoods, this time of the year provides highly nutritive fallen Red-milkwood berries. Shifting sand dunes gradually kill of Red-milkwoods

Figure 5. Heavily degraded Red-milkwood dune forests, just below mouth of Mdumbi estuary. Notice, shifting dune sands and alien vegetation (Lantana, and ink berry in for ground), and dead mature Red-milkwoods

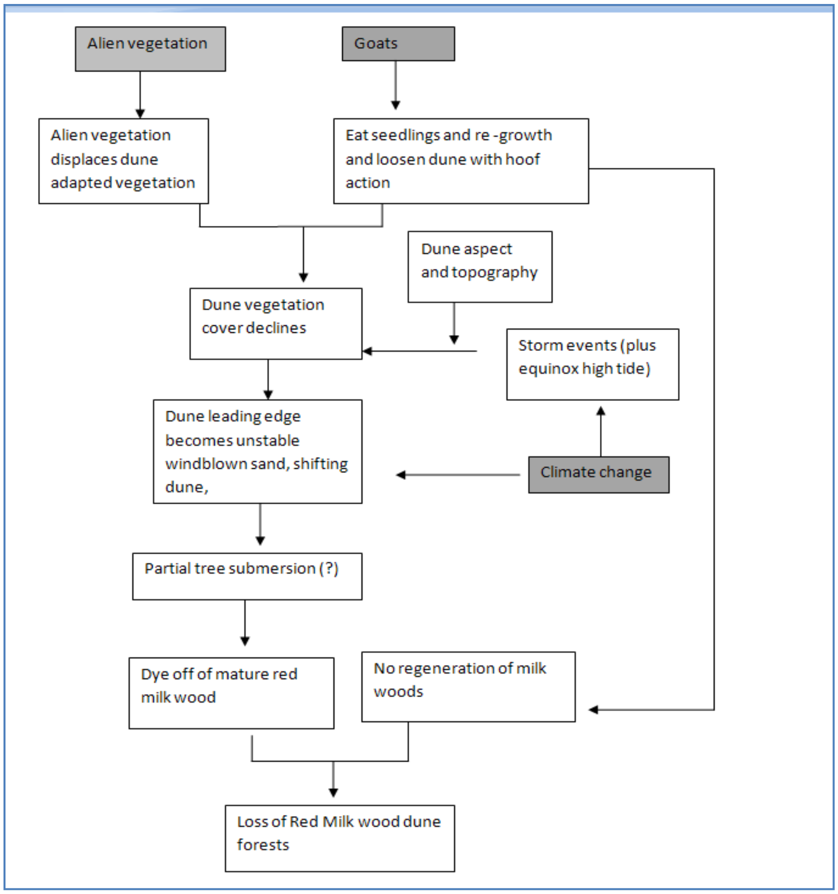

Figure 6. Primary disturbance agents (shaded out blocks), and the resultant chain of events that have led to collapse of Red Milk wood Dune ecosystems, as discussed above. Most factors act synergistically with each other giving rise to positive feedback loops that act to block the recovery processes leading to re vegetation and dune stabilization. Alien vegetation, goats and climate change are all anthropogenic in origin are not 'natural' to these forest. (from Berliner, DD 2012)

Figure 7 Destabilised leading edges for Wild Coast dunes, Mdumbi on left, Bulungula on Right. Note goats, invasive plants (lighter green is inkberry) and remnants of invasive plant hedges)

6.3 The commercial potential of Red-milkwood trees

Although the fruits of the various milkwood species are well known to local communities as refreshing bush snacks, and their nutritional content has been documented by Wehmeyer, 1986, and others (particularly high in Vitamin C). The seed or nut content of these fruits is less well known. Recently , however, Chivandi et. al (2010), have established the high nutritional content of the seeds of the Transvaal Red-milkwood (Mimisopst, zeyheri). They found that even though the seed is relatively low in protein, it is energy dense and has a high oil yield that could be commercially exploited. The high oleic acid content in M. zeyheri seed oil would make the seed a potential nutritional supplement. In addition, M. zeyheri seed is a potential source of calcium.

The oleic acid (OA) content of M. zeyheri seed oil (about 85% of lipid yield) is high and compares well with the 70–78% oleic acid in Sclerocarya birrea (Marula tree) kernel oil (Burger et al., 1987) and 63% oleic acid in Ximenia caffra (Red sourplum) kernel oil (Chivandi et al., 2008), both of which are indigenous fruit-bearing trees that flourish in the same eco-environment as M. zeyheri in southern Africa. In addition, the oleic acid content of M. zeyheri seed (85% of lipid yield) compares favourably with the 70–80% OA content of virgin olive oil (Tere`s et al., 2008). Commercial extraction of M. zeyheri seed oil would mean that about 85% percent of the lipid yield would be oleic acid, a physiologically important monounsaturated fatty acid. Long-term intake of olive oil with its high OA has been reported to attenuate blood pressure and the risk of developing hypertension

Although Chivandi et. al (2010) recommend that commercially viable tree plantations be established to maximise the commercial potential of this tree, it is likely that, at least for the Coastal Red-milkwood, discussed in the case study in the previous section, sufficient stands of wild trees could be commercially harvested from dune forests in the Wild Coast

7 Conclusions

The results of this study show that there are a significant number of wild food plants that have exceptionally high nutritional profiles and that have potential to be commercialized and marketed as *superfood-type-supplements*. These plants occur within the communal areas of the Wild coast. There are a number of distinct advantages of a wild foods enterprise over commercial or even subsistence agricultural production; these include: high potential for conservation spinoffs (a wild food enterprise requires natural habitat to remain intact, as well as providing economic incentives to conserve the forests). In addition, wild foods harvesting is ‘grassroots based’ that can provide employment opportunities to local communities living in areas where these plants occur. Unlike commercial agriculture, and once the enterprise is up and running, maintenance costs will be low, as wild trees grow and produce without any tendering.

There are number of wild food plants from Southern Africa that have already been very successfully commercialized and that are currently providing significant income and improvement to the livelihoods of communities associated with these enterprise, In particular, these include the Baobab and Marula wild foods and cosmetic products produce from the Northern and Limpopo provinces. These can serve as role models for the development of community based wild food projects in the Eastern Cape.

This study has identified a number of plants with in three groups (wild leafy vegetables, fruits, seeds/nuts) that that show high potential for commercialization. The wild leafy vegetables, commonly known wild spinach, ('imifino' in Xhosa and Zulu or 'morogo' in Tswana) are cosmopolitan weeds that have been part of the traditional diets of Africans for a long time. Nutritional evaluation showed that many of these wild are considerably more nutritious than the popular exotic vegetables with high levels of vitamins C, vitamins A and E, iron and zinc, and protein. This study showed that three of the *Amaranthus* species were ranked within the top five for overall nutritional density scores (see table in appendix A). Wild spinach in the Eastern Cape is typically harvested from fallow lands as a weed. It is seldom deliberately cultivated, although it has been commercially produced in other parts of the world (such as India) Leaves are usually processed and canned, but can be dried and stored as a powder. The leaves are valuable source of protein and vitamin A. Their protein content is high, varying between 26 and 30 %. The iron content may be as high as five times the recommended daily allowance, the calcium content at least double, and the vitamin A content, 20 times. Amaranth species also bear edible, protein rich seeds. Flour ground from these seeds mixes well with cereal flours and increases the protein content. These weeds can certainly be considered as superfoods.

The next categories of wild foods considered are the tree-fruits. These are the most commonly utilized wild foods, particular by woman and children while in the field. Although there are a number of examples of successful commercialization of wild grow fruits (e.g. Marula in Northern Province, Mobolo plum in Mozambique, and Num-Num in parts of Kwazulu Natal), no such enterprise exists in the Eastern Cape. This study identified a number of wild fruits with high potential for commercial harvesting based on current usage, palatability, abundance of occurrence and nutritional content. These include the Wild plum (*Harpephyllum caffrum*), the two Red- milkwoods, (*Mimisops Cafra and M. obvata*), the Num-num (*Carissa Macrocarpa*), Dune myrtle (*Eugenia Capensis*) and the two Kei Apples (*Dovyalis caffra*, and *D. rhamnoides*). The commercial harvesting of a number of forest occurring species, in particular the first two mentioned can provide significant incentives to conserve a number of areas with rapidly degrading dune and scarp forests on the wild coast. There are a number of product options that could be explored for these fruits including dried fruits, dehydrated and powdered, jams, jellies and fruit juice beverages.

The third category of wild foods that could be sustainably harvested includes the seeds and nuts of trees. Although there are a number of wild grasses that have highly nutritious seeds, these would require some form of cultivation to enable commercial harvesting, that is outside the scope of this study. There are a number of trees that occur in significant numbers on the Wild coast that show promise for commercialization, these include the high protein containing pods or nuts of Boer-bean trees (*Schotia afra, a*nd *S. brachypetala*), and the valuable oils of the Natal and forest mahogany (*Trichilia emetica* and *T. dregiana*), as well as the high oleic oil contained in the Coastal Red-milkwood (*Mimusops caffra*). The seeds capsules of the Natal wild banana (*Strelitzia nicolai*) are also of potential interest.

The harvesting of wild foods that are seasonally regrown on the plant (i.e. leaves and fruit) can be sustainably harvested, unlike roots, corms or bulbs. However even these plant products will need a certain level of management to ensure that the harvesting pressure is relatively thinly dispersed within a targeted area. This requires that relatively large amounts of the targets species are available; typically this will occur in forested areas. Harvesting should always be done so that no more than 30 % of the available standing crop is harvested at any one season. Because seeds, nuts and fruit are also utilized by wild animals overharvesting is likely to have detrimental effects on forest biodiversity. To ensure that targeted trees can still reproduce, all wild food harvesting enterprises should be accompanied by a seedling reforestation program that will also serve to boost wild populations of the economically important species identifies in this study.

8 Discussion

Wild plants are of considerable importance to food security and life support systems of rural communities. They also play a critical socio and economic role through their use in medicines, dyes, poisons, shelter, fibres and religious and cultural ceremonies (FAO, 1999).

The International Convention of Biodiversity (1994) has emphasized the need to inventory, assess and understand traditional farming systems and the use of wild plants with the urgent need for their conservation, sustainable use and capture of traditional knowledge associated with them. Despite this, to date, systematic knowledge gathered on the uses and potential economic value of wild plants in South Africa is extremely limited, and there is a near absence of any government policy or action by both the development aid community and the government to investigate and implement projects that document their use, and investigate potential for community partnership enterprises. This research report provides a number of highly feasible examples, in which the harvesting of wild foods can provide targeted and direct economic incentives for the conservation of the natural habitat where these plants are found.

Scoones *et al* (1992), attribute this neglect to the lack of information about the extent and importance of wild plants in rural economies, as well as the lack of information concerning the economic value or potential value of wild plants. Since Scoones' *et al* (1992) report there has been renewed interest in the use and marketing of products from the wild. In section 1.5 of this report, I provided a number of success stories of the successful commercialization of wild plant products in certain areas of South Africa; however, none of these are in the Eastern Cape.

Most areas that house wild plant resources are also valuable areas in the own right for the protection of biodiversity. The ability of wild products to provide economic opportunities as well as incentives to poor communities (in areas such as the Wild Coast), to maintain tribal areas in natural habitat conditions (often in or near proposed or existing protected areas) has, to date not been exploited. This report proves a strong and substantiated argument for the development of small scale commercial enterprises based on the use of a number of wild products occurring in the forested areas of the Wild Coast. These wild food products can be marketed to the growing urban demand for 'superfoods'. In addition this report argues that the potential conservation spin- offs associated with the use of wild plants can be significant leading to forest conservation and rehabilitation. There is also the opportunity for these enterprises to qualify for 'fair trade certification', a useful marketing handle.

9 Way forward and vision

This section points to areas where further work will be required to realise the vision

The vision is:

- The establishment of at least two pilot grassroots community driven partnerships enterprises, based on the sustainable harvesting of wild superfoods are set up before the end of 2014; in which:

- local communities receive direct economic benefits ;
- economic values thus derived, provide direct incentives for communities to conserve natural habitat that may be developed into formal sustainable use protected areas.
- minimal negative impact to the environment, and where unavoidable, supplementary planting and reforestation used to mitigate any potential impacts;
- enterprises qualify for 'fair trade certification'.

Further steps required to realise this vision includes:

- Detail chemical analysis of targeted superfoods for nutritional content and for possible anti- nutritional compounds (such as oxalic and phytic acid)
- Investigation into the development of markets and unblocking limitations associated with wild foods product development
  - irregularity of supply of wild plant products;
  - lack of quality standards;
  - lack of storage and processing technology for many of the products;
  - availability of cheap substitutes
  - bias in favour of large-scale commercial agriculture.
- Mapping and inventorying of target wild plant stocks and potential volumes of sustainably harvested products.
- Current conservation status of these wild food plants, and potential impacts of harvesting on them.
- Investigation into techniques of sustainable management , harvesting and impact mitigation
- Investigation into the potential domestication /or semi domestication and cultivation of wild food plants. In such cases research is needed on propagation and screening of populations for desirable genotype.
- Measures to avoid overexploitation and loss of genetic variants that may represent superior genotypes
- Drawing up of sustainable management plans.
- Calculating potential economic values and stocks of wild plants occurring in the Wild Coast with well-established markets for medicinal plant value (e.g. *Prunus Africana*) or cosmetic use (e.g *Trichelia emetic*)[1]
- Drawing up of Joint management agreements set up between government authorities, communities and product development agents.

[1]. *Prunus Africana* or African Cherrie is well established as a valuable medicinal tree. Chemicals extracted from the tree's bark are used in a range of pharmaceutical products to treat enlarged prostate (benign prostatic hyperplasia), This market demand provided an important source of income for small-holder farming communities, especially in Cameroon. It occurs, but in unknown quantities, on the Wild Coast (http://www.bioversityinternational.org/?id=3947). Tichelia dregiana, a close relative of the Natal Mahogany, T. emetica, is currently exploited for its seed oil used in the cosmetics industry.

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APPENDICES

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Appendix A: Top 18 plants selected using % Complete Food Index (CFI), for all parts for species occurring in the Eastern Cape

NAME	GENUS	SPECIES	PART	PROT.	FAT	FIBER	CARBO	ENERGY_kj_100g	Ca	Mg	Fe	Na	K	Cu	Zn	Mn	P	B1	B2	Nicot	Vit_C	% CFI
Slender amaranth	Amaranthus	gracilis	leaves	31.2	1	8.8	20.4	905	2350	1506	82.5	125	5750	2.25	6		576		0.63	7.53	3.4	49
Love-lies-bleeding	Amaranthus	caudatus	leaves	28.8	0.3	7	32.1	1034	3348	1589	23.2		4250	1.6	5.5		248		0.6	5.86	5.6	46
Tumbleweed	Amaranthus	graecizans	leaves	26.1	0.9	13	25.6	903	1850	1450	9.8	125	4250	1.3	5		487		0.4	4.36	13.8	43
Flannel weed	Sida	cordifolia	leaves	24.2	3.4	6.8	45.3	1296	2299	667	79.8	15.3	1394	1.9			339	0.39		9.43		41
	Parinari	curatellifolia	nut	28.7	58	4.3	3.7	2737	182	416	5.54	4.39	470	1.95	3.06		466	0.68	0.2			32
	Parinari	capensis	nut	26.3	65.1	2.6	1	2919	59.3	400	4.73	6.08	470	1.56	3.73		411	0.71	0.19	3.79		31
White Raisin	Grewia	bicolor	fruit_flesh_skin	10.3	0.1	13.5	67	1302	268	317	5.92	12.4	1707	1.29	2.59		181	0.2	0.25	3.47	9.3	28
African brislegrass	Setaria	sphacelata	seed_without_testa	11.1	2.1	29.9	41.3	960		221	6.5	68.4	675	1.75	2.86		250	0.41	0.65	5.21		28
Foxtail millet	Setaria	italica	seed_without_testa	14.3	4.8	8.1	61.3	1452	21	148	3.07	3.95	410	1.3	3.5		397	1.05	0.17	0.59		25
	Acacia	nilotica	gum	1	1.2	0.8	83.7	1468	779	149	19.6	51.5	97	1.83			13.7					25
	Acacia	karroo	gum	6.8	0.6	5.7	69.7	1308	963	111	16.6	36	183	1.01	0.27	0.32	33.3	0.02	0.01	0.04		23
Boer-bean	Schotia	afra	seed_without_testa	11.6	2.6	13	62.7	1340	168	119	15.6	0.54	974	1.4	2.19		174					23
Brandybush	Grewia	flava	fruit_flesh_skin	5	0.3	22.1	60	1103	163	169	3.85	3.1	981	0.32	126		86.5	0.07	0.2	1.63		22
Kunibos	Rhus	undulata	Fruit_berries	5	4.7	19.4	55	1187	189	56.9	3.48	43.9	939	3.71	2.9	1.67	116	0.13	0.02	2.6	6.4	22
Donkey Berry	Grewia	flavescens	whole_fruit	7	1.8	45.6	24	589	147	177	9.15	23.8	926	1.08	0.84		107	0.09	0.06	0.74		21
Red milkwood	Mimusops	obovata	fruit_flesh	1.9	0.3	3	22.9	428	43.9	51.5	0.88	51.6	489	39	0.21		26				60	20
	Schizoglossum	capense	tuber	2.5	0.5	3.1	32	599	153	91.5	2.84	64.5	345	51	0.29		14.6		0.05	2.59	14	19
Wild date palm	Phoenix	reclinata	fruit_flesh	3.2	0.7	9.8	46.3	858	50.6	79.2	182	67	1329	0.33	0.76	0.81	33	0.03	0.02	1.16		18

Appendix B. Top wild fruit plants occurring within the Eastern Cape , ranked according to the CFI (complete food index) all macro nutrients (protein, fiber, carbohydrates) in g/100g, energy in KJ/100g , all vitamins and minerals displayed in mg/100g.

COMMON NAMES	GENUS	SPECIES	PROT	FAT	FIBER	CARBOHY	ENERG	Ca	Mg	Fe	Na	K	Cu	Zn	Mn	P	Thiami	Riboflav	Nicotinic_	Vit_C	% CFI
Donkey Berry	Grewia	flavescens	7	1.8	45.6	24	589	147	177	9.15	23.8	926	1.08	0.84		107	0.09	0.06	0.74		21
Red milkwood	Mimusops	obovata	1.9	0.3	3	22.9	428	43.9	51.5	0.88	51.6	489	39	0.21		26				60	20
Bird's brandy	Lantana	rugosa	2.9	3.4	3.8	19.6	507	48.1	126	18.9		597	1.13	0.69		140				5.1	19
Wild date palm	Phoenix	reclinata	3.2	0.7	9.8	46.3	858	50.6	79.2	182	67	1329	0.33	0.76	0.81	33	0.03	0.02	1.16		18
Buffalo thorn	Ziziphus	mucronata	3.8	0.5	2.1	34.4	659	129	58.3	0.95	5.05	726	0.86	0.52		51.4	0.06	0.05	0.71	42.6	17
coastal bladdernut	Diospyros	scabrida	1.8	0.2	4.2	30.6	552	162	24.7	2.89	14.8	496	0.44	0.56						97.4	17
Cross-berry	Grewia	occidentalis	2.8	1.4	22.3	57.4	1080	183	130		78	579	1.02	1.14		76				18.4	17
Cape ash	Ekebergia	capensis	1.4	0.6	2.5	19.3	370	64.7	52.3	2.4	18	366	1.7	0.55		87.9	0.04	0.02	1.74	1	14
Cape gooseberry	Physalis	peruviana	2.3	0.9	3.6	13.9	306	10.5	34.8	2.37	2.98	496	0.36	0.38		61.5	0.24	0.15	1.68	42	14
Kunibos	Rhus	undulata	2.7	2.9	6.8	21.3	513	91.8	25.4	1.41	26.2	297	0.99	1.17	0.56	84.2	0.07	0.1	0.6	2.3	13
Pigeon wood	Trema	oreintalis	4.5	0.5	1.8	21.3	452				43	302	0.18	0.58		66.9				51.5	12
Brandybush	Grewia	flava	2.1	0.1	2	20	377	68.1	70.5	1.24	3.11	288	0.33	0.56		67	0.04	0.03	0.62	29.4	12
Sour fig	Carpobrotus	edulis	2.1	0.3	1.7	24.3	454	188	100	1.14	295	372	0.13	0.48		53.7	0.09	0.05	0.23	0.8	12
Natal plum	Carissa	macrocarpa	0.5	1.1	1.6	16.4	326	22.6	19.5	0.56	1.58	298	0.21			26.2	0.08	0.08	0.31	52.4	12
Assagai	Curtisia	dentata	4	0.5	4.7	14.7	333	115	52	3.3	10.1	449	0.87	0.45		13.4	0.04	0.02	0.29	11.4	12
Kei apple	Dovyalis	caffra	0.4	0.4	0.3	12.7	235	4.8	0.4	0.14	9.5	606	0.06			10.5	0.01	0.05	0.3	117	11
Wildplum	Harpephyllum	caffrum	0.7	0.2	1.7	9.1	172	47	23.7	0.6	5.73	254	0.14	0.14		13.3	0.12			70.7	10
Yellowood	Podocarpus	falcatus	3	0.3	5.2	17.6	357	46	20.1	1.6	11.5	460	0.98	0.2		10.3	0.04		1.13		10
Monkey orange	Strychnos	spinosa	2.7	0.1	1.4	15.2	305	45.8	43.6	0.75	4.55	328	0.46	0.12		22.6	0.23	0.1	1.39	10.6	10
Bastard Currant	Allophylus	decipiens	2.4	0.4	2.1	20.8	405	25.1	26.3	1.48	15.2	349	0.3	0.6		34				15.8	10
White milkwood	Sideroxylon	inerme	4.3	4.4	1.5	17.3	529	46.4	41.7	1.18		482	0.1	0.2		17	0.06	0.09	0.55	14.8	10