Towards Sustainable Honeybush Harvesting

A combined study of a social survey of current harvesting practices and an ecological study on the relations between Cyclopia intermedia, surrounding vegetation and environmental variables in the Langkloof, Eastern Cape, South Africa

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January 2014

Radboud Universiteit Nijmegen

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Abstract

Honeybush tea is one of South African herbal teas, which has become increasingly popular over the last couple of years. This increased interest has led to a shift in the industry; from a few producers commercially harvesting and processing the wild tea, towards a growing number of people both harvesting the wild tea and experimenting with cultivation of the plants. However, due to this development, wild populations of *Cyclopia intermedia* are now at jeopardy and the plant acquired a red list status for the Eastern Cape in 2011 (Raimondo *et al*. 2011). Few studies have been carried out in order to understand the plants characteristics, niche preferences, distribution range, and the impact the sudden boost in industry will have on the wild harvested populations of *Cyclopia intermedia.*

This study has been carried out in order to gain more insight into both the Honeybush industry and the ecological aspects of *Cyclopia intermedia.* Firstly, by giving an overview on the plants and its characteristics (Chapter I). Secondly, a questionnaire was administered in which the harvesting practices and the idea's and beliefs of the producers were investigated (Chapter II). Thirdly, a field survey was set up to investigate the influence of field ages on several ecological aspects concerning the biomass of the plant, the surrounding vegetation and the composition of the soil (Chapter III). The results of these two studies were combined in Chapter IV, in which an overview into the industry was made using integral theory.

As a result we found harvesting practices to be very heterogeneous. Different techniques concerning the harvesting of the species or the management of the land were applied. However, some consensus was found as well on both the importance of establishing harvesting guide lines and on the importance of more research on the plants for future practices. The ecological study has given more insight into both the ecological aspects of *Cyclopia intermedia* and the influence post-fire age will have on the species and its environment.

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Chapter I: Introduction to Honeybush

1.1. Commercial interest Honeybush tea

Honeybush tea (*Cyclopia* Vent.) is one of the traditional South African herbal teas with a long history of regional use, mainly for home consumption (du Toit *et al.* 1998). However, over the last years, Honeybush tea has rapidly grown into a commercial product with a growing demand worldwide (Joubert *et al*. 2011). The earliest reference of Honeybush, 'honigthee' dates back to a European Taxonomic script of 1705 (Kies, 1951). Originally, the tea was made of *Cyclopia genistiodes* (L) Vent., better known as coastal tea ('kusttee') (Van Wijck & Gericke, 2000; Joubert, 2011). Nowadays, the largest contribution to the honeybush industry is made by *Cyclopia intermedia* E. Mey. ('bergtee')*, Cyclopia subternata* Vogel ('vleitee') and *Cyclopia sessiflora* Eckl. & Zeyh. ('Heidelbergtee') (Joubert *et al*. 2011; du Toit *et al*. 1998). Joubert *et al*. stated in 2011 that approximately 200 ha of mostly *C. subternata* and *C. genistoides* are under cultivation. In order to supply the demand, the highest contribution to the annual production is still made up by wild harvesting of especially *C. intermedia.* The increased demand has placed natural population of *C. intermedia* under pressure through unsustainable harvesting practices (Joubert *et al*. 2011). Therefore it is important to investigate these harvesting practices and create certain 'guidelines' to prevent overexploitation of the natural population.

1.2. Species characteristics of *Cyclopia intermedia*

The genus *Cyclopia* belongs to the leguminous family *Fabaceae*, tribe *Podalyrieae*, and is endemic to the Fynbos biome within the Cape Floristic Region (CFR), the smallest and richest of all six floral kingdoms on earth (Low & Rebelo, 1998; Schutte, 1997). The genus can easily be identified by the trifoliate leafs and its bright yellow, honey scented, flowers (September). The name of the genus is derived of the Greek words Cyclos (wheel) and Pous (foot), which is related to the intrused calyx base (Schutte 1998; Kokotkiewicz & Luczkiewicz 2009). *Cyclopia intermedia* is the most widespread species of the genus and endemic to the Western and

Eastern Cape provinces (Schutte, 1997). Its distribution range includes: Witteberg, Anysberg, Swartberg, Touwsberg, Rooiberg, Kammanassie, Kouga, Baviaanskloof, Langeberg, Outeniqua, Tsitsikamma and Van Stadens Mountains. *Cyclopia intermedia* is an erect, multistemmed robust shrub, which can grow up to 2 meters high. The species occurs on the cooler, wetter southern mountainous slopes on rocky, sandy, to loamy-sandy soil at an altitude ranging between 500 and 1700 meters (Schutte 1997; Joubert *et al.* 2011). Furthermore, the plants are known to be found on soils with a low pH, low phosphorous content and a low nematode count.

Figure 1.1: Left the shrub *Cyclopia intermedia*, right a close up of the flowers and leafs of *Cyclopia intermedia.*

1.3. The Langkloof

The Langkloof area is a 150 km long valley, located in the Eastern Cape of South Africa. On the north side, the valley is bounded between the Kouga and Kammanassie mountains and on its south by the Langkloof, Kareedouw and Tsitsikamma mountains. The valley is home to several villages of which Joubertina is the most important one. The rural areas consist mostly of farms where different kinds of agricultural activities are practised of which livestock- and fruit farming (apples) are the most important ones.

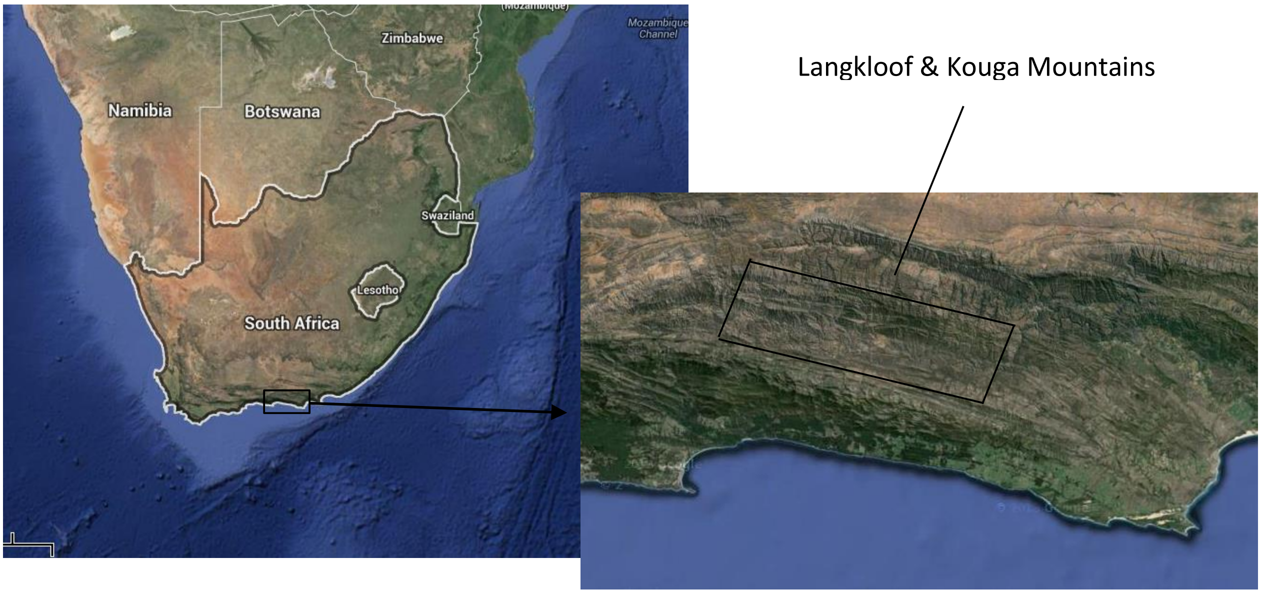

Figure 1.2: Location of study area (source: Google Maps).

Due to the increased demand of Honeybush tea, more and more farmers have quite recently discovered the *Cyclopia* plants growing on their lands or have gained interest in cultivating the tea. For some farmers this has led to a shift in their businesses from having Honeybush as a side product on their lands, to investing a lot of time and money on making it possible to rely on the Honeybush production as their main income. The Langkloof itself is mostly focused on *Cyclopia subternata* (which is also naturally occurring). The Kouga Mountains are partly privately owned areas and partly conservation areas belonging to the Baviaanskloof Mega Reserve. In these areas mostly *Cyclopia intermedia* is occurring, which is harvested in the wild. Rainfall is 650 to 800 mm a year which is higher than the more coastal region of Tsitsikamma and elevation lies between 500 and 1500 m (Smith & Wortel, 2011). The northern Tsitsikamma on the south side of the catchment is a bit lower, up to 1100m, and has more coastal climate with a higher rainfall (850 to 1000 mm a year) (Smith & Wortel, 2011). Because of the wetter and cooler conditions the Tsitsikamma is most suitable for *C. subternata* but *C. intermedia* is occurring as well (Joubert, 2011). In the Langkloof, several producers have started developing ways of cultivating Honeybush (mostly *C. subternata*). In a sustainability report (Smith & Wortel, 2011) it is estimated that there is 30,000 ha of tea bearing land in the Kouga Mountains, 30,000 ha in the Tsitsikamma and 25,000 ha in intermediary ranges (e.g. Suuranys). Present yearly production in the whole area is between 200 and 700 tons (Smith & Wortel, 2011).

Although the industry is developing rapidly, for most farmers it is not possible yet to rely on Honeybush production as their main income. So far, it has been proven to be quite difficult to successfully cultivate the species. An important reason why some farmers invest time and money in cultivating Honeybush is that, as an indigenous crop, the plants are adapted to the fire-prone climate, unlike the fruit trees. Many farmers have seen their orchards bursting into flames due to the intense fire of 2009 which spread all the way from Avontuur to Joubertina (Strydom pers. comm. 2011) and are now looking for other, more sustainable crops, to rely on.

1.4. Fire strategy

The Fynbos region is known to be a fire-prone ecosystem. *Cyclopia* spp. have adapted to the frequent fires by adopting one of the two survival strategies, classifying them into either sprouters or non-sprouters (Schutte *et al.* 1995). *Cyclopia intermedia* is a sprouter, recognised by a woody rootstock, the lignotuber, which is formed by the translocation of photosynthates from the aerial parts of the plant (Schutte, 1995). After an intense fire, it is thought that the plant will resprout using the carbohydrates stored in the belowground lignotuber (Van der Heyden and Stock 1996; Cruz *et al*. 2003). However, allocation of resources to storage carries a cost traded off against growth or reproduction (Chapin *et al*. 1990; Bond & Midgley 2001; Pate *et al.* 1990). Therefore *C. intermedia* will be among the first to reappear after fire, regenerating by producing new coppicing shoots from the lignotuber, but will eventually be outcompeted by other faster growing shrubs (Le Maitre & Midgeley 1992; Schutte *et al.* 1995*)*.

According to Du Toit and Campbell (1990) *Cyclopia intermedia* produces 60 fold less seeds than the non-sprouter *Cyclopia subternata* (Power *et al.* 2011). Besides, the seeds of *C. intermedia* do not germinate as easily as the seeds of *C. subternata* (Sutcliffe & Whitehead 1994). Seed germination is for many Fynbos species stimulated by smoke derived from burning vegetation (De Lange and Boucher 1990, Brown & Van Staden 1997). Seeds of both *Cyclopia* species exhibit a seed coat imposed dormancy, but the seeds of *C. intermedia* also exhibit an embryo dormancy which could be broken by exposure to smoke or ethylene (Sutcliffe & Whitehead 1994). Both the ability of sprouting and the smoke derived germination are specialized adaptations of *C. intermedia* to the Fynbos region, since fire is the most common disturbance regime in the shrublands (Schutte *et al.* 1995; Bond & van Wilgen 1995). These adaptations and the implications of these plant characteristics should be taken into account when harvesting *C. intermedia* in a sustainable fashion. An efficient fire management is essential for maintenance of Fynbos and its biodiversity. Strangely enough, before 1968 the official fire management was to protect Fynbos areas from fire (van Wilgen, 2009). After 1968 it was a policy of prescribed burning of Fynbos vegetation, to safeguard water flow from catchment areas and limiting the spread of fire (van Wilden, 2009). However, recent studies have shown that Fynbos fires are not fuel-dependent and thus wildfire incidence will not be reduced (Van Wilgen, 2009). Therefore, nowadays no pre-described burning is carried out by government officials anymore. However, on private land it is not forbidden to burn the land, but it has to be done under supervision of people of the fire department.

1.5. Sustainable harvesting

As said before, the increasing commercial interest in Honeybush tea has put wild populations of *Cyclopia intermedia* under pressure. This has led to the increasing demand of developing a way in which the plants can be harvested in a sustainable way. For sustainable harvesting, the definition of a sustainable system from an ecological perspective in this study is defined as one that survives or persists (Constanza & Patten 1995) both temporarily and on the long run for the full extent of the species life span. Due to the plants specific characteristics and demands it has yet been impossible to commercially cultivate the species. However, several farmers are currently trying to successfully cultivate the species. Due to its long survival and sprouting ability, it is thought to be more reliable and sustainable than the other *Cyclopia* species. Furthermore, some people claim the plants to have more 'taste'. Therefore, currently the plants are solely harvested in the wild, both legally on private land by local farmers or illegally in the nature reserves and private land.

Especially the illegal harvesting has led to the 'red list' status *Cyclopia intermedia* has acquired for the Eastern Cape in 2011 (Raimondo *et al.* 2011). The current status of the species is unknown but it is likely to decline more than 10 % per year (Raimondo *et al. 2011)*.

For this reason it is important to gain more insight in the harvesting practices and the effects of harvesting on the plants distribution and health. Since some important background information, like unregistered harvesting or fire history, is lacking in unmanaged populations in this study we chose to concentrate on the *C. intermedia* populations found on privately owned land.

1.6. Landholders role in conservation

In the past decade, conservation efforts in South Africa have begun to shift toward private land initiatives (Winter *et al.* 2007). This is due to the fact that on the one hand the formal conservation network lacks means, physically and financially, and on the other hand approximately 80% of the land of the most scarce and threatened vegetation types in South Africa are privately owned (Botha 2001; Winter *et al*. 2007). The contribution private land can make towards conservation is not only investigated in South Africa, but has internationally been addressed, acknowledged and investigated (Bean and Wilcove, 1997; Millar, 2001; Norton, 2000; Miller and Hobbs, 2002).

However, this has not been accomplished everywhere yet. Mediterranean regions, which includes the Fynbos biome, are severely threatened all around the world by pressures caused by human activities (Myers *et al*. 2000; Underwood *et al.* 2009). Besides, certain wildflower farming practices have shown to negatively impact Fynbos diversity (Joubert *et al.* 2009; Davis, 1990; Treurnicht *et al.* 2010). At the same time, wildflower farming has been described as a land-use practice which can be conservation compatible (Sekhran and Richardson 2008).

However, regarding Honeybush, little is known of the harvesting practices and the effects of these practices on the long term. In order to determine how the plants can be harvested in a sustainable way, it is important to first gain insight into the current practices. Besides, in regard to Fynbos conservation, it is important to survey the landholder’s opinion on conservation and sustainability.

1.7. Study setup

We decided to divide our study in two parts; a social and an ecological study. For the social study we established contact with different producers who either harvested the wild populations found on their land, or started cultivating the species. The aim of this study was to gain more insight in the current harvesting practices and in the producer's opinion regarding sustainability and conservation.

For the ecological part of our study we investigated the impact of different field ages and harvesting practices on the plants distribution and production. At different farms we choose different areas with different post-fire ages and investigated the plants characteristics, the surrounding vegetation and the soil composition.

Chapter II: A social survey of current harvesting practices

2.1. Introduction

The sudden increase in commercial interest of Honeybush tea has rapidly changed the industry. Due to the increasing demand, the prices went up dramatically and more and more farmers started harvesting the wild populations of *Cyclopia intermedia* and *Cyclopia subternata* on their lands. Furthermore, farmers have started experimenting with cultivating different species of the *Cyclopia* genus.

This sudden 'boost' of the industry has led to an increased interest of researchers and government officials. The question they want to address is where the future of the industry lies and what the implications of the economic boost will be for the environment and biodiversity conservation. However, most information on Honeybush tea is fragmented and scattered. Especially regarding the production and processing of the tea. In order to tackle the problem of overharvesting of the wild populations of Honeybush, an overview of the current harvesting practices and the people involved is needed. This has been done by interviewing the involved producers (harvesters, farmers and processors) on their harvesting techniques and their ideas regarding various topics including sustainability.

2.2. Methods

The study was aimed at the Honeybush harvesters, farmers and processors situated in the Langkloof valley and the Tsitsikamma and Kouga Mountains (see map). The Langkloof area consists mainly of fruit farms and most farms stretch out over the mountainous areas on both sides. Livestock that is present includes cattle and sheep grazing. The producers were chosen based on records obtained by both an environmental officer from the DEAET (Department of Economic Affairs, Environment and Tourism), an official from the Department of Agriculture and a list of Honeybush farmers obtained by SAHTA (South

African Honeybush Tea Association). Since the Honeybush farming community is relatively small, this type of convenience sampling would not lead to biased results since almost all farmers were included in our sample size (N=22). The only producers not included, were the ones who we were not able to contact or who lived to far away. An overview of the farmers is presented in Figure 2.1.

Figure 2.1: Overview of the farms of the interviewees. Map was made using Google Earth.

Prior to the interview all interviewees were briefly informed of the aims and objectives of the questionnaire. Besides they were told that the results would be used for our MSc thesis's which were done in cooperation with Living Lands (PRESENCE) and Stellenbosch University. The participants were assured that all responses would be treated anonymously and that their privacy would be respected in any publication. Mailed questionnaires were not used to collect data because these usually have low return rates (<35%) (Brand 1994; Van Zyl 1999; Winter *et al*. 2007). Interview duration varied from 0.5 hour to 2.5 hours depending on the amount of information or discussion the interviewee provided or the amount of time he was willing to spend on the interview.

The semi-structured questionnaire (Appendix V) consisted of both open ended questions and phrases, of which the interviewees had to say whether they agreed or not. After some questions/phrases further explanation was asked for, either because we had the impression that the question was misunderstood or to elucidate details on a certain issue. Prior to the questionnaire a pilot survey of two interviews was conducted in order to make sure the questionnaire was structured appropriately and would yield relevant information. The information from the pilot surveys was included in the sample size, since the small adjustments in the questionnaire did not affect the results of the pilot surveys. The questionnaire consisted of four sections that were aimed on the following topics:

- The harvesting practices applied in the Honeybush industry. Central were questions on following themes: what, how and when.
- The management of the land in which the wild Honeybush grows.
- The cultivation practices of different Honeybush species.
- The opinion of the producers on the impact of the harvesting practices of Honeybush on Fynbos conservation

The goal was to create an overview of the current harvesting practices, land management, cultivation practices and attitudes or opinions of the producers. In the first section a distinction was made between wild and cultivated tea and between *Cyclopia intermedia* and *Cyclopia subternata.* The results of this section give insights in the level of sustainable harvesting, the consensus on practices and the possible improvement points. This information can be used for establishing a guideline for sustainable harvesting of the species.

The second section was focused on the management of the Fynbos in which Honeybush grows. Fynbos needs fire in order to renew itself and to survive. We asked the producers whether they practiced fire control and how often Fynbos naturally burns. Besides, we asked them whether they had any other forms of land use like cattle grazing.

The third section was set up around the topic of cultivation. The goal of this section was to gain an overview of the way people cultivated the plants. Most people only started about a year ago with cultivating the plants and the methods they use can be very diverse.

The last section consisted of several statements of which the interviewees had to say whether they agreed or not. Furthermore, they were asked to motivate their answers. At first the five-point Likert scale was used, which is said to be: “a systematic scaling technique to transform attitudinal responses to survey questions into quantitative measures (Falconer, 2000). However, some producers did not really understand this system and since the questionnaire was not filled in by themselves but used as a structure for the interviews, it was decided to leave out the Likert scale but to constrain ourselves to: ‘agree’, ‘don’t agree’, ‘neutral’ and ‘I do not know’. The statements were made along the following themes: conservation, sustainability, harvesting practices, land use and communication.

2.3. Results

2.3.1. Demographic features of study population

To describe the study population, a range of demographic and farm related questions were selected. These questions were orientated on giving a broad view of the background of the farmers and the contribution they make to the Honeybush industry (Table 2.1). 22 people were interviewed in total. Two of them were harvesters that did not own land and were not included in the questions regarding the size of their land and their annual production. One was solely a processor and was not included in the questions regarding the annual production, because the production was related to total amount of harvested Honeybush and the processor did not harvest the tea himself.

Table 2.1: Demographic features of the study population N=22.

Language	English/Afrikaans	Afrikaans		
	11	11		
Years’ experience (yr.)	**<2**	**2-15**	**>15**	
	9	9	4	
Size land (ha.)	**<100**	**100-500**	**500-1000**	**>1000**
	4	3	5	8
Annual production (tonnes)	**<5**	**5-10**	**>10**	**Do not know yet**
	5	5	5	4
Type Honeybush	**Wild**	**Cultivation**	**Both**	
	12	2	8	
Income	**Mainly Honeybush**	**Mainly cattle**	**Mainly fruit**	**Other**
	6	4	5	7

All interviewees were Afrikaans speaking. However, 50% were bilingual and were willing to do the interview in English. 41% of the people only started recently (<2 years ago) working with Honeybush. 18% of the interviewees had more than 15 years of experience. Most (65%) of the producers owned farms larger than 500 ha. The annual production was very variable; all categories resulted in approximately 25%. 21% of the people did not know their annual production yet, for they had just started harvesting for the first year or had not harvested their cultivated tea yet. Most people (73%) did not rely for their income on Honeybush, only 27% of the interviewees did. The rest was divided between fruit (23%), cattle (18%) or other jobs (32%).

2.3.2. Harvesting practices

Table 2.2: General information on harvesting practices.

Species	Intermedia	Subternata	Other		
(more answers possible)	21	11	4		
Process	**Groendal**	**Humansdorp**	**Melmont**	**Heights**	**Own**
	13	2	1	5	1
Plants/seedpods	**Plants**	**Plants+seedpods**			
	15	5			
Time of year of harvesting	**Throughout**	**Summer**	**Winter**	**Autumn**	**Spring**
	6	9	3	1	1
Take into account seeding	**After seeding**	**Yes, cycle**	**No**	**During flower**	
	12	3	4	1	
Harvest yourself	**Yes**	**Supervises**	**No**	**Harvesters**	
	5	4	9	2	
Tools for harvesting	**Sickle**	**Pruning shears**			
	2	15			

All people that harvested the species (N=21), harvested *Cyclopia intermedia*. Half of the people also harvested *Cyclopia subternata*. And some (18%) harvested other species as well. All other species were cultivated for only *C. intermedia* and *C. subternata* grow naturally around the Langkloof, Kouga- and Tsitsikamma mountains. Most people only harvested the plants and not the seedpods (75%). The ones who did harvest the seedpods used those seeds to germinate for cultivation. 45% of the people said to harvest the plants after they had seeded, which is in summer (December to February). 30% said that they harvested throughout the year and 15%, mainly fruit farmers, said they harvested in the winter when it was cooler and it was quiet in the fruit business. Most interviewees (75%) said to take into account whether their plants had seeded or not. Either because they only started harvesting after the plants had set seed (60%) or because they only harvested after a couple of years when the plants had set enough seed (15%).

Harvesting is mostly done by labourers of the farmers, only 28% of the farmers harvested themselves. Most others either let their workers or other people harvest the tea (50%) or supervise the harvesting (22%). For those who had a clear preference in harvesting tool; pruning shears (88%) were more popular than the sickle (12%).

2.3.3. Harvesting techniques *Cyclopia intermedia and Cyclopia subternata*

For the harvesting techniques we made a distinction between *Cyclopia intermedia* (Table 2.3) and *Cyclopia subternata* (Table 2.4). Unfortunately, we only started doing this halfway during the interviewing period. Therefore we got more information from the farmers on their harvesting techniques of *C. intermedia* than *C. subternata.* If we were not sure if an answer was meant for *C. intermedia* or for *C. subternata,* we left the answer out. Therefore the number of answers (N) can differ between the questions.

Cyclopia intermedia

Some (9%) harvested the plants already after one year of growth, 38% waited until the plants had grown for 2 years and 43% harvested between 3-4 years. Only one person waited longer than 4 years before he harvested the plants. 24% of the interviewees did not know from which height they harvested the plants; there was no clear preference between knee (41%) and waist (35%) height. Most people cut the plants low (81%); 38% as far as possible and 43% about 15 cm from the ground. It was difficult to make a rough estimate of the average biomass of one plant, 47% could not give an answer but of the ones who did, 55% said it to be between 1-2 kg.

Table 2.3: Harvesting techniques for *Cyclopia intermedia*.

After how many years (yr.)	1	2	3-4	>4	Do not know
	2	8	9	1	1
From which height	**Knee**	**Waist**	**Do not know**		
	7	6	4		
How far harvest the plant (cm.)	**Far as possible**	**±15 cm.**	**± 30 cm.**	**Leave 1/3**	**Do not know**
	8	9	2	1	1
Estimate average of one plant (kg.)	**<1**	**1-2**	**>2**	**Do not know**	
	1	5	3	8	

For *Cyclopia subternata* the results are shown in Table 2.4.

Table 2.4: Harvesting techniques *Cyclopia subternata*.

After how many years (yr.)	>1/yr.	1	2	Do not know	
	1	3	2	2	
From which height	**Seedling**	**Knee**	**Waist**	**Do not know**	
	2	1		2	
How far harvest the plant	**Pruning**	**2/3**	**Like intermedia**	**Leave bottom leaves**	**Knee**
	5	2	1	1	1
Estimate average of one plant (kg.)	**<1 (>1/yr.)**	**1-2,5**	**2,5-5**	**>5**	**Do not know**
	1		2	1	3

2.3.4. Management of the Fynbos

Most producers who harvested wild population of Honeybush did not perform any management of their land (83%). The others performed some kind of fire-involved management (11%) or cleared alien species.

Of the two who burned their lands, one did so every ten years, after two cycles of harvest, and the other one was planning to burn every three years, after he had harvested the plants.

Besides, we asked several people how often, according to them, Fynbos should naturally burn. Only 21% of the people thought it to be around 5 years, 43% said between 5-10 years and 36% said it burns every 10-15 years. Most people (88%) did not monitor the wild populations of Honeybush on their lands. Of those 88%, 41% did monitor differences in production. Almost half of the people (47%) had encountered people stealing Honeybush on their lands. Most people did not try to plant Honeybush in the wild (60%) and of the ones who did, it was not successful in most cases.

Table 2.5: Management of the wild.

Any managment	Nothing	Fire	Fire strips/alien clearing
	15	2	1
How often do you burn	**Every 3 years if possible**	**Every 10 years**	
your veld	1	1	
After how many years	**±5**	**5-10**	**10-15**
does it burn naturally (yr)	3	6	5
Monitoring of populations	**No**	**No, production**	**Yes**
	8	7	2
Stealing of Honeybush	**Yes**	**No**	
	8	9	
Planting in the wild	**Yes**	**No**	
	5	9	

2.3.5. Cultivation Techniques

Most people (67%) did not plant different *Cyclopia* species on the same land. Most people used sulphuric acid for germinating the seeds (44%). Some other methods that were used are: boiling water, smoke induced, putting the seeds on a wet cloth and adding micro-organisms. Half of the producers used their own seed and one third of the people bought seedlings from different nurseries. In most cases the plants were mixed with other species (57%). Only one person used former Fynbos land to cultivate the species, but this land was covered with black wattle (*Acacia spp.)* which is an alien species from Australia that is invasive and causing a lot of trouble. Ploughing was practiced in half of the cases. And one third of the farmers used a plastic cover to protect the plants against weeds. 88% of the farmers practiced weed control. So far, most people did not experience any severe problems with pests and only one farmer used chemicals to protect his plants against pests. All farmers who cultivated the species watered the plants. They said it was especially important for the establishment of seedlings. Almost all of them used a dripping system.

Table 2.6: Cultivation techniques.

Different species on one land	No	Yes			
	4	2			
How do you germinate	**Boiling**	**Smoke induced**	**Wet cloth**	**Sulphuric acid**	**Micro-organisms**
	2	1 (intermedia)	1	4	1
How do you plant	**Buy seedlings**	**Cuttings**	**Own seed**		
	4	2	6		
Monoculture	**Mono**	**Mixture Fynbos**	**Mixture other**		
	3	1	3		
Where do you grow	**Former farmland**	**Former Fynbos**	**Former meadow**		
	5	1	2		
Cultivation techniques	**Ploughing**	**Clearing**	**Plastic cover**	**Wormtea**	
	4	2	3	1	
Weeding	**Yes**	**No**			
	7	1			
Pest control	**Yes**	**No**	**No but problem**		
	1	6	1		
Watering	**Yes**	**No**	**Only beginning**		
	8		1		

2.3.6. Statements

The 10 Likert statements provided more insight into the ideas and attitudes of the producers. They had to say whether they agreed or not and furthermore we asked them to motivate their answers. Insights in motivations are important to enable structural steps forward in conservation and sustainable harvesting.

Table 2.7: Likert statements on Management of the land.

Statements	Agree	Don't agree	Neutral	Don't know
Management of the land				
Burning the veld has a positive influence	18	3	1	0
Presence of cattle is harmful	8	11	0	3

The first two statements were about the management of the land (Table 2.7). Most people (81%) agreed that burning the veld has a positive influence on Honeybush production. 14%

did not agree. When we asked people to motivate their answers, often the same arguments were given. Both the ones who agreed as the ones who disagreed, claimed that fire-management should be carried out in the right way. The field should not burn too often and people should take good care of the risks. In that case it was good to burn the field, because germination and growth was stimulated due to fire. A list of the pros and cons is given in Table 2.8.

Table 2.8: Pros and cons of fire-management.

Pro	Con
Stimulates growth (4)	*Too risky (1)*
Stimulates germination (4)	*Destroys non-sprouters (2)*
Clears competition (2)	*Too often destroys everything (9)*
Fynbos needs fire (2)	

Concerning the presence of cattle in Honeybush area, 36% of the people claimed it to be harmful for the Honeybush plants. Most of them claimed cattle, but especially sheep, to eat and trample the plants. One producer said cattle is harmful for the whole Fynbos biome and grazing should not be allowed in places where Fynbos is found. 50% of the people said cattle would not harm Honeybush, because often cattle would not reach the high places in which *Cyclopia intermedia* grows. They will walk on paths and not trample any plants. One producer said it might be beneficial to Honeybush production because it might fertilise the plants. The rest of the interviewees (14%) said they did not know the consequences of cattle grazing.

Table 2.9: Likert statements on cultivation.

Cultivation	Agree	Don't agree	Neutral	Don't know
Wild harvested better quality than cultivated	8	2	0	12
Cultivation honeybush is necessary	22	0	0	0

Regarding cultivation of Honeybush (Table 2.9), the producers were asked whether wild harvested Honeybush had a better quality than cultivated. Most (55%) said that they did not know either because they had never tasted pure cultivated Honeybush tea, or because they said that cultivated *Cyclopia intermedia* is not available, so comparisons are not possible yet. Others (36%) said that they thought wild harvested tea to have better quality. People claimed that wild tea, which has grown in nature and natural products in general will always be better than cultivated/ artificial products. Besides, the natural *C. intermedia* is a slow grower and due to the slow growth it should have a better sugar content and more flavour. This argument has also been used in favour of the people who disagreed. They claimed the taste to depend on the growth rate and through cultivation, people could control the conditions in which their plants grow and therefore they might provide better quality.

When we asked the producers whether or not they thought cultivation of Honeybush to be necessary to supply the growing demand, all of them agreed. They said that there will never be enough tea in the wild to support the current demand already. Others said it will be necessary to overcome exploitation of this natural resource.

Table 2.10: Likert statements on conservation.

Conservation	Agree	Don't agree	Neutral	Don't know
Harvesting honeybush negative	4	16	0	2
Harvesting harmful for Fynbos	6	13	0	2
Harvesting forbidden in Nature Reserves	6	12	2	1

The following three statements where on the topic of conservation (Table 2.10). First we asked people whether they believed harvesting of Honeybush to have negative effects on the plants. 73% of the people did not think so, 18% did believe it to have negative effects and 9% said that they did not know. Through asking people to motivate their answers we found out that both people who agreed as people who disagreed, often had the same views. 32% of the people said it should be done in a controlled way and then it could even stimulate the growth of the plants (36%). Others said the same thing and claimed it to be both dependable on how the harvesting is carried out and on the species (23%). However, some said it should be investigated what exactly the best way is to harvest the plants.

For the next statement we went to look at the impacts of harvesting on a broader scale; is harvesting of Honeybush harmful for Fynbos conservation? Most of the interviewees (60%) said that it would not be harmful, 27% said that it would be. Again the need for guidelines was stressed by several producers; if it is done properly it should not be bad for Fynbos. Others said that the little damage that would be done will be absorbed and that other agricultural practices like cattle grazing would be more harmful.

Nowadays, harvesting of wild Honeybush is forbidden in Nature Reserves, but we asked the producers their opinions: Should harvesting be forbidden in Nature Reserves? Most of them (55%) did not agree, 27% did agree, 9% remained neutral and 5% claimed that they did not know. A lot of people, 45%, said that the ECPTA (Eastern Cape Parks & Tourism Agency) should allow controlled harvesting and use the money for building roads, fire managements etc. Some people said that it should be allowed temporarily, until cultivation takes over the production. However, there were also people who said it should remain forbidden; because nature should remain nature and it would be impossible to control the harvesting in a way without harming nature.

Table 2.11: Likert statements on sustainability.

Sustainability	Agree	Don't agree	Neutral	Don't know
I harvest honeybush in sustainable way	19	0	0	2
Research on sustainable harvesting necessary	21	1	0	0
Exchange farmers and research necessary	21	0	1	0

The last topic was on sustainability. For the first question, we asked people whether they harvested in a sustainable way or not. 19 of the 21 people said they did and the other two said that they didn't know, but that they wanted it to be sustainable. We asked the people what sustainability meant and most people said that it meant for them that they didn't cut too often or too soon so the plants would regrow. Others said that sustainable harvesting would mean that their children and grandchildren would also be able to harvest the plants. One person said that sustainability means that you're farming with instead of against nature. However, again, many people stressed the fact that there is a need for guidelines so sustainable harvesting would mean the same for all people.

The second statement goes further on this topic. We asked people whether they believed research on sustainable harvesting to be necessary. Almost all people agreed with this, only one person said that research should not be focussed on the wild harvesting of Honeybush, but on cultivation. He believed wild harvesting to disappear in the future. A lot of people (30%) said that research should be carried out by the universities and not by the farmers themselves. 9% of the people said that SAHTA/ARC should do the research.

The last statement was: exchange between producers and research is necessary for the future. Almost everyone agreed except for one producer who said that not all knowledge has to be shared; people should be able to keep their secrets. Especially for cultivation, some people do not want to share their knowledge, because they have invested a lot of time and money themselves.

2.4. Discussion

2.4.1. Diversification of harvesting practices

This survey has been carried out in order to gain a more complete overview of the current harvesting practices in the Honeybush industry and gain some additional insights regarding the attitudes of the producers. The results show that at this moment there is no consensus on baseline practices. Harvesting practices are numerous and diverse. Many factors contribute to this diversification in the young industry (see list of examples in Figure 2.2). In this study experience and available knowledge, environmental factors and the type of production (wild harvested versus cultivated) are steering factors.

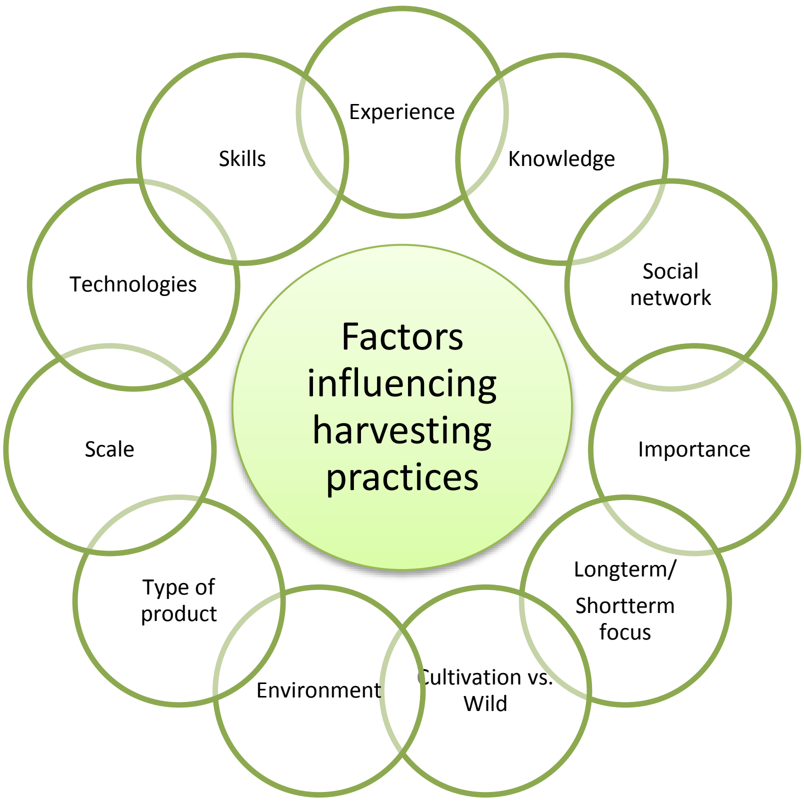

Figure 2.2: Ordination diagram of the different factors influencing harvesting practices.

The amount of available knowledge has a large influence on the harvesting practices. Knowledge can be acquired through experience, but also by contact with experienced producers and experts, and through literature research. As has been stressed before, the industry is relatively new and most producers have only just started either harvesting the wild tea or cultivating the plants. This results in the two distinctive groups of the more experienced and the starting producers. The more experienced producers gather knowledge by experience and often base their harvesting practices on this. This is therefore context specific knowledge and cannot always be generalized. The fact that this group is more experienced does not mean that their way of harvesting is fully sustainable; the decennia long fire-cycles in Fynbos and the lack of monitoring makes noticing effects on populations difficult. However, they do seem to have a clearer idea about trends in their area.

Within the group of starting producers another distinction can be made; there is a group of producers with close communication with information sources (often experienced people or external organizations) and there are producers that are in the starting phase and experiment themselves and/or do not really have any knowledge. Literature research on Honeybush is another way of gaining knowledge but is restricted to some overview articles and some specified articles on Rhizobia. An effort can be done to get information from related species like Rooibos (*Aspalathus linearis)* on harvesting, but a lot of ecological information is not applicable to the *Cyclopia ssp*. Which information is useful can only be tested in practice. The fact that most knowledge comes from context-specific information which is never combined or scientifically verified, increases the diversification of practices.

Large spatial differences exist between producers that operate in the dry environment of the Kouga Mountains and the producers that are situated in the more temperate Langkloof Valley or up the Tsitsikamma Mountains. Through the differences in environment, growing conditions are different and harvesting practices as well. For example the differences in moisture availability can lead to differences in the recruitment and growth rate of the plants which can lead to other harvesting rates. Even within the Kouga Mountains a range of environmental conditions occur and the *C. intermedia* that grows on lower southern slopes might need other harvesting practices than the *C. intermedia* that grows on higher cooler slopes.

The last differentiation is between the producers who only harvest from the wild plants and the producers who rely mainly on cultivation. The harvesting techniques depend on the species and the growth form. These differences have to be taken into account when comparing the harvesting techniques and the possible implications these harvesting techniques will have on the plant species. For once sustainable harvesting in the wild comprehends something different from sustainable agriculture. Where sustainable wild harvesting is about securing healthy natural populations of wild Honeybush and conserving the nature surrounding, sustainable agriculture is about creating a stable supply of tea in a manner that does not have a negative impact on the environment. A consisted definition of sustainability regarding agriculture has been proved elusive (Pearce *et al.* 1989). For Conway (1987) sustainability is 'the ability of an agro-ecosystem to maintain productivity when subject to a major disturbing force' such as drought or a market decline. Therefore it can be stated that sustainability with regard to agriculture is closely related to resilience and is concentrated on production, whereas sustainability in regard to wild harvesting is more correlated to conservation. Harvesting practices in the wild are considered sustainable if the natural populations and the surrounding vegetation are not harmed. Others claim sustainable agriculture to be about: 'relatively small, profitable farms that use fewer off-farm inputs, integrate animal and plant production where appropriate, maintain a higher biotic diversity, emphasize technologies that are appropriate to the scale of production and make the transition to renewable forms of energy (Horrigan *et al.* 2002).

These differentiations have implications for the development of harvesting guidelines. The diversified practices show that there is no clear way forward yet and this means setting up harvesting guidelines will be a long developing process. To get into this developing process several steps have to be undertaken. First of all, all available information (experiences) needs to be combined to see whether any generalization is possible. Also the exchange of information provides the actors with new information to experiment or verify. Secondly, new information should be acquired by large scale producer experiments and by scientific research to verify the local knowledge of the producers. Thirdly, guidelines should consist of a general part which includes the most basic rules of sustainable harvesting and a specified or flexible part for different contexts (environmental conditions, type of production and type of product). To implement necessary immediate actions a preliminary 'code of conduct' could be written based on the available information taking a 'precautionary' approach. In order to combine the knowledge, several facilitated focused meetings have to be organised on short term. This can be done by all interested parties, or by a committee or group of knowledge people who then come up with a draft for the Honeybush community.

Now only the three most important causes for diversification were discussed, but all factors that have an influence should be considered when harvesting guidelines are developed. Leaving out a factor as skills or type of product (high quality vs. bulk) would make the guidelines incomplete or inapplicable.

2.4.2. Different groups of producers

As already mentioned the Honeybush producers can be divided into several groups. Relations between harvesting practices and demographics could be useful when the underlying reason for certain harvesting practices is to be understood. Within the results differences in experience, main income, farm size and percentage of Honeybush area were checked on relations with the answers. The sample size was too small for significant statistical analyses, so only general trends could be looked for.

Not many strong relations came forward. The most evident one was the relation between harvesting practices and the importance/focus of Honeybush for the producer. Here the answers show that producers with Honeybush as their main income, harvest only high *Cyclopia intermedia* (average: 93.3 cm) and cut them low to the ground. These producers were also more concerned regarding the effects of cattle and of harvesting Honeybush on the surrounding Fynbos vegetation. The lack of strong trends is not surprising if one is aware of the amount of factors determining harvesting practices. It is the combination of several determining factors that results in certain practices. It once more shows that the producers are a diverse group of people that come into the industry with different backgrounds. Within the experienced group there are producers that focused all their attention on Honeybush and the ones that have it as a small extra income. Within the Honeybush focused producers there are the ones that work near Tsitsikamma and the ones that work in the Kouga

Mountains. 22 producers are therefore too few to draw any conclusions on the relation between demographics and harvesting practices.

2.4.3. Harvesting practices

Behind some of the differences in harvesting practices there is an interesting argumentation, which could be useful for future research.

Differences in harvesting time were mainly caused by practical restrictions. Most producers agreed that the best time was to harvest in summer after seeding of the plant. In this way the plant was given the chance to reproduce. However, like mentioned in the results, there were also some producers whom were involved in the fruit farming business with summer being the time of harvest for the fruits. Next to this some people found this time of the year too hot and too dangerous because of snakes. Producers that are fully focused on Honeybush have to harvest throughout the year to have a stable income. While harvesting in winter was possible for some producers at the lower slopes of the Kouga and Tsitsikamma Mountains, the producers further in the mountains cannot get to the harvesting areas in winter. This variety of reasons, which are all valid, makes it difficult to give any guidelines on the harvesting season. Recommendations could be given but as long as populations are stable with different harvesting times, the practicalities might be as important. To stabilize populations of course the seeding has to be taken into account (but this can also be done by longer harvesting cycles) and/or the population should be large if seeding is limited by the harvesting time.

Reasons for differences in harvesting cycle of *Cyclopia intermedia* were often related to visible parameters taken to determine whether a plant is matured. The first possible parameter is the seeding. The cycle was determined by the amount of years needed to secure reproduction. This is said to be two; it seems that the plant does not produce many seeds in the first years but does so during the second and third year. More parameters were the losing of lower leaves and colour of the leaves. Other producers hold on to the years it takes to reach a certain height, base their decision on experience or choose the harvesting cycle by looking at other producers. Cutting height was based on the assumption from which height it could best regrow. Some said it did not matter because it regrows from the lignotuber and therefore cut it as low as possible. A few suggested this could even be beneficial, because it creates room for new regrowth after the cutting. Others thought it would be better to leave some part of the stems or left a few stems fully grown. More or less similar reasons were given for *Cyclopia subternata*, but this is a much more vigorous grower and faster seeder. A central aspect was therefore how much you cut and not necessarily when. There should always be a certain percentage of the biomass left to keep the plant healthy. Both the harvesting cycle and cutting height show that there are a lot of important harvesting aspects to study. While some criterion are making more sense (scientifically/ecologically), the results show that producers do have a lot of ideas on where to look for.

From the statements can be seen that there is a common idea around harvesting. Most producers agree that harvesting would not harm the plants or might even stimulate growth, but only if it is done correctly. As shown above, it is yet unknown what the correct way is. In this situation all harvesters are more or less waiting for harvesting guidelines which someone should develop, but it is not clear who and where the information should come from. In the end they themselves are experts and the developers of the future industry including the guidelines. Based on the results we obtained from our survey, field observations and the feedback we gathered during a farmer's workshop, we have tried to fill in some basic information which could be used for establishing guidelines. However, this information has not scientifically been verified and should thus not be treated as such. This overview can be found in Table 2.12. What is important to keep in mind is that these are generalized guidelines, but local conditions like annual rainfall can have a huge impact on the life cycle of the plant (Figure 2.3) and can through this impact influence the way harvesting should be applied.

As Quinton Nortje said: '*You have to monitor through time. It is true that you have to cut after five years. Because the plant is still photosynthesizing, producing and it will store its energy, but it depends on the climate and rainfall. Even a plant that is 8 years old can produce flowers but that would mean that the last 3 years the plant would not have received enough rain.'*

Table 2.12: Overview harvesting guideline for *Cyclopia intermedia* and *Cyclopia subternata*.

Cyclopia intermedia			*Cyclopia subternata*		
What?	**When?**	**How?**	**What?**	**When?**	**How?**
80 cm high, age and colour more important	± 4 years old	Cut at bottom	100 cm high, 20 cm→ pruning	Depends on technique (pruning vs. cutting)	1st year: 1/3 prune, never more than 2/3
10 mm thick	After seeding (cycle)	No up-rooting	10 mm thick	2 yr. when intensively pruned	No up-rooting
Orange/brown stem		Cut sharp/ clean	Yellow/brown stem	Twice a year, if in small amounts	Cut sharp/clean
no leaves on bottom		Use low impact transportation	No leaves first 25 cm	After seeding	Low impact transportation

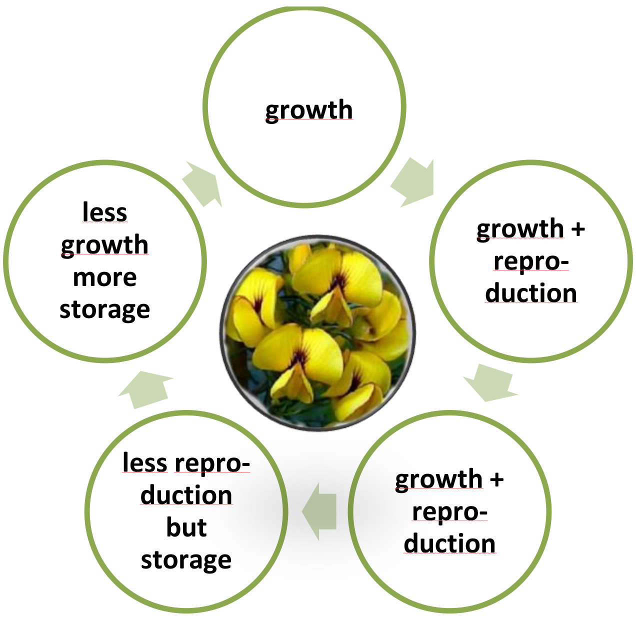

Figure 2.3: Life cycle of *Cyclopia intermedia*. Every circle represents a year.

2.4.4. Land management

Besides the harvesting practices, also the management of the land is of great importance. As a result we have found that the majority of the farmers did not practise any management on their lands. Only few farmers have attempted to burn their land. Also here all people agreed on the fact that burning is good for the production of Honeybush. But in this situation it is not the lack of knowledge, but the lack of skills and the risks of burning which restricts common practices. Furthermore, in burning the field lays the common controversy between stimulating production and the uncertainty regarding biodiversity and ecosystem functioning after frequent fires. Burning is therefore an unexplored territory with possible advantages but also a lot or risks and uncertainties coming with it.

The division between the producers towards the influence of cattle is due to difference in landscape and experience. At some farms the Honeybush is growing on less accessible places, the cattle cannot reach the plants and remain untouched. This not always the case and there are several records of cattle eating Honeybush. Most important seems to be the grazing pressure which should be at least limited. The fact that cattle does eat Honeybush and affects the Fynbos in general could be a valid reason to not consider cattle at all. As has been stressed by some people, both producers and researchers: several types of agriculture can be detrimental for Fynbos conservation including fruit farming and cattle grazing. Extensive grazing (and trampling), can lead to a decline of species. This effect is even greater just after fire when the young, resprouting seedlings are vulnerable since it reduces the vitality of the rootstock (Smith & Wortel 2011). This loss in biodiversity can lead eventually to an increase in both wind and water erosion. Furthermore, in the past, Fynbos has been cleared to make room for orchards. Extensive fires, often man induced, may have negative effects on the tree species which are not adapted like the fire-prone Fynbos vegetation.

2.4.5. Cultivation practices

About a third of the interviewees had some experiences with cultivation of different species of *Cyclopia* Vent spp.. However, almost all have only started recently. Some are very positive on their work and expect a great yield, whereas others are more sceptic. The cultivation practices also vary a lot between the farmers for the same reason as the harvesting practices; a lack of ecological knowledge. However some consensus can be found. For the establishment of the seedlings all farmers agreed that it is very important to water the species constantly. Dripping systems were used to make sure the soil remains constantly moist. What the optimal amount of moisture is, is not known but especially for *Cyclopia intermedia* it seems to be on the low side. This information could be very valuable but it is difficult to extrapolate these insights to natural environments where many variables have to be taken into account.

A lot of debate is still going on, on what the best way is to germinate the species. As has been mentioned before, most *Cyclopia* species have a hard seed coat which is normally broken by heat during fires. Besides, some species (like *C. intermedia*) also remain dormant until the embryo dormancy is broken which can be achieved by certain chemicals. The Agricultural Research Council (ARC) houses a special research programme which solely focuses on research on Honeybush. They have set up cultivation guidelines and workshops around cultivation techniques in which they have taught the farmers to use sulphuric acid for germinating the seeds. However, no experiment have been performed yet to discover which germination practice would be the best for which species. Future research could be done on this topic to make germination guidelines which has been scientifically verified.

More research is also needed on whether the species should be grown in monocultures or in companion with other Fynbos species. Some producers claim these companion plants to protect the plants from pests. It could prevent 'soil sickness', a term that has been used in agriculture to describe the accumulation of pathogens (Patrick *et al.* 1963; Bonamoni *et al.* 2005). This also related to former land use of the cultivation site. The results show that most land used for cultivation is former farmland. On these former land often monocultures (potatoes, wheat, etc.) were used and related 'soil sickness' is not uncommon. Conversion of these 'bad' lands into Honeybush cultivation can be beneficial for the ecosystem. With the necessary treatments, Honeybush can improve soil conditions both by enriching in nutrients and micro-organisms. With a lot more unused former farmland that can be used, this gives possibilities to restructure the regional landscape in a beneficial way for both people and nature.

Although some Fynbos species were seen as companion plants, almost all farmers did remove weeds or places mats on the soil to prevent the establishment of weeds.

Considering pests and pathogens, most farmers did not actively perform any treatments to prevent the plants from becoming infected. So far, no major threats have been observed yet, although some farmers have reported signs of pests. One farmer claimed that some of the wild *Cyclopia intermedia* plants on his have been found dead. He decided to dig out the plants to look at the root system and found the roots to contain holes which he thinks were made by a nematode called 'aalwurm' in Afrikaans (*Ditylenhus africuna)*, a creature known to cause a lot of problems for South African farmers (Steenkamp 2009). Another farmer talked about two different insects who he claimed to eat the seeds from the plants. He described them as a wingless cricket and a snapbeetle. However, these pests have not been verified yet.

All producers have agreed that cultivation of Honeybush is necessary to supply the growing demand. Some have claimed that the harvesting in the wild would disappear once the cultivation can supply a stable amount. Farmers have stressed the fact that more research is necessary to help them cultivating the plants. Some producers have had enough available financial means to experiment themselves and found ways to successfully grow the species. However, they do not wish to share their knowledge with others, since they have invested a lot of their own money and time into the project. Others unfortunately cannot permit themselves to invest money in experiments for the fear of failure. If the industry is to expand in future, more research into cultivation has to be performed. Some, mostly starting, farmers rely on the ARC to help them set up their farms, but other farmers are not on speaking terms with the ARC scientists because they do not want them interfering with their business.

Upon asking who should carry out the research on cultivating and sustainable harvesting of Honeybush, most producers agreed that universities should be involved. To the questions whether the producers considered themselves as possible researchers, most answered that they did not see this. While, as already mentioned, at this time they have most knowledge and are out in the field much more than scientists. While producers mentioned that they are often busy, still in here many opportunities lay for speeding up knowledge creation. An 'action' research approach, where producers are out in the field and take structured notes of their observations in combination of keeping record of their practices, management and production, could give extremely valuable information on implications of harvesting. Especially when this is coordinated by research institutions, that can analyse the data, general trends might be found and new insights can lead to new research and practices. When research institutes are also doing research on the ecology of *Cyclopia* Vent spp., this could be immediately implemented and tracked in the field. This research effort has to be therefore a combination of input from different actors making most efficient use of their expertise and activities. Figure 2.4 is a schematic representation of all the actors who should collaborate on research into cultivation practices, combining their findings could make long term sustainable harvesting possible in the end.

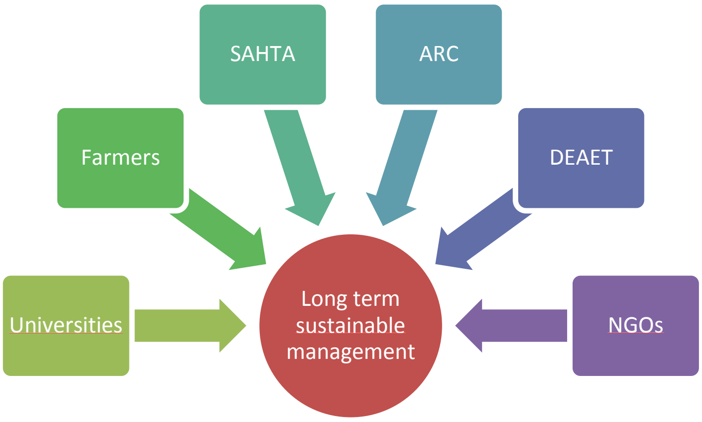

Figure 2.4: Schematic presentation of the actors who should collaborate to establish cultivation techniques and sustainable harvesting practices.

2.4.6. Regional issues

In the study a few regional issues came forward. Results showed that people want to harvest in nature reserves, this is a sensitive point and shows the division between nature conservationists and people that want to use all resources. It can be argued that profits from the resources can be used to develop the area and/or control the Honeybush industry. On the other side it is not known what the function or value is of these populations of Honeybush for the nature areas. Even if harvested is allowed in nature areas, a system needs to be developed how to harvest and control this. An advantage of harvesting the resources is that the plants cannot be illegally harvested anymore. Allowing harvesting on the other hand, could be interpret as a message to stimulate wild harvesting and reveals exact locations of a large amount of resources.

Half of the people is being confronted with stealing. It is an issue that gets many people talking within the Honeybush community. People consider quitting because of the amount of stealing, others report illegal harvesters that go for long distances into the mountains, but there are also people that do not have any problems. There is not a clear explanation for these differences. What is certain, that it is extremely difficult to counteract the stealing by focusing on the illegal harvesters. In the large natural area where the Honeybush occurs stealing cannot be controlled by surveillance. The only way of controlling it in the current situation, is by regulations and strict supervision of the processors. There are only five processing plants in the Eastern Cape and one in the Western Cape where all harvested plants are going, bottlenecks so to say. First implementation of a permit system yielded successes and illegal activities are going down in the Eastern Cape. Still the permits system is not fully fail proof and fraud occurs by switching names or permits. Next to this the regulations only count for the Eastern Cape, to maximize control possibilities to cross regional borders and sell it in the Western Cape need to be prevented. It was reported that illegal harvested material taken by the DEAET is burned. The producers do not understand why the plants are not used to generate income for control. These legal procedures are often in place because of property rights. Resolving this issue lies mainly in clear communication on legal procedures between producers and governmental actors.

Regarding the situation of Honeybush on regional level not much information could be given. This is because not a lot of monitoring is done. Some producers monitor their production but this is not always a good indicator of the state of the wild populations. Here lies a lot of improvement, especially in combination with large scale research projects. Monitoring in collective and structured way could give valuable insights regarding the population dynamics and trends of the different *Cyclopia* Vent spp. and related harvesting practices.

2.4.7. Attitudes towards sustainability

Regarding conservation and sustainable harvesting most producers agreed that these are important topics and that they strive to harvest towards sustainability both for their income and the natural resources involved. Especially the producers who rely on their income on wild population of Honeybush have stressed the importance of sustainable harvesting. However, information is lacking regarding the effects of harvesting and although the producers do not wish to overharvest the plants, at the same time they wish to harvest as often as possible in order to gain as much money as possible. The choice for certain harvesting practices is therefore not only made on arguments for survival of the plant but also on the consideration between long term and short term benefits. This consideration is also being influenced by the already mentioned factor of importance of the Honeybush for the farmer. On the one hand fully focussed producers are dependent on the plants on the long run but also need have to income. Producers with another occupation are less dependent on the survival of the plants but sometimes do not need the money in the short term.

The answers on the questions were also very dependable on the type of farmers. There were producers who were educated and understood some of the ecology of the plant and the consequences of harvesting too often on the resources stored in the lignotuber, others had no idea of this or did not truly understand concepts as 'conservation' and 'sustainability'. Most of the times these producers were only Afrikaans speaking which made it difficult to explain our question or to ask them to give a motivation for their giving answers. When we asked the producers whether or not they thought harvesting of Honeybush would be harmful for Fynbos conservation, a significant part answered no without strong arguments for this. One producer answered that Fynbos was more harmful for Honeybush through competition. Answers like this give an indication of how low ecological understanding of some people is. Without understanding of ecological and global concepts it will be difficult to see why a sustainable industry is necessary. Education and knowledge sharing will be very important to overcome such problems.

2.4.8. Discussion around study design

Next to the discussion on the content some things can be said about the study set-up. Above we mentioned that there are some difficulties when interviewing in Afrikaans. Some questions could not be explained or clarified as much as in English. Furthermore it seemed that sometimes a question was misunderstood, we rephrased the question in this case but it could still be that some questions are not answered correctly. Furthermore the questions regarding sustainability have some kind of moral value and responsibility in it. Being unsustainable becomes nowadays more and more unaccepted. It might therefore that farmers responded in a way that is expected to be a correct answer and not necessarily the full truth. We have tried to limit this by being as neutral and objective as possible. Being neutral and objective was also important for the general response of the producers, we had the advantage of being outsiders but still as environmental students it was important to make clear we did not take a position in debates and to distance ourselves from personal opinions. Subjectivity can also arise when someone is too emerged in a certain situation or place, here comes in the danger of 'downloading'; the looking for information that one already knows or wants to find. To a certain degree this always happens, when asked for clarification the phrasing will steer the answer, but with the straightforward questions in this questionnaire there was not a lot of room to steer the results in this way.

A relatively small pilot survey of only two interviews was done. When looked at the variance in the producers interviewed and their answers, one could advocate a larger pilot survey to be sure that the questionnaire is focused and addresses all relevant questions. However because of the relatively small Honeybush community and limited time, it was decided to keep the pilot survey small. A possible bias in the study is that we did not interview the producers that lived in difficult accessible places. It could be that thereby the study would leave out producers that live further in the mountains, closer to the resources. These producers might have different insights and harvesting practices. However because of the ecological studies several farmers were included that lived far into the mountains. Accessibility in this social study was reduced because there was no 4x4 car at disposal, in contrast to the ecological study.

In the results can be seen that there were different amounts of responses to the questions. This has to do with different type of producers (harvesters, farmers, processors, or combinations of them), type of production (cultivation vs. wild harvesting) and a few questions that were added after the pilot survey. This difference in number makes compare the questions to each other less strong, but this is not the aim of the survey. Besides the amount of responses to the *Cyclopia subternata* is a very small sample. Results in percentages are have thus to be critically looked at.

2.5. Conclusions and way forward

- The community of producers is very heterogeneous. Diverse techniques of harvesting and managing the land are applied. In this study important factors for harvesting practices are experience and knowledge, environmental factors and type of production (cultivation vs. wild harvesting).

- No strong relations were found in the small sample (N=22) between demographics and harvesting practices.

- Differences between producers can be seen in; harvesting time, harvesting cycle and cutting height, the influence of cattle, encounters with stealing and germination techniques. Differences in harvesting time are caused by practical considerations. Differences in harvesting cycle and cutting height have to do with ideas on visible signs for maturity and regrowth of *Cyclopia* spp.

- Common practices and ideas are also found. Producers take into account the seeding, do not think there is a negative influence of harvesting on the plant, use little fire management and do not monitor populations. They do think burning has a positive influence on Honeybush production and harvesting does not negatively influence the Fynbos. Harvesting in nature reserves should be done in a controlled way they say, so it can bring back revenues for the region. And most of the land used for cultivation is former farmland.

- Burning practices can be beneficiary for production but carry also considerable risks and uncertainties. Cattle seems to eat the Honeybush in certain situations, important for the degree of impact is the grazing pressure and accessibility of the plants for the cattle. Stealing is a central topic of conversation in the Honeybush community, but very difficult to control. The best way in the current situation seems to be through regulations for processors.

- There is a contradiction in attitudes toward sustainable harvesting. Producers are dependent on the plants on the long, run but also want to maximize income from production. The final decisions are influenced by expected long-term/short-term results, knowledge level and priority or urgency of production. Education and awareness is needed to give support in making a well-grounded decision.

- Dripping watering systems and weeding are common practice in cultivation. But there is no one way for germination, here more research has to be done. Pests are so far no large threat but might prove some issue in the future with possibly hazardous unidentified insects. Everyone agrees that cultivation is absolutely necessary to supply future demands and stabilize the position on the market. It might even be that wild harvesting is not necessary anymore and would disappear.

- Implications of the diverse practices for harvesting guidelines are; 1) available information should be combined and discussed, 2) new information should be gathered by farmers and scientists in a structured and focused way, 3) guidelines should take into account the different contexts of harvesting Honeybush (environment, type of production and type of product).

- To develop harvesting guidelines it is absolutely necessary that more information is verified and new knowledge is generated. This all has to be exchanged to make it common knowledge. The producers themselves should start to make a code of conduct based on the expertise they already have. Research should be done by several institutions on several topics (e.g. ecology of the plant, harvesting cycle, germination, cultivation techniques, etc.). Ideally this should be done in a combined effort with producers recording their practices and the results of this (monitor their actions and effects), and research institutions collecting and analysing this data and give support with practical ecological research.

Chapter III: An ecological study on the relationship between *Cyclopia intermedia* and its environment

3.1. Introduction

Due to extensive harvesting, wild populations of *Cyclopia intermedia* have been reduced throughout the Eastern Cape and this has led to the 'Red list' status it has acquired in 2011 (Raimondo, 2011). Only few studies have been carried out on Honeybush and none of them has looked in much detail into the ecological aspects of the plant. Most studies have concentrated on the supposed health properties the plant would have. Hawking *et al.* (in prep.) have studied the effects of Honeybush cultivation on the biodiversity and community structure. As a result, they have found that the ecological impact of Honeybush farming is clearly less severe than crops like wheat and even relatively small compared to another indigenous herbal tea plant, Rooibos (*Aspalathus linearis)*. The largest part of the supply is still harvested from the wild and the implication of the harvesting practices on both the plant and the surrounding vegetation are still poorly understood.

In this part of our study, we investigated the relations between three different variables: the plant characteristics of *Cyclopia intermedia* itself, the surrounding vegetation and the soil composition. For the plant characteristics, we looked at different indicators for biomass production of the plant (height, diameter, number of stems and a biomass estimate). For the surrounding vegetation, we concentrated on the number of species, the total cover (further specified into several functional groups) and the height of the vegetation. For the soil composition, we collected soil from the plots to have it analysed for its nutrient content, pH and the amount of inorganic C.

In order to investigate the relationships, we have carried out our study at five different farms. Within a farm, different areas with different post-fire ages were chosen to investigate the impact fire has as a driver of vegetation, as it gives room to a new regeneration phase. Furthermore, between the farms efforts have been made to find areas that are the same post-fire age, so correlations between the farms would be made possible.

Several hypotheses were made prior to the research:

- Species richness will be positively influenced with post-fire age of the field. After a fire, the number of species will increase in this fynbos fire-prone ecosystem through rapid recruitment of the seeders and sprouters (Bond & Keeley 2005). Fynbos needs to burn every 10-15 years to reduce the height of the dominant plants (Bond & Keeley 2005; van Wilgen, 2009). Several studies have looked into the importance of frequent fires on fire-prone ecosystems around the world and found that fire suppression can lead to dramatic effects, like a loss of as many as 50% of the plant species (Bond & Keeley, 2005; Uys *et al.* 2004). This may influence *Cyclopia intermedia* distribution which may be outcompeted by larger species like protea's.

- Biomass production of the *Cyclopia intermedia* plants will be positively correlated with post-fire age of the field. We expect the plants in the older areas to have more biomass than the ones in the younger areas, since those plants have had more time to grow. We also expect the plants to grow faster after they have been harvested once.

- Biomass production of the *Cyclopia intermedia* plants will probably be higher in the Langkloof valley compared to the plants in the higher Kouga Mountains. These differences could be caused by climatic differences and moisture availability. At the Kouga Mountains, the rainwater washes more easily through the sediment of the bedrock compared to the valley, where the water of the neighbouring mountain ridges (Tsitsikamma and Kouga Mountains) accumulates. Besides, the Langkloof is situated closer to the sea, which results in wetter climatic conditions.

3.2. Methods

3.2.1. Study area

Study sites were located on different farms. Selection was done based on information gathered from interviews (see Chapter 2) and the most appropriate farms regarding location, field ages and management records were chosen. In total five locations were selected. Three of these farms were located in the Kouga Mountains (Nooitgedacht, Kritplaats and Brandhoek) and two were situated in the Langkloof, close to the Tsitsikamma mountain range (Heights George and Heights Clive). The Kouga Mountains fall within the non-seasonal rainfall area (Cowling and Holmes, 1992) and receive about 300-600 mm per year (Boshoff *et al.* 2000) with a bimodal peak in autumn and spring. The Heights are situated between Joubertina and Kareedouw. The average rainfall for Kareedouw is 731 mm per year for the period of 1929 to 2006 (Pietersen, 2009). For both regions, the summer months are the driest period. At the Kouga Mountains, frost can occur for 10-40 days per year (Rebelo *et al.* 2006). Temperature ranges from an average minimum in July of 2.9°C to an average maximum in February of 27.3°C (Rebelo *et al.* 2006).

The Nooitgedacht farm (33°47'14.54"S; 24°12'56.17"E) includes a 2500 ha piece of land, surrounded by the Baviaanskloof Mega Reserve. The land is owned by the Nortje family, and already for four generations, since 1927, the Nortjes have harvested and processed the wild populations of *Cyclopia intermedia* growing on their land. At their farm, they maintain a harvesting cycle of five years. After two harvesting cycles, the field is burned in order to keep the vegetation low and to decrease the risks of wildfires.

Kritplaats (33°47'1.60"S; 23°48'41.25"E) and Brandhoek (33°45'26.20"S; 23°54'26.95"E), the two other farms located in the Kouga Mountains, are both owned by farmers who only recently (respectively 5 and 1.5 year ago) started harvesting the wild *Cyclopia intermedia* growing on their land.

The two farms located in the Langkloof are both found in an area called the Heights. The owner of Heights George (33°51'35.72"S; 23°58'28.94"E) started harvesting and processing the wild *Cyclopia intermedia* found on his land 18 years ago, whereas the owner of the other farm Heights Clive (33°52'8.22"S; 23°59'33.89"E) has not started harvesting the wild populations yet. The geographical position of these farms is quite different from the farms in the Kouga, which strongly influences the site conditions. The farms are found in the valley between the Kouga and Tsitsikamma mountains, resulting in a lower elevation and less mountainous terrain. Furthermore, due to the closer proximity to the coast, the annual rainfall is higher, respectively 650 to 800 mm for Kouga Mountains and 800 to 1000 mm for Tsitsikamma.

3.2.2. Field ages

Study sites within the different farms were chosen to represent different post-fire ages ranging from 3 to more than 10 years. However, a large part of the Langkloof area was burned in 2009 and therefore we were unable to find study sites with wild population of *Cyclopia intermedia* older than 3 years. In Nooitgedacht, three different study sites were chosen: Tweeling (Tw) age 3, Hartman (Ha) age 8 and Blaauw (Bl) age 10. In Kritplaats, two different study sites were chosen: Hoekop (Ho) age 5 and Waboom (Wa) age 10. In Brandhoek, two different study sites were chosen as well: Twakkie (Tw) age 3 and Kamp (Ka) age 5.5. Besides the post-fire age, the sites differed as well in the 'age' of the *C. intermedia* plants, depending on when the farmers last harvested their plants (Table 3.1). For Kamp (Ka), it was impossible to find out the age of the plants. Within a plot, half of the plants had been harvested quite recently (some months ago) and the other half had not been harvested before.

Table 3.1: Overview of the chosen areas.

Farm	Name area	Code	Field age (yr)	Plant age (yr)	Number of plots
Nooitgedacht	Tweeling	Tw	3.3	3.3	5
	Hartman	Ha	8	3	5
	Blauwhoek	Bl	10	5	5
Kritplaats	Hoekop	Ho	5	0.6	4
	Waboom	Wa	10	10	4
Brandhoek	Twakkie	Tw	3	3	4
	Kamp	Ka	5.5	?	5
Heights	Heights George	He	3	3	6
	Heights Clive	Cl	3	3	5

3.2.3. Experimental design

The sampling of the study sites was carried out in the months October to December 2012. Prior to any sampling, the study sites were screened so the chosen plots would be a good representation of the area. At every study site, a minimum of four plots of 10 x 10 m were assessed. The plots were preferably situated along a 'cross' with 40 m.

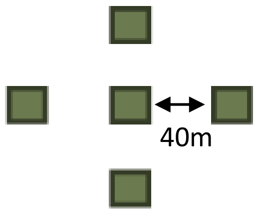

Figure 3.1: Preferred plot design.

3.2.4. Environmental variables

GPS coordinates and environmental variables were recorded for each plot (appendix IV). Environmental variables include: slope, altitude, number of termite hills, plot average height and plot maximum height. For the vegetation composition, the total percentage cover was recorded and further specified for the different growth forms. Plant species were categorized into one of the following growth form categories: graminoids, herbs and geophytes (the herbs and geophytes were combined later on since their coverage was both very low), medium shrubs (< 1 meter) and large shrubs (> 1 meter). Additionally some categories were further specified. The graminoids were divided into Grasses, *Cyperaceae* and Restio's and the shrubs were further categorized into *Proteaceae*, *Ericaceae, Bruneacae, Cyclopia* and Other (which consisted mainly of *Asteraceae*). All individual species in a plot were collected and labelled and the number of species for each plot was counted (Figure 3.2). Unfortunately due to a lack of time and inaccessibility to a herbarium, it was impossible to specify the individual species.

The number of *Cyclopia intermedia* was determined for all the plots and all individual plants were measured. The measurements included: height, diameter and number of stems. Besides, the biomass was estimated by scaling all individual *C. intermedia* plants from 1 to5.5

on a half point basis. A crosscheck between different plots was done by making several photos (including scaling object) of different categories (see Figure 3.3).

For the soil analyses, five soil samples at the depth of 0-10 cm were collected. These samples were taken at the four corners and in the middle, preferably next to a *Cyclopia intermedia* plant, when present. These samples were mixed and sent to the Soil, Water and Plant Tissue lab at the Institute of Plant Production, Elsenburg. The following analyses were performed: pH, K, P, organic C and N.

Figure 3.2: Examples of the plants found in the plots. Plants were acquired at Hoekop (left) and Heights George (right).

Figure 3.3: Picture taken from some plants as an indication of the biomass estimate they received (respectively 1, 3 and 4). The notebook is used as a reference.

3.2.5. Statistical analysis

Statistical analysis was performed for the species characteristics and soil composition using univariate ANOVA's. However, in some cases it proved to be impossible to have the right level of heterogeneity. (All the green graphs represent heterogeneity <0.05 and the red ones

> 0.05). All data were ln- or sqrt- transformed prior to analysis. The relations between the environmental variables were analysed using CANOCO.

3.3. Results

3.3.1. Characteristics of Cyclopia intermedia

The height and the diameter were measured for all the individual plants found in a plot. Statistical differences were found for the height of the plants between the different field ages (Figure 3.4a). For both Melmont, Gerber and Kritzinger, the same trend was found. Plants in the younger areas were significantly smaller than the plants growing in the older areas. A comparison can be made between the two farms at the Heights (He & Cl), Tweeling (Tw) and Twakkie (Ta) for the ages of both the field and the plants are the same. These areas strongly resemble each other regarding the height of the plants. No significant differences were found between the different field ages for the diameter of the plant. Only the farms on the Heights differed significantly from each other ($p<0.001$***) (Figure 3.4b).

For the mean number of stems, a trend could be observed between the different field ages (Figure 3.5a). For Brandhoek (Gerber), the mean number of stems is higher in the oldest area (Ka). However, for the Melmont area, the number of stems seems to be declining as the fields get older and the same result was found for Kritplaats ($p<0.01$**). Hoekop (Ho) was harvested quite recently (7 months) and it was apparent that after the plants were harvested, more stems were produced. However, it was observed that only few of these fresh sprouts would remain once the plants grew older. This effect had also been observed at the two oldest areas (Bl & Wa) which both had the lowest amount of stems.

For the biomass index, no clear correlations were found (Figure 3.5b). Significant differences were only found for Kritplaats. The plants in the older area (Wa) had a biomass index which was significantly higher compared to the plants growing on Hoekop (Ho) (Figure 3.5b). However, the two areas at the Heights differed from one another. The values of Heights George (He) were similar to the values found in the other three-year-old fields of the Kouga Mountains (Tweeling and Twakkie).

a) *b)*

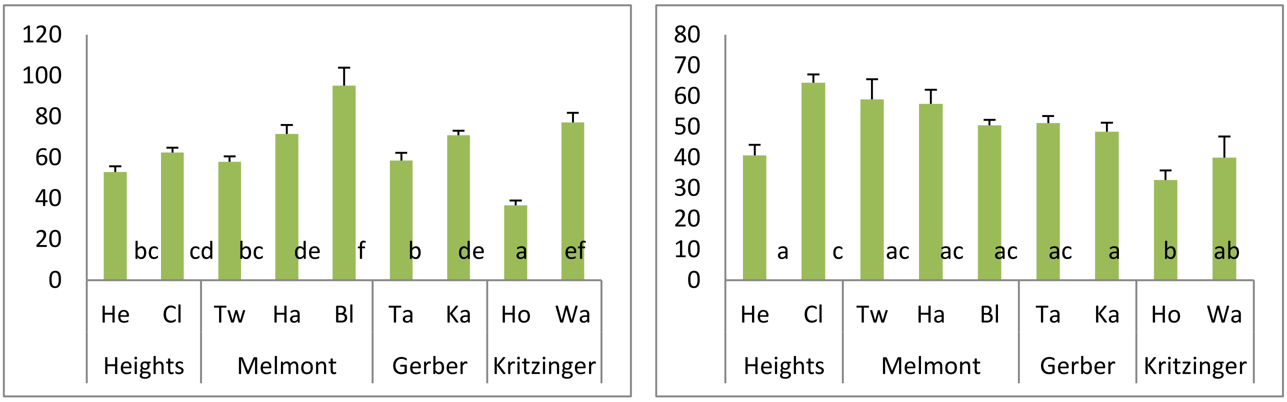

Figure 3.4: Mean height (cm) (a) and diameter (cm) (b) of the *Cyclopia intermedia* plants in the different areas (coded according to Table 3.1). Data are means + standard error (S.E.). Letters indicate statistical differences.

a) *b)*

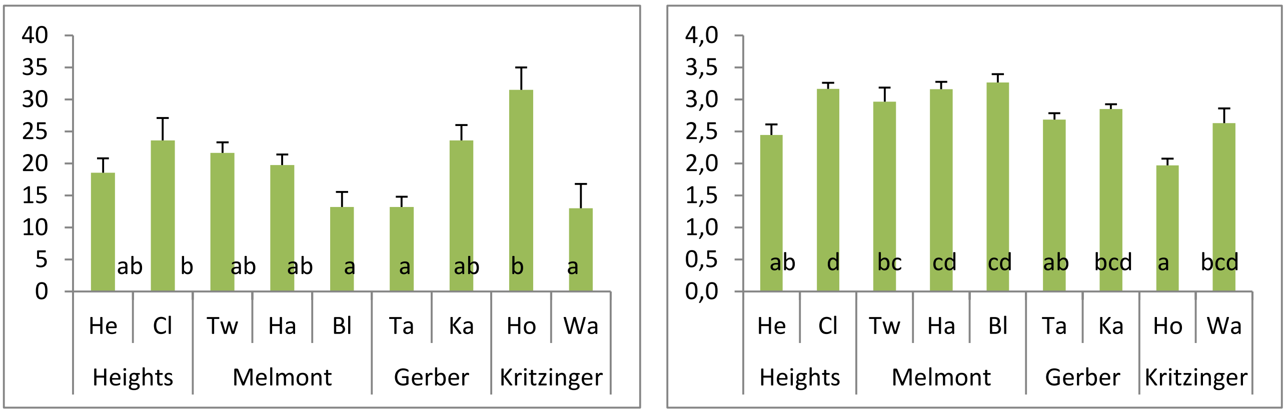

Figure 3.5: Mean number of stems (left) and biomass index (right) of the *Cyclopia intermedia* plants in the different areas (coded according to Table 3.1). Data are means + S.E. Letters indicate statistical differences.

3.3.2. Vegetation composition

No significant differences were found for the mean number of species found in a plot (Figure 3.6a). For the mean number of *Cyclopia intermedia* plants no significant differences were found either. This was mostly due to the high variance found within an area, as is indicated by the standard error bars. For Melmont and Kritplaats there seems to be a trend that the younger areas contain more plants than the older ones. However, the opposite was found for Brandhoek (Ta & Ka) and none of these differences were significant (Figure 3.6b).

The maximum height of the surrounding vegetation was highest in the older areas. The highest vegetation was found at the two ten-year old study sites (Bl & Wa). For Melmont and Kritplaats these differences were significant (Figure 3.7a). Both the mean and maximum height of the Heights plots (He & Cl) were comparable with the younger areas in the Kouga with more or less the same age (Tw, Ta & Ho). For the mean height of the vegetation, the same trend was observed as for the maximum height, with the only difference that Ho and Wa did not differ significantly here.

The mean percentage of cover seemed to increase as the field got older (Figure 3.8). The highest cover was found in the oldest area (Bl). However, for Kritplaats there did not seem to be a difference between the two fields and the differences between Twakkie (Ta) and Kamp (Ka) were not significant. Furthermore, the farms on the Heights differ significantly ($p<0.001$***).

a) *b)*

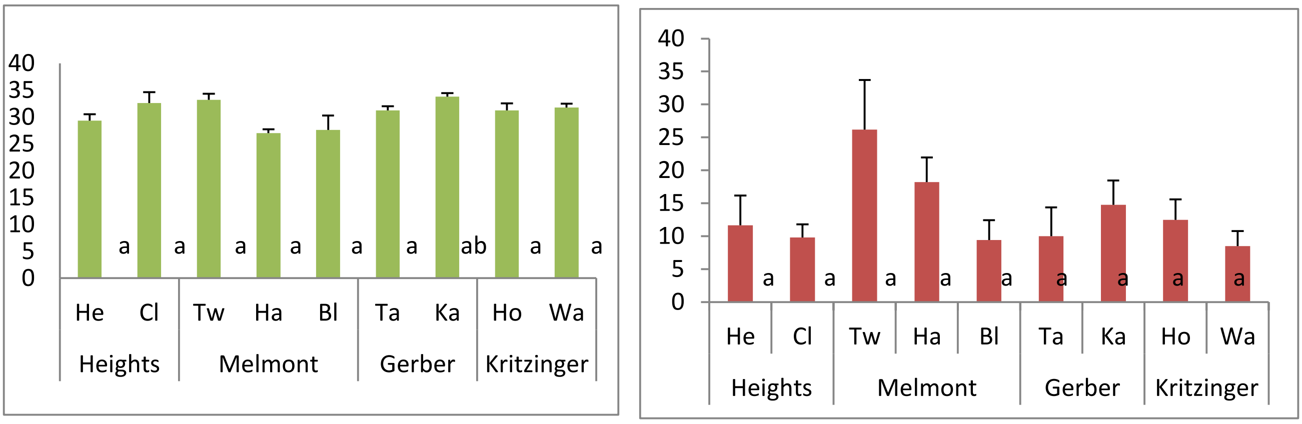

Figure 3.6: Mean number of species (left) and mean number of *Cyclopia intermedia* (right) in the different areas (coded according to Table 3.1). Data are means + S.E. Letters indicate statistical differences.

a) *b)*

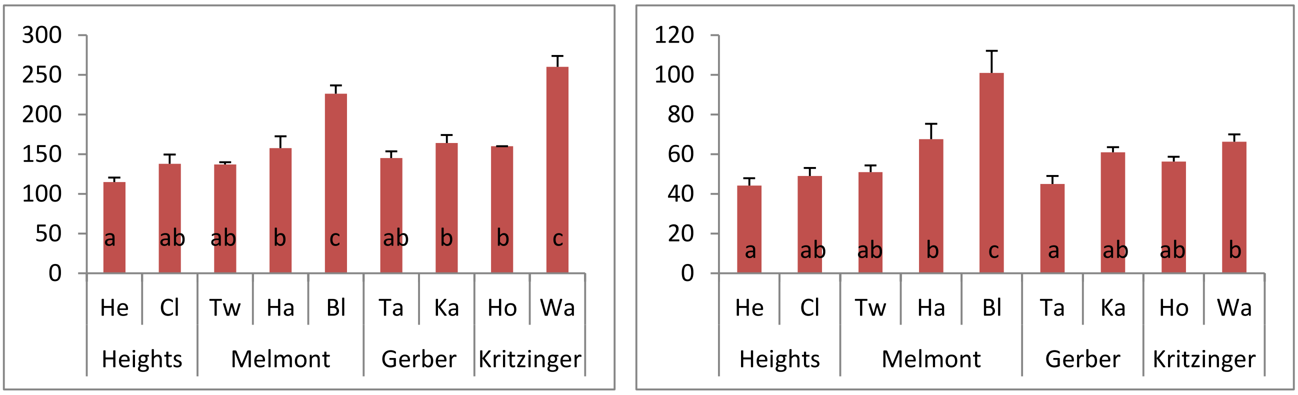

Figure 3.7: Mean maximum height of vegetation (cm) (left) and mean average height of vegetation (cm) (right) in the different areas (coded according to Table 3.1). Data are means + S.E. Letters indicate statistical differences.

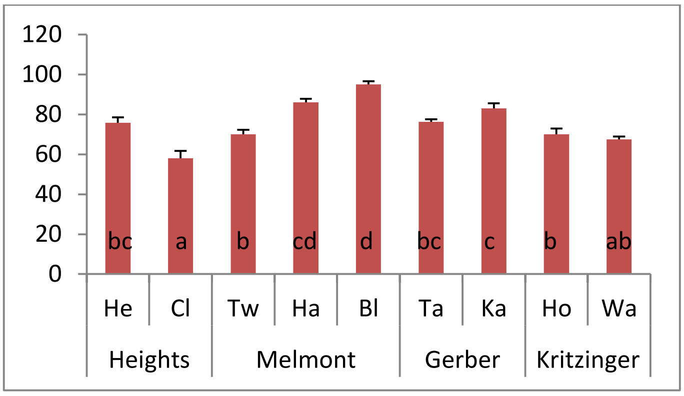

Figure 3.8: Mean percentage of total cover in the different areas (coded according to Table 3.1). Data are means + S.E. Letters indicate statistical differences.

In Figure 3.9, the total cover was further specified for different functional groups (graminoids, geophytes/herbs, medium shrubs & large shrubs). The large shrubs mostly occurred in areas which were older (Ha, Bl, Ka and Wa). For some this is related to a decline in percentage of medium shrubs. The percentage of graminoids does not seem to differ between the different areas.

In Figure 3.10, the cover has been specified further. For most plots the graminoids consisted of the largest part of restio's. The protea's were highly representative in the shrub layer, in the older areas, the percentage of high shrubs consisted primarily of protea species (Figure 3.10).

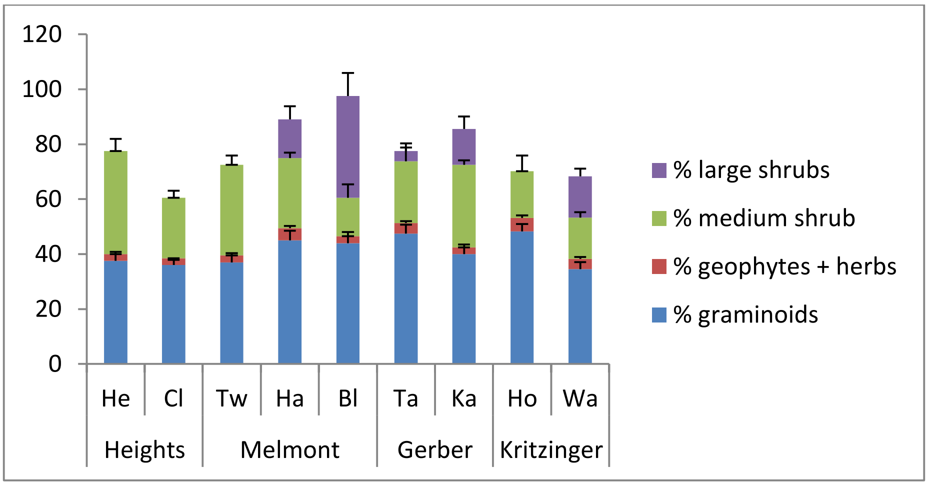

Figure 3.9: Mean percentage of total cover specified for certain functional groups (graminoids, geophytes+herbs, medium shrubs and large shrubs) in the different areas (coded according to Table 3.1). Data are means + S.E. Letters indicate statistical differences.

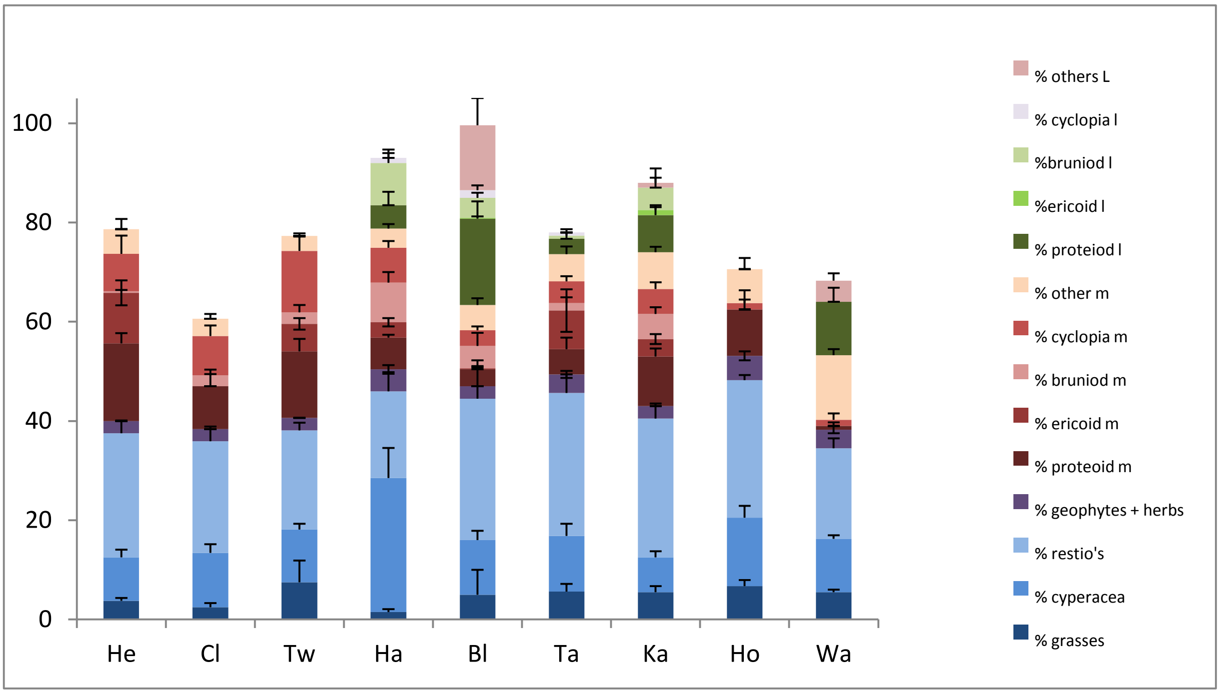

Figure 3.10: Mean percentage of total cover of the different areas further specified (coded according to Table 3.1). Data are means + S.E. Letters indicate statistical differences.

3.3.3. Soil composition

The mean carbon level seemed to increase as the field got older (Figure 3.11a), although those differences were not always significant. Furthermore, Heights George (He) seemed to stand out with much higher levels than Heights Clive (Cl). For the mean level of potassium (Figure 3.11b), no correlations with field age were found.

The ammonium level and level of phosphorus both showed a trend comparable to the levels of carbon (Figure 3.12a/b). The mean level of both ions increased as the fields got older. Again significant differences were found between the two farms at the Heights.

For the pH, no significant differences were found between the areas (Figure 3.13). In general it seems that the pH was a little bit lower for the Melmont farms. The highest pH values were found in the Langkloof valley at the Heights (He & Cl). All the pH values were relatively low with the highest one being 4.8 (He).

a) *b)*

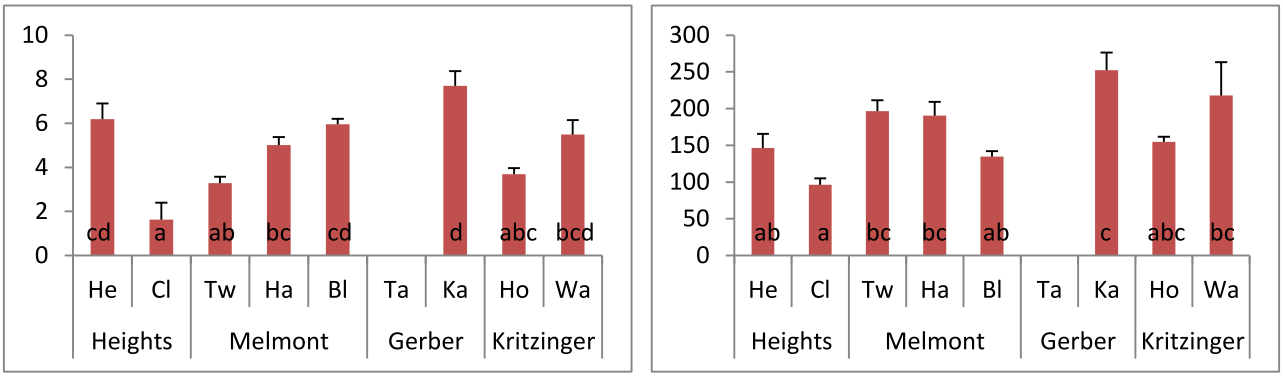

Figure 3.11 Mean carbon level (%) (left) and mean potassium (mg/kg) (right) in the different areas (coded according to Table 3.1). Data are means + S.E. Letters indicate statistical differences.

a) *b)*

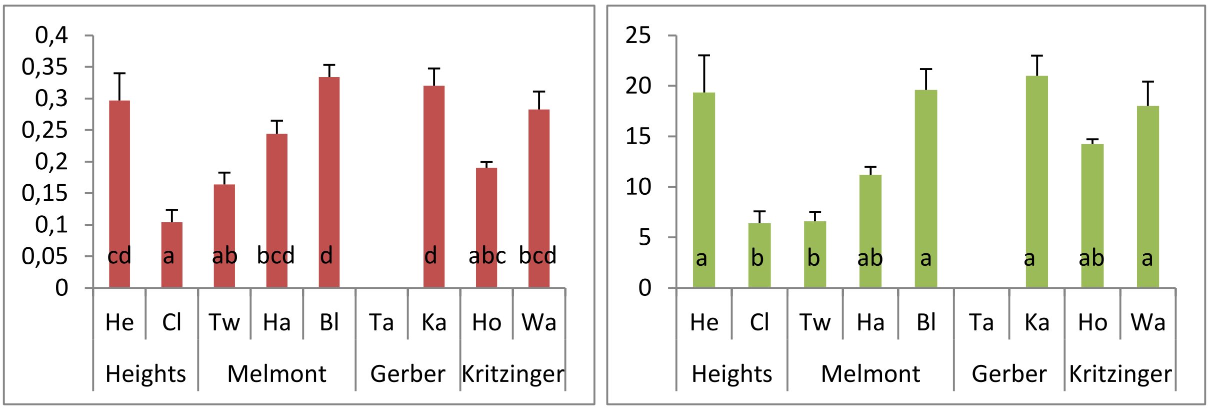

Figure 3.12: Mean ammonium level (%) (left) and mean phosphorus level (mg/kg) (right) in the different areas (coded according to Table 3.1). Data are means + S.E. Letters indicate statistical difference.

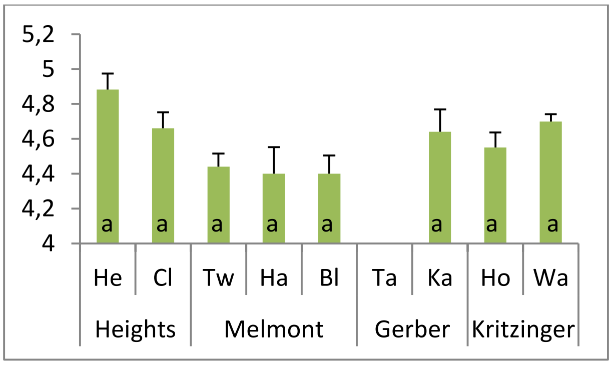

Figure 3.13: Mean pH for the different areas (coded according to Table 3.1). Data are means + S.E. Letters indicate statistical differences.

Table 3.2 Statistical representation of the mean values (± standard error) of the average number, height, diameter, number of stems and biomass of C. intermedia of the different areas (Heights G., Heights Cl., Tweeling, Hartman, Blauw, Twakkie, Kamp, Hoekop and Waboom). Environmental variables include: average height, maximum height and total cover of vegetation and the soil composition: carbon (C), potassium (K), ammonium (NH4), phosphorus (P) and pH. P-values are indicated with: * <0.05, **< 0.01, *< 0.001.**

	Heights G. (He)	Heights Cl. (CL)	Tweeling (TW)	Hartman (Ha)	Blauw (Bl)	Twakkie (Ta)	Kamp (Ka)	Hoekop (Ho)	Waboom (Wa)	F value	P-value
av # cyclopia	11,67 ± 4,51	9,8 ± 1,98	26,2 ± 7,53	18,2 ± 3,75	9,4 ± 3,04	10 ± 4,38	14,75 ± 3,69	12,5 ± 3,07	8,5 ± 2,25	1.09	0.393NS
av height (cm)	52,84 ± 2,86	62,51 ± 2,29	57,98 ± 2,58	71,57 ± 4,41	95,2 ± 8,67	58,48 ± 3,78	70,94 ± 2,08	36,61 ± 2,31	77,13 ± 4,78	45.54	0.000***
av dia (cm)	40,65 ± 3,50	64,40 ± 2,58	58,93 ± 6,64	57,46 ± 4,64	50,52 ± 1,80	51,24 ± 2,27	48,43 ± 2,95	32,69 ± 3,05	39,96 ± 6,89	7.67	0.000***
av # stems	18,55 ± 2,26	23,58 ± 3,50	21,64 ± 1,65	19,76 ± 1,64	13,19 ± 2,36	13,19 ± 1,58	23,58 ± 2,41	31,49 ± 3,48	12,98 ± 3,81	3.78	0.000***
av biomass	2,45 ± 0,16	3,16 ± 0,09	2,96 ± 0,22	3,16 ± 0,12	3,26 ± 0,13	2,68 ± 0,10	2,85 ± 0,08	1,97 ± 0,10	2,63 ± 0,23	9.66	0.000***
av # species	29,33 ± 1,20	32,6± 2,01	33,2 ± 1,11	27 ± 0,71	27,6 ± 2,68	31,25 ± 0,75	33,8 ± 0,66	31,25 ± 1,31	31,75 ± 0,75	3.12	0.009**
Av. height (cm)	44,17 ± 3,75	49 ± 4	51 ± 3,32	67,5 ± 7,77	101 ± 11	45 ± 4,08	61 ± 2,45	56,25 ± 2,39	66,25 ± 3,75	10.47	0.000***
max Height (cm)	115 ± 5,63	138 ± 11,58	137 ± 3	157,5 ± 14,9	226 ± 10,77	145 ± 8,66	164 ± 10,3	160 ± 0	260 ± 13,54	18.64	0.000***
tot. Cover (%)	75,83 ± 2,71	58 ± 3,74	70 ± 2,24	86 ± 1,87	95 ± 1,58	76,25 ± 1,25	83 ± 2,55	70 ± 2,89	67,5 ± 1,44	20.44	0.000***
av C (%)	6,19 ± 0,72	1,62 ± 0,77	3,28 ± 0,28	5,02 ± 0,35	5,95 ± 0,25		7,71 ± 0,67	3,70 ± 0,27	5,50 ± 0,64	12.05	0.000***
av K (mg/kg)	146,3 ± 19,3	96,2 ± 8,9	196,6 ± 14,9	190,4 ± 18,9	134,6 ± 7,3		252,4 ± 23,7	154,75 ± 6,9	218 ± 45,4	7.11	0.000***
av NH4 (%)	0,30 ± 0,04	0,10 ± 0,02	0,16 ± 0,02	0,24 ± 0,02	0,33 ± 0,02		0,32 ± 0,03	0,19 ± 0,01	0,28 ± 0,03	9.18	0.000***
av P (mg/kg)	19,33 ± 3,70	6,4 ± 1,17	6,6 ± 0,93	11,2 ± 0,8	19,6 ± 2,06		21 ± 2	14,25 ± 0,48	18 ± 2,42	7.68	0.000***
av PH	4,88 ± 0,09	4,66 ± 0,09	4,44 ± 0,07	4,4 ± 0,15	4,4 ± 0,10		4,64 ± 0,13	4,55 ± 0,09	4,7 ± 0,04	2.42	0.042*

3.3.4. Relations between environmental and species variables

The relationships between the species' characteristics and the surrounding vegetation are presented in a canonical correspondence analysis ordination diagram (Figure 3.14). The first axis explains most of the data (eigenvalue 0.027; variance: 69.6%). The sum of all eigenvalues is 0.090 and the sum of all canonical eigenvalues 0.038. This means 3.8% of the variance in the species data can be explained by the environmental variables.

As shown in the ordination diagram (Figure 3.14), the younger study sites are separated from the older ones. The older sites (blue circle) are positively correlated to several environmental variables including maximum and average height which explain most of the first axis. The second axis is more explained by the graminoids and the percentage of medium shrubs. The second group (red circle) is negatively associated with large shrubs. The percentage of graminoids is more associated with the younger plots (round dots) compared to the older ones (stars, squares and diamonds).

Table 3.3 Overview of the different symbols used in the CANOCO graphs.

= Heights G.	= Tweeling	= Hoekop	= Twakkie
= Heights Cl.	= Hartman	= Waboom	= Kamp
= Blauw			

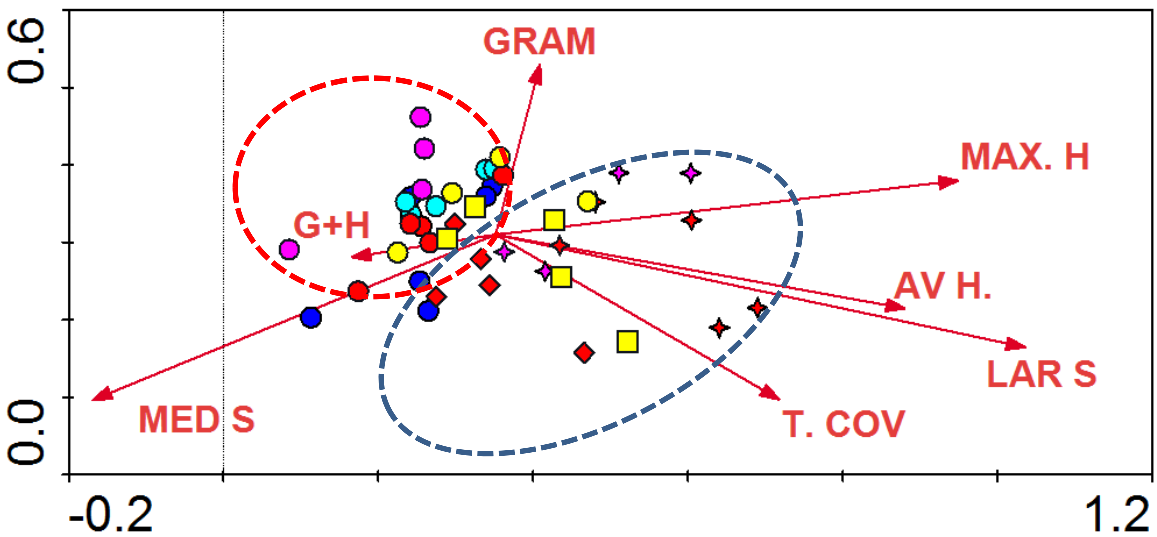

Figure 3.14 Detrented Canonical Correspondence Analysis (CCA) ordination diagram showing the relation between the study sites (species data include height, diameter, number of stems, biomass index and abundance of *Cyclopia intermedia* and environmental variables (data on the surrounding vegetation). Explanation of the symbols can be found in Table 3.3.

Another canonical correspondence analysis ordination diagram was made to present the relationship between the species characteristics and some environmental variables including the total coverage, the average height, field age and the age of the *Cyclopia intermedia* plants (Figure 3.15). Again the first axis explains most of the data (eigenvalue: 0.022; variance: 98.6%). The sum of all eigenvalues is 0.090 and the sum of all canonical eigenvalues: 0.024. Thus 2.4% of the variance can be explained by the environmental variables. Again, the older sites (blue circles) are separated from the younger sites (red circle). The older plots more positively influenced by the age of the plants. This makes sense because the plants in the older plots are often older than the ones from the fields that have been burned more recently. The same applies for the other variables. All the environmental variables that we have chosen here (total cover, plant age, field age and average height) were higher at the older study sites compared to the younger.

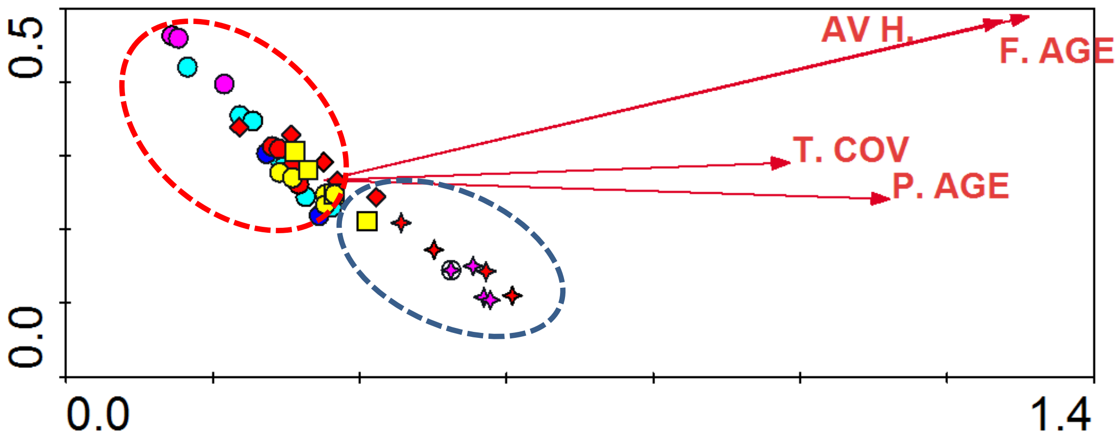

Figure 3.15 Detrented Canonical Correspondence Analysis (CCA) ordination diagram showing the relation between the study sites (species data include height, diameter, number of stems, biomass index and abundance of *Cyclopia intermedia* and environmental variables (average height, total cover, field and plant age). Explanation of the symbols can be found in Table 3.3.

3.4. Discussion

In this part of the study we tried to investigate the relationship between three different variables: the species characteristics, the surrounding vegetation and the soil composition. However, it proved to be challenging to find farms with comparable field conditions. Only Nortje had harvested the wild population *Cyclopia intermedia* for many years, the rest of the farmers had only recently started harvesting. Therefore we were unable to compare the effects of different harvesting techniques.

In the Melmont area, we were able to find three different areas with different post-fire ages, respectively: 3, 8 and 10. At the two other farms at the Kouga Mountains only two different post-fire ages were investigated. This was due either to the unavailability or the inaccessibility of another study site. At the Langkloof valley, two different farms were investigated which were next to each other and which were both last burned at the same fire in 2009. Luckily, it was possible to make correlations between the farms for the younger areas (He, Cl, Tw and Ta).

3.4.1. Characteristics of *Cyclopia intermedia*

Our hypothesis was that biomass production of *Cyclopia intermedia* would be positively correlated to the age of the field. This is true for the height of the plants (Figure 3.1a). As a result we have found that for all three farms at the Kouga Mountains, the height of the plants increased as the field gets older. Striking is that the plants of Hartman (Ha), which are as 'old' as the plants from the three year old areas (He, Cl, Tw & Ta) are significantly bigger. This is an indication of the more rapid recruitment and growth which would occur after harvesting. Comparing the two oldest areas (Bl and Wa) a difference was observed, although not significant. The plants at Blauw (Bl) seem to be higher than the ones growing at Waboom (Wa). The difference could be caused by the fact that the plants at Blauw had been harvested five years ago and the ones at Waboom had never been harvested before.

For the number of stems we have observed that once a plant has just been cut it starts making a lot of new thin green stems. Once the plants grow older, some of these stems die off and only a few survive and will bear flowers. This effect can be seen from the results. The highest number of stems was found with the youngest plants (Ho) and the lowest amount of stems with the oldest plants (Bl, Wa). The number of stems is therefore not the best parameter to assess a plant's health or yield; a better parameter would be the number of branches on top, but this is very time consuming.

For both the diameter and the biomass estimate no correlations were found. For the diameter there seemed to be a trend that it became less as the field grew older. A reason for this could be that other shrubs start to outcompete *Cyclopia intermedia* after 3 years. The opposite was found for Kritplaats, but a possible explanation could be the fact that the plants at Hoekop (Ho) were very young and still growing rapidly. The biomass estimate was only done by visual assessment and could therefore be a less consistent parameter where correlations are difficult to find.

Another hypothesis was that there would be differences between the plants growing at the Kouga Mountains and the ones at the Heights, due to spatial differences like moisture availability, geology, etc. For this hypothesis we have found no evidence. No significant differences were found between the 3-year old areas from the Langkloof (He and Cl) and the 3 year old areas from the Kouga Mountains (Tw and Ta)..

3.4.2. Surrounding vegetation

One of our hypotheses was that the number of species would increase as the field got older, with the maximum at around 10 years (Bond & Keeley, 2005). However, no differences were found between the different fields of different ages. According to our data, post-fire age and species richness are not correlated.

No significant differences were found between the different study sites for the abundance of *Cyclopia intermedia.* However, both Melmont and Kritplaats show the same trend. As the fields got older, the number of *C. intermedia* plants declined. The opposite was found for Brandhoek; here the amount of *C. intermedia* is higher at Ka (5.5 years) than at Ta (3 years). We expected the number of *C. intermedia* plants to be less at the older areas. Just after a fire, the plants will either resprout from their rootstock or the smoke and heat will lead to germination for some of the seeds that are buried in the soil. Through time, some plants will outcompete the young *C. intermedia* plants leading to a decline in abundance again. In order to test this hypothesis, a study should be carried out surveying the recruitment and survival of the plants between two fire intervals.

Both the mean and the maximum height of the vegetation were positively correlated to the age of the field, as was expected. The older the fields, the higher the surrounding vegetation. The younger fields (3 years old) all strongly resembled one another. For the oldest fields (Wa

& Bl), a different outcome was found for the mean vegetation. It seemed to be much lower at Waboom than at Blauw. This could be caused by the differences in vegetation composition. At Blauw, the vegetation mainly consisted of woody shrubs as Protea, Brunia and Leucadendron, whereas the composition of Waboom (Wa) consisted of more lower shrubs and graminoids with at several places large waboom (*Protea nitida)* sticking out (Figure 3.10).

According to Figure 3.8, cover was also positively correlated to field age. Especially for both the Melmont and the Brandhoek (Gerber) area. However, this is not the case for Kritplaats (Kritzinger). Figure 3.9 and 3.10 give a more detailed description about which functional groups are more present at the plots. The greatest difference lies in the amount of large shrubs between the older and the younger areas, especially the large protea shrubs, like *Protea nitida*. Between the two Heights farms, the greatest difference lies in the percentage of ericoid shrubs, which is much higher at Heights George (He).

At the start of our research, the plan was to make relevés using the Braun-Blanquet methodology. Unfortunately due to the inaccessibility to a herbarium and the lack of expertise with the Fynbos vegetation, this plan had to be cancelled. Instead, we tried to quantify the vegetation in the chosen functional groups. We indeed observed differences in vegetation both between the plots in one area and between the different areas. For future research it would be very interesting to try and quantify the vegetation to species level.

3.4.3. Soil composition

The bedrock of the Kouga Mountains consists of alternating white quartzite sandstone and subordinate shale horizon (Rebelo *et al.* 2006). The different layers of sandstone are derived from the Table Mountain Group (TMG), which are associated with acidic, nutrient poor and well-drained stony soil with a clay content of less than 5% (Van der Waal *et al.* 2012; Du Toit & Haughton 1954).

The role of nutrients, in particular nitrogen and phosphorus, as determinants of the vegetation structure and function, is extremely important for Mediterranean-type ecosystems like Fynbos (Kruger *et al.* 1983). The soil N-contents are directly influenced by fire through volatilization or oxidation of organic N. (Stock & Lewis, 1986). Furthermore, the deposition of ash from burned plants and litter would also affect the available nitrogen (Raison 1980; Stock & Lewis 1986). Studies on nitrogen have found minerals like NH_4^+ and NO_3^- to be present in greater quantities in burned soil compared to soil of similar unburned sites (Christensen 1973; Sharrow & Wright 1977).

Honeybush is a legume and highly dependent (70-100%) on N_2-fixation for its N uptake in the wild (Spriggs 2004). Honeybush is also mycorrhizal and thus the mycorrhizal fungus would aid in both the N and P uptake (Spriggs *et al.* 2003; Hawkins *et al.* 2005).

Based on this knowledge, we expected the amount of nutrients and pH to be overall low, due to the low soil level and the influence of the bedrock. Unfortunately, the soil samples from one of the study sites (Ta) were lost in the field.

The study sites at the Heights are situated in the valley where water from the mountains and rain water can accumulate, therefore we thought the mineral content should be slightly higher compared to the higher situated plots at the Kouga Mountains. However, the plots we took were situated on a slope and the soil was very rocky and the organic layer (o-horizon) was quite thin.

We expected the nutrient content to be higher at the younger areas, as the effects of the fire would still be more apparent at these sites. However, we found no articles claiming anything about how long the effects of the mineralizing would last.

The organic carbon percentage was calculated using the Walkley-Black method. As can be seen from Figure 3.11, the percentage of organic c increased as the fields got older. The amount of organic carbon is related to the vegetation and the amount of litter produced by this vegetation. Therefore it is not surprising that the amount would increase as the time passes and more organic matter is deposed. According to Cowling *et al.* (2004) Fynbos is a carbon rich ecosystem with carbon fixating abilities.

Striking is the great difference between the farms on the Heights (He& Cl), where the carbon level at Heights is almost six fold higher. No plausible explanation can be given yet although we expect this high carbon level to affect the level of nutrient holding capacity.

The cations, NH_4^+ and K^+, show a pattern more or less comparable with the carbon percentage found in the soils. However, for potassium (K^+) a different pattern was found, with different values for Tweeling (Tw) and Hartman (Ha) two study sites of the Melmont farm. The cation exchange capacity (CEC) is the number of positive charges a soil can contain and is correlated to other values like pH and the level of organic matter. The pH values of the soil are all quite low (ranging from 4.4 to 4.9) and do not seem to be correlated to the concentrations of cations found in the soil.

Inorganic P in the form of phosphate (PO_4^{3-}) is extremely important for plants. As said before the levels of phosphate are generally low: 3 to 20 mg/kg (Hawking *et al.* 2005). This correlates to our findings with the highest level (average ± 20 mg/kg) and the lowest level of 6 mg/kg (Figure 3.12). Hawkings *et al.* (2005) have that found plants can adapt to these low levels of phosphate and nitrogen by forming cluster roots. They have investigated this effect for *Leucadendron laureolum* (Protaceae) and *Lupinus albus* (Fabaceae). Maybe this could also be the case for Honeybush, which is also a Fabaceae, for it often grows in the vicinity of Protaceae. One of the farmers has mentioned that he often saw 'tolletjiesbos' growing close to *Cycolopia intermedia.* It would be interesting to investigate this type of facilitation in future research.

3.4.4. Relations between the environmental variables

DCCA ordination diagrams were made to verify the correlations between the species data and the environmental variables. Often, the species composition is used as the species data of the plot, however in this study we were unable to qualify all the plant species. Therefore, we have used all the data on *Cyclopia intermedia* (abundance, height, diameter, number of stems and biomass estimate) as the species data. Figure 3.14 shows the correlation between the species data and several coverage data. The study sites are divided into two groups: the older and the newer plots. As a result the older study sites are more positively correlated to coverage and height of the vegetation. Often the plants were bigger at the older study sites and the coverage and height of the vegetation were also higher. Figure 3.15 confirms this result, for it can be seen that the older study sites (blue circle) are more positively correlated to age of the field (F-age).

Multivariable statistics were also checked in SPSS with GLMs. Here results were less representative than the DCCA. Besides some small significant values for soil, there were no significant results. These values resulted from combinations of 4 or more factors which were transformed in logarithms and categorized. With the measurement methods, these values are not convincing enough to show sound relations.

3.4.5. Discussion around study design

It was difficult to find comparable study sites. Primary reason for this was the differences in harvesting practices of the farmers. They all started at a different time with different harvesting cycles and also land management was slightly different. The influence of management on the results can therefore not be determined. Next to this, the sites differed also in environmental conditions. Although kept to the minimum, the mountains are rather variable in conditions (moisture, mist, temperature, etc.), due to minor changes in elevation, position in the mountain range, main aspect, etc. Keeping these factors as comparable as possible was the main point in selection, but eventually it turned out that his can only be done up to certain level.

It is assumed that all these variables can have a relatively large influence on the results. Doing a field study on Honeybush, with a limited amount of time, has thus been proven difficult. A possible way to monitor the plant’s ecological characteristics would be on collective producer-based projects.

Another challenge is the absence of a control situation in the field, because it cannot be assessed if a plant is never harvested and what the complete natural situation is.

Furthermore, it would have been better to measure direct environmental variables as moisture availability and temperature, but limited resources made this impossible. Time is important for the amount of replicates that can be assessed, and during this study we had only few. And more expertise on Fynbos would have improved results on vegetation competition.

All these reasons combined make that the results could not reveal strong relations between *Cyclopia intermedia* and the field age or environment variables. The fact that *C. intermedia* is able to occur at still quite a broad range of environmental conditions within the Eastern Cape makes only field studies insufficient to get the necessary knowledge. This advocates a combined approach of experimental ecological research with large field studies.

Another difficult aspect was to determine the best variables in order to assess the most important characteristics of *Cyclopia intermedia* (regarding health or production). In this case was chosen for height, diameter, number of stems and biomass estimate but this is done arbitrary because there is no scientific information to base this on. Variables like amount of leafs, colour of leafs and stem, the plant's geometry, etc. could also be explanatory. What are the best ones is not known.

3.5. Conclusions and the way forward

- Our results show that the height of *Cyclopia intermedia* is positively correlated to field age. For the other characteristics no correlations were found. There are some indications that harvesting (as seen at Melmont) has a positive influence on the growth of the plants. For future research it would be very interesting to monitor the biomass production of the plants over time.

- The vegetation composition differed between the study sites. The biggest differences were found between the younger and older areas. However, as mentioned before, it proved impossible for this study to make relevés at species level. If future research is carried out on the vegetation composition it would be interesting to see which differences can be found and how these differences are correlated to the characteristics of *Cyclopia intermedia* and the soil composition. *Cyclopia intermedia* as a nitrogen fixator could have a great impact on the vegetation structure.

- For the soil composition, we have found some differences between the areas of which some can be explained, but others cannot. Due to limited time and resources we have chosen to only test a few variables. In order to gain a more complete overview of the microclimate of the plants, it would be good to perform an analysis for all nutrient and mineral concentrations. In this research we have not included much geology or hydrology records, but this would also contribute to the understanding of the environment. Rainfall, moisture and temperature are important factors which have to be monitored over time, which could be done in cooperation with the farmers.

- As a last remark, in this research we have chosen to only study areas in which *Cyclopia intermedia* was present. If the research were to be continued it would be important to look at study sites which seem to be similar in appearance (abiotic factors as topography, soil type etc. and biotic factors like vegetation types) but in which *Cyclopia intermedia* cannot be found. Furthermore, the measurements should be done through time on the different farms in order to see what the implications of harvesting will be and to have more replicates.

Chapter IV: An integrative overview for more sustainable Honeybush harvesting

4.1. Introduction

In previous chapters the studies are described which were done with a predefined goal, methodology, resulting in concrete results. However many links exist between the ecological aspects and the social parts of this study. Furthermore by seeing, feeling, hearing and being in the Honeybush community, observations and insights which do not belong to the predetermined studies are left unmentioned. In this chapter, we would like to integrate the personal observations and separate results to get to recommendations which are aimed at a holistic approach to improve sustainability in the harvesting of Honeybush.

A bird's view of this study and its insights shows that the industry has many different ecological, organizational, technical and social aspects which we encountered. From this perspective the industry can be described as a complex system with 'wicked problems'. With the aim to provide valuable recommendations we believe it is necessary to not just show one aspect of the issue but to approach the industry from a holistic perspective. For this we use the Integral Theory from Wilber (1995). The term 'sustainability' in this section is differently from what is described in the first chapter. In this chapter 'sustainability' has a much wider meaning; not only the ecological side of the issue but also social justice and economic sustainability is included in working towards 'sustainable harvesting'.

4.2. Integral Theory

Integral theory (Wilber, 1995) is a theory and simple framework developed to integrate different perspectives and methodologies. The objective is to make research and perspectives on problems more realistic and holistic, so that solutions are designed in a way that is synchronized with reality and therefore perform better.

The fundamental recognition is that every issue has at least four perspectives along two distinctions; 1) an inside and outside perspective and 2) a singular and plural perspective (Esbjorn-Hargens, 2009). This leads to four perspectives; the interior individual (I), the exterior individual (It), the interior collective (We) and the exterior collective (Its). In every issue all these perspectives are dimensions of reality that are always present (see Figure 4.1). These four dimensions co-arise and are mutually implicated in each other; they influence reality simultaneously and are interlinked. When certain dimensions are not addressed, a part that shapes reality is missing and solutions or creations will most likely be less effective and/or less sustainable.

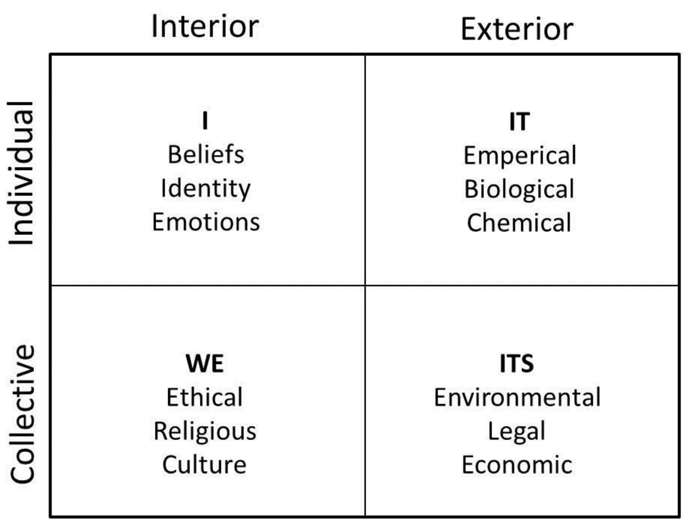

Figure 4.1: Wilber's framework of dimensions (1995).

The framework of Wilber is more extensive than this; it also recognizes that there are more elements which should be used to fully grasp the whole reality (different levels, lines, types and zones). To keep the overview simple and information workable in this report only the different dimensions are used.

While this framework can be an extensive tool to address all aspects of an issue, in this study it is used simply to make sure conclusions and recommendations are given in an integrative way. By using the integral framework we are aware of the multiple dimensions of the reality of the Honeybush harvesting. Using the results from our study to only give recommendations on the ecological side of the issue would be very limited and would not be likely to get the industry towards sustainability.

4.3. The Honeybush Model

In the applied integral framework of this study sustainable Honeybush harvesting is the central issue. In the previous chapters the exterior dimensions were central. In these dimensions the 'It' dimension of the Honeybush harvesting is dominantly the plant itself and the harvesting practices. The 'Its' dimension is the system level; the larger ecosystem, market and legislation. Nevertheless the interior dimensions have a large influence on whether the Honeybush harvesting can become sustainable in the end. The 'I' dimension deals with the identity of the farmers including their personal consciousness (e.g. awareness of interdependency), beliefs (e.g. experiences with burning) and feelings (e.g. connection with nature). The 'We' dimension looks from the point of the producers and nature conservationists in group context; traditions and related morals, and views on the product and communication within the groups.

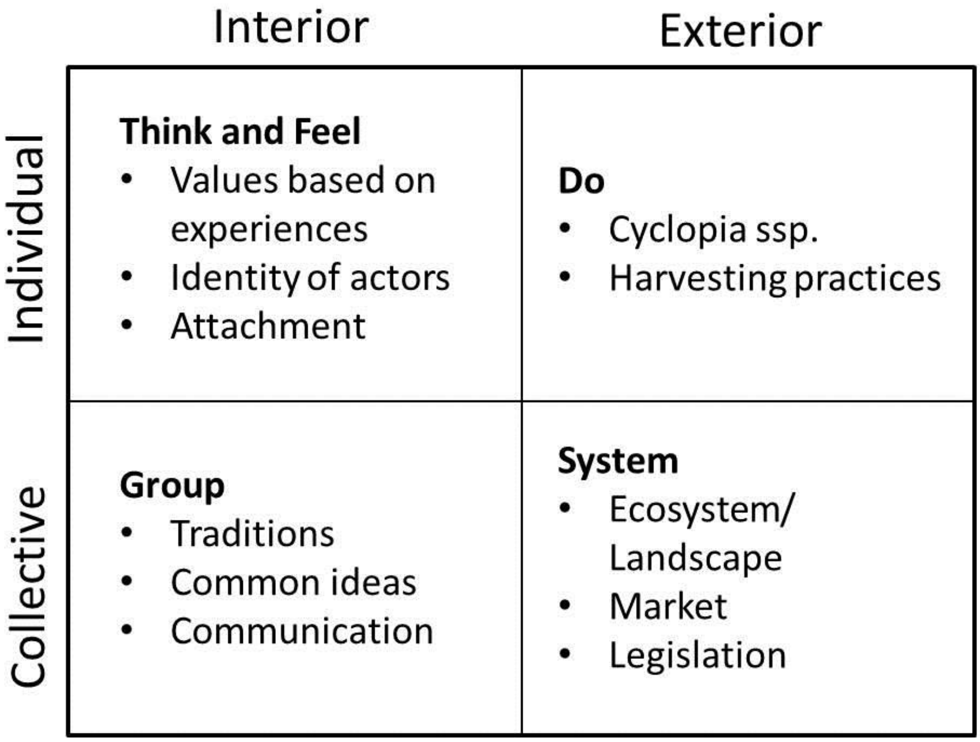

Figure 4.2: Framework of dimensions filled applied on sustainable Honeybush harvesting.

The above model (Figure 4.2*)* gives an overview of the different aspects that came forward in this study. It shows that the plant itself is a central topic but the model makes you aware that this is only in one dimension of reality. Even if you would know the plant in detail you cannot reach sustainable practices when there is a short term focus, a part of society is excluded or the ecosystem is neglected. Here lies the link with the social part of the study; ecological information is only useful if the other dimensions are synchronized. Only sustainable harvesting practices can be reached when also the other dimensions are taken into account and recommendations are aimed at every dimension of reality that influences the practices.

We acknowledge that the insights from this study does not necessarily cover every issue that is important for sustainable harvesting, but it gives a clear overview of all the different dimensions that need to be included in the development of sustainable harvesting practices. In the next sections the main conclusions and recommendations are discussed for every of the four dimensions.

4.4. The Plant Perspective (It)

The central concept in the exterior individual dimension is *Cyclopia* and related harvesting practices. In this dimension it is all about how to harvest the plant in a way that is not harmful for the plant or can even stimulate growth. To be able to do this, a lot of knowledge and/or experience is needed, for instance; information on the translocation of resources, the lignotuber, ecological drivers for growth and germination, and many more ecological insights. In the ecological study the focus was on relationships with the direct natural environment. This could reveal some characteristics of a productive habitat and drivers for growth. These drivers are important to find, to understand the plant's requirements for growth and thus for where to find and harvest the plant and how to cultivate it. While the results did not show direct relations, several experienced producers in the Kouga claimed that for example the moisture availability at the right moment is essential for strong growth. Especially when plants are still young and competition is low, high moisture availability stimulates growth. On the other side, for high quality tea stress was said to be important. Plants would otherwise be large but too green, with too many flowers and little taste. In the much wetter Tsitsikamma Mountains this was less obvious, probably moisture is less determining than in the Kouga Mountains. However, it is difficult to separate the influences of different environmental conditions; moisture is not the only important factor. The previous chapters show this as well; different situations and contexts also exist in this 'It' dimension; for example different genotypes could be in need for different conditions. All these variations should be taken into account when studying the ecological aspects of the plant.

Despite the lack of knowledge, this study shows that similarities can be found in the harvesting. Ideas around seeding, the low harvesting height of *Cyclopia intermedia*, the eating of Honeybush by cattle, the positive influence of burning, the need for cultivation, etc. were generally accepted among producers. These similarities of producer's experiences are important to make generalizations which can be used for the first steps towards harvesting guidelines and as a code of conduct.

We have seen how difficult it is to construct harvesting guidelines when there is no common understanding, beliefs or practice, and only little information. Besides, there is only little communication between the different actors and within the producing community. While the goal of constructing harvesting guidelines is a very important one, it is unrealistic in this situation. A more appropriate goal in this sense would be to all agree that these guidelines are not realistic yet and write down basic understandings; a code of conduct based on principles and shared values and communicate all new information and regular discuss whether this is of value (for future guidelines).

How does this dimension influence sustainable Honeybush harvesting?

Clearly this dimension is central. Without knowledge about the plant, it is impossible to known what the maximum production is and how to reach this. This directly influences the market. Without knowledge about the practices no legislation can be made. Without knowledge of the plant and the practices, it is not known what the effect of harvesting is on the landscape. Without knowledge of the individual exterior, no sustainable harvesting is possible.

Recommendations:

- Increase knowledge by applied ecological studies that are useful for both ecologists and farmers. A selection of practical topics can be found in appendix III

- Increase validity of study results by setting up large scale study projects and collaborations between different study institutions and farmers. It is important that these are long-term projects.
- Start a long-term project on harvesting and management guidelines in which add-on of information is possible. It is important to already start with writing guidelines for what is known now and in coming years make it more specific.
- Not only use traditional ways of study, but come up with alternatives; BSc. students, let farmers document in simple scientific way, etc. The study should be coordinated and documented by a central actor which can steer the process and make sure that the new information is valuable and will be used.
- Exchange and discuss current information. Look for patterns, similarities and investigate these.
- Reduce cattle in Honeybush area as much as possible.
- Reduce pressure of wild harvesting as soon as possible so the shift towards sustainable cultivation can be made.
- Document on which subjects are common agreements and make a code of conduct.

4.5. The Landscape Perspective (Its)

Sustainable Honeybush harvesting has of course also a strong system aspect. The 'Its' dimension includes several different fields where this aspect is presented.

On the ecological system level, the population of Honeybush is important. Influences on the individuals affect the population. This combined effect on all individuals is an important process for the survival of the species and therefore for sustainable harvesting. Up till now, the harvesting is mostly focused on the survival of the individual. The population has hardly been monitored so far, so this should change. Only when populations are measured, conclusions can be drawn whether or what kind of harvesting has a negative influence for Honeybush. The population is of course linked to the ecosystem as a whole. An individual Honeybush plant has only little influence on the surroundings but if the effect of all individuals is added up, a population can have a significant effect on the surroundings. The exact ecosystem functions of the plant are unknown yet, but the nitrogen fixating ability and the strong pioneer characteristic are surely affecting the ecosystem. Therefore it is also important to know how the plant is embedded in the ecosystem, to understand the effects harvesting will have on the surrounding vegetation.

Another important component on the system level is the market. With an increasing demand for ‘healthy’ teas, the demand on Honeybush tea increases but of competitive products as well. This creates windows of opportunities of the market. Multiple aspects need to be taken into account to make use of these windows. Establishing a strong market position requires first of all a supply that can answer the demand. A stable supply is not in place yet; there are not enough consistent producers and fluctuations are caused by changing environmental conditions and failing yields and cultivations. Furthermore, Honeybush should be marketed in such a way that it can create its own niche. This means further investigation of properties but also creating a story around it. Having a sustainable industry is one of the best ways to build this story. The market and industry are of course elements that are intertwined. How the market will develop depends on the industry and vice versa. It is therefore important to know what the possibilities are on production level; what kind of product can be delivered (quality, taste, etc.) and what is the maximum sustainable production of the industry? And on the other side it is important to know how many possibilities the market has to upscale the industry, taking into account strong competition and a limited demand for tea. The insights of both sides are important in the change of the industry and how intentional interventions towards sustainability are designed. As markets fluctuate, it is important to hold on to a flexible approach and continuously be able to adjust interventions.

Legislative issues are already shortly discussed in Chapter 2. Also these take shape on landscape level. The amount of stealing is declining because of regulations but remains high. The many jobless and people with low incomes know that the plants can earn them some money and are easy to get. Some people do not even know it is illegal to harvest them without a permit. It shows the inequality within the population and the difficulty of controlling a widely occurring plant. It is impossible to put the whole region under surveillance, especially the mountainous areas. So the remaining two options are controlling the collection points and/or including the whole community so that revenues are shared and stealing declines by self-regulation. Controlling collection points with permits stays problematic while wild harvesting is the main production way. It is difficult to estimate the amount of Honeybush that can be harvested from a certain area and give sound permits. Here more ecological knowledge would provide a great deal of improvement. Next to this, being able to count on the honest cooperation of the collectors is crucial for a fraud-proof permit system.

How does this dimension influence sustainable Honeybush harvesting?

From an industry perspective this dimension links all aspects. Working towards sustainability has to be done by including many different elements, for a holistic approach this dimension is important. A view that includes the whole region is needed to solve the current bottlenecks of the industry; 1) the ecosystem which is linked to the plant, practices and production on the long run but also to other ecosystem services as water and soil health. 2) The market that is now still in a juvenile phase can only grow strong by regional cooperation and linking it with production and standardized harvesting. 3) Legislation can work when directly linked to the individual and social dimension; when persons are willing to put genuine effort towards honest revenues.

Recommendations:

- Include effects on the ecosystem in the large research projects of harvesting.
- Start preliminary studies on market opportunities. This could be done by students or distributers themselves. Included should be the possible niches and related products.
- Start studies on opportunities for a transition towards a more sustainable regional land use after having a better idea of the effects on the environment and possibilities on the market.
- Further improve controlling of processors. Processors should be fully transparent with numbers and names. Also processors in other regions should be included.
- Look for other ways of controlling stealing. Self-organizing or self-regulation could be one possibility, but in this case the people and community should all be willing to cooperate.

4.6. The Social Perspective (We)

Looking from a social point of view shows that several types of actors make up the Honeybush business and are related to sustainable harvesting. There are the farmers, landowners, the workers, harvesters, processors, the external experts, etc. Each of these actors has a certain role to play. The results of Chapter 2 already have shown that within harvesters there is a lot of difference, and actually most of them can be further subdivided into groups. Most important is that these groups have their own point of view, traditions and social values that influence the way they act.

While many different distinctions from person to person can be made, the most evident group distinction in the Honeybush industry is between the poorer coloured people, the farmers that own the land and the external researchers or nature conservationists.

1) The poorer coloured people are often doing low-income physical harvesting work. They are often from the poorer township areas or the 'workers' of the landowners. Because of their social background, their educational level is low and their future perspectives often hopeless. In this self-maintaining situation, short term benefits become more important and the survival of the species less important or even unnoticed. They do not have a lot of traditions around farming, but there is a strong sense of community in which their social habits and ideas are shaped.

2) The farmers are often landowners as well. They have a lot of knowledge about their area but look at this from a perspective which is directed towards using and producing on the land. Honeybush is therefore one of the resources that can be used to gain more revenues from their land. Survival is important for the timeframe of the farmer's life. Using the land in its fullest is a farmer's attitude.

3) The external academic people look differently at sustainable harvesting. Most of the time highly educated and without direct connection or benefits from the lands, stakes are different. They have less attachment to the practices or cultural landscape itself and a large interest in the topic from an objective stand. With aims to gather data and knowledge they fit in the scientific traditions. Furthermore, nature conservationists have a special connection with the larger system and care a lot about the survival of the species and conservation of

Fynbos. In which culture and background the actors developed steers how they act and think, and therefore whether sustainability can be aimed for. Because of these different origins all interventions (communication, guidelines, legislation, etc.) should be somehow suitable for the different worldviews of the actors to intervene effectively and steer the whole industry. For instance guidelines that are made for farmers or researchers will be difficult to follow for the workers. Like said earlier, within these groups many different people exist; a landowner can still care a lot about the nature on its land. However, it is important to realize how these social and cultural factors influence the sustainability of harvesting.

Besides having interventions aimed at the different target groups, another option is to try to get the groups closer together (this not only counts between groups but also within groups, see Chapter 2). This does not mean erasing all differences between groups; this is not possible and not desired. Diversity can be used in social learning; showing different perspectives in a social context and learn from that. What should be aimed for is that the different groups understand each other and their differences, and look for similarities or differences that can be bridged. Communication and participation are key-words here. In the current situation, this communication is largely lacking and fragmented (see appendix II). Meetings and incentives are often done with one group instead of approaching the whole Honeybush community. The common controversy between nature conservationists and farmers is a good example. Both parties are very distrustful and hesitate to collaborate, due to the stressed differences around ideas on nature and production. While this is true up till a certain extent, both parties want survival of the species and care about the area. Conservationist should realize that you cannot expect that farmers just let go of their income or traditions and farmers should understand that there is also the responsibility towards the larger ecosystem and the ones that benefit from it. Dialogues on this and searching for solutions together is a much stronger approach to work toward sustainability than trying to convince one of the groups. In general a lot more information could be collected and used when all experiences and knowledge would be shared.

Also part of this cultural dimension is the involvement of the whole community. The willingness to involve also the less developed part of the community in the industry is central when sustainability includes social justice. Without this, the producers will keep having problems with illegal harvesting and unsustainable practices. The people have to feel engaged and a sense of ownership of the issues to be willing to change practices. A flourishing Honeybush industry could even have positive side-effects on the region, including its criminality, health and politics. To engage the poorer community, incentives are needed that make these people serious cooperating partners. An already existing example is the formation of harvesting coops, which are independent groups of harvesters. This is still relatively small, but could be extended when wild harvesting would become a specialized niche where there is room for community involvement and the members are educated. This is one possible effort to include other parts of the community in the industry, but more incentives can be started; shared property rights, community cultivations and harvesting educators just to name a few. The step towards successful community involvement is too large to let them do it all by themselves, collaboration with more knowledgeable actors and facilitating or steering organizations are needed.

How does this dimension influence sustainable Honeybush harvesting?

The social dimension is inherently linked with all other dimensions because the dynamics and thinking of different groups do influence the acting and thinking of the producers and other actors. This can manifest within groups, as traditions and common practices can hinder or stimulate sustainability and are not always easy to change. But it can also manifest between groups, as the differences can create clashes. Still the groups are dependent on each other and have to find a way to work toward sustainability. In this social dimension communication and involvement are the most important ways to create a Honeybush community in which traditions, social values are not a problem and all human capacity is used to improve harvesting.

Recommendations:

- Investigate group dynamics and thinking to get an overview of positive and negative traditions regarding sustainability.
- Look for similarities between the different groups and use them to solve controversies.

- Create an open dialogue between farmers and nature conservationists and try them to let go of the usual way thinking.
- Enhance communication and stimulate creation of bonding. To do this so called 'bridgers' are needed that can connect different worldviews. Also central organization and influential people can be included to bring people together.
- Involve communities through several initiatives; strengthen coops and let them do the wild harvesting, partial ownership of cultivation, etc.

4.7. The Individual Perspective (I)

The individual interior perspective is all about what happens inside the actors. What the actors feel and think. Also this is an important driver for the behaviour of the actors and the underlying reasons for this, the deeper values, are important to understand.

Identity is a term often appearing in this interior dimension. The identity of the actors is the collection of the different values present inside a person. These values come from different sources including cultural background, education, personal interests and experiences, and close people and family. The line between socially (collective) or personally (individual) constructed values is not easy to distinguish. However, differences within the groups are seen and result from differences in these personal values. Some farmers will have for example a much more sustainable approach because the attachment they have with a certain area, plant, animal or nature in general. Or because of the experiences they have with practices like burning or grazing. The same accounts for the other actors. A certain attitude is constructed through a personal history including many different sources of input.

A few important personal issues encountered in this study are; the experiences of producers which shape practices, the importance of Honeybush which varies between actors and the ideas around sustainability which differ a lot.

1) Experiences and related knowledge acquisition has a large impact on how actors think and therefore the choices they make. This varies a lot between the farmers, between the harvesters and between the researchers. With more or different information, more possible frames take shape and different choices will be made.

2) The fact that several farmers see Honeybush as a side business and others as their main practice or an opportunity to reshape the future of the whole region is another sign of the personal interpretation of the situation. Not necessarily good or bad, seeing Honeybush as a side business could be dangerous because this can lead to practices that are purely aimed at short term benefits. If there is a lot of knowledge on the plant, these practices can be suited to the perspective of side business but in the current situation it seems more profitable to create a strong and united industry to ensure good care of the plant and surrounding.

3) Ideas around sustainability differ because of multiple reasons; attachment to nature is one but also thinking on long term or short term or thinking about maximum profit will influence practices. This has also to do with thinking terms of cycles and systems or in linear patterns. This awareness of interdependencies can have different levels. From an egocentric point of view where actors are central and their harvesting is fully disconnected from others issues, to a holistic approach where the harvesting of a plant can be connected with all nature surrounding it or the improvement of all regional people. One of the issues in the current harvesting situation is that this level of integrating and system thinking is not common within producers. To change perspective from a product and short term benefits towards revenues from a sensitive system that consists of numerous elements takes effort and conviction, and is not always desired. Still it is needed because this is often the only perspective in which industries can make a real transition towards sustainability. A closed cycle design is necessary; this means taking the diversity of elements into account. Here lays an important role for communication and education. All knowledgeable actors should be introducing and explaining the concepts that are central in sustainability issues. Of course there are producers that are familiar and know a lot on system level but many harvesters do not have this knowledge yet. With creating understanding of the problems changing practices can be understood and therefore easier and better lasting.

How does this dimension influence sustainable Honeybush harvesting?

The individual dimension is characterized by diverse set of values that influence the individual actors. It is impossible to take all those values and its sources into account. However, one has to be aware that it is directly linked to how the producers harvest, how social groups work and the way the market is directed. So the individual dimension does influence all other dimensions as well and it should not be overlooked in finding new ways to sustainability. It would take a lot of effort and resources to investigate this dimension in detail and the question is whether it is efficient in taking the industry forward. However, some key-issues like the connection with nature and the long or short term thinking are valuable to investigate. These attitudes and it is values are the sources on which a sustainable harvesting system must run in the end.

Recommendations:

- Investigate attitude of producers and identify key issues and drivers in personal values, including; connection with nature and traditional practices, perspective on profits and future, importance of Honeybush, and relations with other producers and nature conservationists.
- Determine attitudes and values which hinder sustainable practices.
- Make producers aware of their attitude and open to discuss how this is connected to sustainability; organize meetings where people can discuss these things in a safe social environment.
- Let producers see/experience that experiences are personal and do not always represent the truth.

4.8. Leverage points

Because of the complexity of the Honeybush industry it is not possible to come up with predefined goals and path towards sustainability. Change towards an industry which will benefit the whole community and nature on longer term will most probably happen through a set of events, the impact of the effort of key-players and by the increase of knowledge. When looking at all dimensions and aspects of the model as summarizing recommendations we can point towards some leverage points to foster this change process.

- *Communication in the industry*

  There is only little communication among the different actors. This causes that there is no common vision on the practices, insights and future of harvesting Honeybush. A clear overview on what is going on, what research is being done or who is harvesting is missing. Because of this, it is hard to work structurally on improvements and address the needs of the producers by other institutions. A lot of effort is wasted, knowledge is unused and projects are inefficient and not effective. We acknowledge that good communication is not easy with the fluxes of producers coming and going, and producers with little time living far apart. Nevertheless it is a serious leverage point because improving this could help speed up progress in every aspect of the industry.

- *Research*

  More knowledge is absolutely necessary to get to sustainable resource use. If it is not known what the plant needs to survive, it is impossible to create harvesting guidelines. Also on ecosystem level and the market more information is needed to determine what sustainable is in the long run. By research not only the conventional forms of research by research institutions are meant but also research by farmers, students, NGOs and combinations of them should be considered. Important is that it is coordinated and constructively builds a knowledge base from which guidelines can be made. To fully address all dimensions of sustainability, researches should be done from different angles. A combination of different methodologies will show the harvesting from different perspectives and give better insights in underlying reasons.

- *Social Learning*

  Related to better communication, but important to mention separately is the leverage point of social learning. Up till now this way of creating knowledge and improving is hardly used while especially in the context of the different producers in different places, social learning could make a useful contribution to sustainable harvesting. The exchange of already existing knowledge and discussion of this in a circle of knowledgeable minds and fresh views could richly enhance knowledge creation. The future perspective is even more promising as social learning could be a tool to create new knowledge in an interactive way which is much more structured, focused and widely accepted.

- *Collective projects*

  The previous three leverage points could be brought together in this last leverage point: collective projects. Research has to be done in a way that is useful for all actors, where everyone can use his/her expertise and give his/her opinion. This requires a collective way of acting in projects. In this way projects will be more focused, give a sense of unification and ownership, and contribute to the industry as a whole. Collective projects have furthermore the advantages that large databases of information can be made much more efficiently and long term aspects can be included easier. By working together, producers, research institutions, NGOs and other actors can synchronize their activities and all contribute much more effectively. Producers for instance know their area and are out in the field often while research institutions have the knowledge and accessibility to do scientific research. Examples of collective projects are:

  - *Data exchange*; structural programs to publish data and new knowledge so that everyone is able to access the necessary and up to date information.
  - *Research projects;* different kind of research projects where farmers 'local' knowledge and observations from the field are used to build a database and perform scientific research. Also experimental studies can be tested by farmers in the field.
  - *Creating guidelines; c*ollecting and creating information in a collective way, and come to a common understanding and guidelines by open discussions.
  - *Community involvement;* development of projects where the whole community is included is important to improve social conditions of the region. For instance part of the community could form cooperatives for managing wild harvested areas.

4.9. An outsider's perspective

When looking at the harvesting from an outsider's perspective, one can see that the only future for Honeybush is at 'landscape level'. Surely a few relatively large or specialised producers could survive on its own, but without a stable production and a system level approach there cannot exist a resilient sustainable industry. Coordinated production and processing should take place. One possible future scenario could be the division between two types of production; larger-scale bulk Honeybush versus high quality sustainable wild harvested Honeybush. The larger-scale bulk would be produced through cultivation on abandoned farming ground and should take into account land degradation effects to stabilize production. Wild harvested Honeybush could take a specialised niche, where more matured tea is produced in a fully sustainable way, including community involvement, nature, etc. This way of production on a regional scale would mean a shift in the current situation from highest production and most focus on wild harvested Honeybush towards a focus on cultivated production. This would release pressure on the natural populations and better conservation of Fynbos. To do so, better established cultivation practices are needed and therefore more research and experiments have to be done to increase production in a sustainable way and decrease risks of failures. When the market shows possibilities for a large demand, it could even be that Honeybush cultivation can cause a shift in regional landscape planning. Honeybush cultivation is far less detrimental for the environment than for example cattle- or fruit farming. Honeybush (*Cyclopia)* is a native plant which does not require a lot of extra resource input. An increase in the proportion of Honeybush area connected with a decrease in the area of water-intensive fruit farming and grazing would result in a much more ecologically balanced landscape.

Whatever future plans will be, in our view, currently the main restriction towards a structurally more sustainable situation is the lack of unification. What was experienced during the study was that actors are not acting as if they are one industry. Mostly actors are doing their own thing for their own reasons. Having your own reasons is not a bad thing, it actually often gives people freedom to do what they are most motivated for, but when there is no feel for the larger system and the contribution toward this system, then a lot of energy is wasted, which makes it difficult to combine incentives and act as one industry. Acting as one is important for creating a strong industry and market position and ensuring that the industry does not have negative (long term) effects on the region. Without a sense of direction, it is extremely difficult to implement the recommendations put forward.

In order to unify the industry and to be able to address all dimensions of reality simultaneously, a process facilitator is necessary. Its primary task is to bring people together, enhance communication, organize exchange of information and create and maintain momentum. Without a central and driving force, the risk is that the connection of the producers with the larger system is missing or lost. When one aspect will be neglected, other aspects will follow because they are all connected. And even when separate parts improve individually, other parts are needed for successful implementation and progress. The facilitator should be a central actor or organization with a strong network and good communication skills. It should be able to keep an eye on all changes and organize gatherings to evaluate progress and enhance collaboration. It should have a clear idea of what the producers think, want and need, and what the interest is of other parties and what they can contribute. A neutral stance in the industry is essential to make sure all aspects get the attention they need. Facilitators could be an organization like SAHTA, an independent NGO or a committee with a mix of experienced and new motivated producers, and/or eternal experts.

Flexibility/adaptability is a key issue with so many contexts and changes. The fact that there is still a lot of uncertainty and changes are continuous and profound means that the central actors (producers, facilitators, project managers, government officials) have to constantly connect with the current situation, observe what is going on and ask what is needed at that moment to become more sustainable. This will differ through time when conditions, resources, people and even the central actors themselves change. Secondly, continuity is very important. Without this, trust will be low and the readiness to put effort in projects will be equally low. People have been too many times promised improvements without real results. Long-term projects, with people that are there to stay, is therefore a necessity.

All in all many things can be said, but what is going to happen mainly depends on the energy that is putted in the industry by enlarge. Honeybush has the potential to increase social, environmental and economic conditions, but it is a complex industry and sustainability is still something very unclear and uncertain. Motivated key-players need to combine their efforts to clarify these uncertainties and reveal the direction towards sustainable harvesting.

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Appendix I: Species Distribution Model

Introduction

In the process of exploring feasible and valuable research topics, several possible options were discussed. One of them was a species distribution model, and this research was carried out until the feedback from fieldwork showed that the aims of the study were not realistic and the research had to be discarded. Nevertheless, in the weeks of preparation and fieldwork, insights and data were collected which should not be lost. In this appendix an overview will therefore be given of the research set up and the gathered data. In this appendix general issues around honeybush, as described in the main chapters, are left out.

The Problem Statement and Research Questions

Because of the current limitations towards large scale cultivation of Honeybush, the wild harvested production requires much attention. There is a lack of information about the distribution, amounts, harvesting rates and ecology of the wild species. A better overview of the situation is urgently needed to get to sustainable wild harvesting and securing conservation of the species. An overview of the status is also necessary when giving permits thereby controlling harvesting of the wild species (CapeNature, 2007). This is especially the case for *Cyclopia intermedia* in the Kouga. It is a species that occurs through the whole area and has an important role in the Honeybush industry. It is harvested on private lands and from nearby natural (conservation) areas (Agricultural Research Council, 2010b). The distribution and amount is however unknown. Not only will research of wild species give a better overview of urgent issues in wild harvesting, it will also give insights on *Cyclopia* as a genus and show opportunities regarding cultivation and harvesting practices.

The aim is to work from urgent practical issues and get results which are useful for local development. Therefore some key questions are chosen that need to be answered to get insights leading to sustainability:

- What is the fine scale distribution of *C. intermedia* in the Kouga?

- What is the niche of *C. intermedia*?

The research will focus mostly on these questions. They can give clarity about the current location and related opportunities and bottlenecks in the wild harvesting. Next to that it has a large explanatory component in the ecology of the species. Studying this question requires determination of most predictive indicators in the distribution of the species and a predictive habitat map hopefully shows patterns that could give a better idea what the realized niche of *C. intermedia* is. The questions are purposely kept broad; this gives room for adaptations in the field when real issues and difficulties start rising and with many people working on Honeybush insights and ideas can change quickly.

Other questions which will be looked at are:

- What is the estimated biomass of C. *intermedia* in the Kouga?
- What are current harvesting rates, locations and frequencies in the Kouga?
- What harvesting practices are used for C. *intermedia*?
- What are opportunities and bottlenecks in the distribution of *C. intermedia* in the Kouga?

When the distribution, biomass and harvesting rates are known, an estimate can be made how the amount of *C. intermedia* will change in the short term future. To get detailed data for biomass and harvesting rates will be challenging, this is another reason why the focus is more on the distribution of *C. intermedia*. While looking at the occurrence of the species it will be interesting to look whether from field observations and interviews can be determined what harvesting practices are used. In this way local knowledge might be extracted and hopefully will show possibilities where improvements in sustainability can be made. The last question is about the possibility to interpret the results combine this with a coarse scale predictive habitat map made by a collaborating research from the Nelson Mandela Metropolitan University (NMMU) and data from nature conservation agencies and previous studies on land use of the farmers in the region.

Aims:

- Create a fine scale predictive distribution map of *C. intermedia* using a Geographic Information System (GIS).
- Create a detailed niche description for *C. intermedia* in the Kouga.
- Give estimate of the current decline/increase of *C. intermedia* in the Kouga region.
- Give an overview of harvesting location, frequency and practices.
- Discuss together with the Honeybush community opportunities and bottlenecks in harvesting locations and wild harvesting decision-making.

Materials and Methodology

Distribution

Since computational power is large enough for accurate GIS programs mapping distribution can be done in cost and time efficient way by species distribution modelling (SDM). Based on relations between environmental variables and species occurrence SDM is static and probabilistic (Guisan, 2000). However when working with fixed objects (plants) at a certain moment in time this is reasonable. Furthermore the models assume an equilibrium state, while in reality many ecosystems are non-equilibrium (Guisan, 2000). In this case it can be assumed as equilibrium because it is about the distribution at present and in the short term future and not about long term shifts of populations. The final outcome the SDM is a predictive species distribution map with a large ecological explanatory value.

Data selection and collection

Models can be based on presence only, presence/absence or abundance data. Presence only models can be used in data sets with only little data but have less statistical power. The presence/absence data is often more accurate; the data sets need to be of high quality and larger and therefore are more based on empirical evidence (Guisan, 2000). Abundance data has the advantage that it could produce a more accurate abundance map however strong relationships has to exist between abundance and habitat quality and real abundance and measured abundance, which are often not clear in data (Pearce, 2001). Very recently a coarse scale predictive distribution map of *C. intermedia* for the Langkloof has been created on presence only data by the Nelson Mandela Metropolitan University, Port Elazibeth, South Africa (NMMU). This map is very useful but does not give enough insight in the habitat requirements of *C. intermedia* to predict occurrence on fine scale which is eventually needed. Therefore it is chosen to develop a finer scale model. Resolution of available maps is not fine enough and some variables are not available at all thus an approach based on real data is needed. This means that high quality presence/absence datasets must be created. To get a detailed description the amount of C. intermedia and health characteristics were written down in presence records. The amount of flowers were divided into three groups and examined by eye. The diameter and height of five plants representative for the plot were measured. Also the age of vegetation and C. intermedia given by the landowners was noted.

Another step in developing a model is choosing the extent and grain size. The extent in this research is the farm of family Nortje, owners of Melmont Honeybush Tea. This area of 3500 ha has many occurrences of *C. intermedia,* this gives the possibility to create a dataset with many presence and absence on a small scale. Another advantage is that the people have a lot of local knowledge on the plant and the distribution. The boundaries of the farm are not the natural boundaries; this makes distribution modeling a bit more complicated (Guisan, 2005). However with the coarse scale model can be determined whether certain environmental conditions are missed. If this is the case and these conditions have important predictive value the extent might have to be adjusted. Possibly the extent can be increased when results show that the model can be extrapolated or interpolated with available or few extra data. Determining the grain size depends mainly on the accuracy needed, the scale at which the predictive variables vary and computational power (Guisan, 2007). The finer presence/absence data is sampled the more accurate the grid size can be. However one should be careful of spatial autocorrelation; when data points are so close together that they actually all represent one location. Furthermore there should not be mismatches between the grid size of the presence/absence data and the environmental variables. The scale at which predictive processes occur should be understood to choose the right grain size. Too large grain size could make important small scale processes disappear; too small scale grain size would erase the predictive value of environmental patterns (Guisan, 2005). With fixed species like Honeybush it is not enough to have all suitable conditions in a cell but they have to overlap at a specific point in the cell, often a finer scale is then necessary.

One of the central decisions for a model is choosing what independent variables to use. This depends on the dependent variable that is modelled, the data that can be gathered and the expected most predictive variables. In this case the dependent variable is Honeybush, a plant that is restricted to a certain habitat and is not mobile which makes it a bit easier. Direct, indirect or resource variables can be used (Franklin, 1995). Direct variables are the variables that will directly influence the physiology of the plant, but is not consumed by the plant like temperature or permeability. Indirect variables are variables that do not directly influence the physiology of the plant, for example: topographic characteristics (slope, altitude, etc.). Resource variables are the variables directly consumed by the plant like nutrients, light or water (Franklin, 1995). Because of limited time and financial resources deciding which variables is a restricted choice. Resource variables are ecologically very important but difficult to measure. Often easier are the direct or even indirect variables.

The indirect variables are directly linked to direct variables (slope to hydrology, aspect to temperature and moisture content, etc.) and are accurately mapped in digital elevation maps (DEM) (Guisan, 2000). However DEMs can only be used to a certain geographical extent, if used at too large scales the variation in soil and climatic conditions becomes too large to model with indirect variables (Guisan, 2000). Indirect variables that were measured are elevation, inclination and aspect. Positional data was noted to extract the variables also from DEMs and include profile curvature. Elevation was measured with a 5m accurate GPS. Aspect was measured simply with a compass. Inclination was supposed to be taken with an inclinometer but because of reservation issues it was not available, the inclination was therefore guessed and checked with DEM data.

In the mountainous areas sharp boundaries exist in environmental conditions and vegetation communities which makes indirect variables less accurate. Therefore there will also be looked at important direct variables which can give present environmental conditions on a finer scale. Direct variables measured are soil variables (pH, soil texture/structure, organic material and soil depth), vegetation type and associated plants. Also the existing geological and hydrological maps were looked at.

Even resource variables will be taken into account. Because of the fine resolution more focus is on ecological processes that can only be modeled by using resource variables. Resource variables taken into consideration are available nutrients, soil moisture content and light conditions.

To get an accurate map based on the real niche, also disturbances have to be taken into account; in the Kouga most important disturbances are fire and human impact/land degradation. Fire, land use and harvesting information could therefore be useful.

It is important that a sampling strategy is developed a prior to the fieldwork. Data is most meaningful along the main gradients of the most predictive variables. In this way it can be checked how important the factor is and if it is increasing the power of the dataset. It is best to gather the data in random gradient transect sampling which can be developed with GIS or done with a Gradsec approach (Guisan, 2000). It is important to have equal numbers of environmental data thus a stratified approach. To get independent data the minimum distance between sampling points has to be determined in the sampling strategy and is based on the environmental variables (Wintle, 2005). Because only vegetation and topographical variables were known a prior to the fieldwork the sampling was done based on these strata. With GIS several maps (see Figure…) were developed on which was decided where accessible main gradients in the area were. In these areas transects were taken with a minimum of three 10x10m plots every 50 meter. These measures were decided on through considering practical and ecological aspects. After exploring the field 10x10m was considered to be the smallest size in which can be said whether a plot is presence or absence. To get a fine scale distribution model the distance between the plots should be as close as possible but one should take spatial autocorrelation into account therefore 50 meters seemed to be an appropriate distance. Next to that the slopes were often not long and on other sides of the mountains impossible to say whether they are accessible and/or useful. The length of transects differed from 150 up to 400 meters. After the first fieldwork the amount of plots in each category of the different variables were counted to reconsider the transects for the next field so the data was as stratified as possible.

Choosing the model

Although the research never reached this stage, one of the most important steps in modelling is choosing the model. There are many different models and methods all with different purposes. With the specific conservation purpose to determine relatively accurately the distribution of *C. intermedia* a goodness of fit is needed. It is therefore of prime importance to distinguish suitable from unsuitable habitats (Guisan, 2005). At the same time it would be interesting to see if we could not only predict but also explain the distribution with environmental variables.

Models can be divided into three categories: analytical, empirical (both correlative) and mechanistic (Levin, 1966 as referred in Guisan, 2000; Beerling, 1995). Analytical models are accurate but are based on mathematics and simplified reality and have no ecological theory. Mechanistic models are based on the ecological mechanisms, require a lot of input knowledge and focus on generality. They are deemed to be less accurate because they are not based on large sets of real data but have large ecological explanatory value and are judged by their ecological sound prediction and not accuracy per se. Empirical models are somewhere in the middle; they are based on real data and accurate but do not have to be general. In reality there is no such strict distinction (an empirical model can still be general) but it helps to clarify the focus of the model. In this research an empirical model would have been most probable, it is accurate and based on real data. Transformation of presence/absence data is often necessary before starting the modeling. Because independent datasets are needed spatial autocorrelation has to be removed (Crossman, 2008). When using general linear models (GLM) or general additive models (GAM) data need to be normally distributed, then logistic transformations are often used.

Of suitable modelling classes neural networks and generative algorithms are complicated models which are most appropriate for analytical purposes (Guisan, 2000). However they are accurate, do not need large datasets or absence data and there are possibilities with programs like MAXENT. MAXENT is a generative algorithm based on finding the distribution of maximum entropy with the constraint that the expected value of each feature under this estimated distribution matches its empirical average (Philips, 2004). Models that suit in many cases are the GLMs and GAMs. GLMs are easy to create, adapt and interpret which makes it suitable for mechanistic models (Wintle, 2005). However accuracy is needed to make a valuable predictive distribution map. More complicated and harder to interpret but with more predictive power GAMs seems also suitable. The decision to choose for a certain model will be done when a clear view on the amount and quality of data is there. RandomForest algorithms are not so suitable for coarse scale models but when modeling small scale they can give interesting results. It is also possible to run several models and choose the best one (in accuracy or reality) or even combine the models. Araujo (2007) states that ensemble forecasting often makes predictions more robust because it eliminates the variable nature of one kind of model. In the iterative process of MAXENT, notions of ensemble forecasting are already included but it can also be done by consensus forecasts which include different model classes (Araujo, 2007). In most models can be decided how strict the model should be regarding the decision whether an area is suitable or not. This has of course consequences for the result and conservation decisions and should be decided a prior to the modeling (Loiselle, 2003). A narrow model will cause false-absence errors thereby excluding possible important population locations. A broad model will include false-presence and gives a too optimistic view on the distribution. Selection of the variables included in the model can be done in several ways. When working with GLMs or GAMs backward selection will work best in situations with collinearity (Wintle, 2005). Crossman (2008) states that selection is best with the use of HSI because this is the only way to secure that realistic variables will be included in the model. Furthermore the amount of variables should not be too large to prevent useless variables in the model while excluding predictive ones. Harrell (1996, as referred in Wintle, 2005) stated as a rule of thumb to have not more than obs/10 predictive degrees of freedom.

Limitations of the models are that species might propagate to remote places which seem unlikely from predictive variables. Locations where a species have been but is disturbed or the other way around areas which where suitable and turned not really suitable but still *C.*

intermedia is present cannot be predicted. Also competition is difficult to include in the models (Guisan, 2000; Wintle, 2005).

Validation

Performance of the model can be measured in different ways. Kappa and ROC are two of the most used ones (Fielding, 1997; Guisan, 2000; Wintle, 2005). The Kappa uses all components of a confusion matrix for the observed and predicted presence/absence counts and measures agreement (Fielding, 1997). However it is based on arbitrarily chosen threshold and equal sample size are necessary. A threshold independent measure is the ROC; a plot of true-positive against false-positive. The AUC (area under curve) can be taken as a single measure for overall accuracy (Fielding, 1997; Hirzel, 2006).

Models with large datasets can be divided in a model set and test set. By having data that is not included in the model performances can be checked. However with smaller data sets the predictive power will decrease too much when divided in two sets therefore bootstrapping can be applied (Wintle, 2005). Bootstrapping will do a series of resampling the modelling data and performance checks. By iterating this many times a reliable measure of performance will be given. It shows whether the model is not too optimistic.

Also ground truthing of selected sides was one of the things that should have been done in the second stage of fieldwork. These selected sides can be determined by discussing the coarse scale predictive distribution map. In this way the ground truthing directly has practical value. With ground truthing beyond the model's initial extent it shows whether the model has some general applicability or it only accounts for the study area.

With the results of the validation phase it could be decided whether the model is accurate enough to be used or whether it has to be improved to achieve the goals. When a model is accurate and shows different predictive variables than the coarse scale model it could be used to enhance the coarse scale model.

Niche description

With the fielddata also a niche description can be made. Correlations between presence records and environmental variables can give a niche description. However this should be critically assessed because a lot of small scale processes are left out. This niche description can then be compared to other already existing descriptions.

Data

In total 74 plots were done in which the environmental variables were noted. As verification for the fielddata and supplementary data GIS maps were created and the elevation, aspect and slope were extracted for the plots. With this data some analysis were done to check for first correlations and whether it could serve as the basis of a species distribution model. After discussing the variables with an expert in this field, it was decided that it would be more valuable to shift the research to other topics than to develop a model which would not be specific enough in the end.

Now it is known that critical for a fine scale model on *C. intermedia* are temperature, soil permeability (soil texture) and nutrient availability. Models with these variables might be able to give the predictive niche for Honeybush. The environmental variables that lack existing independent maps have to be mapped as well. This has to be done with equally distributed samples, these can be interpolated and against this background the variables can be modeled.

Results

Although the data is never thoroughly analysed first results show only little correlation. Oneway ANOVA's in SPSS 20 are made for the presence against the most accurate environmental variables (Table 1). In these figures it can be seen that differences between presence and absence are not as clear as hoped for. There is the expected significant difference in aspect with a more south-westerly aspect in the presence plots. A significant difference is seen in elevation but this is related to the incomplete and therefore unstratified sampling. A significant difference is also shown in total cover. Absence has a higher total cover than presence, this could be a sign that higher vegetation cover limits the presence of *C. intermedia* However there is no further evidence for this. For slope, curvature and other vegetation parameters no significant differences are present. If looked in detail to the whole range of the values no single trend can be shown in relation to presence/absence.

Table 1: statistical results of several tested variables

	Aspect	Elevation	DEM slope	Total cover	Shrub layer	Grass layer
Mean Presence	206,26	932,09	21,67	79,83	39,44	33,61
Mean Absence	155,27	863,71	22,57	72,68	42,59	38,57
Std. Dev. Presence	56,94	100,91	7,60	12,10	21,80	19,26
Levene's test	,011	,000	,015	,167	,648	,119
Sig.	,002	,003	,672	,034	,557	,279

Furthermore there was the possibility to make a separate niche description with the fielddata of this research. By looking at the means and deviation of the presence plots (Figure 1) some sort of niche description can be given. The figure shows that niche description is comparable to the other ecological studies. With a southerly aspect, elevation in a large range (the whole range was not studied), on the mid-steep slopes and in fynbos vegetation with a bit higher cover range.

Conclusions and recommendations for future studies

It is of course disappointing to discard a piece of research where has been worked on for weeks, nevertheless a lot has been learned from this work and not all was lost time. Besides getting to know the area and learning how to set up research in a different country with limited resources some conclusions and recommendations can be made regarding modelling the distribution of *C. intermedia.*

First conclusions can be drawn from flaws in the experimental design, the reason why the research did not work out as predicted. Modelling a species distribution can have many forms depending on the goal of the study. For regional scale output a complete different model and therefore experimental setup is needed than for a fine scale distribution. Where in the past decades a lot of attention was directed towards regional scale output for management purposes it is now recognized that this information is valuable in only limited situations. In many situations also fine scale distribution is needed to understand the processes that drive the distribution and to make sound management decisions. This is also the case with *C. intermedia,* where a predictive map that shows whether the species could possibly occur in 1 km^2 is not enough to make conclusions about abundance or distribution patterns. Often within a km^2 there is a lot of variation in occurrences and absences. The ecology on smaller scale causing this shift in experimental setup includes different environmental drivers. Because of limited resources there was chosen for environmental variables which are easily measurable. Although it was known that these variables have only limited predictive power on small scale it was hoped that still a fine scale model could be build. In the end this was not the case and an expert told us that the model really needs detailed measurements of the variables including a measured background. Not only were the costs far too great to continue this research, needed variables like moisture and temperature are time-dependent, something not possible to measure within a couple of months. The measurements would be going to predict vegetation type but were not specific enough to predict on species level. It is an indication of how important the connection is between the goal and the experimental setup. Predicting fine scale distribution is directly linked to understanding the micro environment of the species niche.

A second conclusion can be drawn from field observations in combination with the collected data. Both show that *C. intermedia* is a species that has not a small niche. It occurs in many places with different conditions. Quickly changing conditions in the area makes it also difficult to know which environmental factor is driving distribution. Whether, for example, moisture content or temperature is more important is not possible to say at the moment. Although it is much suspected that moisture is one of the driving factors, moisture content is not feasible to measure in detail for a small scale model. This makes the model dependent on indirect factors like shade, rain, soil composition, temperature, etc. With many factors that influence moisture content and with changing conditions year-round, it is extremely difficult to select predictive variables and make a small scale predictive model which gives useable results. Also the factor time might be important; the timing of increased moisture and drought is according to farmers important for the establishment, growth and quality of the plant. Because it is not known which are the most important driving factors, it makes it difficult to create a strong predictive model.

So why was this option considered and carried out at all? This was because of a gap between goals of institutions and the expertise on species distribution modelling. Distribution information is highly valuable however when considered practically background knowledge is too small to build a strong predictive model. This was not known by the actors putting forward the goals and us until a meeting with an expert on species distribution modelling.

From these conclusions some recommendations from our point of view can be made. The question is; what role can fine scale species distribution modelling possibly play in future research on *C. intermedia*? The value of detailed distribution data is huge but fine scale modelling is difficult without understanding the ecology of the plant in detail and generalization is often not possible because of site specified models. To keep small scale modelling as a possible research topic the primary focus of the research should become the ecology of plant and not to make a final product which can be used in management, as this is not feasible in this stage. Environmental variables which are required for such a study are moisture content, temperature and nutrient availability. They should be measured in presence and absence situations but also as background data for the model. In this way the study can look for the driving factors in the distribution. This is still site specific and before generalization it should be verified by conducting a comparable research in a different area. The model can in this stage not yet be extra- or intrapolated because of the lack of strong background material. The purpose should be extract ecological knowledge and a better niche description, this could help to improve regional scale distribution which might be used for regional management.

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Appendix II: Essay: The Connection of a Newcomer

An essay about the fragmentation in the Honeybush industry by Luuk Huijgen

The Honeybush industry

New industries experience a lot of change. In the process of setting up new product chains many questions remain unanswered and a lot of uncertainties exist. There is no established market yet, demand and supply keep shifting, the quality of the product varies, it is difficult to predict what the market and product is going to look like in the future, etc.

This is also the case in the Langkloof, Eastern Cape, South Africa. In this region a new product is rapidly growing; Honeybush. Honeybush (*Cyclopia* ssp.) is a shrub which belongs to the biodiversity hotspot and sensitive biome of Fynbos and from the stems a sweet herbal infusion can be made. The multistemmed shrub can grow up to 3 meters and is adapted to intensive fire regimes (Joubert, 2011). Because of similarities with the popular Rooibos, Honeybush is now becoming more and more popular. A strong increase in price shifted the tea from a small home-consumption product to a business which can make up a considerable part of the regional income. This makes it a new financial resource for the farmers which mostly left the Fynbos land untouched.

However the industry is still in a juvenile phase. There is very little known about the plant, its ecology, habitat and life cycle. Although related to Rooibos it’s a totally different species for which cultivation practices have to be reinvented. While outside actors and experts hope to see the industry develop towards a model example of endemic sustainable product and industry, it is difficult to predict what is going to happen. The industry is fragmented, few people have experience and many farmers have their own harvesting practices.

As said in the beginning new industries experience a lot of change. That the Honeybush industry is going to change is certain. How it is going to change, in what direction and whether it will be sustainable is much less certain. Actors and policy makers are therefore confronted with a lot of difficulties.

Fragmented Communication

One of the problems in the young industry is the fragmented communication structure in the Langkloof. Farmers live and work separately from each other, do their own experiments and construct their own reality.

No scientific studies have been done on the reasons behind this fragmentation but based on observations several possible causes can be pointed out.

First of all the fragmentation is because the industry is just starting; there is a large flux of people coming in and going out. People do not know who is harvesting Honeybush and although there are some organizations in the industry they cannot centralize all processes and changes at the moment.

Among the producers there is no communicative structure. Different from urbanized areas these farmers live outside of town and have a much more solitary life. They do have their regular visits to town and farmers meetings where they interact with other farmers but this is limited to fewer occasions and less people. Next to this, Honeybush is often a side business, not a primary income. With pressing issues like fire management, erosion and floods their conversations with other farmers are often more focused on other topics than Honeybush. Honeybush is a natural resource on their property which only recently became feasible to harvest and this is mostly done by the workers. This means that the farmers did not have to have contact with each other. I experienced that new farmers often get interested by talking to one of their closer contacts but not necessarily have to know other Honeybush farmers.

Another possible reason could be that there is no consensus and actually very little known about the topic. This makes the farmers think that people do not have much valuable information to share.

In summary in a fragmented industry people;

- Do not know of each other's existence.
- Do not want/need to know each other.
- Do not have the possibility to get to know each other.

In different levels all of these are present in the Honeybush industry.

In this early phase the industry can only build resilience and a stable supply by cooperation between all producers and processors. With mostly inexperienced and small scale producers it is otherwise impossible to offer a product with the quality and marketing customers demand. Maybe even more importantly steering the industry towards sustainability is a necessity which can only be done by collective actions. Without strong communication valuable information is lost and no guidelines can be developed to secure both the farmer’s incentives and conservation of nature. Therefore two central questions are identified:

- How can fragmented communication shift to a unified community?
- What could be central players in this process?

The aim of this essay is to give a communicative perspective on the fragmentation problem in the Honeybush industry of the Langkloof and based on this perspective come up with recommendations that could help change actors to solve the issue.

Concepts for Connection

Now that the background of the fragmented industry is set it can be analysed based on theoretical concepts.

Language through a change model

The Honeybush industry is first placed in the change model of Van Woerkum *et al.* (2010). In this model three sources of change are described; Practices (track-bound change), Events (chance change) and Language (interactional change). The interactional model connects these sources to explain change. While all sources of change are inherently interlinked we start off from the source of Practices. This is because track-bound change is the starting position for the external actors; like scientists, policy makers and nature conservationists. Although some regulations are in place and developed, because of the limited knowledge and many uncertainties there are not many specific tracks yet. The track-bound change for all actors is towards sustainability. Goals and guidelines are needed but no one really knows how to get there and so Events are an important source for change. Who is doing research on it, how much money becomes available and how the market fluctuates are all influences which can have large impact but are beyond control of the Honeybush community. While there are no practices yet and chance will drive a lot of the change, still intentional change towards sustainability is desired. To make a step towards collective action and sustainability the source of change focussed on is therefore Language.

Language, through everyday interaction with others, is the means by which our norms and values are shaped is stated by the communicative action theory (Habermans, 1984 referred by Kim and Kim, 2008). Also through everyday talk people understand what other wants and where common grounds are (Kim and Kim, 2008). Norms and values can be reinforced or redefined by interaction (Van Woerkum *et al.* 2010). Next to shaping norms and values, conversations and discussions stimulate social learning, creative ideas and solutions. As Bate (2004) states: “Language is the key, for it is language that gives birth to meaning; and if people share a language they will also share meaning.” Although difficult to control, language determines many aspects decisive for change processes.

Conversations and stories

In language as a source of change, conversations and storytelling are considered to belong to the most important concepts. While both concepts are used in this essay preference is giving for the term ‘conversations’ because ‘storytelling’ has the notion of a story in it, here defined as a recital of event(s), while this is not the case in all everyday interaction which can change language. Conversation is defined here as all interaction in which a dialogue is present and norm and/or values are expressed. Nevertheless, also storytelling is used because interaction in the form of stories is a powerful tool for changing language.

According to Bate (2004), storytelling is the way language transforms in a specific context. They have a deeper meaning including sharing and shaping values and identities. Thereby storytelling is a mechanism to go from different perceptions to a community of practice which is goal-directed and has a single voice. In such communities work is done more effectively, people are more open and honest and there is a sincere drive towards the collective goal. Creating a single identity with shared values makes that a community can have a strong and unified sense of direction. Bate (2004) states that stories are important in all stages of change; from initiation to implementation. This includes in building personal awareness and understanding, recognition of alternative perspectives, creating ideas for change and counter-narratives for existing ideas and keeping the momentum.

Change interventions are normally based on the idea of one ‘true’ reality. Ford (1999) introduces a conversational approach towards reality. He distinguishes reality in first-order realities and second-order realities. First-order realities Ford refers to as: “the physically demonstrable and publicly discernible characteristics, qualities, or attributes of a thing, event, or situation.” Second-order realities are the ones that are created through giving meaning and values to this first-order reality.

These are thus the perceptions and interpretations of the first order reality by the observer. Both realities, Ford argues, are constructed through the context of conversations in which the observer is or was present. Change agents should therefore not focus on one reality but manage all different existing realities. Changing these realities will provide new opportunities for intentional change. “The job of change agents, therefore, would be to create new realities in which people and organizations are more effective in achieving the outcomes to which they are committed.” (Block, 1993 referred by Ford, 1999)

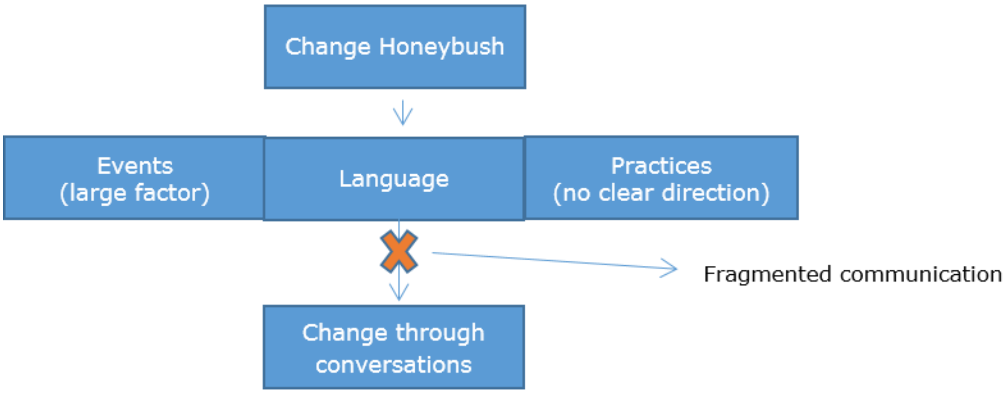

Figure 1: How to get to intentional change

Space for change

In the fragmented industry the first fundamental question is then; how can we create a situation in which conversations are stimulated and altered by change agents? In the reasons for the fragmented industry two different main restrictions towards interactional change can be distinguished; there is not much space for conversations and there is a lack of need or interest to interact.

Central in this case is a space to interact and share values. As mentioned Bate’s (2004) storytelling and Kim and Kim’s (2008) everyday talk can be applied to the Honeybush industry where everyday talk (and especially stories) has the power to reform fragmented communication to an organization of producers. However, in order for everyday talk to take place there has to be an interactional space. Space for interaction can manifest in several forms. Nowadays, in developed societies virtual space for interaction is very important. More and more individuals become connected and can communicate directly with each other. Face to face interaction space can emerge in many situations. Organized meetings are the most obvious ones, but not less important are informal occasions. Every space where meetings take place can be seen as opportunities for interactional space.

The need for conversations is another prerequisite to move people into the direction of storytelling. This need has to do with the importance of concrete results and first order realities (e.g. the amount of income from an activity), but maybe even more important are framing and second order realities (e.g. how important it is for the future or on regional scale). Aarts *et al.* (2011) refer with framing to definition of Entman (1993): "To frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described." The frame is a perception based on norms and values, altered by social environment and the purpose of the interaction. It therefore also determines the relative importance of the problem in interactional and social context.

Networks

To understand how to enhance (everyday) interaction most efficiently, an analysis of the network of the Honeybush actors is needed. It is important to see how all actors are connected to see where and how new spaces for conversation can be created and who could play a key-role in interactional change. Shirky's (2008) Small World network describes how networking works in a better than random way. The idea is that many small groups (or 'Worlds') of close interaction are connected with each other by a few actors that have many links to other small groups. The links in the small groups between the closely related actors is called 'bonding capacity' and the links between the highly linked actors is called 'bridging capacity'. Also Christakis's (2008) concept of the Network Society which explains how important networks are is useful. In his idea networks are central drivers of how someone's life is coordinated. It shows that physical as well as emotional aspects of human lives are nowadays influenced by their network. This not only expresses the strong connection to everyday talk, but also that the place of an individual in a network is important in how the society influences him/her. To effectively change stories, focus should be on the persons with many connections ('bridgers') and have a central place in the society.

Self-organization

When talking about change towards collective action through networks we implicitly include another aspect of communication and change; self-organization. Self-organization is a concept based on the fact that without external rules people will still find ways to organize themselves. Through interaction and group dynamics creative and flexible solutions emerge to structure phenomena. By increasing conversations and stories the process of self-organization will increase as well, which in turn can increase the amount of everyday talk again; a reinforcing process. Self-organization could therefore play a role in creating everyday interaction space. Ultimately, self-organization can lead to the independence of many external organizations.

Trust

One aspect that is missing in the story so far is trust. Here we use the definition used by Lewicki (2006): “An individual’s belief in, and willingness to act on the basis of, the words, actions and decisions of another.” We are talking here about identity-based trust; trust that is based on common understanding. To actually share meanings and values in everyday talk, to belief stories, to create networks and to initialize self-organization there has to be trust. Without trust interaction is limited to sending messages between actors. In receiving the messages and later stages of interpreting and shaping values the information could be perceived as unreliable and is not accepted.

The Honeybush story

In explaining and linking the concepts with the background of the industry a part of the Honeybush story is already told, nevertheless in this section a complete analysis of the situation in the Langkloof is done.

As explained in previous sections we know that the background of the issue leads us to the focus of language in the Honeybush industry. No analysis is done on the current use of language in the industry, but a few observations are made. It seems like people with a focus on Honeybush do have a lot of conversations and stories around Honeybush, but people that have it as a side activity have not. Furthermore the stories I heard were often focused on financial potential, stealing and legislation and/or harvesting/cultivation practices.

The experienced Honeybush actors have many stories, which can lead to large amounts of social learning, but there is not enough interactional space for them to share and discuss stories. The lack of interactional space is more evident with the large farmers because Honeybush is growing in the mountains, which makes living near the resource more solitary. However this is slowly shifting with the expansion of cultivation. Also the internet, which only part of the Honeybush farmers have access to, will become more important. Besides the continuous demands on the farms make it difficult to leave and so the farmers are also limited in time. Next to this, the large farmers and/or experienced people are often also the processors, in order to have a strong market position processors need to make a unique product and are therefore hesitant to share or discuss stories with other processors. Furthermore because there is not much consensus or literature on Honeybush and much is based on experience and experiments, sometimes experienced people feel they already know best and think they do not benefit from interaction. Framing this way does not let them realize that industries are interconnected and can have much more potential in collective settings, and that creativity and out of the box thinking in social learning can also bring improvements for them. Related framing is that the Honeybush is only a product for individual incentives and not an incentive for the whole region regarding economy and sustainability. In the case of the latter frame, discussion and interaction with other actors becomes more important. For the group of people for which Honeybush is a central issue and do have stories, current limitations to change language are: possibilities to interact (time/space), the market position and the framing of knowledge sharing and incentive level.

The smaller Honeybush producers are generally living more accessible. While still the same arguments of time constraints apply, some of them do have more opportunities for interaction. The issue is also framed differently; Honeybush is less central in their lives, therefore they do have less stories and Honeybush is of less importance. They often do not know the potential of Honeybush on a landscape level. Besides small farmers think they do not have enough knowledge to share stories. They often came in by talking to a bigger Honeybush actor and have different position in the network.

The networks in the Langkloof are still much more based on family, neighbours and close colleagues. These networks are a clear example of Small World networks. The highly connected people we can put in a few dominant networks of the Honeybush society: the Honeybush focused farmers and processors, the dominant employers in the region (mainly large fruit farmers), the external organizations (legislation, research institutes, etc.) and the informal network (large families, church, bars, etc.). In all these networks there are people which have a central position in the Honeybush society with many connections. The small farmers are more positioned to the sides of the Honeybush society with fewer connections, but can still have important roles in the other networks (e.g. large employers or informal network). I do not go into detail here because there is no proper network analysis done and the informal social context is not known in detail.

In the Langkloof currently self-organization plays only a minor role. Guidelines of farmers are not there yet, experiments are done on individual level and illegal activities have to be controlled from administrative levels. Every now and then the processors and central players do meet and the South African Honeybush Tea Association (SAHTA) is an organization created to represent all actors in the industry (although still initiated by the Agricultural Research Institute). This minor role might be because the actors do not see the use of organizing themselves, but it is also difficult when an industry is fragmented. Expected is that forms of self-organization could naturally emerge through influential and central producers. In order to achieve this, the network has to be strengthened and stories should activate the whole community. In the beginning this will be difficult but it is a reinforcing process; once stories play an important role and producers organize meetings, agreements and rules themselves. This will strengthen the network and conversations which in turn can lead to more self-organization.

Trust is an issue in every intervention with existing systems. This is also the case in the Langkloof where farmers, which have to work hard to survive, want to see results or evidence before cooperating in experiments. With a few exceptions, the ones that have either the space to fail or the motivation to improve practices, it is difficult to let the farmers invest a lot of their time in meetings around sustainable harvesting. Change actors should therefore not only be able to manage stories but should also be trusted. Only if the producers are accepting the stories than values are shaped and the gap between listening and understanding is closed.

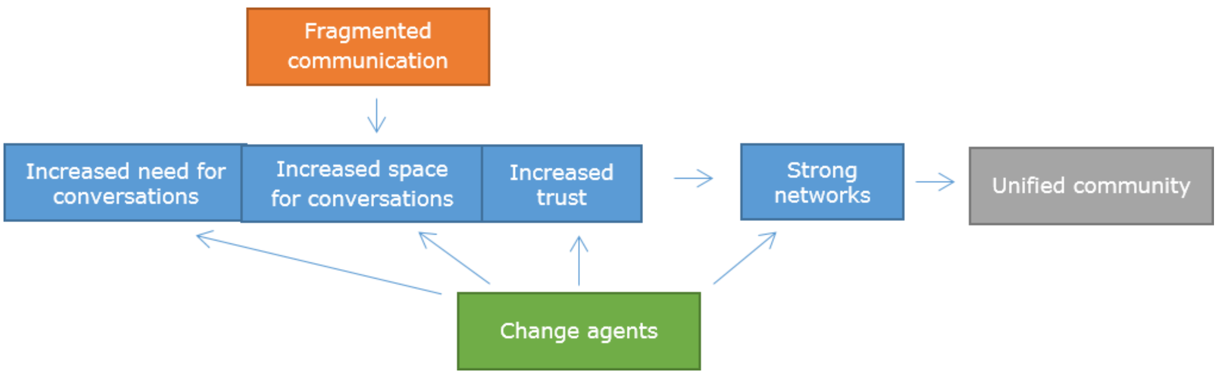

Figure 2: From fragmented communication to a unified community.

Actors for Change

Without going into detail in this part we discuss which actors could be possible change agents in this fragmented situation.

Ideally change agents are so called 'bridgers' which have a strong position and trust in the Honeybush society as well as good connections with the sustainability networks. They are open-minded, can handle constant change and see opportunities in early stages. This last skill is called self-transcending knowledge by Scharmer (2001) and deemed important to change unpredictable systems. Actors determined to put so much energy in change are difficult to find, especially in an industry where most people have little time.

In this profile an open-minded, respected, producer which is not afraid of failing and wants to work towards a sustainable industry would fit best. The large advantage is the communication with other farmers and therefore possibilities to change the language as well as understanding practical issues.

Also external communication specialists could be change agents. They are often aware and capable of communicational processes and have the advantages of being neutral and looking from different perspectives. However a large disadvantage is the lack of trust and detailed knowledge around the social environment (backgrounds, relationships, etc.), existing stories and networks of the Langkloof. Often it requires a large amount of time to get to know this. Possible opportunities exist when a farmer and an external communicator work closely together.

Somewhere in the middle of these two possible change actors are the people from the central organizations. These people do have some knowledge of social environments (it depends on the issue whether this is enough) and have a better position in the networks than external communication specialists. However, they are often not neutral anymore and have several agendas of their own (not only changing the system towards sustainability). This does not have to be a problem but should be openly discussed. The SAHTA and research institutions as the ARC and universities that have a participatory approach are examples of these central organizations.

Because chance is so important for change, with the right connections and timing every person could be a change agent. In order to change the system he/she should be able to change language in an effective way. Furthermore, there does not have to be one change agent. All these actors could do what they are capable of in their time available to change language and stories. Note that such processes do have to be coordinated because in order to have intentional change there has to be a sense of universal direction.

Change agents should manage…

In this section a broad outline is made of what change agents should manage when focusing on language. Specific tasks and procedures cannot be given, because there is not enough knowledge. Concrete actions are context dependent and should be based on the norms and values of the farmers, the conversation that are held, stories that are told and the opportunities that exist in the daily life of the farmers to interact. These things can only be designed by or in interaction with the local people (and farmers themselves) that have experience and live in the area.

Language and Stories

If intended to change the industry towards sustainability, first of all change agents should know what the topics of conversations are and what values and norms are expressed in current use of language. Only when this is clarified conversations can be managed. Ford and Ford (1995) described the different conversation types in change; initiative conversations, understanding conversations, performance conversations and closing conversations. Most important for the Honeybush industry at the moment are the 'understanding conversations' around sustainability. The initiative is already there but the understanding is not, performance is difficult with the limited information.

Examples of managing the existing conversations are; making some more powerful, distribute some effectively, discuss them more often, etc. Change actors can also produce counter-narratives, stories that undermine the current situation, and create new stories about sustainability in which different values can expressed. Changes could be to put the focus on stories around harvesting practices and make values and concepts around sustainable harvesting more important. On the other hand, stealing is a very sensitive story; there should be dialogues to come to solutions but stories around legislation can quickly turn negative and discourage people. While stories can help addressing these issues, of course a great deal of work lies outside of this communicative aspect. The social context of the Honeybush industry and community involvement should be addressed in several ways.

To manage stories there has to be trust. Trust between the farmers, different actors and in the change actors. Therefore the change actors should be aware of his relationship with the other actors and build trust. Showing similar intentions, sharing your values and create common understanding are ways of building trust. Also stimulating this between the farmers and other actors is an important task of the change actors.

Managing stories is strongly related to reframing. Already mentioned are two framing issues where reframing is desired: from 'it is only side business/home use' to 'landscape level product'. And from 'no one has real knowledge' to 'together we can create social learning'. This reframing can help with increasing the influence and importance of Honeybush stories and strengthen the network and sharing of stories. But this reframing is not easy and straightforward. Change actors should be capable to clearly distinguish first and second order realities, then underlying assumptions and consequences will be revealed (Ford, 1999). Aarts (2005) describes four activities (conforming, bureaucratizing, creating, innovating) resulting from different sort of framing characteristics (little/large open-mindedness, little/many cognitions). Taking different ways of framing into account gives a better fitted approach to the different groups of actors. Reframing can only be done when the underlying goals of the actors are discovered and conversations are managed; create, share and discuss different values. In order to do this the change actors should put effort in creating possibilities to share values, create common understandings and goals, and creating possibilities for themselves to manage these stories; they should create interactional space and strengthen networks.

Interaction Space and Networks

Important for the change agents is to create space for change, in this case directly linked to space for interaction. Regular farmers meetings are often organized around several issues and there is not much time for Honeybush. The potential in these meetings lies within framing and putting Honeybush higher on the agenda. However, human beings are social creatures and do not only need interaction for practical reasons but also for emotional reasons. Therefore two different sorts of events can be focused on; issue-related and entertainment-orientated.

Issues related events are straightforward but important; creating events around Honeybush. These events are immediately focused on what should be discussed. Change agents should understand that this does not have to be a large or difficult event to organize; the goal is to create opportunities for everyday talk. In here language can be directly managed. It should be done in modern and innovative fashion, something farmers can relate to and would be of value for them but also something which is new and interesting. It also does not have to be formal; possible meetings could be Honeybush tea tasting (maybe even for the women only) or monthly meeting at the bar with all Honeybush farmers.

When talking about entertainment events it is not meant that change agents should organize parties, but it is to show possibilities of how to bring Honeybush in everyday life. When organizing workshops and meetings related to Honeybush there is possibility to gain publicity, for example: simply by putting posters in central meeting places (like the bars, shops, church, etc.). These central meeting places could also be used for informal activities in which Honeybush becomes central, e.g. pastors could make a service in which they use Honeybush as central example or bars/shops could do a free period of Honeybush tasting in corporation with one of the processors. Because families are important also children could have an influence; do activities on schools or church related to Honeybush with the children. Most importantly change agents should search for central meeting places, discover what farmers are looking for when outside of work environment and think about how to integrate Honeybush in this opportunity.

Forms of virtual interaction are currently nearly absent, however in the future possibilities do lie here. More widely internet access, lower costs and the future generation will all cause the internet to be more important. Larger producers do have internet access and this might be the first step in enhancing communication. In the situation of being isolated and limited in time, virtual interaction would largely contribute to new interaction space. Already now, with the people that have internet access, this form of communication could be explored. Newsletters from the different actors, event agendas, a knowledge database and maybe even a forum where knowledge can be exchanged could be tried.

Networking is already connected to all the activities previously described, by creating interactional space there are opportunities to strengthen networks. The change actors should be mainly focussing on creating possibilities to network at these meetings; like stimulate the exchange of contact details and direct communication between farmers, include all actors, go to the farms, etc. Some special attention can be given to strengthen the network between the key-players in the networks; organize special meetings or sources of communication (like internet) between these people. In order to do this, first the key-players and their intentions have to be identified to find common grounds from which dialogues and developments can take place. Understanding the Honeybush society and its network, how it influences decisions and which people to use to stimulate language around sustainability, is one of the fundamental tasks of the change agents. Only then real opportunities for effective communication and thus change are highlighted.

One aspect we did not touch upon yet is the fact that people do not know of each other's existence. The rapidly changing industry makes it difficult to keep track of all actors coming and going out. This will stay this way until the industry and market get more stable. Related to understanding the network it is still important for the change actors to keep as much as possible an overview of the network. This might be done through legislative channels, but also through making standardized contact forms for everyone attending meetings and collecting these at a central place. In the future internet could be an essential tool to coordinate this.

Conclusion

To very shortly conclude, intentional change is primarily focused on practices however while there is no clear direction in this early phase a considerable amount of effort for change should be focused on interaction. In a fragmented Honeybush industry this is difficult and therefore change agents should be working towards a collective community with common sense of direction around sustainability. Change agents could be any actor in the industry but should be respected, flexible and motivated, and should have a strong position in the Honeybush and sustainability communities. The main actions in working towards a collective community are managing conversations, creating interaction space and strengthening networks.

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Appendix III: An overview of research questions

Introduction

During our research we stumbled upon many gaps in knowledge and possible research questions in order to fill in these gaps. These questions were gathered both from farmers during the interviews or during the workshop which was organised to discuss the results of our survey and from 'experts' in the Honeybush industry for whom we also organised a workshop. Other questions have been formulated by ourselves during the course of our study. The questions have been ordered based on their topic.

Research question

Ecology:

- How were the species distributed in the past? How are the past and present correlated? How are the species distributed nowadays? Is there a possibility for farmers monitoring the species on their land with help of researchers/ students?
- Which nutrient does Honeybush require to grow? What is the role of phosphor on the growth of Honeybush?
- How does the field change after fire: amount honeybush/ changes in vegetation? Will the sprouters remain but the seeders change over time?
- What the best way to burn the field, less risky? Is it possible to establish network on fire management with neighbours?
- Is it possible to successfully plant Honeybush in the wild?

Harvesting:

- When is the best time to harvest Honeybush?

- What are the implication of harvesting and how far need the plants to be cut? Is there a possibility of monitoring differences in harvesting practise and age of plant over time?
- Is it possible to find beneficial micro-organisms which could promote growth if the plants were sprayed with it after harvest?

Sustainability:

- Which harvesting techniques are sustainable?
- What is the impacts of harvesting on the ecosystem?
- Where to allocate the 'value' (money) on the production chain? Should it be at producing or processing? Will this contribute to the stop of illegal harvesting
- What is the impact of harvesting of Honeybush on the plants characteristics, the surrounding vegetation and the soil composition
- Which pest are there found in the wild and how should you deal with them in a sustainable way?

Legislation:

- What is the extent of illegal harvesting and the effects?
- How to stop illegal harvesting? Will the permit system or Coops contribute to the stopping of illegal harvesting?
- Why are people not allowed to harvest in nature reserves anymore? Why don't the people from Eastern Cape Park and Tourism Agency (ECPTA) harvest themselves and use the money to improve the roads?

Cultivation:

- What is the best way to germinate the seeds (smoke/ethylene induced germination, cold treatment/ addition of micro-organisms)? Are there differences between the species?
- Which species to plant in which environment?
- Which cultivation techniques are the best?
- Which micro-organisms should be added?
- How to keep the risk of pathogen attack as low as possible (companion species, blend beneficial fungi/bacteria, intercropping etc.)?
- Are there differences in taste/ quality between cultivated and wild harvested species?

Appendix IV: Data collection sheet

General data

Plot-Nr.	Date	Latitude		Longitude	weather
age field	age plants	Altitude		Aspect	Slope
Amount	Harvest?	Termite(#/%)	Note (grazing, pests?)		

Honeybush

Height		**#stems**		**Biomass estimate (1-5)**	

Vegetation cover

Total cover	Av. Height	Max. height	%graminoids	%grass	%restio	%cyper
% geophytes	% Herbs	% medium shrub 0-100	Large shrub> 100			
		Proteoid:	Proteoid:			
		Ericoid:	Ericoid:			
		Bruniod:	Bruniod:			
Number of species:		Cyclopia:	Cyclopia:			
Dominant species:						

Soil analyses

Soil text.	Soil type	OM

Appendix V: Questionnaire

Questionnaire

- [nd] interview on /12

WHAT

- Q1: How much land do you own? (total/arable)

- Q2: How long have you + family been farming honeybush?

- Q3: Do you have other income besides honeybush?

- Q4: Which species do you harvest?

- Q5: Where do they get processed?

- Q6: Do you harvest from the wild or also cultivation,

If yes: which species

- Q7: Only plants or also seedpods

- Q8: What is your annual production in (ton/year)? (divide wild/cultivation)

WHEN

- Q9: When do you harvest: Throughout the year/summer/spring/winter/autumn

- Q10: Do you take into account if the plants are flowering or seeding or if they have flowered before

- Q11: After how many years do you harvest (1,2,3,4,5 whenever I want)

- Q12: From which height do you harvest?

HOW

- Q13: Do you harvest yourself?

- Q14: How far do you harvest the plant: (half, 2/3, whole plant, leave some stems)?

- Q15: Different harvest techniques depending on age plant?

- Q16: Which tools do you use for harvesting the species?

- Q17: Roughly estimate of average of one plant?

MANAGEMENT OF WILD

- Q18: How do you manage your land? (nothing/ fire management/ clearing competing species)

- Q19: In case of fire management: how often do you burn your land? (every 5, 10, 15, 20 years. I don't burn the field, it burns naturally after… years.

- Q20: Do you monitor your populations? (Do you have an increase/ stagnating of decreasing of populations?)

- Q21: Have there been changes in the way you harvest over the last couple of years. If so why? (production/ market/ techniques/ sustainability)

- Q22: Have other people harvested honeybush on your land without your permission

- Q23: Have you tried to plant Honeybush in the wild?

If yes, did it work and do you think this will contribute to your production?

- Q24: Have you done any other experiments?

SOME QUESTIONS RELATED CULTIVATED HONEYBUSH

- Q25: Do you grow different *Cyclopia* species on one land?

- Q26: How do you germinate plant the species establish the seedlings(planting)?

- Q27: Do you grow the species in monocultures or together with other species?

- Q28: Where do you cultivate the species: former farmland - former fynbos – former meadow

- Q29: How do you cultivate the species? (cultivation techniques..)

- Q30: Do you weed? How often?

- Q31: Do you practice any pest control?

- Q32: Do you water the species?

SOME PHRASES RATE FROM 1-5

P1: Burning the veld has a positive influence on the Honeybush production

P2: Presence of cattle in Honeybush area is harmful for the species

P3: Harvesting of Honeybush has a negative influence on the plant

P4: Harvesting wild population of Honeybush is harmful for Fynbos conservation

P5: Harvesting of Honeybush should be forbidden in Nature Reserves

P6: Wild harvested Honeybush has better quality than cultivated Honeybush

P7: Cultivation of Honeybush is necessary to supply the growing demand

P8: I harvest honeybush in a sustainable way

What does sustainability mean for you?

P9: Research on sustainable harvesting of Honeybush is necessary

P10: Exchange of knowledge between farmers and research is necessary for the future

***Which Honeybush tea tastes the best?**

OTHER INFO