STUDY INTO THE ESTABLISHMENT OF AN AROMA AND FRAGRANCE FINE CHEMICALS VALUE CHAIN IN SOUTH AFRICA (TENDER NUMBER T79/07/03)

FINAL REPORT
(Submission Date: 15 September 2004)

Part Four-
Report: Aroma Chemicals Derived from Essential Oils

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PART 4 – AROMA CHEMICALS DERIVED FROM ESSENTIAL OILS

This Report has been prepared in four separate Parts. Each Part is self-contained and self-explanatory.

Part One-
Executive Summary

Part Two-
Report: Aroma Chemicals Derived from Effluent from the Paper and Pulp Industry

Part Three-
Report: Aroma Chemicals Derived from Petrochemical Feedstocks

Part Four -
Report: Aroma Chemicals Derived from Essential Oils

NOTE:

PART 4 – AROMA CHEMICALS DERIVED FROM ESSENTIAL OILS

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1 PROJECT HISTORY AND OVERVIEW

1.1 Brief

The Terms of Reference required that the Consultant consider the potential synergy between a synthetic aroma, fragrance and flavour value chain and a value chain based on the exploitation of South African natural products.

This line of enquiry was based on the underlying assumption that South Africa is endowed with a wide diversity of plant material, which offers significant potential for exploitation as a source of aroma, fragrance and flavours fine chemicals. This section of the Study was ancillary to the main focus of the Study, which was the review of a basket of larger volume aroma and flavour chemicals to be derived from petrochemical feedstocks using technology developed by AECI (and now owned by CSIR), with a view to creating the core of a aroma fragrance fine chemical value chain.

1.2 Decisions on Approach

The initial desktop research performed by the Consultant highlighted the fact that although there are many different forms in which natural products enter the flavour and fragrance market, for example teas and tinctures, it is the essential oils industry that provides the chemical components that may form part of a suite of aroma, flavour and fragrance fine or speciality chemicals. The Consultant therefore recommended, and it was accepted, that the focus of this section of the Study be on essential oils.

Furthermore, the Consultant determined that the potential for exploiting essential oils from indigenous plant material was limited in the short term but held potential for the medium to long term. However, since the delivery systems for indigenous essential oils would be similar to those required to deliver the internationally accepted essential oils, it was proposed that the Consultant give consideration to the potential of developing the South African essential oils industry in respect of internationally accepted oils, with a view to it enhancing the prospects of developing the aroma, flavour and fragrance industry in South Africa. This approach was agreed.

The production system for essential oils is primarily an agricultural one. The down stream beneficiation involves chemical processes of a reasonably simple nature. The complexities arise when one becomes involved in the formulation aspects of the flavour and fragrance industry. From an agricultural perspective, crop selection is a key component of the essential oils industry. This is a reasonably complex issue relating to agronomics (climate, plant characteristics, yields, and organoleptic and chemical considerations). It was agreed

that this aspect of the essential oils value chain should only be dealt with in broad terms. It was agreed that a separate study would be undertaken to investigate the agricultural and horticultural issues that arise in respect of essential oils. In the circumstances, it was proposed and agreed that the Study concentrate on the broader strategic industry-wide issues and not on crop specific issues, except to the extent that these were illustrative.

The main objective was to address the potential for essential oils industry to contribute to the creation of an aroma, flavour and fragrance value chain in South Africa.

1.3 Definition and Relevance of Essential Oils

Essential oils are naturally occurring volatile products obtained from various parts of plants. Essential oils are usually extracted from the plant material by steam distillation, expression, or solvent extraction. Essential oils are distinguished from the fatty vegetable oils, such as canola and sunflower, by the fact that they evaporate or volatise in contact with the air and they usually possess a strong aroma. These products are complex mixtures of organic chemicals, the nature and relative proportions of which are determined by the genetics of the plant species, environmental factors (e.g. climate) and agricultural factors (e.g. soil conditions, nutrition, time and conditions of harvesting and methods of post harvest handling) and manner of extraction. The amount of oil extractable ranges from an infinitesimal quantity to as much as 1-2% of the dry weight of the plant material distilled.

The chemicals present in essential oils may be classified as follows:

- Hydrocarbons of the general formula (C_5H_6)n-terpenes;
- Oxygenated derivatives of these hydrocarbons;
- Aromatic compounds having a benzenoid structure; and
- Compounds containing sulphur or nitrogen.

These constituents are synthesized by the plant during its normal development. Their presence can be optimized or manipulated by manipulating the factors mentions above (i.e. environmental factors, agricultural factors and manner of extraction).

The essential oils industry is primarily an agricultural industry with the product being sold into several different markets (foods and beverages, aroma and fragrances in foods, nutraceutical applications, medicinal applications, cosmetics and personal hygiene products, pesticides). The technologies for distillation or extraction of the essential oils are reasonable accessible and simple to operate. The essential oils market is growing internationally as

there is a trend towards “naturals” in the flavour and fragrance industry. Most naturally derived chemicals have their synthetic counterpart; however there has always been a niche for the natural products. Only 20 to 25% of essential oils are chemically processed so as to isolate individual aroma chemicals. The majority are used in there original complex form.

2 OVERVIEW OF THE AROMA CHEMICAL INDUSTRY

2.1 The South African Chemical Industry

South Africa has the largest economy on the African continent, accounting for 25% of Africa's GDP. The South African chemical industry is driven by the relatively large South African home market, accounting in many instances for the bulk of sub-Saharan African consumption. The South African chemical industry is of substantial economic significance to the country, contributing around 6% to GDP and approximately 25% of its manufacturing sales. It employs approximately 100,000 people. In 2001, the industry had an output of R 62 billion, exports accounting for R 29 billion, approximately 50% of domestic production.[1, 2] The chemical and related industry is import-oriented, with export levels approximately half of import levels. In chemicals alone, 57% of the trade deficit pertained to downstream fine chemicals.

The industry, the largest of its kind in Africa, is highly complex and widely diversified, ranging from high volume-low value commodity or bulk chemicals through to high value-low volume, complex and highly specialized products. However, whilst the upstream sector is concentrated and well developed, the downstream sector, although diverse, remains under-developed. Chemical operations in South Africa focus predominantly on basic upstream chemical manufacturing with major production of liquid fuels, olefins, organic solvents and industrial mineral derivatives and downstream formulation and polymer conversion. There are a few major, integrated companies (companies employing more than 150 people) involved mostly in primary and intermediate manufacturing, with small (companies employing less than 50 people) and medium-size (companies employing between 50 and 150 people) enterprises found mainly in downstream formulation and conversion processes.

South Africa has historically had a bias towards upstream commodity chemicals production, as a result of its internal need to guarantee a supply of liquid fuels during period of economic sanctions. The industry focus was on the implementation of technology, rather than the development of technology. The commodity chemical sector is therefore well established, whilst the downstream industry remains comparatively underdeveloped, with relatively low levels of scientific and technological skills available.

[1] Seminar at the Helsinki School of Economics April 10, 2002:The New South Africa: Opportunities for Trade, Investment and Partnership
[2] South African Department of Trade and Industry Web-site: Overview of the South African Chemical Industry

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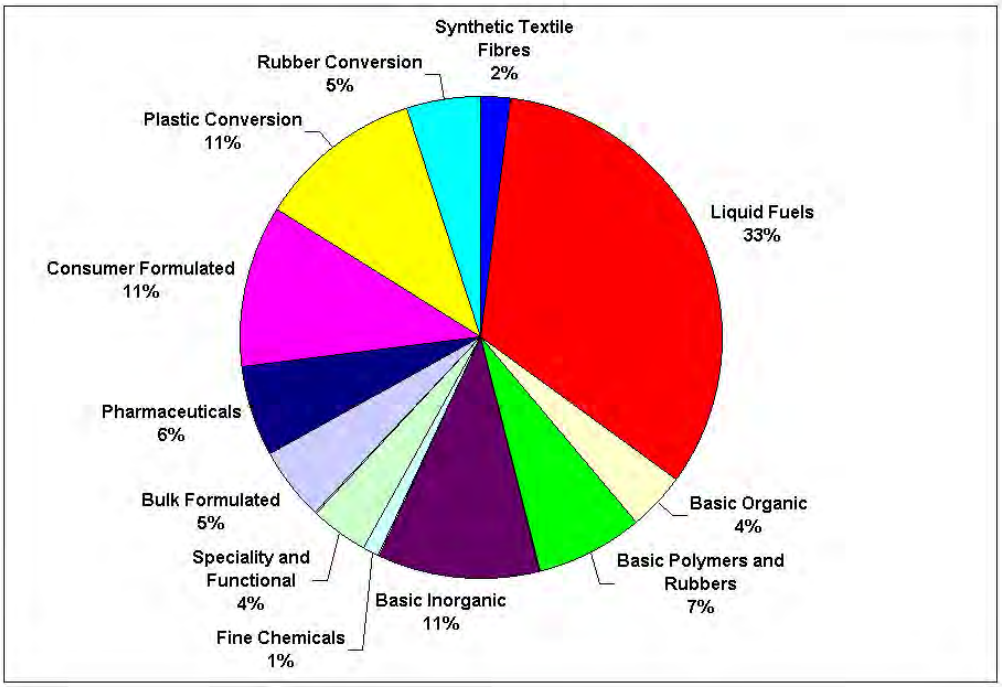
Figure 1 outlines the breakdown of the South African Chemical Industry according to the Department of Trade and Industry. The diagram shows that the Fine Chemicals, Speciality and Functional Chemicals currently only comprise 5% of the chemical sector.

Figure 1: The Structure of the South African Chemical Industry. [3]



The South African chemicals industry is in the midst of turmoil, and is undergoing a massive transformation process, these changes affecting mainly the downstream chemical sector. The restructuring process of large South African chemical companies due to global economic forces has resulted in a reduction in innovation from within the private sector. Research and development undertaken by large South African companies, with the exception of SASOL and some innovative small firms has shown a significant, measurable decline in the past four years. In many cases this results in many technologies being developed overseas. This trend is supported by the recent offshore listings of several large technology-intensive South African companies followed by the tendency for these companies to source research outside South Africa.

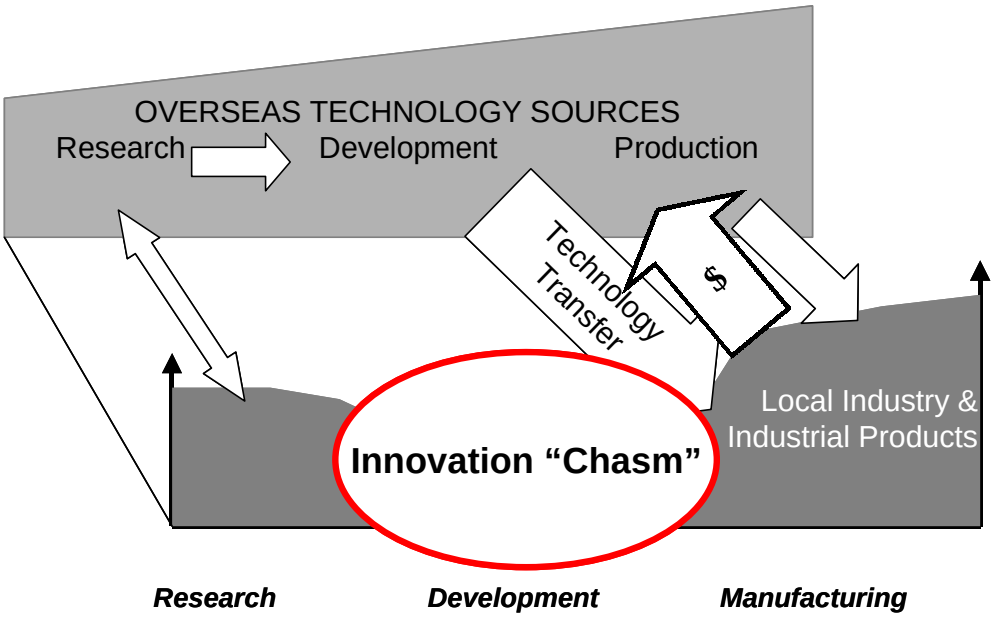
This process is resulting in a serious depletion of strategic skills in South Africa. Research and Development expenditure has been declining in the last 5 years, with South Africa undertaking only approximately 0.5% of global research. The percentage of the South African gross national product spent on research and development has declined from 1,1%

[3] South African Department of Trade and Industry Web-site

in 1990 to its current level of around 0,7%. This is compared to the average OECD country, where expenditure is 2,15% of GDP; with at least 30% of Research and Development spending in large integrated developed economies made by the government. Currently, there is less than one researcher for every thousand members of the workforce, as compared with five in Australia and ten in Japan.[4]

Globally, the sector is knowledge-intensive and technology-intensive. However, South Africa does not conform to these trends, as evidenced by the indicators for value added per employee and wages, being substantially below international best practice. South Africa is a net importer of technology, and is generally recognized as being successful as a technology adapter and extender. The implementation rather than the development of technology has been a focus of South African industries and economic growth based on local innovation is low. A key feature of the South African terrain is therefore that, whereas South Africa both exports and imports technology, it rarely takes its own technologies through the complete development cycle. There is evidence of good technologies that are lost or not commercialized due to a lack of innovation resources. This phenomenon has lead to the so-called "Innovation Chasm". This is an innovation gap that exists between the knowledge generators and the market and has never been addressed strategically. This feature is depicted in a diagram below.[5]

Figure 2: South Africa – "The Innovation Chasm"



[4] UNDP Report: 2001 Technology and Development
[5] A National Perspective: Contribution of Research and Innovation to the SA Economy. Adi Paterson (Department of Science and Technology)

High population growth constantly exceeds the growth in employment demands. This is compounded by the consistent loss of jobs in the formal sector, as the country's economy moves away from labour-intensive to capital-intensive operations. The labour market is characterized by an oversupply of unskilled workers and a shortage of skilled ones. Furthermore, in South Africa, the distortion of under development and/or disinvestment in the majority of South Africans has resulted in the skewed skills profiles from a racial perspective and in terms of the 'soft' and 'hard' qualifications. An overwhelmingly white, male and aging scientific population is not being replaced by younger groupings more representative of the country's demographics.

A study for the Chemical Industries Sector Education and Training Authority (CHIETA) has found that while black people are predominantly located in the lower-skill occupational categories, 83% of African employees reported receiving no training relevant to work in the previous year, compared with 46% of white employees.[6] A HSRC[7] study for the CHIETA on the skills needs in the chemical sector in South Africa has indicated that more than two thirds of all the workers in the Chemical Industries Sector are black, but that many top-level decision makers (financial, managing, and related senior management positions) and technically qualified posts (chemical, production, and process engineers etc.) are predominately filled by white males. The average age of workers at all occupational levels, except for that of operators, seems to be increasing, which makes the training of replacements an urgent matter.

The fact that employers in the Chemical Industries Sector experience difficulty in recruiting new staff at the managerial, professional and technician level, especially affirmative action candidates, can be ascribed to the low output of graduates in the natural sciences. This is indicated by the fact that South Africa produces about 10 times fewer scientists and engineers compared to typical first-world countries. Figures from the Department of Science and Technology state that only 3.9% of approximately 490,000 learners who wrote Matric exams in 2000 passed mathematics on the higher grade, and 4.7% passed science on the higher grade. The continual plea for access to expatriate skills and capacity by the industry is backed up by statistics that show there are insufficient locally based professionals to meet the demands of the sector in the short term.

South African ageing and shrinking human resources in science and technology are not being adequately developed and renewed and the number of A-rated scientists is declining annually. In 1998, 45% of all scientific publications were by authors over the age of 50. This is further compounded by the emigration of senior and junior scientists to further their careers in countries with a more competitive research environment. Innovations, patents and

6 Chieta Report: "A Demographic Profile of the Workforce in the Chemical Industries Sector and Sub-sectors" May 2002

7 HSRC Chieta Report "Skills Needs by the Chemical Industries Sector in South Africa" December 2003

technology transfer are not sufficiently rewarded as core tasks of academics and researchers at academic institutions.[8] This focus is reflected in the relatively low number of patents per South African scientist. Start-ups are derived at a low level of 2 per 100 patents in South Africa, ***vs*** the international norm of 10 to 15 start-ups for every 100 patents.[9]

Over the last 5 years, the chemical sector has nevertheless increased employment by 2.1% per annum and achieved an annual average value-added growth rate of some 5.1%.[10] South Africa's performance in mathematics and science seems to be reaching a turning point and inequalities are gradually being eliminated. Although there has been some progress in developing black managers in the science and technology system there are still far too few black researchers. The percentage of university graduates (of all population groups) in the natural sciences has returned to the 1985 level.

The future prospects of the chemical industry will depend on an appropriate skills development and retention strategy. The South African government has adopted a proactive approach to many of the fundamental issues affecting the country. One of these is the investment in, and management of, human capital development in order to strengthen the transformation of its science and technology capacity. The chemical sector can therefore be seen as a critical industry from which to advance South Africa's social economic development objectives.

Stimulating the growth of a globally competitive and sustainable aroma and fine chemicals value chain can be seen as a means of developing the Fine Chemical, Speciality and Functional Chemicals sub-sectors and addressing the strategic imperatives discussed above that confront the growth of chemical industry as a whole. The findings enumerated in this report would suggest that by South Africa supporting an investment in an Aroma and Fine Chemicals cluster based on the portfolio of products indicated, the downstream sector would benefit positively and would help to bridge the innovation gap identified in the national research and development strategy for South Africa.

[8] Draft Emerging Biotechnology Roadmap: Department of Science and Technology: November 2003
[9] National Biotechnology Audit: September 2003
[10] Chemicals SA 2003: South Africa's Petrochemical Industry – Globalisation, Restructuring, and Government Policies

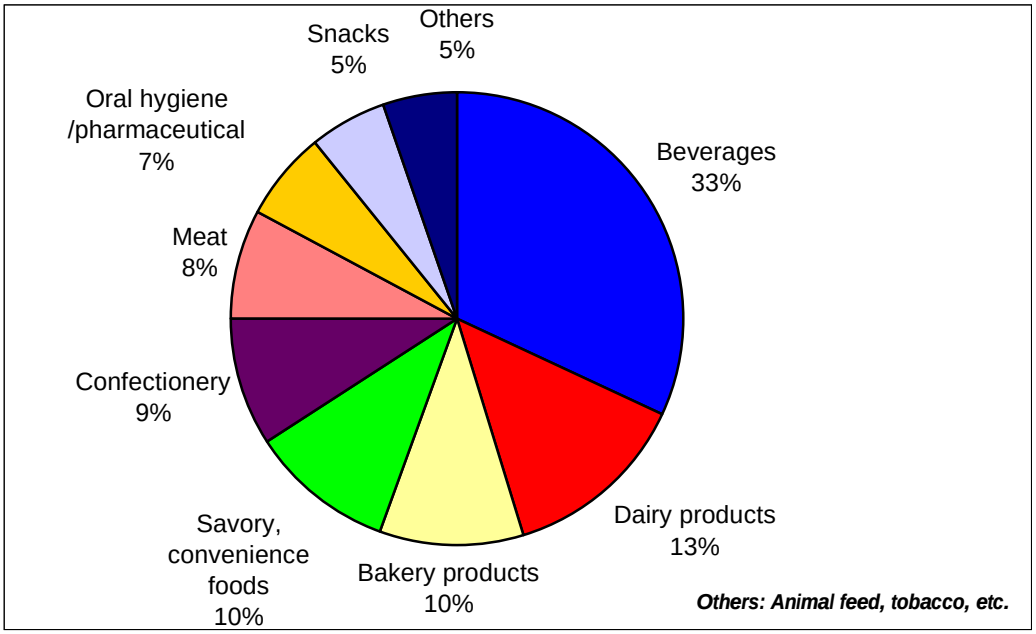
2.2 Overview of the International Flavour and Fragrance Industry

This section of the report provides an outline of the Flavour and Fragrance industry in a global context. It also serves to describe the position held by aroma chemicals and essential oils in this market.

Flavour and fragrance formulations are widely used globally for enhancing, among others, foods, beverages, detergents and pharmaceutical products. Compounded flavour and fragrances are thus complex blends designed to impart either an attractive taste and aroma to processed foods and beverages, or a pleasing scent to consumer products such as perfumes, toiletries, household cleaners etc. The formulations may contain aroma chemicals as well as essential oils and natural extracts. The formulation will also contain solvents, diluents and carriers.

Figures 3 and 4 outline the breakdown of the use of flavour and fragrance compositions in the end-markets. [11]

Figure 3: Flavours End-Use Market

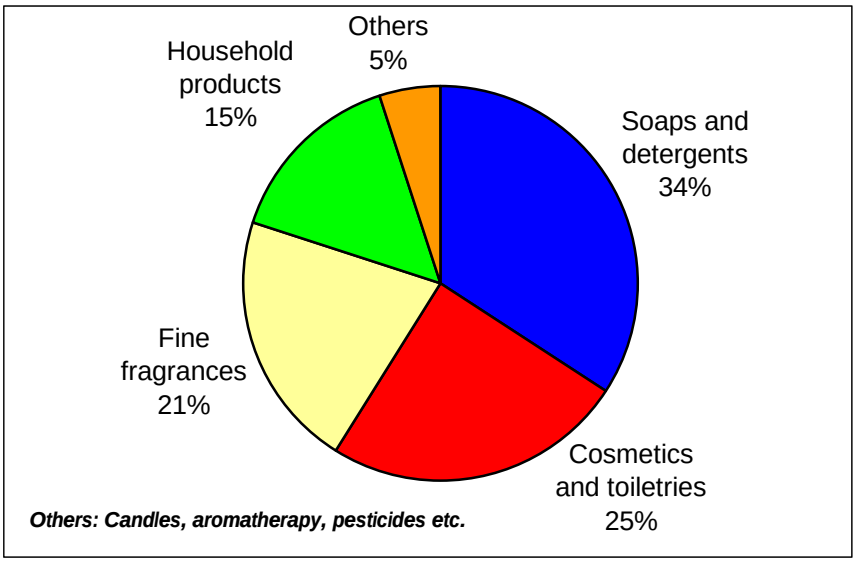


It is interesting to note that the major use in the flavour market is in beverages. In the fragrance end-use market, over 50% is used in two applications i.e. soaps/detergents and cosmetics/toiletries. These end-use markets are characteristically first-world markets. This

[11] Chemical and Engineering News: July 14, 2003

is supported by the global consumption usages for flavour and fragrances, which show that the USA accounts for 31% of the market, with Western Europe representing about 29% of the world market and Japan 12%.[12] The rest of the market lies in developing countries with high growth rates and potential, as use of the consumer products in these particular major end-use markets increase. The South African market in 1999 was worth a total of $ 107.3 million. Flavours were the largest application of $ 56.7 million.[13]

Figure 4: Fragrances End-Use Market



In 2002, the worldwide flavour and fragrance business, including sales of compounded flavour and fragrance products, aroma chemicals as well as essential oils and natural extracts, was valued at an estimated $ 15.1 billion. [14] The industry is segmented broadly into three areas:

1. Isolation of synthetic and natural aroma chemicals or essential oils/natural products. (Aroma Chemicals are single, chemically defined substances which act on the senses of smell and taste; and essential oils are naturally occurring, volatile products obtained from various parts of plants.)

2. Compounding of these products into formulations tailored to meet specific customer requirements

[12] Chemical and Engineering News: July 14, 2003
[13] IAL Consultants: 2000 Data; C&EN July 2003; IAL Data 2001
[14] Leffingwell and Associates

3. The sale and use of these formulations in the production of personal care and pharmaceutical active ingredients, food and beverage markets etc.

This flavour and fragrance value chain is represented in Figure 5. This report uses the term "Flavour and Fragrance industry" to encompass this full value chain.

Figure 5: Flavour and Fragrance Industry Value Chain

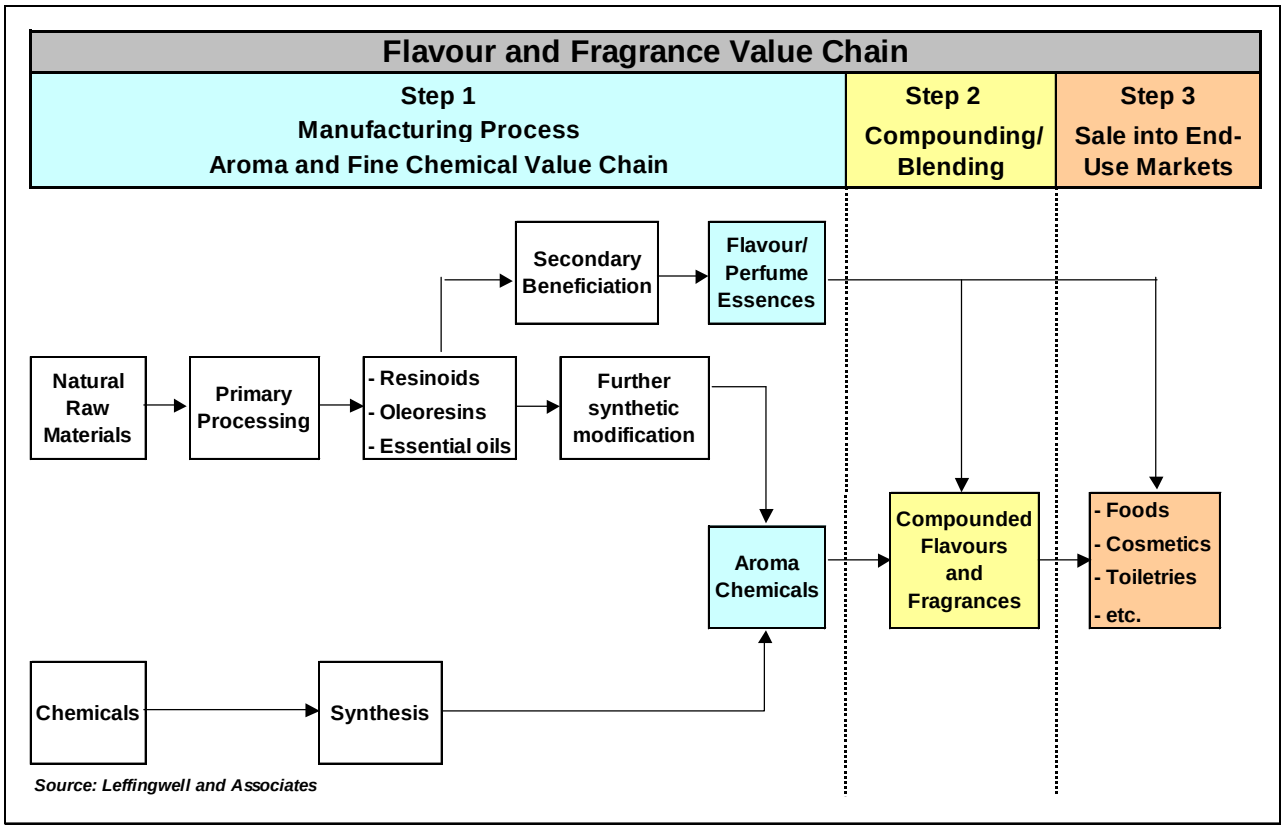


Table 1 illustrates the contribution of the various components of this value chain.[15] It is worth noting that over 75 % of the industry's value lies in the composition of the flavours and fragrances.

[15] Chemical and Engineering News Estimates May 2002/Leffingwell and Associates

Table 1: Value of the Flavour and Fragrance Industry 2002[16]

	% of the Value Chain	$ Billion
Aroma Chemicals	12%	1.8
Essential Oils and Natural Extracts	12%	1.8
Flavour Compositions	41%	6.2
Fragrance Compositions	35%	5.3
TOTAL	**100%**	**15.1**

Production of aroma chemicals is estimated to be worth $ 1.812 billion. In 2000, the SRI Chemical Economic Handbook report estimated the market for aroma chemicals to be $ 1.766 billion.[17] This estimate was based on supply and demand estimates by the major geographic regions.

A recent survey by the market research company, Freedonia Group[18], forecasts growth in global demand for flavours and fragrances of 5.4% per annum, with the industry reaching $ 18.4 billion in 2004. Market growth will primarily be due to strong growth in the developing regions of Latin America and Asia (excluding Japan). Countries such as China, Brazil, India, Mexico, Vietnam and Chile particularly are experiencing dramatic growth in their food-processing and consumer-product industries. It is predicted that the growth in developed markets will in contrast be slow. The developed countries market growth is characterised by trends, which favour less flavour and fragrance-intensive consumer goods, consolidation in end-user industries, strong pressure on price reductions, and market maturity. It is also anticipated that the growth in the essential oil and natural extract market will exceed that in the synthetic aroma chemical market.

Large international Flavour and Fragrance houses specialise in the compounding of flavour and fragrance products. A number of these houses also produce selected aroma chemicals for captive use. In addition, some also manufacture personal care active ingredients from captive and purchased aroma chemicals. Generally, success in the formulation and compounding business is dependant on the ability to offer a basket of products, and an ability to respond quickly to ever-changing trends in consumer preference. Most major participants in the Flavour and Fragrance industry operate internationally and maintain a presence in virtually all markets of the globe. The major motivation for this is that the leading Flavour and Fragrance houses are following key end users such as food processors and

[16] SRI Chemical Economic Handbook Report: Aroma Chemicals and the Flavour and Fragrance Industry August 2001
[17] SRI Chemical Economic Handbook Report: Aroma Chemicals and the Flavour and Fragrance Industry August 2001
[18] Freedonia Group News Release 2003

detergent producers to these regions. China, Brazil, and Mexico have as a result seen a strong growth in production.

Over recent years there has been a large amount of rationalisation and consolidation within the industry and this process is likely to continue. It has been estimated that there are over 1,000 companies active in this industry worldwide, but 12 international flavour and fragrance companies hold over 65% market share. One major reason for this is that of the cost of owning an adequate infrastructure, which includes the cost of toxicological testing, research and development, quality control, and efficient manufacturing and marketing, is so high that only the largest of companies can afford it. The costs associated with these activities also explain the reason for the high value associated with this segment of the market.

Table 2 outlines the top 12 companies in 2002. [19] It is noticeable that the top 6 participants have sales over $ 800 million. The next tier has sales in the region of $ 200 to 400 million. Below this level, the industry is highly fragmented with a host of much smaller players. A recent report from SRI International comments that there is a "virtual absence of medium-sized participants" with sales in the region of $ 75 to $ 100 million.

Table 2: Estimated Sales Volume Flavour and Fragrance Companies 2002

Company	Country	$ million	Market Share
Givaudan	Switzerland	1,933	12.8%
IFF	USA	1,809	12.0%
Firminech	Switzerland	1,373	9.1%
Symrise	Germany	1,300	8.6%
Quest International	UK	1,153	7.6%
Takasago	Japan	850	5.6%
Sensient Technologies	USA	423	2.8%
T.Hasagawa	Japan	381	2.5%
Mane SA	France	270	1.8%
Danisco	Denmark	263	1.75
Degussa Flavours	Germany	234	1.5%
Robertet	France	218	1.4%
TOTAL TOP 12 COMPANIES		**10,206**	**68%**
Others		4,894	32%
TOTAL		**15,100**	**100%**

[19] Leffingwell and Associates

There are a number of reasons for this consolidation. A major reason has been the pressure on prices. As outlined above, the major market is USA followed by Europe and Japan. In the USA the advent and power of the supermarket chains has placed pressure on consumer product manufacturers to drop costs in order to be given "shelf space". This has lead to consolidation amongst consumer product manufacturers. These manufacturers in turn have pressurized the Flavour and Fragrance houses (which once commanded huge margins) to reduce prices. The Flavour and Fragrance industry is thus reacting to the concentration of its customer base. In addition, end-users have found it too costly to deal with too many Flavour and Fragrance houses, and accordingly only deal with the largest few. If the Flavour and Fragrance house is not strong in all markets it cannot keep the custom of a larger customer such as a Unilever or Proctor and Gamble. Thus growth in turnover by the Flavour and Fragrance houses has come primarily from acquisitions with the company profiting from economies of scale.

A further reason for the consolidation has arisen from major chemical companies wanting to stick to core business of high volume manufacturing. As a result, many of them have sold their Flavour and Fragrance divisions to previous competitors. Recent examples are Bayer, which used to own Haarmann & Reimer, which was merged with Dragoco forming Symrise in 2002. In 2000, Roche spun off Givaudan. The only chemical company still with a Flavour and Fragrance house is ICI with Quest International.

The smaller and medium sized companies active in the Flavour and Fragrance industry have survived by concentrating on their specialist knowledge within a niche market and offering services and products that the industry giants don't offer. An example of this is Treatt plc, based in the United Kingdom. This company acts as a one-stop shop for the Flavour and Fragrance industry in Europe, but not in the US. Fine chemical companies are increasingly forging partnerships with Flavour and Fragrance customers through joint projects and special services, and are becoming indispensable partners of the Flavour and Fragrance industry. Rhodia is an example of this trend, producing natural vanillin under license from Givaudan who could not justify operating the process on its requirements alone. Fine chemical companies can develop new compounds at a smaller scale or offer process improvements to customers losing patent protection. The proposed portfolio of the petrochemical suite of products was designed to position AECI in this segment of the market.

2.2.1 Aroma Chemicals

Aroma Chemicals can be manufactured ***via*** a number of different routes:

1. **True synthetic chemicals**: This includes chemicals produced by synthesis from both natural aromatic compounds and from synthetic feedstocks e.g. petrochemicals.

2. **True Isolates**: Single aroma chemicals, which are extracted from natural materials and subjected only to further processes of purification. These include the following: anethole, camphor, citral, eugenol, and menthol.

3. **Chemically modified derivates:** Made by converting isolated products into a different chemical by subjecting them to various chemical processes. This includes the crude sulphonated turpentine derived aroma chemicals such as citral, geraniol and linalool. Crude sulphonated turpentine is a by-product of the Kraft paper pulping process. It also includes vanillin produced from lignin, also a by-product of the paper pulping process.

Aroma chemicals can be classified according to their chemical structure. The main groups and their share of the aroma chemical market are detailed in Table 3. [20] There are about 2,800 aroma chemicals approved for use in flavour and fragrance formulations worldwide. However, only a few hundred are produced in volumes over 50 tons for the merchant market. It is considered that synthetic aroma chemicals constitute 70 – 75% (by value and volume) of the raw materials used in the flavour and fragrance formulations. The aroma chemicals under consideration in this study fall into the categories of either benzenoids or terpenoids.

Table 3: World Consumption of Aroma Chemicals

	Percentage by Value	Percentage by Quantity
Benzenoids	34	48
Terpenes/Terpenoids	37	34
Musk chemicals	13	7
Other aroma chemicals.	16	11
	100	100

The majority of aroma chemical manufacturing is by batch processing, often in multi-purpose plants. This is due to the fact that few aroma chemicals are consumed in large enough volumes to justify dedicated equipment. Manufacturers need to shift production from one product to another as the market demand changes. Some aroma chemicals do have a demand in other purposes, however, the application as a flavour and fragrance ingredient usually is the most profitable for these products.

[20] SRI Chemical Economic Handbook Report: Aroma Chemicals and the Flavour and Fragrance Industry August 2001

Aroma chemicals are generally produced by three different types of companies:

- Flavour and Fragrance Houses:

  These companies produce the chemicals for their own use in compounds and blends and often also sell them on the merchant market.

- Large Diversified Chemical Companies:

  These companies manufacture aroma chemicals as a minor component of their overall chemical business by upgrading small amounts of their large-scale chemical production is to flavour and fragrance specifications. Product is sold to formulators or flavour and fragrance houses; the chemical companies do not themselves sell the products into the end consumer markets.

- Medium and Small Chemical Producers:

  These are companies involved in the synthesis of aroma and other fine chemicals using specialised technical knowledge. (AECI as a producer of a portfolio of fine chemical aroma products would have belonged in this category)

The aroma chemical industry has consistently earned returns in excess of the chemical industry standard. As it is so closely tied to the health, personal care, and food and beverage markets, it is robust, insensitive to commodity cycles, and relatively recession resistant. Success in the production of aroma chemicals is generally characterised by:

- Consistent product quality
- An approved organoleptic quality
- Long-term customer relationships
- Technology driven cost leadership
- An ability to research, develop and commercialise aroma chemicals
- A robust raw material/feedstock position

2.2.2 Essential Oils

Essential oils are naturally occurring volatile products obtained from various parts of plants. Essential oils are usually extracted from the plant material by steam distillation, expression, or solvent extraction. Essential oils are distinguished from the fatty vegetable oils, such as canola and sunflower by the fact that they evaporate or

volatise in contact with the air and they usually possess a strong aroma (the name comes from "essence"). The amount of oil extractable ranges from an infinitesimal quantity to as much as 1-2% of the dry weight of the plant material distilled.

The methods of extraction differ considerably. The sources may be fresh or dried fruit, leaf, bark, root or seed. A typical essential oil is a complex mixture of chemical compounds, each of which possesses its own, individual set of properties. The odour of the oil can be due mainly to one single chemical constituent, or to a mixture of several odoriferous chemical bodies. The chemical constitution of the bodies may not always be known.

The major producers of essential oils are Brazil, China, U.S., Egypt, India, Mexico, Guatemala and Indonesia. All of them, with the exception of U.S., are developing countries with very low labour costs. The major consumers are the U.S. (40%), Western Europe (30%) and Japan (7%).

Although the essential oils industry is primarily an agricultural industry, the oils make up an important component of the flavour and fragrance supply chain, alongside synthetic aroma chemicals. Sales of essential oil and other natural extracts were equal in value to those of aroma chemicals in 2002 (estimated US$1.8 billion each). Essential oils are sold into several different markets (foods and beverages, aroma and fragrances in foods, nutraceutical applications, medicinal applications, cosmetics and personal hygiene products). Most naturally derived aroma chemicals have their synthetic counterpart; however there has always been a niche for the natural products. Furthermore, over the last 50 years, the demand for essential oil products from plants has gradually increased because of a number of factors. Demand for flavouring, perfumery, and aromatherapy materials has risen because of the steep rise in the world population and a desire for greater variety in their food by the people of the industrialized countries. The increased concern for the environment and for the safety of food and the general difficulty in manufacturing synthetic alternatives has also contributed to the continued growth in demand for plant based essential oil products. According to the United Nations Trade Statistics, trade in essential oils and related products are growing at roughly 10% per annum whereas the overall flavour and fragrance market is growing at between 4% and 5% per annum.

The world trade in essential oils may be divided into two components, often referred to as the major and minor oils. With regards to the major oils, these are those oils that are traded in large quantities (but often lower prices). There are approximately 160 essential oils traded globally. The top 10 oils make up some 80% of the world trade in essential oils. The remaining 150 minor essential oils are of higher value but are traded in quantities ranging from a few kilograms per annum to a few hundred tons per annum.

Although it is possible to isolate aroma chemicals from essential oils this is only done in respect of the major oils, where the economies of scale allow for the natural isolate to compete with the synthetic counterpart. The competition in the major essential oils is stiff with the low cost producers of Asia and South America dominating (particularly Brazil and China). On the other hand, the minor essential oils are traded and used more or less "as is". Their attraction is in their complex chemical structure and consequent organoleptic properties they possess. The minor oils are more difficult to produce as they are not produced in "plantations" and neither can they be highly mechanised.

South Africa has a long involvement in the essential oil industry with regards to the production of major essential oils like eucalyptus and citrus oils, supplying some 5% and 2% of the world market respectively.

2.3 The South African Flavour and Fragrance Industry

The market for flavours and fragrances in South Africa and Sub-Saharan Africa in 1999 and projected for 2004 is shown in Table 4 below.

Table 4: Market for Flavours and Fragrance in South and Sub-Saharan Africa: 1999 – 2004[21]

End-use ($ millions)	South Africa		Sub-Saharan Africa	
	1999	2004	1999	2004
FLAVOURS				
Beverages	18.1	21.0	22.4	30.8
Dairy	9.3	10.9	8.0	10.6
Snacks/Savoury/Convenience	7.0	9.2	6.8	9.7
Bakery	6.4	6.7	5.6	6.2
Confectionary	5.2	5.6	6.2	6.9
Meat	5.1	6.4	3.5	4.7
Oral Hygiene/Pharmaceutical	3.0	4.6	3.0	3.9
Others*	2.6	3.1	4.0	4.9
TOTAL	**56.7**	**67.5**	**59.5**	**77.8**
Growth Rate		**3.6%**		**5.5%**
FRAGRANCE				

[21] An Overview of the Global Flavours and Fragrances Market: IAL Consultants 2000

Soaps / Detergents	24.6	27.7	28.6	36.5
Cosmetics/ Toiletries	12.0	14.7	13.0	17.2
Household cleaners	8.3	9.2	5.9	7.4
Fine Fragrances	2.5	2.7	1.1	1.3
Others#	3.2	3.4	3.7	4.1
TOTAL	**50.6**	**57.8**	**52.3**	**66.5**
Growth Rate		**2.7%**		**4.9%**
GRAND TOTAL	**107.3**	**125.3**	**111.8**	**144.3**

**** Including Pet Food and Tobacco***
#* Includes: Candles, aromatherapy, insecticides etc.

In South Africa, the current emergence of the black middle class is having a positive impact on the consumption levels of flavour and fragrance containing compounds.

The largest flavours sector in Africa is beverages followed by the dairy section. Higher flavour loads tend to be used in the beverage sectors in the African markets compared to more developed markets. For example, in Western Europe, fruit-flavoured soft drinks typically contain 12% fruit juice, reducing the need for added flavour. In the majority of countries in Africa, no fruit juice is used at all. Although South Africa in general has a food culture similar to the rest of Africa its food processing sector is however more sophisticated than in the rest of Sub-Saharan Africa.

Within the fragrance sector, the largest use is in soaps and detergents. Within this sector, washing soap is predominant in the less affluent regions, where the use of washing machines is at nominal levels. Many cosmetics and toiletries multinationals have located production facilities in South Africa as a production base for the Sub-Saharan region.

The South African total market in 2004 was therefore predicted to be $ 125.3 million. At an exchange rate of R 7/US$ this is equivalent to R 877 million. This figure for the value of the South African Flavour and Fragrance market in 2004 has been confirmed by industry sources. The regional South and Sub-Saharan African market in 2004 was expected to be in the order of $ 279 million or R1,887 million. Growth in the region is anticipated to continue to be strong, the flavours market growing at 4%.

3 ESSENTIAL OIL INDUSTRY AND MARKET ANALYSIS

3.1 International Market – Overview

There are well over 160 recognised essential oil crops but most are of minor importance in terms of worldwide demand. The top ten crops by volume account for about 80% of the total world market for essential oils.[22] The remaining 20% of the world essential oil market comprises over 150 crops. The largest of the internationally traded essential oils are set out in the table below:

Table 5: The World's top 20 Essential Oils[23]

Essential Oil	Volume (t)	Value ($ mill)
Orange	26,000	58.5
Cornmint	4,300	34.3
Eucalyptus cineole-type	4,300	29.8
Citronella	2,830	10.8
Peppermint	2,367	21.6
Lemon	2,158	21.6
Eucalyptus Citronellal-type	2,092	7.3
Clove Leaf	1,915	7.7
Litsea Cubeba	1,005	4
Sassafras (Brazil)	1,000	4
Lime Distilled	973	7.3
Native Spearmint	851	17
Cedarwood (Chinese)	800	3.2
Lavendin	768	6.1
Sassafras (Chinese	750	3.0
Camphor	725	3.6
Coriander	710	49.7
Grapefruit	694	13.9
Patchouli	563	6.78
TOTAL	**88 769 tonnes**	**$340 mill**

[22] Agricultural Note AG0656: Dept of Primary Industries/ Dept of Sustainability and Environment Australia

[23] Brian A. Lawrence, 1993: A planning scheme to evaluate new aromatic plants for the flavour and fragrance industry

PART 4 – AROMA CHEMICALS DERIVED FROM ESSENTIAL OILS

The major exporters of essential oils are the United States (US), the European Union (EU) and a number of developing countries, the most important of which are China, Indonesia, India and Brazil. In 1998 the EU accounted for 52 per cent of the value of world exports, and the US 13 per cent (UN 1999). Developed countries are the main importers of essential oils, with the EU and the US accounting for 44 per cent and 8 per cent respectively in 1998 (UN 1999).

The major consumers are the US (40%), Western Europe (30%) and Japan (7%).

The major essential oil world crops are: citrus (US, Brazil, Mexico); mint oils such as peppermint (US), spearmint (US) and cornmint (China, India, South America); and lemon fragrance oils such as citronella, lemongrass and Listsea Cubeba (China, India, South America). Eucalyptus oil is produced in Brazil, China and South Africa, as well as in Australia. Cedarwood oil is confined to North America as a by-product of the timber industry. The clove industry is confined to Indonesia.

The major producers of essential oils are Brazil, China, US, Egypt, India, Mexico, Guatemala and Indonesia. All of them, with the exception of US, are developing countries with very low labour costs. The US is prominent in respect of crops that are highly mechanised, such as peppermint.

Over the last 50 years, the demand for essential oil products has gradually increased because of a number of factors. Demand for flavouring, perfumery, and aromatherapy materials has risen because of the steep rise in the world population and the emergence of new middle-class societies, particularly in the east. Furthermore, there is an increased demand, by the people of the industrialized countries, for greater variety in their food and a trend towards health and wellness. The increased concern for the environment and for the safety of food has also contributed to the continued growth in demand for naturally derived flavour and fragrance products (such as essential oils).

The United Nations International Trade Yearbook[24] indicates that trade in essential oils is growing at a rate of approximately 10% per annum. In 1998, world exports of essential oils and related perfumes and flavours were valued at US$ 7 435 million and imports at US$ 6 811 million (UN 1999). Table 2 shows that the value of world trade has increased substantially between 1986 and 1998.

[24] United Nations International Trade Yearbook 1999 and 2002

Table 6: World trade in essential oils and related perfumes and flavours[25]

	1986	1990	1994	1998	1986–98
	US$m	US$m	US$m	US$m	% pa
Exports	2 149	4 122	5 051	7 435	10.9
Imports	2 008	4 206	4 802	6 811	10.7

These world export and import figures may be misleading as it includes double accounting (imported goods re-exported with or without beneficiation) and a wider range of products than just essential oils. For example, in 1993, industry expert Brian Lawrence estimated the world production of essential oils to be some 56,000 tons with a value of some US$ 500 million, whereas the world export and import figure for 1994 was US$5051million and US$ 4802 million respectively. The value of production of essential oils is approximately 10% of the value of international trade in essential oils and related products as measured by the United Nations Trade Statistics. It is estimated that the world production of essential oils in 2003 was approximately 130 000 tons with a value of approximately US$1 billion[26]. This is in line with the growth rate of 10% year on year, experienced since the 1980's.

Some 50% of the world production of essential oils is used in flavours (predominantly beverages), a further 5% to 10% in phytotherapy and aromatherapy, 20% to 25% in fragrances and 20% to 25% is used for further fractionation for the isolation of aroma chemicals. Within the fragrance category, 70% is used in household products, with another 20% used in toiletries and personal care items and the remaining 10% used in fine fragrances (perfumes).

3.2 South African Market – Overview

South Africa has a well-developed chemical and consumer products manufacturing industry which has a demand for fragrances (mostly synthetic aroma chemicals) and has a well developed food processing industry demanding flavours.

[25] Source: United Nations International Trade Yearbook 1999

[26] Industry Sources

PART 4 – AROMA CHEMICALS DERIVED FROM ESSENTIAL OILS

According to industry sources, the South African flavour and fragrance industry was worth approximately R900 million in 2003. Approximately, two thirds of the market is for flavours and the remainder for fragrances.

On the whole, synthetic aroma chemicals and natural formulations are mostly imported into South Africa through branches of the large flavour and fragrance houses. To the extent that local manufacturers of end products are themselves international companies or are manufacturing under licence to international companies, these companies source the majority of their chemicals through the same flavour and fragrance houses as their international principals do. Accordingly, the local market in South African essential oils is relatively small (with the exception of eucalyptus and citrus oils) and South Africa is a net exporter of essential oils.[27] Local exports of essential oils are approximately R100 million per annum and local imports of essential oils are approximately R40 million per annum.[28]

From a production or supply perspective, the South African essential oil industry has two main components: firstly, the cultivation of "classic" or exotic essential oils and, secondly, the harvesting or cultivation of indigenous essential oils (which, besides Buchu oil, is commercially much less significant). With regards to the classic essential oils, these may be viewed in two parts. The first are the major bulk commodity oils, such as eucalyptus and citrus oils, for which South Africa is already an acknowledged world producer. Secondly, there are the smaller niche minor essential oils (world market of less than 500 tons per annum) which include: Geranium, Lavender, Chamomile, Rosemary, Jasmine, Basil, Melissa, Marjoram and Thyme.

The current South African production of essential oils is approximately 2100 to 2900 tons per annum. Production has been on the increase in the last five years.

[27] DTI Export Import figures (2002)
[28] SARS (Customs & Excise)

Table 7: Estimated South African Production (2003)[29]

Essential Oil Type	Volumes (p.a.)
Major Oils	
Orange	300-500 tons
Lemon	200-500 tons
Lime	1400- 1600 tons
Eucalyptus (cineole type)	200- 300 tons
Minor Oils	
Rose Geranium	3000 kg
Lavender /Lavendin	2000kg
Jasmine	2000-3000kg
Rosemary	400-600kg
Chamomile	30-40 kg
Tagetes	6000 -7000kg
Buchu	500-1000kg
Artemesia	500-800kg
TOTAL	**2100 -2900 tons**

With regards to unique indigenous essential oils, South Africa has several species which have obtained international acceptance and many that have not. South African indigenous plants which are being cultivated or harvested in the wild for their essential oils include: Buchu, Artemesia and Tagettes (the latter, although not originally indigenous is now endemic). Not all of these are used in the flavour and fragrance industries, for example Buchu is also used in medicinal preparations. Other uniquely South African offerings include Cape Chamomile, Cape May Oil and Cape Snow Bush. These and other products are largely exported in a few kilograms per annum to speciality buyers in US and Europe.

However, the potential for the commercial exploitation of South African flora may be significant. The world flavour and fragrance industry is driven by novelty and the international F&F houses, like Givaudan, send out fragrance and flavour hunters worldwide. The Givaudan groups are called "Scenttrek" or "TasteTrek"[5] (depending on focus), and they have travelled to countries such as French Guyana, Gabon, Madagascar, Papua New Guinea and South Africa to investigate and take samples of indigenous flavours and

[29] Industry Sources

fragrances. It has been reported that Givaudan has “taken” some 20 new fragrances from South Africa alone over the last couple of years. This illustrates the potential as well as the threat posed by the industry.

There has been a lot of research that highlights that South Africa is considered to be a "hotspot" for biodiversity with more than 22,000 plant species occurring within its boundaries. This represents 10% of the world ' s plant species. However, it is especially the Flora Capensis that is most unique. This, the Cape Floral Kingdom, is the smallest of the world ' s six Floral Kingdoms. It contains 8,700 species of which 68% are endemic.[30] South African indigenous crops are used in a number of different applications, such as the trade in medicinal and cultural plants, food crops, and ornamental plants. Indigenous medicinal plants are used by more than 60% of South Africans in their health care needs or cultural practices, with approximately 3,000 species being used by an estimated 200,000 indigenous traditional healers.[31] It is this heritage which the CSIR (Bioprospecting Division) and others is attempting to unlock in a manner that will allow for the commercial exploitation of South Africa’s natural resources. Using indigenous knowledge systems as the basis for plant identification and analysis, it is possible for scientific and commercial players to identify new entrants into the international flavour and fragrance market. However, as already stated, this initiative is more likely to succeed on the back of a flourishing conventional essential oil industry.

3.3 South African Market - General Comments

The analysis of the local essential oils market is difficult because of the lack of quality information. The import and export figures kept by DTI and SARS (Customs & Excise) are generally not that informative. The figures more accurately deal with products such as Orange, Lemon, Lime, Geranium, Lavender, Jasmine and Peppermint, but do not deal with important products like Eucalyptus, Chamomile and Lemongrass. The latter products are “bundled” under the category “Other”. The “Other” category is relatively large. For 2003 the

[30] Coetzee, C., E. Jefthas, and E. Reinten. 1999. Indigenous plant genetic resources of South Africa. p. 160–163. In: J. Janick (ed.), Perspectives on new crops and new uses. ASHS Press, Alexandria, VA.
[31] Van Wyk, B-E., B. Van Oudtshoorn, and N. Gericke. 1997. Medicinal plants of South Africa. Briza Publ., South Africa.

SARS figures for "Import- Other" was R13,26 million out of a total of R50 million and for "Export- Other" was R31 million out of a total of R110,3 million[32].

Furthermore, the code for essential oils also includes concretes, resinoids, distillates and oleoresins. In the case of oleoresins, the contribution is significant (making up 22% of exports in 2003). Oleoresins are those extracts which include a mixture of essential oils and resins, the details of which products are not broken down.

When reviewing the South African essential oils import and export figures there are several features that may be observed.

The export figures are slightly inflated and do not reflect the level of production in South Africa. Conversely, the import figures do not reflect the level of consumption in South Africa. This is a common problem, even in developed markets, for example Britain exports much more than it produces because it imports for re- export. Therefore the size of the market appears inflated. This is also the case for South Africa, where South Africa often acts as a conduit for product into Sub-Saharan Africa. For example, in 2003, South Africa imported 4,333kg of Lavender oil and in turn re-exported approximately 1000kg to Sub-Saharan African countries.

In many cases South Africa imports and exports the same product. This is even the case where South Africa is an acknowledged world supplier. For example, South Africa is a major producer of orange and lemon essential oils (in 2003 exports of 287 tons and 197 tons respectively) however South Africa also imports orange and lemon essential oils (in 2003 imports of 58,7 tons and 6 tons respectively). This occurs largely for one of two reasons, either the essential oil needs to have particular characteristics which only pertain to the imported product or because there is an overriding market relationship between the overseas seller and the local buyer.

For the reasons stated above, it is also difficult to discern from the import and export figures what the local production and consumption of an essential oil is. One needs to compare the import and export figures to market intelligence gleaned from local producers.

The local production figures are currently difficult to obtain. There is very little sharing of information. Even the South Africa Essential Oil Producers Association (SAEOPA) (which has established new branches in Kwa-Zulu Natal and the Cape) has only been able to collect figures for the Mpumalanga area as the collection process is totally dependent on personal

[32] SARS, Customs & Excise (2003)

relationships. Figures also tend to be based on hectares under cultivation and not on actual kilograms or tons of oils distilled. Accordingly, local production figures gleaned by the consultant (see Table 7 above) are rough estimates only.

3.4 South African Market - Trade Partners

The key producers of essential oils world-wide are mostly developing economies (e.g. India, China, Brazil, Indonesia, Mexico, Egypt and Morocco), with the key exception being USA (peppermint and other mints). It is estimated that 65% of the world production of essential oils is produced by developing countries. However, in respect of essential oils, South Africa imports mostly from US (32.9%), Britain (15.8%), France (10%), together with India (11%) and China (5%).

Table 8: South African Essential Oil Trade Partners Imports 2003[33]

Country	Value ($) Imports	Percentage
United States	2,172,570	32.88
United Kingdom	1,042,720	15.78
India	782,784	11.85
France	714,076	10.81
China	329,859	4.99
Netherlands	279,663	4.23
Australia	174,909	2.65
Spain	174,699	2.64
Switzerland	125,022	1.89
Zimbabwe	113,228	1.71
Cuba	113,128	1.71
Germany	113,025	1.71
Italy	106,206	1.61
Indonesia	74,498	1.13
Malawi	48,563	0.73
Other	234,147	3.68
TOTAL	**6,608,097**	**100%**

[33] DTI Trade Figures 2003

The above figures (Table 8) reflect at least two aspects of the market. Firstly, the developed world (particularly US and Europe) dominates the flavour and fragrance industry, in particular the formulation of compounds for end-use. The majority of the world's primary production is imported by US and Europe, beneficiated there and exported to the rest of the world. Secondly, countries tend to import commodities from their traditional trade partners.

With regards to South African exports, the figures (Table 9 below) illustrate how the economic periphery (developing nations) provides primary materials to the economic hubs (developed nations). There are two primary features of South African exports. The first is that the majority of produce goes to Europe (49%), US (24%) and Japan (4.5%). The second is that South Africa, in turn being a regional economic hub, plays a role in on-selling product to African markets (e.g. Zimbabwe, Zambia, Mozambique, Angola and the like – some 7% in 2003).

Table 9: South African Essential Oil Trade Partners – Exports 2003[34]

Country	**Value ($) Exports**	**Percentage**
United States	3,659,458	24.6
Germany	2,031,685	13.65
France	1,605,341	10.79
United Kingdom	1,314,408	8.83
Spain	960,369	6.45
Netherlands	749,032	5.03
Japan	659,028	4.43
Switzerland	601,171	4.04
Canada	538,761	3.62
Australia	454,976	3.06
Angola	414,144	2.78
Zimbabwe	305,639	2.05
Belgium	206,479	1.39
Mozambique	198,820	1.34
Malawi	150,115	1.01
Other	1,029318	6.92
TOTAL	**14,878,744**	**100%**

[34] DTI Trade Figures 2003

3.5 South African Market - Overview for Specific Oils

General Comments

Essential oils share a common value chain. However, each essential oil has its own particular dynamics. This depends on how and where it is produced (both nationally and internationally) and what its end uses are. In some instances it is clear where the oil is being sold (e.g. Eucalyptus, Citrus and Buchu). However because of the small quantities, it is difficult to track the sales of many of the South African essential oils as they are sold locally to small traders or into the growing aromatherapy market. Below are a series of market-related monographs on each of the essential oils currently commercially produced in South Africa.

Orange

Citrus oils are produced as a by-product of the citrus fruit and fresh fruit juice market. South Africa is a net exporter of orange oils (as it is of fresh fruit). Orange oils are usually cold pressed (and not steam distilled). The main producers are the fruit producing co-operatives: Associated Fruit Producers, Valor Co-Op, Granor Passi, Onderberg Verwerkings Co-Op, Magalies Co-Op and Letaba Co-Op. Recently, a well established producer (Dickon Hall) went out of business as a result of the down turn in the markets. A large portion of production is purchased by a local company, Teubes (Pty) Limited (Gauteng Province), for further processing and fractionation, the rest is exported. The citrus flavours generally are used in the softdrink and confectionary industries.

Internationally, the orange oil and limonene markets are dominated by a few big players. Brazil is the main competitor, producing 45% of the world's citrus oil, and has a strong effect on the market. South Africa supplies about 2% of world demand.

Table 10: South African Orange Oil Imports and Exports[35]

Year	Import (kg)	Export (kg)
1999	79,443	495,241
2000	175,513	531,230
2001	85,379	325,142
2002	58,498	504,031
2003	58,768	287,221

The price of orange oils has been steadily on the rise going from R4/kg in 1999 to R20/kg in 2003. The price is driven by the current shortage of orange oil on the international market. This is expected to change in the future as India is known to have established more orange plantations over the last few years. When these plantations come into production the price is expected to drop to about R8/kg.

Lemon

Citrus oils are produced as a by-product of the citrus fruit and fresh fruit juice market. South Africa is a net exporter of lemon oils (as it is of fresh fruit). The main producers are Associated Fruit Producers, Valor Co-Op, Granor Passi, Onderberg Verwerkings Co-Op, Magalies Co-Op and Letaba Co-Op. A large portion of production is purchased by Teubes for further processing and fractionation, the rest is exported. The citrus flavours generally are used in the softdrink industry, for example, Coca Cola. Besides beverages and confectionery, Lemon oil is also used in fragrances, where it provides a “top” note.

Table 11: South African Lemon oil Imports and Exports[36]

Year	Import (kg)	Export (kg)
1999	34,575	185,583
2000	76,868	181,740
2001	18,601	249,108
2002	7,982	506,882
2003	6,124	197,815

[35] SARS (Customs & Excise)
[36] SARS (Customs & Excise)

Although also a commodity, the prices for lemon oil are better than for orange and lime, but are relatively flat. Historically, Argentina upset the lemon market with over-production. Prices went to a twenty year low, dropping from $12/kg to $4/kg in 18 months. Producers of lemon oil currently budget for prices of R30/kg for the next few years. Local prices are currently between R35/kg and R40/kg. Lemon, like the other citrus oils, lends itself to rectification and further refinement. This is done in South Africa by Teubes. Five-fold lemon oil is sold for about R450/kg.

Lime

Citrus oils are produced as a by-product of the citrus fruit and fresh fruit juice market. South Africa is a net exporter of lime oils (as it is of fresh fruit). The main producers are Associated Fruit Producers, Valor Co-Op, Granor Passi, Onderberg Verwerkings Co-Op, Magalies Co-Op and Letaba Co-Op. A large portion of production is purchased by Teubes for further processing and fractionation, the rest is exported. The citrus flavours generally are used in the softdrink industry.

Table 12: South African Lime oil Imports and Exports[37]

Year	Import (kg)	Export (kg)
1999	9,395	45,105
2000	14,277	18,649,569
2001	5,998	711,005
2002	4,729	1,482,458
2003	1,602	1,686,768

The current price for lime oil is approximately 50 cents/kg. The price for lime oil was R38/kg in 1999. Even with exchange rate differentials, this demonstrates the cyclical and volatile nature of the commodity prices

Eucalyptus (Cineole-type)

The species grown in South Africa since the 1950's is ***Eucalyptus Smithi*** . It is grown in the Eastern regions of Southern Africa (including Swaziland) from Kwa-Zulu Natal to Limpopo Province. This Eucalyptus produces a cineole-type oil. Cineole-type oil is predominantly

[37] SARS (Customs & Excise) It is noted that the export figure fro 2000 appears anomolous

used in medicinal applications, but there are some flavour applications. The two principal perfumery oils are produced from ***E. citriodora*** and ***E.staigeriana***.

The world production and trade in Eucalyptus oil is dominated by China. Because of lack of production figures and domestic consumption figures in producer countries, it is difficult to accurately quantify the world market. In 1991 it was estimated that China produced some 70% of the world's cineole-type oil.[38] In 2004 it is estimated that this has risen to between 90 and 95%. In 1991 it was estimated that South Africa produced between 150 to 180 tons of oil[39]. By 2002 this had risen to 300 tons[40]. This constitutes some 5 % of world production.

Table 13: World Production and exports of Cineole-type Eucalyptus Oil 1991[41]

Country	**Production (Tons)**	**Exports (Tons)**
China	1600-2000	1300-1500
Portugal	150-200	150
India	150 -200	-
South Africa	150 - 180	120
Australia	120 -150	100
Swaziland	80 -100	80
Chile	80-100	70
Spain	50 -100	50
Total	**2480-3130**	**1870 - 2070**

US and the EU are the largest importers of eucalyptus (some 400t and 1800t respectively in 1990). The current market price is approximately $5.00/kg. Prices are continually under pressure as a result of the huge supply from China. Discussions with local producers indicate that at the current price levels and with the stronger Rand it is impossible to compete with the Chinese. Some of the larger producers have been able to turn from exports to supplying local markets, particularly for medicinal use. Larger South African producers produce in excess of 60 tons of oil per annum, but the average production per farmer is between 20 to 30 tons.

[38] "Processing, refinement and value addition of non-wood forest products" T de Silva and CK Atal, FOA
[39] "Processing, refinement and value addition of non-wood forest products" T de Silva and CK Atal, FOA
[40] DTI Export Figures (2002)
[41] "Processing, refinement and value addition of non-wood forest products" T de Silva and CK Atal, FOA

Geranium (Pelagonium, rose-scented)

Pelargonium capitatum is one of several species grown for its essential oil. Pelargonium is grown in diverse areas in the world (e.g Reunion Islands, China and Egypt). The story of Pelargonium illustrates the importance of the selection of the correct plant species. There are at least five different species that are grown for their oils, each with different properties. For example, ***P. graveolens*** and ***P. capitatum*** are rose-scented and ***P. tomentosum*** is peppermint-scented. The most sought-after cultivar produces the so-called "Bourbon Oil". This was thought to be a hybrid of ***P. graveolens*** but was later found to be a hybrid between ***P. capitatum*** and ***P. radens***.

Geranium is one of the more important raw materials for the fragrances industry. The oil is used in perfumes, soaps and the like and provides a strong middle note.

The major markets for geranium oil are the US, France, Germany, Britain and Japan. France is a major re-exporter of geranium oil, which is often further, distilled and re-blended there to client specifications. World demand is difficult to assess and fluctuates widely. Annual worldwide production is reported to be over 500 tons per annum.

There are many types of geranium oil each with their own characteristics and prices. For example, in 2001, the prices were $40.50/kg (Chinese), $70.00/kg (Bourbon) and $41.00/kg (Egyptian).

Geranium is grown quite widely in South Africa, but not without some difficulty. One large producer in Mpumalanga noted that he could only get the "Bourbon Oil" characteristics half the year due to harvesting conditions. The George Oil Project (sponsored by SAB) failed when it was unable to scale up to the projected 100 ha under cultivation and the yields were far lower than consultants advised.

As with all essential oils, production can be quite erratic, however South Africa is now a net exporter of Geranium oil. Most is exported to Britain and a major player in the South African market appears to be Biosys Plant Extracts (Pty) Limited and its client farmers.

Locally, Geranium oil fetches prices between R800/kg and R1 200/kg, depending on volume and quality. Geranium oil is one of the most widely produced essential oils in South Africa.

Table 14: South African Geranium Imports and Exports [42]

Year	Import (Kg)	Export (Kg)
1999	634	12
2000	554	60
2001	464	800
2002	242	425
2003	612	3,912

Lavender/Lavandin

There are three types of lavender commonly on the market:

- ***Lavandula angustifolia*** or true lavender (which fetches the highest price on world markets, but has a lower yield per hectare);
- ***Lavandula spika*** or spike lavender (which fetches a fair price but has a smaller market); and
- Lavandin which is a hybrid of the two (which has the lowest price on international markets, but gives the highest yields per hectare and is hardier).

The South African Customs & Excise figures combine Lavender and Lavandin.

The world production of high quality Lavender oil is estimated to be about 200 tons per annum. World production of Spike Lavender oil is estimated at 150 tons to 200 tons per annum. World production of Lavandin oil is estimated at about 1000 tons per annum.

The prices obtained for lavender oils vary widely based on quality and batch size. A good quality Lavender oil may sell for R1500/kg. Lavandin oil on the other hand sells for approximately R200/kg.

Success in Lavender oil depends on the correct genetic material. Linalool acetate and linalool are the key determinants, and there must be no camphor and only traces of cineol. Local varieties tend to be high in camphor, which is not acceptable on world markets.

Lavender oils are used in the fragrance, perfumery (giving a middle note) and aromatherapy industries. Lavender is used extensively in household cleaning products for the strong fresh fragrance.

[42] SARS (Customs & Excise)

Most Lavender oil is imported to South Africa from Britain or France (both countries having a long standing tradition in Lavender). The South African export figures include re-exports to other African countries (e.g. Kenya Malawi, Zimbabwe and Zambia). Genuine export of South African product is estimated as being in the region of 600kg per annum (some of which is re-imported from France and Britain in formulations).

Table 15: South African Lavender and Lavandin Imports and Exports[43]

Year	Import (kg)	Export (kg)
1999	5,132	70
2000	14,470	556
2001	4,686	30
2002	7,110	287
2003	4,333	1,990

The price of Lavender can fluctuate tremendously, for example in 2000 10,250 kg of oil was imported from Australia at R14/kg when the average price for lavender from England and France, over the same period, was R170/kg. The average export price in 2003 of Lavender oil was R648/kg with the prices going over R2000/kg for exports to the Netherlands and Germany (both known for paying a premium for organically certified oils). However, the floor price for non-organic oil is generally accepted as R300/kg.

Estimated production for 2004 is 1200 kg and 3.700kg for 2005 (there are many young plantings). There is a significant amount of lavender being grown in the Cape and the Midlands of Kwa-Zulu Natal.

Jasmine

Jasmine is used in perfumery, inclusive of household cleaning products. Jasmine gives a lingering base note.

Imports of Jasmine, although in small quantities, come from France or Britain. Jasmine will, generally, be imported in finished fragrance products and will not reflect on the essential oil statistics.

[43] SARS (Customs & Excise)

The Jasmine produced in South Africa is generally sold as an absolute (i.e. it has been produced by solvent extraction). Jasmine is very labour intensive and the petals are picked by hand at night to improve the quality of the oil. Yields are typically very low. One ton of petals produce roughly 1kg of absolute.

Table 16: South African Jasmine Imports and Exports[44]

Year	Import (Kg)	Export (Kg)
1999	98	45
2000	13	-
2001	7	2,311
2002	1	120
2003	-	3,274

The large exports of Jasmine in 2001 and 2003 were to France. This may well have been attributable to Robertet in Rustenberg. It is possible to stockpile essential oils as they have a long shelf-life, if kept under the right conditions.

Robertet of France took over Rollan Essential Oils in Rustenberg as one of its international subsidiaries. Robertet Aromatics produces (and contracts farmers to produce) Jasmine and Tagetes oils and extracts. All of the production is sent to France to be standardized and used in fragrances. Robertet is a family business now listed on the Paris bourse. It has an annual turnover of Euro 200 million and subsidiaries on five continents.

The export price of Jasmine over the period 1999 to 2003 ranged between R600-R650/kg.

Lemon grass

There are two types of lemon grass: ***Cymbopogon citrates*** and ***Cymbopogon flexuosus.*** Lemon grass oil is well supplied by China, India, Sri Lanka and Madagascar. Nevertheless there is a good international market, but supplies must be consistent and have sufficient volume.

Lemon grass requires well drained soil, and sunny hot humid conditions and is grown in Mpumalanga. ***C. citrates*** grows better below 750 metres and ***C. flexuosus*** is better at higher

[44] SARS (Customs & Excise)

altitudes. The lower the altitude and more alkaline the soil, the higher is the citral content of the oil. The citrates variety is in demand if the citral content is high.

The South African production figures are not readily available. The price for lemon grass oil is R300/kg to R400/kg. Although it is a bulk oil, well supplied from the east, it is still grown locally because of its versatility in various applications, both as flavour and fragrance.

Chamomile (Roman and German)

There are two types of Chamomile: Roman and German. German Chamomile is more highly sought after and has a blue hue as a result of its Azulene content.

Very little Chamomile is produced in South Africa ((estimated at about 30kg to 40kg per annum). The world market is also very small at an estimated 20 tons per annum. However, it is a highly profitable crop and there are community programs in the Eastern Cape that are scheduled to produce German Chamomile within the next two years. There are also large plantations in Lesotho that are currently exporting between 300kg to 400kg per annum directly to the international market.

Depending on the type and whether it is organically certified or not, Roman Chamomile prices range from R1500/kg to R3000/kg and German Chamomile from R5000/kg to R10,000/kg.

The University of the North-West (formerly Potchefstroom University) has a project involving the supercritical extraction of Roman and German Chamomile oils. This improves the quality of the oils.

Peppermint

Peppermint (***Mentha piperita***) is used primarily in beverages and confectionaries and in personal hygiene products, such toothpaste. These are staples; hence the reasonably steady rate of imports year on year. The largest producer of peppermint oils world wide is the United States (production is highly mechanized). Peppermint can only be grown at certain latitudes (which would limit production, in South Africa, to the Southern Cape).

South Africa imports over 90% of its requirements from the US and Britain. The price of peppermint oil has been reasonably stable over the five year period (1999 to 2003). Peppermint is sold locally at between R90/kg and R120/kg. The product is a commodity and the market is mature. Mint formulations are strictly adhered to and as a consequence most

mint imports are already formulated by the parent company (be they a flavour or fragrance house or a producer of consumer products).

Production in South Africa is limited, with the exact quantities unknown. There are no exports to speak of as the exports from South Africa are mainly re-exports into Africa, including Kenya and Zambia but predominantly Zimbabwe. Most local production will be sold into the local aromatherapy market.

Table 17: South African Peppermint Imports and Exports[45]

Year	Import (kg)	Export (kg)
1999	52,330	1599
2000	50,332	2390
2001	47,188	1,052
2002	42,630	1,468
2003	53,530	2,636

The University of the North-West (formerly Potchefstroom University) has a project involving the supercritical extraction of peppermint oil. This improves the quality of the oils.

Other mint

The largest of the other mints appears to be spearmint (***Mentha Spicata***). In general spearmint is used in confectionaries and in personal hygiene products like toothpaste. Spearmint is also a staple; hence the reasonably steady rate of imports year on year. The largest producer of mint-related oils is the USA (Northwest) and Canada. The mints market is mature and formulations are strictly adhered to. As a consequence most mint imports are already formulated.

[45] SARS (Customs & Excise)

Table 18: Other mint Oil Imports and Exports

Year	Import (kg)	Export (kg)
1999	21,283	233
2000	26,208	477
2001	40,815	1,484
2002	29,155	148
2003	24,954	958

The exports from South Africa mostly constitute re-export sales to Zimbabwe.

Although still commodities, other mints tend to fetch, on average, a higher price than peppermint (between R150 and R250/kg over the period 1999 to 2003).

Rosemary

Rosemary is grown extensively, but a large proportion of the product is sold fresh or dried. It is estimated that producers of Rosemary oil in the Cape are producing 400 to 500kg per annum. There are a few producers in the Gauteng area. The bulk price for Rosemary oil is approximately R300/kg.

Tagetes

Khakibush (***Tagetes minuta***) is a South American plant that is now endemic in many parts of the world, including most of South Africa. The general consensus is that Khakibush is easy to grow. The crux is to successfully distill the oil and to have a market. The essential oil (commercially known as Tagetes or Tagets) is used in perfumery and as a flavourant in food, beverages and tobacco. It has unique compounds and there is no suitable substitute for true Tagetes oil.

The world market for Tagetes is estimated at between 8 to 11 tons per annum. Zimbabwe use to be a large producer, but now South Africa is taking up the slack. It is estimated that South Africa produces some 6 to 7 tons per annum.

The current price of Tagetes (April 2004) is between R400/kg and R700/kg, although prices as high as R1000/kg are being asked locally (which is considered by some in the industry as being too high). There is a view that there is an oversupply of Tagetes and this is driving down the market prices. Some committed producers argue that there are large variations in

quality and this affects pricing, explaining that satisfied customers are willing to pay the higher prices for sustainable volumes and quality.

Buchu

Buchu is a perennial shrub with woody branches. There are several varieties of Buchu the most well-known of which are the ***Agothosma betulina*** and ***Agothosma crenulata.*** The round-leaf Buchu (A. ***betulina***) is the most used for essential oil. Buchu is restricted to South Africa and is a typical component of the Cape Fynbos. Buchu is both wild-harvested and cultivated in the Cape. Attempts have been, and are being, made to grow Buchu elsewhere (for example Australia). However, it is difficult to cultivate wild plants outside of the natural habitat, for example, attempts to grow Buchu in Mpumalanga have shown that Buchu is susceptible to fungus.

Buchu has been used for medicinal and cosmetic purposes for centuries. More recently it is sought after for its application in the food industry. Round-leaf Buchu contains valuable essential oil rich in isomenthone and diosphenols. It is also contains sulphur compounds that give it a characteristic black-current smell and flavour.[46] The oil is also used in perfumes and colognes for fruity notes.

The South African Buchu industry has had mixed fortunes in the past and is considered to be in danger of substitution once again unless the prices drop. In the last century, it was much in demand in Europe until the 1960's onset of the synthetic flavour market. Cheaper, easier synthetic options pushed Buchu off the international map, and it was only in the late 1980s and 1990s, with Germany's burgeoning consumer interest in things 'natural', that Buchu made its current comeback. The exports of Buchu both of oil and dried product amounted to R20 million in 2000[47]. Dr Cobus Coetsee, formerly of the Agricultural Research Council (ARC), estimates that the world market is potentially worth R100 million. Ninety per cent of product is exported. The majority of this is exported to Germany, which pays a premium for "natural" product. The current price of Buchu oil is between R7,000/kg and R15,000/kg, depending on its quality. This is about twice the price of some of the more expensive essential oils like German Chamomile. The price is driven by scarcity of supply and the continued high demand. However, it is generally held view that the price of Buchu is too high and that this will undermine the market by forcing users to turn to substitutes.

[46] Prof Ben-Erik van Wyk, "Medicinal Plants of South Africa"
[47] Wesgro

Organizations, such as Cape Nature Conservation, are involved in community based projects involving commercial cultivation of Buchu, which projects will increase cultivation thus increasing supply and reducing the price. This may assist with the creation of a sustainable industry.

Afriplex in the Cape, an innovative food technology company, is using super critical extraction methods to beneficiate Buchu oils (amongst others).

Artemesia

African Wormwood (***Artemesia Afra***) is an erect shrub with highly aromatic feathery leaves. It occurs over large parts of the eastern half of southern Africa and northwards to tropical east Africa and Ethiopia. The plant is rich in essential oils, but these vary from region to region with remarkable variety in their composition.[48] The effect of this is that careful selection of plant material is required in order to get the required chemical profile.

It is estimated that local production is between 500 and 800 kg per annum and the price varies between R200/kg to R300/kg. Most of the production is cultivated but some wild harvesting still continues. Zimbabwe was a larger producer of Artemesia, but this production has been disrupted.

The University of the North-West (formerly Potchefstroom University) has a project involving the supercritical extraction of Artemesia oils. This improves the quality of the oils.

Other indigenous essential oils

There are many initiatives aimed at producing novel indigenous essential oils. These include the Cape Chamomile (***Eriocephalus punctulatus***) and Cape Snowbush (***Eriocephalus africanus***). However these are very small enterprises located mostly in the Cape, where they take advantage of the uniqueness of the Cape Fynbos. Essential oils produced in this way are exported in very small quantities (a few kilograms per annum) to specialty/novelty buyers in USA and Europe. These oils are sold for between R2600/kg to R3900/kg.

The large traditional buyers of oils are generally not interested in novelty oils as they have no mass market application. This creates a “chicken and egg” situation. It is not economic to step-up production without a market and there is no market without significant volumes of production and market acceptance. One way of overcoming this, in the long-term, is to develop a local industry capable and interested in beneficiating its own oils. This would

[48] Prof Ben-Erik van Wyk, “Medicinal Plants of South Africa”

increase levels of off-take, help generate standards and accepted usage. There is a clear argument to be made that if South Africa and South Africans do not use their own indigenous materials for the production of commercial products then there is no reason to expect foreigners to do so.

Other Unique South African Plant Products sold in large quantities

Along with Buchu, there are other indigenous plants that are traded extensively on the international market (i.e. volumes measured in tons). These include teas such as Rooibos and Honeybush and extracts such as Aloe gels from the Cape Aloe Ferox. These are also large markets and are qualitatively different from the products referred to so far. However, only Buchu produces an essential oil used in the flavour and fragrance industry. Together with rooibos and honeybush tea, buchu is one of three South African medicinal plants used in international medicine and is recognised by the British Pharmacopoeia Martingdales.

Table 19: Unique South African Best Sellers [49]

Product	Volume (t)	Value (R mil)
Rooibos	6000	60
Honeybush	150	1
Buchu	150	20
Aloe Ferox	400	6
TOTAL	**6300 tonnes**	**87**

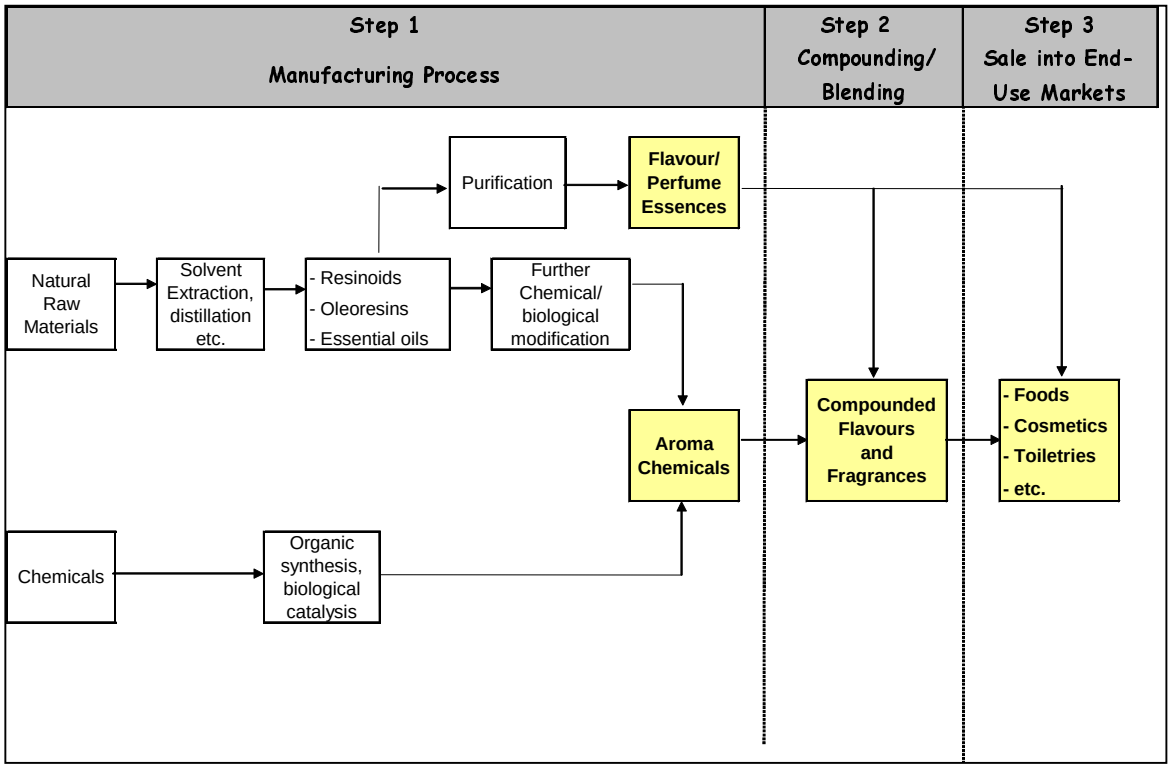
[49] Source: Wesgro 2000

4 VALUE CHAIN

4.1 Value Chain Overview

With regards to applications in the flavour and fragrance industry, the essential oils are used either “as is”, which is the case with the minor or smaller oils (e.g. geranium), or they are further processed in order to produce natural isolates, which compete with or enhance synthetic aroma chemicals. The latter only relates to some 20 to 25% of essential oils. The essential oil value chain and the manner in which it integrates with the aroma chemical value chain is described in the Figure below.

Figure 6 : Essential Oil and Aroma Chemical Value Chain to Flavours and Fragrances



The stages in the essential oils value chain (and the relevant issues) may be briefly summarised as follows:

1. Crop selection:
    a. Knowledge of local soils and climatological conditions;
    b. Knowledge of appropriate crops (esp. correct genotypes)
    c. Knowledge of markets (prices and customers)

2. Crop Cultivation (beginning with pilot scale and scaling up):
    a. Sourcing of plant material (seeds or seedlings)
    b. Planting
    c. Crop management (pests and irrigation)
    d. Harvesting

3. Primary Processing (e.g. Drying, distillation)
    a. Quantities (economic yields)
    b. Qualities (chemical and sensory qualities)
    c. Certification (e.g. standard testing or organic certification)

4. Further beneficiation (e.g. Rectification, Fractionating, Formulations)

5. Sales and marketing
    a. Market knowledge
    b. Market reputation
    c. Market access

    [Note: as will be discussed later, very often the further beneficiation and the sales and marketing go hand in hand as the chemist responds to the market needs]

It is not possible to consider essential oil production and beneficiation in South Africa, or indeed in any country, without considering the complete value chain. A large component of the value chain is agricultural. As will be discussed later, some of the main obstacles to growing the essential oils industry in South Africa have arisen from the institutional and structural "disconnects" between agriculture and industrial beneficiation (e.g. funding available for either traditional farming (food crops) or chemical manufacturing, but not for essential oil production, which falls in between). Fortunately this is changing. Industry stakeholders are unanimous in their view that unless the volumes of quality oils are increased the economies of scale required to encourage later stage innovation and

beneficiation of essential oils (be it for the flavour and fragrance industry or medicinal use) will not arise.

It is also difficult to separate out the flavour and fragrances component when discussing the production of essential oils. Essential oils are used for many purposes. A large amount of essential oil production is used for medicinal purposes or in the "wellness" industry (phytotheraphy and aromatheraphy) or cosmetics. Often it is necessary for the producers to plant a diversity of crops to protect against risks relating to crop and market failure. At the level of the primary producer no distinction is made with regard to the end-use, unless that producer is integrated vertically through to the end user, as is the case, for example, with some of the larger eucalyptus oils producers.

Accordingly, this Study also gives consideration to the agricultural stages of the value chain, with a view to providing a comprehensive picture of the key drivers of the essential oils industry.

4.2 Agricultural Production

Crop selection

The raw materials for the production of essential oils are plants and there are two generic sources of these materials: 1) wild harvesting or 2) cultivated plants. Most of the generally accepted essential oils are derived from cultivated plants. It is the process of cultivation that allows for the greater supply of oils (with consistent qualities) which in turn assists in supporting demand for the oil. Those indigenous plants that are in large demand are the subject of studies and trials to put these crops under cultivation. Most indigenous plant material used for the export market is now cultivated (e.g. over 50% of Buchu is now cultivated).

There is a misconception that there is a ready market for new products, previously unknown in trade. The reality is that the fragrance and flavours industry is very conservative, making the likelihood of success with a new essential oil very small. Any acceptance of a new essential oil product would need to go hand in hand with new product development. This will not be done unless there are clear benefits and the new essential oil product can be produced in the desired quantities at the required specification. Accordingly, the American

FAO recommends that producers focus on established oils for which there is a known demand or those that are large volume oils which have the flexibility of serving as alternative sources of chemical isolates[50].

Furthermore, the FOA has noted that there is a wide variation in the characteristics of wild plant materials and the focus of producers should therefore be on cultivated crops using known cultivars. There is a clear message to treat "experimental crops" with caution. Very deliberate activities need to be undertaken in order to secure international acceptance of a new oil. It requires a long and concerted effort, beginning with the setting of standards with regards to plant material and moving to selecting harvesting and extraction methodologies to produce suitably profiled oil.

The question of plant material selection has created one of the greatest barriers to entry in the past. There are two main issues. Firstly one needs to select a crop that suits a particular region. In this analysis climate, topography, soil and drainage, availability of water, shelter and weed profile are all considered. Secondly, one needs to select the geno-type that will provide the best yields and the desired chemical properties. A lot of selection is done by trial and error.

Selection of Exotic or Classic Essential Oil crops

South Africa is blessed with a wide range of microclimates. Climates range from the temperate through to the sub-tropical. This allows South Africa latitude to experiment with the cultivation of crops. Crop and geno-type selection has occurred using international benchmarks and local trials.

Based on historical experience the following exotic essential oil crops have been successfully grown in South Africa:

[50] FAO "Flavours and Fragrances of Plant Origin" Published on website (www.foa.org)

Table 20: Crops grown according to region[51]

Region	Crop
Lowveld (Mpumalanga and Limpopo province)	Pelargonium (Geranium) Lemon grass Lavender Rosemary Spearmint Chamomile Citrus Tagettes
Kwazulu-Natal	Eucalyptus Lemon grass Pelargonium (Geranium) Rosemary Lavender Spearmint Oil Tagettes
Central Interior (Free State, Northern Cape and Northwest Province)	Jasmine Pelargonium (Geranium) Lavender Rosemary Spearmint Oil Peppermint Oil Tagettes
Cape	Citrus Lavender Rosemary Pelargonium (Geranium) Chamomile Peppermint Tagettes

Selection of Indigenous crops

With regards to crop selection in respect of indigenous plants, the matter is simplified. The key criterion is the market. Thereafter selection of the crop must generally follow the

[51] Gathered from SAEOPA and other sources

geographic location of the species in the wild (although experimentation occurs in other areas having comparable climatological characteristics). The key issue here is the selection of a particular strain or variation that yields the best quality oils. Those countries that have successfully introduced new oils to the market have done so by carefully selecting and propagating the best genetic variation in order to cultivate it. This provides for sustainable quantities and consistent quality.

The current indigenous essential oil crops which are successfully cultivated or harvest in South Africa on a sustainable commercial scale are set out in the Table below.

Table 21: Indigenous crops[52]

Crop	Wild/ Cultivated	Area
Buchu	Both	Western Cape
Lippia Javanica	Both	Limpopo, Mpumalanga
Artemesia	Both	Mountainous regions of South Africa Limpopo, Mpumalanga

Crop Cultivation

Availability of Plant material

One of the key inhibiting factors for essential oil production is the lack of reliable plant material. Much time and money has been wasted planting crops of the wrong geno-type. Different varieties of the same crop species can contain varying concentrations of the active ingredients and changing growing conditions can alter the content of the active ingredients. The extent of this variability has largely been determined through trial and error, sometimes at great cost. This explains some of the secrecy inherent in the industry.

Even once the correct plant material has been identified it is often in short supply. Producers spoken to have explained that often the scaling-up process (from pilot to full production or expansion of production) is retarded by the lack of availability of seed or seedlings. It is for this reason that farmers and producer organizations, such as South African Essential Oils

[52] Collated from various websites and interviews.

Producer Association (SAEOPA), have, or are, developing their own nurseries or “mother blocks”.

The abovementioned problem also applies in respect of indigenous species. In the case of "wild crafted" species, the chemical profile of their essential oils is very unreliable. This is because in nature wild plants exhibit considerable genetic variations. This problem can be overcome by switching from wild harvesting to cultivation. Accordingly, institutions like the CSIR and ARC, often in conjunction with producers, are endeavoring to move the industry from wild harvesting to cultivating selected cultivars.

Agricultural Production

Production in South Africa falls into three main categories:

1) Cultivation by commercial farmers
2) Cultivation by small communal farmers
3) Harvesting from the wild both by land owners and on communal land (Each crop having its own particular dynamics)

The basic requirements for the cultivation of essential oil crops (whether commercially or communally) are:

- A minimum size plot of 25ha (crop dependent, particularly where multiple harvest per year);
- Access to irrigation (most sites);
- Effective weed and pest control of a type that does not contaminate the oil (a serious matter if organic certification is being sought);
- Good harvesting techniques (mostly about timing);
- Good post-harvesting product management (preserving quality which effects yields); and
- Access to primary processing facilities.

Each crop has its own peculiarities. With regards to exotic crops, these features are reasonably well documented. One of the key constraints is accessibility of information and education. Organizations such as SAEOPA, BioAfrica, CSIR and ARC provide such support to producers, on various terms.

Harvesting from the wild

The features of harvesting from the wild depend on the nature of the plant and the parts required. Each plant has different features. Successful harvesting in the wild requires as much technique as cultivation. All the factors need to be considered, including the time of harvest, the exact parts to be harvested, the handling and treatment of harvested materials and the exact processes for extraction.

Whatever the specifics, the key issues that arise in the context of harvesting wild plants are:

- ensuring consistent quality; and
- ensuring sustainable harvesting methods.

The two above factors are the key drivers towards increased cultivation of indigenous plants. If one is able to establish standard cultivars and generally accepted farming and harvesting methods one is able to ensure quality and a sustainable supply for the long term. Besides the commercial rationale, there is also a strong environmental conservation lobby behind the move from wild harvesting to cultivation. The phrase that has been coined is “cultivation for conservation”.

One of the challenges in developing new essential oil crops or in establishing a new geographical area for the production of an essential oil already on the market is procuring or developing genetic lines with the suitable agronomic characteristics and desirable chemical constituents. The evaluation of a large and diverse germplasm collection thus becomes the first step in new crop development. This stage alone can take many years.

Key Drivers in respect of Agricultural Production

Purchasers, particularly in the European market (the most important market for South African essential oils) are specifically looking for adherence to Good Agricultural Practices (GAP). These act as barriers to entry to products from emerging markets. The key components here are:

- Properly documented standards and procedures for each crop type;
- Education and training in general agricultural management for developing farmers and communities; and
- Education in respect of the management of essential oil crops.

Furthermore there is trend, particularly in Germany, towards “naturals”. Accordingly, Organic Certification is now almost a prerequisite for certain oils into certain markets. The process of Organic Certification is a process that ensures that all plant material can be traced back to its origins and where production processes are carefully monitored so as to exclude the used of chemical fertilizers, herbicides and pesticides. The larger local players, such as Biosys and Teubes, offer organically certified products to the market, which command a premium in price.

Countries that are making progress in the development of their essential oil industry (e.g. Australia and New Zealand) set and market standards and specifications for their crops and oils. In this manner they create standards which give comfort to buyers and constitute differentiation and barriers to entry in respect of competing product. This is particularly the case with indigenous crops. Standards are set in conjunction with international customers.

Many countries have government funded programs to establish new industries for export and which absorb much of the developmental costs associated with the evaluation and introduction of new crops. When these programs are coupled with crop champions and a strong relationship with the processing industry, the success of new crop development significantly increases. Such programs have been successfully applied in western Canada, Israel and Hungary.

4.3 Primary processing

Introduction to general process

The essential oils from aromatic plants are volatile and thus, lend themselves to several methods of extraction such as hydrodistillation, water and steam distillation, direct steam distillation, and solvent extraction[53]. The specific extraction method employed is dependent upon the plant material to be distilled and the desired end-product.

Plant products can be sold as harvested, or dried, or powdered. Produce can also be processed to extract oils on site. Many essential oils are made simply by placing the leaves and other plant parts whole into a steam distillation pot. In South Africa, the majority of extraction is done in steam distillation pots situated on or near the producing farms. The oils are mostly sold in this form without further processing. In many instances the producer’s

[53] (ASTA 1968, Guenther 1972, Heath 1981, Sievers 1928)

focus is on obtaining “Organic Certification” (an agricultural practices issue) for the oils and not on further processing.

Although the primary process for the production of essential oils in South Africa is steam distillation, there is a trend towards more sophisticated extraction processes.

The essential oils which impart the distinctive aromas are complex mixtures of organic constituents, some of which being less stable, may undergo chemical alterations when subjected to high temperatures (i.e. when using standard steam distillation). An alternative is to use organic solvent extraction to ensure no decomposition or changes have occurred which would alter the aroma and fragrance of the end-product. Newer methods of essential oil extraction such as using supercritical CO_2 may also be used. This process yields very high quality oils but is generally beyond the financial means of most South African processors (one notable exception is Afriplex in the Cape, distillers of Buchu oils for export). Overall, the world demand for essential oils extracted by using steam extraction, and that of oleoresins using solvent extraction processes, has leveled-off in recent years. The new demand is for purer more natural products. Furthermore, new regulations in the major western markets limit the amount of detectable solvents in both oleoresins and essential oils. Therefore, supercritical extraction methods using carbon dioxide could play an important role in the future development of a South African plant extract industry.

Besides the standard distillation or extraction facilities, there are additional equipment and facilities that are required. Where there are large volumes of product this often has to be dried, post-harvest but before extraction processing, in order to preserve quality. Furthermore, since essential oils can be stored, storage facilities (dark cool rooms) can be useful for managing market demand. However, care must be taken that oils are stored in containers that do not contaminate the oils (glass or aluminum are the best). The drive towards quality and consistency furthermore requires that producers should have access to laboratory facilities, preferably a laboratory including Gas Liquid Chromatography (GLC) equipment.

Quality, standards and testing:

The primary objective of primary processing is to achieve the best quality and quantity of product. For this reason standards and testing are important.

The basic usefulness of standards for essential oils is as an aid for better trade. Standards can be used to help determine the authenticity, geographical origin and quality of the oils. They provide differentiation for the supplier and comfort for the purchaser.

PART 4 – AROMA CHEMICALS DERIVED FROM ESSENTIAL OILS

There are two basic types of standards which should be considered by any essential oils industry:

- the actual specification for the essential oil (be it based on world standards such as an ISO standard or a local standard in respect of new products); and

- the actual method of performing any analysis against the standard.

The specification defines the limits for the measurement of the various parameters for the particular oil. Traditionally there have been physical determinations such as density, optical rotation, refractive index, solubility in alcohol and chemical determinations of major or other components of interest.

The analysis of essential oils is best carried out by Gas Liquid Chromatography (GLC) and would be used to give detailed information on the composition of individual oils, as well as to confirm the absence or upper level of contaminants, solvents or undesirable components. This analysis in effect becomes the guarantee and is used to establish both price and comparability. Any standard must also include a definition of the actual method of analysis used since this can affect the outcomes of any analysis. This is particularly important in trying to establish GLC "fingerprints" or profiles of essential oils. The same method of analysis must be used for any comparative analysis involving different laboratories to get good inter-laboratory reproducibility. This enhances the credibility of such standards and testing.

The flavour and fragrance industry is run largely on reputation, for consistency in quality and characteristics. If countries and companies gain a good reputation in this regard they should be better able to compete successfully at the international level.

With regards to indigenous products, it is important to establish an internationally recognized standard. This was one of the ways in which Australia recovered in the Tea Tree Oil market (by setting and marketing a standard that benefits Australian producers in the world market). In such an instance, the specifications used by the South African industry would include a chromatographic profile for the oil which sets out limits for the representative and characteristic components of the oil. Such profiles could then be presented to bodies, such as the United States FDA or FEMA, to be adopted as the standard profile for the product. It is very likely that an existing set of specifications would be adopted rather than incurring the time and expense of proposing yet another set of standards, particularly if this standard is provided by a reputable national body. It is in the best interests of the South African essential oil producers to be pro-active and to ensure that any proposed specifications are realistic and meet the needs of the producers, traders and end-users. An appropriate mechanism for doing this may be through the South African Bureau of Standards (SABS), or similar organization which is a member of the ISO.

4.4 Further Beneficiation

Overview

The use of essential oils, in the fragrance market in particular, is a complex affair. A Frenchman by the name of Piesse devised a system whereby fragrances are compared to notes on a musical scale. Accordingly, essential oils may be classified into "top", "middle" and "base" notes. For example, the "top" notes are light and fresh and would include lemon and Eucalyptus. These fragrances are immediately apparent as they are of high volatility. Whereas, on the other hand, "base" notes are rich heavy scents that linger and would include Myrrh and Jasmine.

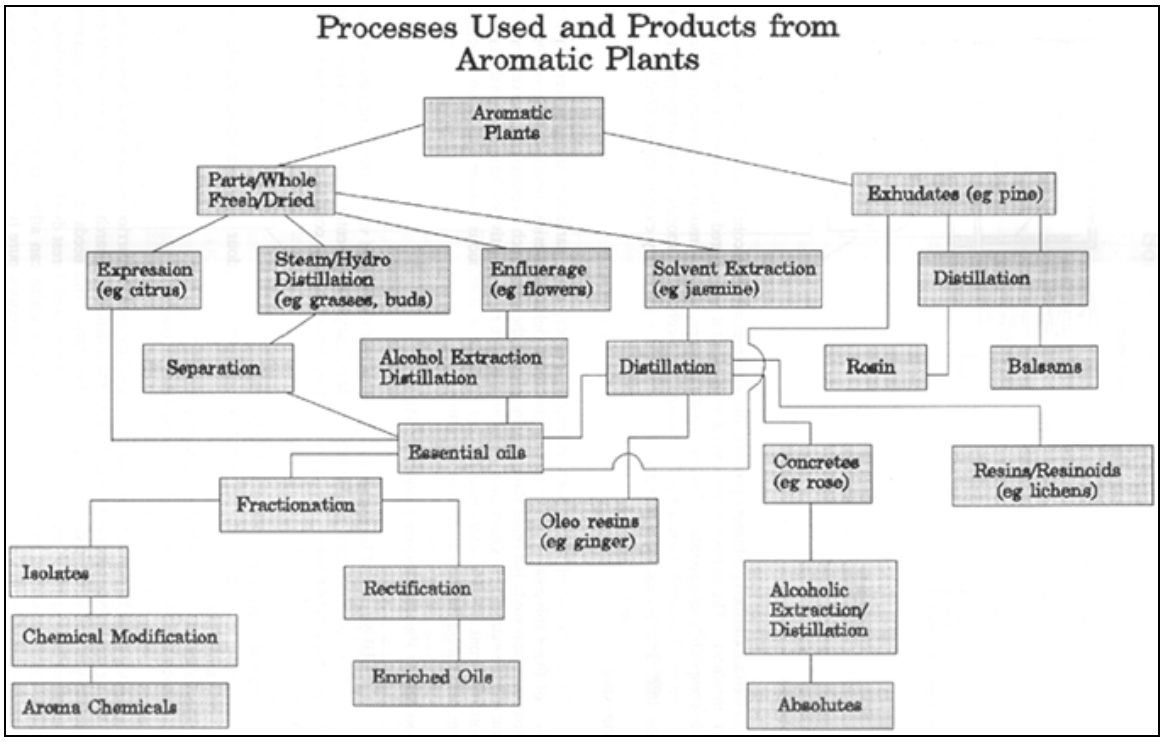
Since essential oils are a complex of chemical compounds it is possible to manipulate the components to bring out a certain desired quality. This may be done by a process of fractionating. It is also possible to "split" the essential oil into its chemical components and thus isolating a chemical constituent. Furthermore, it may be that particular oil has a "still" note as a result of degradation during the initial extraction process. In these cases it is possible to "rectify" the oil. The process of rectification may consist of one or more of the following:

- removal of moisture, colour and sediments;
- removal of compounds in order to improve the odour characteristics, stability and sustainability;
- isolation of compounds that are highly valued;
- enrich the oils by removing or adding other fractions.

This is the crux of the further beneficiation of essential oils. Although it is possible to isolate individual aroma chemicals from essential oils ("true isolates"), this is only done in respect of 20% to 25% of the oils produced (and then only from the major oils where there are economies of scale). The majority of oils are used "as is" in their complete complex form.

The processes used for primary beneficiation through to secondary beneficiation are described in the figure below:

Figure 7 : Processes used in respect of beneficiating aromatic plants[54]



The technology for these processes is relatively simple and inexpensive. Furthermore the equipment is multi-purpose and once the investment has been made the producer can switch from one oil to another. The robustness of a business established in this segment of the value chain is dependent on its ability to provide a basket of oils to customers. Therefore this type of business is driven by a market focus and must be responsive to customer demand. In most cases, these further beneficiation processes are performed with the assistance of an olfactory expert. These are persons with a technical or scientific background (usually chemistry or food science) who have been trained to use their sense of taste and smell to analyse flavors and fragrances. This allows for the human sense experience to be correlated with the chemical analysis. There is an acknowledged shortage of such persons in South Africa and it is general accepted that such persons need to gain experience overseas with one of the large flavour and fragrance companies (for example Aubrey Parsons, one of South Africa's pre-eminent industry experts is ex-Haarman & Reimer). In Europe, involvement in flavors and fragrance industry is often a family affair because of the nuances and artistry involved.

[54] Processing, refinement and value addition of non-wood forest products", T de Silva and CK Atal, published by FOA

PART 4 – AROMA CHEMICALS DERIVED FROM ESSENTIAL OILS

In an industry as small as the current South African industry there is very little scope for down stream beneficiation. Where there are bulk oils (e.g. eucalyptus and citrus) these are used to isolate chemicals that compete with synthetically derived aroma chemicals (e.g. cineole from Eucalyptus). However, for the rest there is very little scope for beneficiation. The reasons for this may be summarized as follows:

- Natural isolates have to compete directly with synthetic equivalents. Generally speaking the cost/benefit analysis favours the synthetic products.

- Depending on the application, very often the attraction of an essential oil is in its complexity. Often, it is not clear what molecule in fact yields the desired characteristic, or how the various molecules interact to provide the desired characteristic. Accordingly, essential oils are often use as is (perhaps with some dilution).

- The additional cost of isolating an active ingredient or increasing the concentration is not offset by a commensurate increase in potential selling price. The additional cost makes the end-product too expensive with no real discernable benefits to the end-users.

- The quantities of oils being produced do not provide sufficient feedstocks to sustain significant investment in further beneficiation processes. This is demonstrated by the fact that South Africa really only has one company that processes essential oils for further value addition (Teubes (Pty) Limited).

- Most buyers prefer to perform the rectification or isolation themselves as this is core to their processes and their value addition. Accordingly, whilst one is relying on exports and there are few local users of the oils, the opportunities for beneficiation are limited.

The other area of local downstream beneficiation lies in the actual end-use of the essential oils either in food and beverages or applications in personal care and hygiene products. At present the main local downstream beneficiation of aroma chemicals and essential oils is concentrated in the flavour and colouring market for the production of foodstuffs and beverages. There are approximately a dozen such small and medium sized companies in

South Africa. On the other hand, the fragrance market is either a matter of bulk chemicals for household cleaners (simple chemistry performed by multi-nationals producing mass-market products) or perfumery (more complex chemistry which is driven by large multi-nationals with access to markets and resources for mass marketing campaigns).

Given the current structure of the fragrance market there are few opportunities being exploited there, albeit that there is a growing market in the production of "low-price" household products for the local lower income groups (e.g. washing powders and detergents) which may yet prove lucrative.

Another area of beneficiation is the inclusion of products in personal care products (e.g. hand creams, de-odorisers and health applications). What makes this market segment of interest is its synergies with tourism and tourism related retail in such areas as Kwazulu-Natal Midlands and the Mpumalanga Lowveld.

The growth of opportunities for further beneficiation of essential oils (together with aroma chemicals) would require an increase in local production of products utilizing flavours and fragrances.

With regards to the downstream application of essential oils, the Table below summarises the usual applications:

Table 22: Usual End Applications for a Selection of Essential Oils

Essential oil	Common uses
Citrus	Industrial solvents, fragrance for cleaning products, flavouring
Spearmint	Toothpaste, mouthwash, confectionery flavouring
Peppermint	Toothpaste, mouthwash, chewing gum, food flavouring, cosmetics, tobacco flavouring
Lavender/lavandin	Fragrances, toiletries
Eucalyptus	Cough/cold remedies, solvents, cleaning agents, flavouring
Chamomile	Perfumery and personal care products
Lemon Grass	flavouring
Geranium	Perfumery and personal care products

Thyme	Toothpaste, Mouthwash, Disinfectants, Cosmetics
Basil	Foods, dental and oral, fragrances
Jasmine	perfumery, inclusive of household cleaning products
Rosemary	Fragrances, processed meat flavours, cosmetics and natural anti-oxidants
Melissa	Fragrances and flavours (food and soft/alcoholic drinks).
Majoram	Fragrances, processed meat flavours and alcoholic beverages
Buchu	Enhances fruit flavours and various medicinal applications
Tagettes	perfumery

4.5 Marketing and Sales

Introduction

The previous step in the value chain is often closely related to the marketing and sales function. This is because the market requires knowledgeable suppliers and attentive service. Furthermore, there are an increasing number of regulatory regimes which producers must keep in mind, for example the EU has recently published a list of allergens which includes chemicals found in essential oils.[55]

The aroma chemical and essential oils industries are characterised by the difficulty of "breaking into" the international market. There has been a marked consolidation of the industry, with many chemical companies, as well as manufacturers of consumer products, disposing of their flavour and fragrance divisions to the large flavour and fragrance houses, as each industry focuses on its core business. There has also been consolidation in the end user market (the manufacturers of consumer products) as margins have been squeezed by

[55] See Appendix "I"

powerful chain stores. Accordingly, end users now prefer to deal with the large flavour and fragrance houses to reduce transaction costs.

The market is further characterised by the fact that flavours and fragrance formulations depend on consistency of supply, both as to quantity and quality. Most end users have a very specific specification for their ingredients and it is not unusual for a formulation for a product to have been developed around a specific specification acquired from a particular source of the ingredients.

On the other hand, whereas, "breaking-in" is difficult, once relationships have been developed with international purchasers stability of off-take is assured, provided that the specifications continue to be met. There is a long process of "courtship" that must therefore be engaged in in order to secure reliable markets. This involves the presentation of "samples", the making of adjustments to product and the giving of assurances of stable supply. It is said that there is a two stage process when dealing with international flavour and fragrance houses. This first is securing the privilege of being able to submit samples. Since testing takes time and effort only sample from suppliers who have a good reputation or reference are tested. The initial tests are simple colour and smell tests. Only if these tests are positive will the oil be sent to the laboratory. The second stage is obtaining feedback, even when the oil is rejected. This second stage is most difficult to secure since in involves the flavour and fragrance house disclosing what its criteria are and thereby perhaps giving away hints on its formulations and approach to compositions. Approved suppliers are given the benefit of feedback which reinforces the on-going supply relationship.

4.6 Value Chain Conclusions

What is interesting is that a review of international literature indicates that the issues confronting any country endeavouring to upgrade its essential oils industry are very similar.

The American FOA identified the following as the most crucial challenges faced by developing countries endeavouring to grow industries in non-wood forest products:[56]
(The italics are ours for the purposes of emphasis)

- Poor harvesting (indiscriminate) and post-harvest treatment practices;

[56] "Processing, refinement and value addition of non-wood forest products" T de Silva and CK Atal, FOA

- Lack of research on development of high yielding varieties, domestication etc;
- Inefficient processing techniques leading to low yields and poor quality products;
- Poor quality control procedures;
- ***Lack of R&D on product and process development;***
- ***Difficulties in marketing***;
- ***Lack of local market for primary processed products;***
- ***Lack of downstream processing facilities;***
- ***Lack of trained personnel and equipment;***
- Lack of facilities to fabricate equipment locally;
- ***Lack of access to latest technological and market information***.

Of interest here is the identification of the other factors of production (besides the agricultural) that are necessary for the successful growth of a national industry (those in italics). The largest components are access to markets and market information that drives processes and innovation. A number of these shortfalls will be highlighted in the next section which deals with the current state of the South African essential oils industry.

5 CURRENT STATE OF SOUTH AFRICAN ESSENTIAL OIL INDUSTRY

5.1 Agricultural Stakeholders

Once again one needs to distinguish the South African bulk essential oils (e.g. citrus and eucalyptus) from the smaller essential oils e.g. (geranium, lavender and chamomile). The former is largely self-sufficient and established. For example, the eucalyptus oil industry in South Africa is about 70 years old and commands some 5% of the world market. The latter is relatively new in South Africa. Historically, it was the CSIR that pioneered the growth of the industry in the smaller essential oils. The CSIR's stated aim was to promote higher value industrial crops that would have rural development potential.

The growth of the South African essential oils industry has been largely haphazard. The industry is very fragmented. It is being driven by two main factors. Firstly, commercial farmers are seeking alternative high value crops to diversify risk and increase profitability. Secondly, rural communities, Government and NGO's are seeking high value crops that can be produced on a co-operative basis thereby creating jobs in economically depressed rural areas.

The South African essential oils industry comprises over 100 small producers of which only a dozen, or so, of the commercial farmers and a couple of community projects are regular producers. Most oil production is in the Limpopo and Mpumalanga regions, Kwazulu-Natal and the Cape.

A key indicator of the current size of the South African industry is the number of operational distillation facilities. According to the South African Essential Oil Producers Association (SAEOPA) there are approximately 33 commercial stills in operation in South Africa, most of which are in the range from 250kg to 500kg units. Most of these stills would be considered to be of sub- economic size.

Table 23: Estimated Number of Commercially Operational Stills[57]

Province	No. Stills
Eastern and Western Cape	8
Kwa-Zulu Natal	7
Mpumalanga	8
Free State	2
Gauteng	5
Northern Province	3
TOTAL	**33**

Historically, the CSIR has had the most experience with the South African essential oils industry. The Agricultural Research Council (ARC), on the other hand, has had little focused involvement, only getting involved in isolated instances when individual researchers have had the inclination and the budget. The CSIR has met with mixed success in the promotion of the industry. One of the difficulties that the CSIR has faced is balancing its role as a publicly funded research institution and its responsibility to be partially self-funded. On the one hand CSIR is a publicly funded institution from which research should be made available to the public. On the other hand, the CSIR is expected to generate supplementary funding from other sources (mostly of a private nature). This latter position requires that they adopt a proprietary stance with regards to information and research outputs in order to have a basis for transacting with the private sector. This ambiguity has affected the industry negatively (causing mistrust and lack of exchange of information). Many farmers and other stakeholders have resented having to pay consulting fees to the CSIR to access information on the essential oil industry. The South African Essential Oils Producer Association (SAEOPA) was formed in 2000 as an alternative to the CSIR as a source of know-how for current and potential producers.

SAEOPA began in Mpumalanga, but since 2003 has a branch in each of Kwazulu-Natal and the Western Cape. SAEOPA is a voluntary association, with a board, and administered on a part-time basis using small annual subscriptions (currently, R250.00 per member). SAEOPA was established as an alternative to the CSIR and Biosys Plant Extracts, which were the original promoters of the industry in South Africa. It appears that some producers resented the fact that the CSIR, as a public research institution, was charging farmers commercial consulting rates for the disclosure of basic industry information. SAEOPA's stated objective is to support its members, who primarily comprise producers of essential oils. By pooling their information and experiences, the members hope to promote the industry and the

[57] Information from SAEOPA

interest of their members. SAEOPA supports its members throughout the value chain, beginning with the dissemination of information on agricultural issues and ending with marketing matters. With regards to the latter, representatives of SAEOPA have attended various trade missions sponsored by Department of Trade and Industry (DTI). These trade missions are largely considered to have been successful with the prospect of orders being placed. However, in the process, SAEOPA has identified several issues that need to be addressed in order to secure market access:

- The need to consolidate production in order to supply sufficient quantities with consistency. The volumes are required in order to get serious international attention.
- The need to have basic testing facilities (e.g. Gas Chromatograph) in order to test oils and to be able to give assurances with regards to quality and characteristics.

As a general observation, the study has revealed that there have been many disparate projects and studies conducted by various institutions at various levels (e.g. CSIR nationally and the Provincial Departments of Agricultural regionally). Furthermore, the National Botanical Institute (NBI) has information regarding South African flora and biomes and the National Department of Agriculture has the details of soil profiles and climatic conditions. There are also centres of knowledge developing, such as at Cedara Agricultural College in Kwazulu Natal, where local commercial producers are interacting with researchers. On the whole, information is considered to be available but not readily accessible. There is a need to catalogue and consolidate the information gathered by public institutions over the years.

The largest immediate player in the South African essential oil market is Biosys Plant Extracts (Pty) Limited. Biosys began as a collaborative effort between CSIR and a British company, Biosys Limited in 1998. It was the recognition of the constraints of entering the international market that caused the CSIR to form an alliance with the British company Biosys Limited. Out of this alliance Biosys Plant Extracts (Pty) Limited (a foreign owned South African company) was formed. Biosys Plant Extracts still works closely with CSIR, but is now wholly independent of the CSIR. Biosys acts as a technical and marketing agent for essential oil producers, thereby meeting the issues identified by SAEOPA (mentioned above). Given the difficulties of “breaking into” the international market, Biosys has strategically focused on established essential oil markets and has steered clear of experimenting with “new” oils. Biosys’ focus is predominantly on the agricultural component of the value chain as it has identified this as a critical component for meeting the requirements of international buyers. In particular, Biosys assists producers with obtaining Organic Certification. As an intermediary, Biosys endeavors to match successful producers to pre-identified buyers, thus ensuring consistent and reliable markets for its clients (both the buyers and producers). This relational approach places inflexibility on the market but benefits those who have made the investment and have secured the market. Biosys currently

has some 50 commercial farmers as clients, of which less than half are producing commercial quantities.[58] Biosys also works very closely with Teubes (Pty) Limited. Although operating independently, the CSIR continues to be interested in essential oil production where this involves rural development projects (e.g. Giyani in the Limpopo Province, growing Lippia and Geranium), generally this oil is sold to Biosys.

Other players include Bio Africa, which is predominantly a national agricultural consultancy to farmers and communities in Southern Africa. Bio Africa also has its own distillation facilities in Gauteng and a network of international buyers.

On the whole, most essential oil producers sell their oils to Biosys or to Teubes (Pty) Limited for export or sell directly into the local market, mostly for aromatherapy applications.

5.2 Indigenous Essential oils

There is a distinct industry in indigenous essential oils. However, besides Buchu, this segment is very small and predominantly focused in the Cape. The Buchu industry is fragmented with both cultivated and wild harvested plant material being used. There is also a lot of illegal harvesting taking place. The Buchu industry is considered to be facing a crisis in that demand is high and is pressing prices so high that substitute products may well be sought. There are quite a number of small indigenous essential oil producing companies, the most prominent of which is Grassroots Natural Products (Pty) Limited. The indigenous essential oils market is also tied in with the broader industry for plant extracts, for example Afriplex (Pty) Limited is predominantly involved in teas (Rooibos and Honeybush) and tinctures, but also deals with essential oils derived from the Cape fynbos. Most indigenous essential oils are either sold in small quantities directly to select buyers in Europe and the US or to Teubes (Pty) Limited. The indigenous essential oil industry in South Africa is primarily a cottage industry.

The exploitation of indigenous plant material holds some interest for rural development. Those indigenous plants that are wild harvested are often harvested by rural communities, either on their own land or that of a commercial farmer (who then shares in the revenue). There are a number of projects being undertaken, for example Buchu cultivation under the auspices of Cape Nature Conservation, to take these rural communities into the new cultivation projects as a means of rural development and upliftment. This process of moving towards cultivation will ensure the long term sustainability of these industries and enable rural communities to create wealth from indigenous knowledge. The CSIR has continued its involvement with essential oils (separate from Biosys) to the extent that this involves the

[58] Information from website (www.biosys.co.za) and Dr Learmonth.

cultivation of indigenous plant material (eg. Lippia javonica is being grown by a community at Giyani for use as an insect repellant).

5.3 Secondary Beneficiation and Marketing

South Africa generally has a strong competence in chemical production. This is evidenced by the availability of "toll" or "contract" manufacturing facilities, used in generic drug and cosmetics manufacture. However, there are a limited number of persons who process essential oils.

It is estimated that Teubes (Pty) Limited, of Gauteng, processes some 90% of the South African essential oils. Oils are bought from producers across South Africa at prices determined in accordance with the quantity and quality. Clive Teubes is a chemist (ex-AECI) with over twenty years in the aroma chemical, flavour and fragrance industry. Clive Teubes acknowledges that it took him over ten years to gain the market knowledge and access he now has. The main market of essential oils is the export market. The difficulty is getting access to the international flavour and fragrance houses. The international companies are looking for producers who will "stay the distance". Therefore relationships take a long time to develop. However, the experience of Teubes is that it is possible to access the large flavour and fragrance houses in Japan, Europe and the USA. In order to do this Teubes has had to develop the capacity (perhaps the best developed in South Africa) to analyse and categorise oils (using analytical chemistry and a panel of organoleptic specialists) and to rectify oils. Great care is taken to meet the technical and organoleptic requirements of the international buyer. With regards to the local market (which is limited), Teubes complements its export business in essential oils with the production of basic synthetic aroma chemicals products (primarily flavours) which Teubes supplies to local manufacturers as import substitutes. Teubes' approach is essentially market driven, responding to market needs making use of Southern African natural resources. Teubes brands itself as an "out of Africa" company and leverages natural resources from other essential oil producing countries (e.g. Madagascar, Kenya, Zambia and Rwanda) in order to broaden its suite of products. The Teubes' plant and equipment are multipurpose and operations are flexible. This allows Teubes to respond to market demands and survive fluctuations.

Afriplex (Pty) Limited, of the Western Cape, is predominantly concerned with producing plant extracts, teas and tinctures. However, it does process some essential oils but these are limited to those coming from the Cape fynbos, in particular Buchu oil. Afriplex is in partnership with Cape Nature Conservation in respect of the Elandskloof community Buchu project. Although Afriplex has focused more on teas and tinctures it does have the commercial capacity to make supercritical extractions (the only commercial scale facility in

South Africa). Afriplex is also considered to be a strong and dynamic company on the basis that it has a wide range of products to offer arising from its niche in the Cape Floral Kingdom.

5.4 Fragrance and Flavour houses - Local

South Africa does have some local formulators. They are predominantly in the food and flavours industries. According to industry estimates there are approximately a dozen such companies, which contribute some 20% of the local production of flavour compounds (approximately R120 million turnover per annum). These include such companies as Cranbrook Flavours, Flavourcraft and Janderee. South Africa produces a negligible amount of fragrance compounds. South Africa has an association, the South African Association of the Flavour and Fragrance Industry (SAAFFI), which represents the interests of the industry. The 27 members represent local and international players, producers and customers.

The majority of flavour and fragrance compounds are imported and used directly by manufacturers. There is a limited amount of formulation in South Africa. In most cases, formualtion processes are performed with the assistance of an olfactory expert. There are only a handful of such people working in South Africa.

Some small local flavour formulators, supplying the snack market in particular, are of the view that the use of “nature identical chemicals” that meet local taste are the future growth areas in the South African food industry, as these chemicals are not subject to the vagaries of agricultural production.

5.5 Fragrance and Flavour houses- International

The local flavour and fragrance market is dominated by the international players. They account for almost all of the fragrance compounds and formulations and at least 80% of the flavour compounds and formulations. The local subsidiaries of the large flavour and fragrance houses such as IFF, Symrise, Quest and Firmenich are part of their group’s global buying strategy. They purchase the best and the cheapest internationally. In this way they are able to give the best prices to local customers even for relatively small quantities. To the extent that they have to formulate for end-users this is done in United States, Europe or Japan. Little to no development is done in South Africa or any other peripheral market. Generally speaking, the local companies do not have any production facilities. They act as sales and marketing centers in the local markets. The local companies may act as a conduit

for new flavours or fragrances but all assessments are done overseas. Generally, local producers find that dealing directly with the offshore head office is more effective than interacting with the local offices.

There is one noticeable exception to the foregoing. This is Robertet, a French company with a local subsidiary. Robertet is ranked about number 12 in the world as a flavour and fragrance house with about 1,4% share of the world market. It forms one of the second tier companies with turnover in the range US$200 million to US$500 million per annum. Robertet has over a dozen subsidiaries across the globe (on five continents). It is a fourth generation family business (founded in 1850), headquartered in France and now listed on the Paris bourse. It began predominantly focused on producing natural products but has now diversified into the full range of products relating to fragrances and flavours. Its stated objective is to grow by 10% per annum in order to retain its independence in the market place. Through its subsidiaries it has access to a wide range of natural plant materials and aroma chemicals. Through its diversification strategy it is able to hedge against the risks associated with crop failures and to benefit from access to novel flavours and fragrances. However, all formulations and intellectual property are housed in France. It is understood that Robertet in South Africa is investigating novel flavours from South African flora. If successful, this will form part of Robertet's competitive advantage in the international market. It is reasonable to assume that Robertet has a similar strategy in each geographical area it operates in. South Africa has no companies to compare with Robertet, none having its international reach, product diversity or turnover.

5.6 Governmental Stakeholders

The National Department of Agriculture (NDA) has recently established a department to give consideration to new industrial crops, including essential oils. The post was recently created and an appointment made in July 2004. The direction to be taken by the NDA has not yet been determined. Agricultural Research Council (ARC) reports to the Minister of Agriculture and has as its primary focus research into food-crops. However, the ARC does have a unit in Rustenberg which focuses on industrial crops, particularly tobacco and cotton. On the whole, besides some work on Buchu, conducted in at the ARC unit in Elsenberg, Western Cape, the ARC has not paid much attention to essential oil crops. The ARC has advised that there is no map of the growing regions in South Africa. In order to get information one has to approach various different government departments. Dr Cobus Coetsee, formerly of the ARC, advised that most information is available but not really accessible to the public. For example, the National Botanical Institute (NBI) can provide information on the occurrence of indigenous species and some provincial Agricultural Departments can advise on commercial

crops that are grown regionally (with a bias toward food crops). On the other hand, one would need to access the AGIS (the agricultural information system) to find soil and climate charts for the country. The consolidation of basic agricultural information has been recognized as a need by the NDA.

The government institution that has given the most attention to essential oil production is the CSIR. As mentioned above, it was the CSIR's realisation that market access for essential oils was difficult that it established Biosys Plant Extracts (Pty) Limited in conjunction with a British company. The CSIR has done work, together with commercial farmers and communal farmers, on a wide range of oils, including geranium, chamomile, lavender, peppermint and lemongrass. This work is now largely in the hands of Biosys, but CSIR retains an interest where essential oil production is undertaken by rural communities, where CSIR provides consulting services to the project.

The Department of Science and Technology (DST) has also identified essential oil production as an important priority. Its interest in the industry is largely channeled through three initiatives. The first is the work of the CSIR (in particularly community projects, such as Giyani, Driekoppes, Badplaas and Pacaltsdorp). Secondly is the work of the Institute for Natural Resources (At the University of Kwa-Zulu Natal University) in Kwa-Zulu Natal. Thirdly, is through the new chemical sector incubator (Chemin) situated in Port Elizabeth. Chemin has successfully piloted an essential oil project in the Oliver Tambo Municipal area in conjunction with the local authority. The DST has plans to roll-out further community based essential oil programs in the coming year.

The CSIR (Bioprospecting Division), the Institute for Natural Resources (INR) (in KwaZulu Natal) and the ARC and others have various programs in place that are focussed on promoting the commercial exploitation of South Africa's natural resources. Using indigenous knowledge systems as the basis for plant selection, it is possible for scientific and commercial players to identify new entrants into the international flavour and fragrance market. This however is a long term process as the market is conservative. The focus of most of the research is on medicinal uses of indigenous plants and not flavours and fragrances. Funding for such research is inhibited by the current size and profile of the industry.

The DTI, in particular Trade and Investment South Africa (TISA), has a chemical sector desk that has identified essential oil exports as a potential growth area. DTI has been working together with SAEOPA in order to improve the international profile of the South African industry. SAEOPA has sent representatives on trade missions to various trade fairs, with

varying degrees of success. SAEOPA has however been unable to leverage its membership subscriptions to form an Export Council. Exports Councils are funded by the Sector Specific Assistance Scheme (SSAS) of the EMIA programme and makes ***inter-alia*** provision for the operational funding of the Councils. A decision has been made to place a moratorium on the creation of additional Export Councils until such time as more funding is made available for this purpose. Industries that wish to benefit from the other forms of assistance within SSAS may do so by creating a joint action group.

5.7 Grounds of Competitive Advantage

There are no particular inimitable grounds upon which South Africa can claim competitive advantage in the global essential oils industry. However, whenever South African industry representatives are overseas they regularly receive queries about the South African essential oils industry. There appear to be a combination of factors that are in South Africa's favour as a player in the global market. These include:

- Being in the Southern Hemisphere – many of the world's growing regions are in the Northern Hemisphere and the effects of the seasons makes Southern Hemisphere suppliers attractive.
- Having traditionally strong trade links with Europe - as a major importer of flavour and fragrance materials.
- Already being established as a world class agricultural producer in a wide range of products.
- Having a diverse climate with a range of biomes - thus allowing for a good selection of essential oil crops to be grown.
- Having good quality soils – being largely uncontaminated by centuries of exploitation as is the case in the developed world.

The only other grounds of competitive advantage, in the long term, may be access to unique plant materials which could provide a platform for the creation of new markets in which South Africa could dominate. Such domination would need to be based on good science, established trade links and reputation, all of which may be established in advance. Competitive advantage is something that may be created by properly organising the industry and creating the necessary factors for success.

6 Economic and Commercial issue

6.1 General comments

Over time, various South African organizations have gathered data with regards to the actual cost of production of essential oils in the South African. These include organizations such as Biosys Plant Extracts (Pty) Limited, CSIR, SAEOPA and BioAfrica[59]. Much of this information was and is being gathered on the basis of trial and error activities and the results are considered to be confidential. Furthermore, farmers are notorious for cross-subsidizing crops within their farming unit and thus detailed costs of production are often difficult to determine. The best source of information may be the community-based projects where the rigors of project management should produce more accurate data.

From international literature and local experience it is possible to determine the general parameters concerning yield and returns. For example, CSIR has provided the following figures for Geranium -***Pelargonium Graveolens*** (Conventionally grown) [60]:

Table 24: Sample economic summary prepared by CSIR

Plant material (kg/ha/annum)	40 000
Oil yield (%)	0.13
Oil yield (kg/ha)	45
Farm gate price ($/kg)	60
Annual income (R/ha)*	28460

* Assuming R/$ of R9.80 (2001 figures)

Naturally, the parameters need to be adapted to reflect the current exchange rate and the current market price. So for example, the US$ price has since gone up to about $90/kg, and the Rand has strengthened against the US Dollar. However, at a R/$ exchange rate of R7 to the US$, the annual income per hectare is still approximately R28,000.00. The estimated cost of cultivation per hectare is about R10, 000.00/hectare. This yields a profit per hectare of R18,000.00 per annum, which for a stand of 20 hectares translates into a gross profit of R182,400 per annum. This analysis does not take into consideration the operational costs and the initial start-up costs.

[59] See example of SAEOPA information sheet on Lemon grass – Appendix A
[60] Additional figures provided in Appendix "B"

In order to perform a sensible economic analysis one needs to generate a financial model literally from the "ground" up. One begins with the analysis of the available farming area and what crops it can produce. This requires detailed consideration of the agricultural aspects of essential oil production, which are beyond the scope of this Study. Accordingly, this Study doe not include a detailed economic analysis of the product of the various oils.

However, although each farm and each crop has its own particular economic parameters, the general economic considerations are quite generic. To this end the Consultant has compiled a check list of issues to be considered when constructing a business plan for an essential oil crop. (See Appendix "C").

Furthermore, the rest of this section of the report highlights some of the generic economic considerations affecting essential oil production.

6.2 Economic decisions

Although the decision to farm essential oils must be an economic one, there are several varied reasons for producers undertaking essential oil production. Agricultural is a risky undertaking and therefore market-risk management and crop diversification play a particular role. Some of the considerations prompting a producer to enter into the essential oils industry include:

- A diversification of agricultural production;
- Relatively small area under crops (20 to 50 hectares);
- The produce, if stored under the right conditions, can be held for extended periods of time;
- Since the crops are not edible they are not subject to theft;
- It is a higher value crop, though prices fluctuate;
- Crops can be versatile (e.g. lavender can be sold fresh, dry or as an essential oil);
- Interest in distillation process and the end products (products can be sold directly into niche markets like aromatherapy); and
- The market is a specialty market and buyers tend to be more loyal to producers.

From a community development perspective one can also add:

- There is good potential for job creation (particularly if organically certified oils are to be produced); and
- There is potential for the creation of better skilled and paid jobs.

6.3 The start-up cost

One of the key barriers to entry into the essential oil industry is the start-up costs. Besides the considerations set out in the checklist, there are several "rules of thumb" that have been determined:

- The basic economic unit of production is 20 to 25 hectares (ensuring sufficient material through the distillation unit);
- The land should be irrigated; and
- The optimal still size should be approximately one ton.

The extent of the outlay is dependent on what infrastructure is already available. The key costs here are:

- the cost of irrigation, which may cost up to R10,000/hectare to establish;
- the cost of a distillation unit, which may cost up to R500,000; and
- the cost of establishing the crop, costing approximately R9,000/hectare (most are perennial).

With regards to the still, there are several technology options available but the consensus is that stills should be manufactured from stainless steel and steam distillation process should be used. This is not the cheapest option but is the most economical in the long-run. Furthermore, short cuts on the distillation unit could render the oils unmarketable. The estimated cost of a one ton still (together with boiler, condenser, Florentine flask and mechanical hoist) is R500.000.00. The cost of the distillation unit is one of the key barriers to entry for most farmers. However this can be mitigated where farmers share facilities on a toll basis. The potential prohibitive cost of a distillation unit is one of the impetuses for the need to develop a suitable mobile distilling unit that can be "leased" to a farmer or community until they are persuaded of the viability of the crop.

On average it is estimated that it costs some R20,000 per hectare to establish an essential oil crop (irriagation, soil preparation and seed/seedlings). However, the cost varies depending on the original cost of crop material. It usually takes two to three years to begin commercial production and another two to reach full-scale production. This period requires funding. Commercial farmers carry the cost of rolling-out an essential oil business by subsidizing it from their existing operations. As an indication of how much it costs over a period of some 3 to 5 years to establish an essential oil growing business, it has been estimated that a community-based project requires an investment of between R3 million and R4 million over five years in order to become established[61].

However, one of the benefits of essential oil production is that one can scale-up production in phases, thereby mitigating risks and allowing for adaptation. The process for the establishment of an essential oils production facility is generally done in phases. For example, Biosys works on three phases:

- Phase one - Pilot sites of approximately 0.2 hectare trial blocks per crop (a selection of 3 or 4 crops).
- Phase two - Production of 25 ha
- Phase three - Production of 50 ha

A similar process is being followed in the Eastern Cape, in a community based project, where the process is:

- Pilot – for training and plant propagation
- Phase one – larger scale production (60 ha and four crops)
- Phase Two – transition to “organic” production (60ha)

6.4 General comments on Financing

To date the development of essential oil production has been financed in one of two ways:

- In the case of existing commercial farmers, this has been financed by revenue from existing operations or by borrowing from existing financiers (e.g. overdraft).

[61] Based on the budgets of a couple of community-based projects reviewed.

Commercial farmers are well known for cross-subsidizing their operations and treating their farm as a single economic unit.

- In the case of emerging farmers (of which there are very few examples) the funding has been by way of assistance from local or provincial development agencies (e.g. the project at the Oliver Tambo Municipality in the Eastern Cape or Buchu projects in the Western Cape) or national government in conjunction with state institutions like the Department of Science and Technology (DST) and CSIR (e.g. the project at Giyani in the Limpopo Province).

There is a third type of financial support that is emerging. This is where buyers of the oils are either jointly investing in distillation equipment or lending distillation equipment to the producer, thereby sharing in the establishment costs and sharing the risks.

There are several state organizations or schemes that may be of relevance to a person wishing to initiate an essential oils business. However, the Consultant is not aware of any instances to date where commercial farmers have raised finance from any of the state funding institutions (e.g. The Enterprise Organisation (TEO), Industrial Development Corporation (IDC) or Land Bank).

In theory, the Land Bank is best positioned for lending to a farmer wishing to establish an essential oil production capacity. However, the experience of SAEOPA members is that the Land Bank expects the farmer to put up 50% of the financing up-front and that this has prohibited accelerated start-up. Farmers therefore slowly scale-up using their own resources over time. This has been found to be slow and onerous since there is a need to get to the minimum operating level of 20 to 25 hectares as soon as possible. There are two main start-up costs that tend to be significant hurdles for farmers, the equivalent of which the Land Bank is known to finance in other ventures (e.g. fruit growing). The first is the establishment of the crops. The second is the upfront investment in distillation equipment. It appears to be the perceived risk of the essential oil industry that makes the Land Bank wary. This may be mitigated by other types of government or parastatal support to the industry.

6.5 General comments on Government Support

Consideration has been given to the possible introduction of special producer focused incentives for the essential oil industry; however, internationally these have not proven to be effective. In fact incentives create perverse incentives enticing players into an industry for

the wrong reasons. In Australia, producer incentives to encourage entry into the tea tree oil industry resulted in a temporary increase in production that was unsustainable and later resulted in several liquidations, negatively impacting on the industry. The emerging international consensus, which is supported by strategy consultants such as Michael Porter[62], is that Government's most effective role is in factor creation. This involves creating and enabling environment and factors for the development of an industry. The specific areas of application in the essential oils industry are publicly funded research and development and the improvement of education and skills development delivery systems. These are the recommended focus areas of Government support.

The essential oil industry has significant technical (agronomic) and financial barriers to entry. The two phenomena are of course related. The industry requires some initial support (both technical, commercial and financial) in order to break out of its current constraints. Once some success has been achieved, players will find it easier to enter the industry. For example, if the Government Departments (e.g. Agriculture) and Research Councils (e.g. ARC and CSIR) were to put more public technical support behind essential oil crops this could provide the information and assurances required by financiers, like the Land Bank, to enable them to adopt a less risk averse stance.

The essential oil industry has benefited and would continue to benefit from export incentives and assistance supplied though DTI (TISA). SAEOPA has been on several trade missions with varying degrees of success. However, the main constraints are still producing adequate volumes and the need to have standards and testing to consistently meet quality standards. The formation of an essential oil Export Council could be useful in that it would allow an organization like SAEOPA to leverage its own funding and promote industry co-operation for exports. However, SAEOPA has been advised that there was a moratorium on the formation of new Export Councils. The position is that due to a proliferation of Export Councils, and the budgetary effects this had had, DTI is now insisting that industry groupings first form Joint Action Groups, as a precursor to applying for recognition as an Export Council. A Joint Action Group may be formed where companies within a sector agree to co-operate with regards to a industry related matters (for example, research on export markets) and who then approach TISA for the purpose of gaining assistance for that particular initiative. As has been pointed out, in terms of the value chain, profile in the international market is crucial. South Africa requires an overall strategy for developing the face of the South African essential oils industry. DTI and other affected governmental agencies need to engage the industry on a uniform approach to this matter.

[62] "The Competitive Advantage of Nations", Porter, M. Macmillan (London) 1990

Another area where government support may be required is in the case of developing communal land. With regards to communal farmers and rural development, one of the unique features that need to be addressed is the clarification of the land rights. Any uncertainty as to land ownership and land usage rights has a negative impact on commercial development and particularly access to finance. The few communal projects involving essential oils (e.g. Oliver Tambo Municipality) have first had to settle the land rights issues prior to commencement. This is both a legal and political (local government and tribal authorities) exercise.

6.6 General comments on the potential relevance of Co-operatives in the Essential Oil industry.

Historically, Co-operatives have been successfully utilised in the creation of the South African agricultural sector. Co-operatives have historically been managed by the National Department of Agriculture. This is about to change. The introduction of the new Co-operatives Bill could herald a new generation of co-operatives in South Africa. In terms of the proposed Bill, the DTI will take over responsibility for co-operative structures and these will be administered by CIPRO (Company and Intellectual Property Rights Office).

Informal, contractual, co-operative structures have been successfully used for a number of "new style" agricultural ventures (for example, flower growing and fish farming). Co-operatives are useful for the following reasons:

- They help integrate various stages of the supply chain for mutual benefit;
- They mitigate risks for small producers;
- They mitigate risks for potential financiers;
- They mitigate risks for end-buyers.

With many agricultural ventures there can be a significant premium earned by those intermediaries that sell produce into the international or local market. This benefit may not always be shared with the primary producers. Accordingly, there is a mismatch between risk and reward and new industries may never get off the ground unless the benefits of the final sales are in some manner shared with the primary producers. This dilemma has already been felt in the local essential oil industry. Growers feel aggrieved at the difference in price received at the farm gate when compared with the export prices. Exporters on the other hand are concerned that growers do not appreciate the time and effort required to match oils

to buyers. These poor perceptions are being remedied as the industry grows. Already greater degrees of co-operation are emerging between growers and marketers (e.g. co-investment in distillation units).

Many agricultural endeavours have significant ancillary requirements that can benefit from "bulk" purchases. This may include seed (or seedlings), fertiliser and equipment. Furthermore, there may be specialised equipment which is more affordable and economic when acquired and operated co-operatively. The payment for the acquisition and operation of such facilities is better managed on a broader co-operative basis and risks are shared.

The collective responsibility of a co-operative towards repaying financiers reduces the risk. The potential of a crop failure and therefore cashflow problems is mitigated when the risk is spread across several independent, but co-operating, producers. Co-operative structures could greatly increase the likelihood of funding.

Buyers when selecting suppliers take cognisance of the supplier's ability to deliver the required quantity and quality of product. Local essential oils producers have experienced the difficulty of obtaining a buyer without a guaranteed minimum supply of product. There is therefore a need to "bulk-up" supply in order to attract a buyer. If the bulking up process is independent of the individual growers the advantages of increased prices is lost to them.

The above objectives can be achieved by using company or contractual mechanisms. However, the proposed Co-operatives Bill provides formal mechanisms for the establishment of co-operative structures. These structures will have common statutorily prescribed features which will aid with their establishment, ensure transparency and good governance. The Bill provides for different levels of Co-operatives ranging from a Primary Co-operative to Secondary, Federal and then culminating in a "co-operative apex organisation". Co-operatives can be organised on geographical or sector specific bases. These features allow for flexibility and growth of a co-operative structure.

Recommendation:

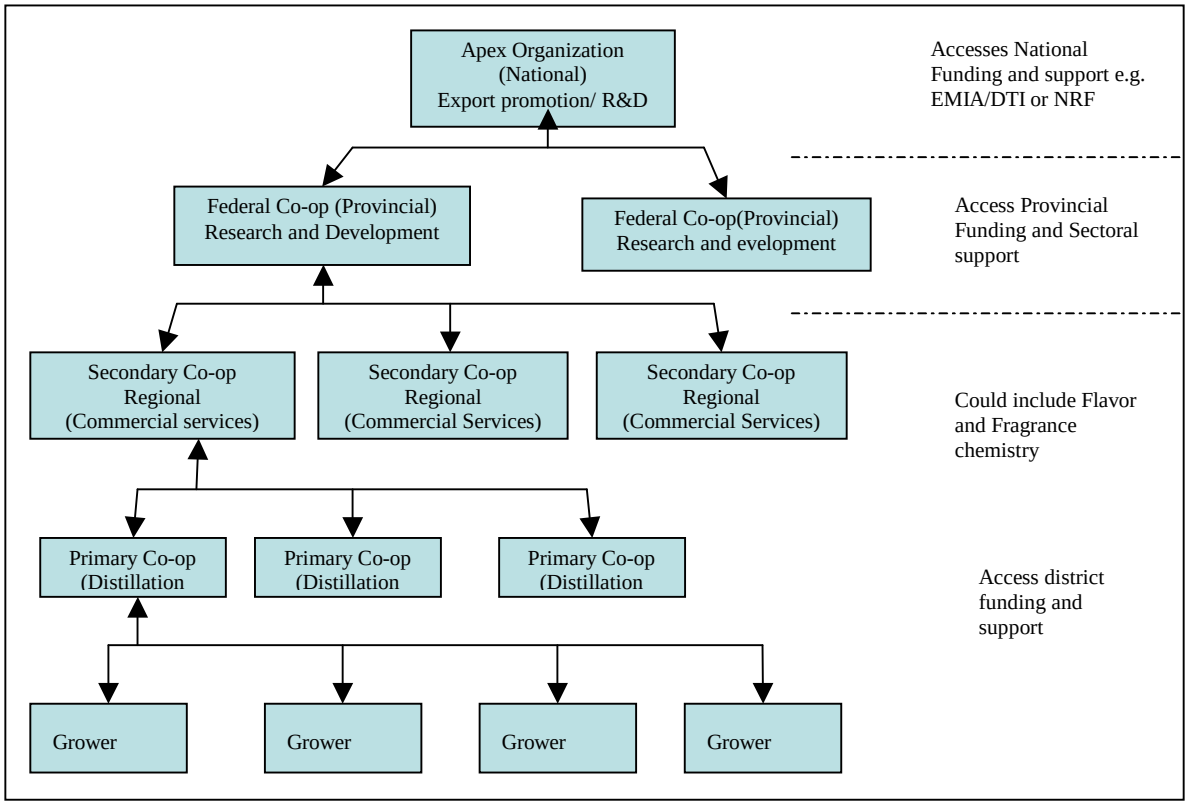
In the event that the Bill is enacted, there will be a need to investigate the detailed application of Co-operatives for use in the essential oils industry. In general, these co-operatives would probably be regionally based (as opposed to crop based) and have the following components:

- Grower members (perhaps separate growers for young plant material and others for oil distillation, depending on crop selection)
- Distillation facilities and oil storage facilities
- Testing and R&D management facilities
- Buyers for inputs such as fertilisers and plant materials
- Centralised marketing arm.

It may be that, in the initial stages, the co-operative makes use of the Primary and Secondary Co-operative Structures proposed by the Bill. That would mean that a smaller geographically located group of growers, with a distillation facility, could form a Primary Co-operative, which in turn could be a member of a Secondary Co-operative which owns the bulk storage, testing and marketing facilities. The Secondary Co-operative could service the "higher needs" of a number of participating Primary Co-operatives. It is foreseeable that, if, for example, certain Secondary Co-ops are known for different oils types, Secondary Co-ops could form a Federal Co-op to better promote those particular oils at a national and international level (alternatively Secondary Co-ops could form a Federal Co-op at Provincial level to coincide with Provincial assistance programs). In turn Federal Co-ops could form a national co-operative apex organisation to promote South African essential oils nationally and internationally.

The following diagram illustrates the potential application of the Co-operative structure to an essential oil industry in South Africa:

Figure 8: Illustrative Co-operative Structure for Essential Oils Industry



The structures proposed by the Bill are flexible and lend themselves to commercial innovation. As co-operatives grow in size the functionality may change. For example, there may be potential for value addition such as producing isolates. This could occur at the Secondary Co-op or Federal Co-op level. Co-operatives could be structured to coincide with support structures provided by national and provincial government agencies.

7 ATTRACTIVE OPTIONS

7.1 General Considerations

Careful thought has been given to the selection of essential oils that would make attractive options for commercial production. It is possible to perform a theoretical economic analysis of each essential oil that can be successfully grown in South African and then to rank them in accordance with their current and predicted profitability.

However there are so many variables at work that such an exercise would be largely academic. Furthermore, agricultural decisions are quite complex. In 1934 EW Bovill, then chief executive of RC Treatt, quoted a Senior Agricultural chemist of Kenya "***The production of essential oils is perhaps more chancy than most farming propositions; it most certainly requires more attention and supervision than most, and, with certain rare exceptions, does not pay much more highly***"[63]. He was discussing why farmers are interested in essential oil crops. To his way of thinking the only economic benefit was the high value in proportion to their bulk which makes essential oils easy to store and transport. Other than that their interest was largely related to the "novelty of the process of distillation" and the "agreeable nature of the finished product". The essential oils industry has producers that come and go, but some stay. It is those that stay that make the industry what it is. Any successful promotion of the industry should bear this in mind.

Accordingly, it is important to begin with the producer. Whether the producer is a commercial farmer or a communal farmer, there needs to be a level of commitment. The choice to farm essential oil crops must be based on a realistic understanding of the opportunities and constraints of the crops. Farming is as much a way of life as it is a business proposition.

In order for essential oil crops to be successfully grown in South Africa it is generally understood that the crops must be irrigated. This already suggests that farming areas must already be under irrigation or have access to good supplies of water. Irrigation is costly but allows the producer a significant number of options with regards to crop choices (many of which yield similar returns to essential oils). In addition, the producer needs to invest in a distillation unit, which may cost up to R500,000.00. Accordingly, any person wishing to promote the production of essential oils needs to identify suitable land and suitable farmers.

[63] Published again 66 years later in Perfumer& Flavourist Sept/Oct 2000 and annotated by his grandson H Bovill the managing director of Treatt PLC.

In the case of communal farmers these should be farmers with agricultural experience and expertise preferably using irrigation.

Having identified the land and a farmer, one would work through a system of crop selection. This would begin with the horticultural questions related to which plants would grow in that geographic area and then move on to matters of economic returns. As will be discussed later, there are many parameters that can impact on the overall financial viability. It is clear that any such undertaking must be on the basis of a properly worked out feasibility study and business plan that is tailor made to the site. Discussions with some producers highlighted that one of the key consulting needs was the development of the business case for a particular crop or suite of crops[64]. The economic viability of an essential oils business will depend on a wide variety of information inputs such as cost of irrigation, access to distillation facilities, area of land available, level of training required, access to plant material, sources of fuel and the like. Each case must be tailor-made with the farmer's understanding and buy-in.

Due to the volatile nature of essential oil prices and the impact of exchange rates on prices in Rand terms, it is necessary for the farmer to consider a risk management approach with regards to essential oil crop cultivation. This may involve cultivating several essential crops (not necessarily only the most lucrative at that time) and perhaps mixing this with other food or non-food crops. Furthermore, since the primary issue is good farming technique, agricultural considerations may prevail over pure market price considerations. Another consideration is access to a market. In this regard consultation with a buyer or agent is valuable in making a choice of crop. It is accepted practice that there be some trial and error as the producer woos potential buyers. Furthermore, it is not unusual for a potential producer to begin to work with a buyer or agent prior to commercial production. One of the features of the industry is the potential for producers to work closely with buyers.

7.2 Attractive Options

With the above in mind, the Consultant has not endeavored to perform a comprehensive economic analysis of a potential basket of essential oil crops and, thereafter, attempt to select a handful of very attractive products. The emphasis must be on the long term creation of a sustainable producer base for a wide range of oils.

From a national perspective there are appear to be two approaches which one could take towards selecting essential oil crops as attractive options:

[64] Discussions with SAEOPA members

- Either one chooses a select few oils and focuses on these as a first phase of development; or

- one encourages a wider range of production through general support structures, thereby broadening the base product offering and encouraging a measure of diversity in the industry.

The benefit of the former approach is that there is a focus of resources and quicker learning takes place. This can put South Africa on the map with regards to production of a particular essential oil. However, the down side of such an approach is the possibility of creating a glut in supply and thereby damaging the very industry one is trying to foster. This has been the predicament faced by many of the South East Asian producers. As it is, some industry experts are expressing concern about the focus on Rose Geranium in the South African industry and are advocating a wider range of oils be promoted for the long term stability of the industry.

It is proposed that there be some measure of focus but on a basket of oils. After discussions with industry players, particularly buyers and agents, the Consultant has compiled several lists. These are attached as Appendix "D" . Lists A and B are based on buyers' experiences in the local and international market. List C represents a broader selection of oils that would be of use to a person in the flavour and fragrance formulations business. The Consultant has compiled a primary and secondary list based on the aforementioned lists (Table 25 below). The primary list should be seen as the mainstream crops for which there is more than adequate market knowledge and technical support available to see immediate success. The secondary list contains those additional oils that may be of interest for those wishing to broaden the base of essential oil production in South Africa.

In compiling the Lists, the Consultant has avoided the bulk mature markets (such as eucalyptus, mints and citrus). South Africa already has a significant presence in both eucalyptus and citrus oils market, but these markets are always under pressure from low cost producers.

Table 25: Proposed list of attractive essential oil crops

Proposed Primary List	Proposed Secondary list
Geranium Roman Chamomile German Chamomile Rosemary Oil (verbenone type and cineol type) Lemon Balm (Melissa) Marjoram Thyme oil Basil oil Lavender Oil Lavandin Oil Lemon grass Buchu	Spearmint Peppermint Parsley Seed Jasmine Tuberose Marigold Celery Seed Vetiver Cassie (Mimosa) Yarrow Dill Tarragon Coriander Fennel Vaerian Helichrysuam

7.3 Potential size of industry

Introduction

It is difficult to estimate the potential size of any future essential oil industry in South Africa. The industry is essentially agriculturally based and the current Study does not encompass the agricultural component. Furthermore, the essential oil industry encompasses many different products with many with different attributes.

It must be born in mind that the current analysis excludes the bulk essential oils such as eucalyptus and citrus oils. These are mature industries (high volumes low price) in which South Africa already has a significant international presence. For example, in 2003 South Africa exported approximately 485 tons and 300 tons of citrus and eucalyptus essential oil respectively (some 2% and 5% of the world market respectively). The focus of this Study is the smaller essential oils, particularly those set out in Table 25 above.

Parameters

There are probably two core parameters to estimating a realistic size of a future South African essential oil industry. The first is the likely available farming land and the second the inherent constraints of the global market (its size and current growth rate).

Available productive land

Throughout the world, the essential oil industry is characterized by "growing regions", perhaps the most famous of which is Grasse in France. Similarly one would expect that South Africa would have various growing regions, depending on climatological and other factors. The identification of such areas is one that would require extensive agricultural inputs and is outside the scope of the current study. However, it is recognized that the majority of essential oil crops grown in South Africa require irrigation. This can be done via boreholes, or from rivers and dams, but an obvious source of suitable land must include land within existing Irrigation Boards and Government Irrigation Schemes.

According to the Department of Water Affairs and Forestry there are approximately 300 such irrigation schemes throughout the country, although these are not evenly spread. Irrigation schemes tend to involve high value crops, such as table grapes in the Northern Cape and Hex River Valley or cash crops like fresh vegetables in the Oberholzer District on the West Rand. Accordingly, farmers in these districts usually have several options with regards to crop choices. Furthermore, they may be inclined to switch from one crop to another so as to respond to fluctuating market conditions. Without having the benefit of any closer analysis of the various irrigation districts, if one assumes that only 5% of the irrigation districts are suitable for essential oil production this would amount to 15 potential growing areas. If each growing area, conservatively, included only 200 hectares of production at any one time, this would amount to a total of 3000 hectares under cultivation.

To calculate the potential value of such productive capacity requires further assumptions. There is a large variation in the economics between the various essential oil crops. For the purpose of the current exercise, we have used the basic economics of the "rose geranium".[65] The alternative would be to endeavour to assume some kind of mix or average. It is believed that using an actual single crop is a more transparent manner of estimating the potential size of the industry. In any event rose geranium oil (non-organic) is moderately priced and can be grown in many regions in South Africa. 3000 hectares of cultivated rose geranium would translate to an industry turnover of approximately R125 million per annum, being produced from 150 tons of oils.

[65] See Appendix B for details

Inherent Market Constraints

The possible constraint will be the size of the international market for the products being produced. The market sizes for the smaller essential oils are not readily ascertainable. They range from as little as 10 tons per annum (e.g. Chamomile) to over 500 tons per annum (e.g. Geranium).

In consultation with local market stakeholders it has been determined that the above estimate is not unrealistic if one considers the South African experience to date and the niche nature of some of the oils and the prices that they can fetch (particularly when they are organically certified).

The following table gives an indication of the potential of the South African essential oils industry (in the selected crops) over the next five years:

Table 26: Estimated Potential size of South African Essential Oil industry in five years

Estimated Potential Market Value of Selected Essential oils			
Proposed Primary List of oils	Estimated International Demand (tons per annum)	Estimated Market RSA could command (tons per annum)	Export market price (US$ per Kg)
Geranium	600	50	90
Roman Chamomile	20	0.5	350
German Chamomile	4	0.2	500
Rosemary Oil (cineol type)	150	10	25
Rosemary Oil (verbenone type)	150	10	25
Lemon Balm (Melissa)	0.5	0.2	750
Marjoram	65	1	75
Thyme oil	30	1	75

Basil oil	50	5	30
Lavender Oil	420	25	60
Lavandin Oil	1200	25	30
Lemon grass	2000	5	20
Buchu	6	6	3000

The volume and the value of this suite of essential oil products is approximately 140 tons and at a value of approximately R200 million per annum. It is noted that Buchu is expected to pay a dominant role.

Conclusions

Although, the question of the potential size of the essential oil industry is difficult to estimate, it is considered that an industry of some additional 150 tons per annum is not unrealistic. The value of the industry per annum may well be understated if the higher value crops are targeted for production.

8 SOCIO-ECONOMIC IMPACTS AND BENEFITS

8.1 Job creation

Chemical Sector

The chemical sector employment that could potentially be created by the growth of the essential oil industry would have to be determined from the resulting potential growth of the Flavour and Fragrances industry in South Africa. This would be a long term benefit. However, the secondary beneficiation stage of the essential oil industry has a lot in common with other specialty chemical segments. The types of jobs that would typically be created are those that relate to the Fine and Specialty Chemical sector. According to the Chemical Sector Skills Development Plan, the skills requirements in this sub-sector are process operators, formulation technicians, plant superintendents, warehousing & distribution, engineering & maintenance. The skills development plan further notes that there is also general shortage of R & D technicians in the sub-sector. Besides the general technical skills required, the flavor and fragrance industry (even as it relates to a young essential oils industry) has some additional and very specific skill requirements. The flavour and fragrance formulation industry requires specific skills in the area of chemistry as it relates organoleptic discrimination and analysis. These skills are also required in order to successfully establish the South African essential oil industry.

Agricultural Sector

In addition to the above, one cannot loose sight of the fact that the agricultural component of essential oils industry will have an impact on employment. Some of these jobs include analytical chemists and laboratory technicians.

Agriculture is traditionally a creator of a significant number of employment opportunities for relatively unskilled persons, albeit at relatively low wages. Currently, agricultural accounts for some 6% of South Africa's GDP and 9% of its employment. This is considered low by comparison to other emerging markets.[66] The historic, and continuing, exclusion of the majority of the population from involvement in commercial agriculture is one of the causes for

[66] "Policies to Promote Growth and Employment in South Africa" JD Lewis, July 2001, World Bank, Discussion Paper 16 ,

this. Agriculture and rural development is one of the ways in which South Africa can alleviate poverty and create wealth.

Based on consultation with industry players it is estimated that for every 1 hectare under cultivation one creates 1 semiskilled job and for every 20 hectare unit one creates one skilled job. This is particularly the case where one is wishing to move to organic farming techniques. If one accepts the premise that the potential of the South African essential oil industry (excluding the existing market in bulk oils) could be approximately R125 million originating from some 3000 hectares cultivated, then the industry could create some 3000 semi-skilled and 150 skilled positions. These estimates are similar to those produced by applying the coefficients determined by the World Bank, and derived from the table in Appendix "F". The coefficients set out in the table below apply to each R1 million of output thus providing a job creation estimate across a range of employment categories:

Table 27: Agricultural Job Creation in the Potential Essential Oil Industry[67]

Employment Type	Factor	Jobs
DIRECT JOBS		
Professional	0.08	10.02
Skilled	1.00	125.22
Semi-skilled	16.65	2084.85
Informal	0.69	86.40
TOTAL DIRECT	**18.42**	**2306.48**

8.2 Creation of a production platform for non-food/industrial crops

One of the more interesting, and perhaps significant, potential benefits of developing the essential oils industry in South Africa is that it could provide a production platform for the cultivation of other non-food crops such as indigenous plants grown for the extraction of their flavour, fragrance or medicinal properties.

[67] Coefficients drawn from Appendix "F"

PART 4 – AROMA CHEMICALS DERIVED FROM ESSENTIAL OILS

It is widely understood that South Africa, indeed Africa, has a great many indigenous plants that have potential commercial value. However, in order to exploit these commercially and on an international scale one needs to move from wild-harvesting to cultivation. This is required in order to ensure sustainability, both in terms of quantity and quality. International studies and local experience (e.g. the CSIR) has shown that it is very difficult to bring new botanical extracted products to the international market. Besides having to create the initial demand one is also faced with queries with regards to safety, quantity and quality. These latter issues are only addressed by good agronomic practices and having the infrastructure and skills to manage chemical products.

Essential oils and other non-food crops generally require a higher level of expertise to grow. This requires training and support. The additional complexities and costs constitute a barrier to entry and accordingly a concerted effort is required. This fact has been recognized by the National Department of Agriculture, which, together with Provincial Departments, is investigating the requirements for expanding what they have termed the “industrial crops”. Industrial crops are to be divided into three sections: a) fibre crops (cotton, jute and hemp etc); b) essential oils; and c) medicinals. The Department of Science and Technology has also identified essential oils as an area requiring attention. These departments join TISA (DTI) as government departments recognizing the need to investigate the potential of the essential oils industry.

Since essential oils form an accepted part of the international trade in botanical extracts, the development of the industry would form a good base upon which South Africa could establish itself as a producer of botanical extracts. International literature and experience has shown that commercial production of novel indigenous products is best conducted as part of a broader strategy of positioning the country and its producers as world-class suppliers of related but existing and accepted products. The development of the essential oils industry could be a precursor to a wider cluster of industries bringing high value natural products to the international market, and would have a broader impact than just the flavours and fragrance industry.

9 TECHNOLOGY, INTELLECTUAL PROPERTY, RESEARCH AND DEVELOPMENT

9.1 Standard Technologies

There are several options available for the "extraction" of essential oils from plant material. By far the most common locally (and internationally) is steam distillation. All the crops in Lists A and B of Appendix "D" can be distilled by steam distillation.

In the steam distillation process, steam is generated in a boiler and is piped into the bottom of the still vessel which contains the plant material. As the steam rises through the plant material the volatile essential oils are released and are carried upwards with the steam and pass from the top of the still through a condenser. The condenser is continually cooled by cold water passing through a system of internal tubing. This cools the steam (water and oil mix) into a liquid. The water and oil mixture flow into a separator (usually a Florentine flask) where the oil, generally having a specific gravity less than water, floats to the surface and is collected. The water is collected separately as "hydrolats" and the oil is further "dried" to remove any excess water.

The oil is then bottled in opaque jars (preferably glass or aluminium) and kept at cool temperatures. Most oils suffer a degradation of quality if they are exposed to sunlight or high temperatures.

The key components of a steam distilling unit are:

- The boiler to generate steam ;
- The still for holding the plant material to be steamed;
- The condenser for distilling the steam into oil and water; and
- The separator (usually a Florentine flask) used to separate the water from the oil.

Although the technology is reasonably simple the distillation process needs to be well-managed and there are several factors that can impact on the yield and quality of the oil:

- Besides the harvesting issues (such as time of harvest), there are the post harvest treatment of materials which varies from crop to crop. Some crops benefit from a little drying as this reduces the water content and thereby exposing the oil glands more effectively. Other materials need to be distilled fresh as they quickly degrade and loose their volatile components.

- The heat and pressure under which distillation occurs is important as it can effect yields and the composition of the oil. It is possible to overheat or burn oils and thereby change their composition.

- The time of distillation impacts on cost of production. The efficiency curve for oil extraction implies that a distillation time beyond one hour is inefficient.

- Proper packing of plant material is important to ensure that the steam rises uniformly through the charge. This affects yields.

- A good head of steam and good flow rate are required to achieve good yields.

Accordingly, distillation needs supervision and the parameters need to be measured and matched against the analysis of batches of oil, which then provides feedback on the success of the distillation process.

There is a lot of literature and opinion concerning still design and operation[68]. Detailed information can also be acquired from reputable sources like Agrelek (who provide technical support to those using electricity for agricultural purposes) and those companies that manufacture stills and related equipment.

9.2 Capital and Operating Costs

Costs of a standard distillation unit with a one ton still, with boiler and condenser is approximately R500,000. There are cheaper options but these are not advised. The cost is not a result of the components being imported (they are not), but because they are best made out of stainless steel. The stills are made locally by engineering works. The other components the boiler and the condenser and Florentine flasks are purchased “off the shelf”. There is also an occasional secondhand market for distillation equipment. In some markets, in order to upgrade oil quality and returns to the growers, governments have introduced cheap but effective stills (e.g. Sri Lanka, Indonesia and Bhutan). Consideration could be given to research into a “government issue” still and whether or not this would provide any economic benefits.

[68] See for example Appendix “F” an interesting extract from a consulting report done by CL Green for the Cambodian Government

The running cost of distillation (besides cost of capital) is the labour and the power for heating the boiler. Fuel sources for the boiler include:

- Coal or timber – cheapest if readily available (e.g. Nelspruit region)
- Diesel – expensive therefore needing larger still unit to process economically
- Electricity – is similar to coal provided one is able to process outside the peek tariff times (if not the cost is more equivalent to Diesel).

The distillation costs (excluding capital costs) only make up some 1% of the cost of producing the oil. If one includes the capital costs this rises to almost 30% for a 25 hectare operation. However, once the producer scales up to 50 hectares this percentage drops to around 10%. The estimated cost per charge (one ton still) is R120.[69]

9.3 New extraction methods

All methods of distillation can be performed at above or below atmospheric pressure and this can impact on the composition of the oil. Some oils are deliberately extracted in a vacuum so as to enhance the occurrence of certain chemical compounds. These technologies are used in the secondary beneficiation processes, where further distillation under varying temperatures and pressures, allows for the isolation of selected components of the oil.

In mature oils markets (such as the citrus oil industry) the modern extraction plants are fully computerized and can produce oils whose composition is accurately controlled and which conform to pre-determined standards and end user requirements[70].

Carbon Dioxide-extracted essential oils were conceived during the search for a complete replication of nature by extracting without damage or adulteration. The heat involved in normal extraction does effect the composition of the essential oil. CO_2 when at sub-ambient temperatures is liquid and acts as a natural solvent.

The critical point for CO_2 is at 31^{o}C and at pressure 73.8 bar. Sub-critical Liquefied CO_2 (between -55 and 31 ^{o}C and 5 to 74 bar) behaves as a non-polar solvent. CO_2 operating in the normal working conditions, between 0 and 10 ^{o}C and 50 to 80 bar, acts as a selective solvent. In this range, CO_2 has the density of fluids, low viscosity and the diffusion properties of gas. By varying the temperature and pressure within a range one can be selective about the substrate of extraction. As a solvent, CO_2 is odourless, tasteless, colourless and easy

[69] Parameters provided by Biosys Plant Extracts (Pty) Limited
[70] Swaine and Swaine (1988) Citrus oils: processing, technology and applications. Perfume & Flavourist 13(6), 1-20

to remove. CO_2 is also readily available, cheap and easy to recycle, making operational costs cheap. However the initial equipment cost is quite high. Since the equipment operates under controlled pressures it must be engineered from high quality stainless steel and all welds are x-ray tested. Such equipment can be manufactured in South Africa. A small scale commercial plant is estimated to cost R1.5 million.

Due to the relatively low temperature of CO_2 extraction, the extracts are different from steam distilled oils. The liquid CO_2 extracts also include light fractions of resins, giving the extract and element of an "absolute". In this manner the liquid CO_2 extract is more representative of the original botanical material. Although this is attractive, it does introduce change to the end result and the users of the products in the main are still to be convinced of the relative benefit of the "improved" extracts in the light of the additional costs.

The main benefits of CO_2 extraction may be summarized as follows[71]:

- No solvent residues. Extracts prepared with organic solvents are heated under vacuum to remove the residual solvent. This heating can negatively impact the top notes which evaporate. In some cases to preserve the top notes a residue of solvent is retained.

- No "off notes". During steam distillation the heat causes decomposition of certain materials and generates traces of nitrogen and sulphur compounds. These give unpleasant "still notes". Although these still notes sometimes age and disappear if the oil is kept, this required storage for up to 6 months. CO_2 extracted oils have no such still notes.

- More "top notes". Due to the lower operating temperature the volatile top notes are preserved.

- More "back notes". Since CO_2 extracts the character of the "absolute" – molecular weight 200-400, these components add to the overall character of the extract.

Research on the technology began in the 1960's and reached its peek in the 1980's. The outstanding task for today's researcher is to apply the technology to actual materials and to document the effects and benefits of the technology to industry. Even worldwide, the technology is not used for many essential oil products and in fact is used mostly in specialized food technology applications, such as removing caffeine from coffee beans.

[71] David A Moyler, Liquid CO2 extraction in the flavour and fragrance industries ,Chemistry and Industry, 17 October 1988

In South Africa, the use of the technology is still mostly at laboratory or pilot scale. For example, the University of the North West (formerly, Potchefstroom University) is involved in projects involving Chamomile, Artemesia, Lemon balm and Tswane University of Technology is involved in extracting oils such as Avocado oils. Only Afriplex (Pty) Limited, in the Cape, appears to be using it on a commercial scale (Rooibos extraction). Generally it is considered too expensive and the benefits are not yet demonstrable at the cost.

9.4 Intellectual Property Issues

In respect of the production of essential oils, the intellectual property issues fall into three categories:

- Agronomic
- Distillation
- Market Knowledge

The intellectual property issues are more a matter of trade secrets and are not of the nature of constraints relating to patented processes. On the whole there is a lot of general published information available on crops (even technical information on agronomy and oil composition). With regards to the agronomy the intellectual property is more about lessons learned in the field. Even with regards to distillation, the state of the art is public knowledge and has been for many years. There may be some registered designs where persons have innovated around layout and design. However, the engineering firms that manufacture the stills locally are qualified and experienced in design of this equipment. The other key technology is the steam boiler. This too is old technology and suppliers are able to provide advice.

The true intellectual property in the supply chain rests predominantly in the market knowledge and the ability to interact with Flavour and Fragrance houses. Although this knowledge is not proprietary it is difficult to acquire. To be successful one needs chemistry and organoleptic skills and experience in order to analyze oils and match them to prospective buyers. The essential oils industry, as well other flavour and fragrance segments, requires a unique combination of science and art. Taste and smell are complex senses and different cultures and markets have different requirements. Since the market is “sample” driven it is important to know where to send the particular oil to. Successful players in the market develop a “library” of essential oils and the requirements of the various markets.

Furthermore, there is some scope for the chemist to “rectify” an oil to make it more acceptable. This of course increases profitability.

The area where intellectual property rights issues may arise is the area of the exploitation of indigenous plants, where use is made of indigenous knowledge to arrive at commercial applications. This matter came to the South African public’s attention in the case of the appetite suppressant drug P57 which was derived using the indigenous knowledge of the Khoi people. The developers of P57 were obliged to recognise the interests of the indigenous people. It is now recognised that indigenous knowledge of a plant and its uses represents a significant step and a cost saving in the process of bringing a new product to the world market. At present no legislation exists to cover these issues, but a proposed law to be known as the "Protection of Indigenous Knowledge Act" is being prepared to advance the promotion and protection of indigenous knowledge. [72] The purpose of the act is not to prohibit the exploitation of indigenous plants but seeks to promote and develop the use of indigenous genetic material, by ensuring that the rights of the lawful owners of the initial knowledge are taken into consideration as the plant material is commercially exploited. It is hoped that the proposed legislation will contribute to documenting indigenous knowledge and to providing a platform for commercialisation. The key to the legislation’s success will be whether or not it can provide a clear mechanism for the creation of legally defensible intellectual rights and a mechanism for licensing these rights to commercial entities for commercialisation.

9.5 Research & Development

The potential for research and development falls into several categories. For the purposes of this Study we are not specifically considering the body of research that has to be undertaken or continued with regards to the agronomy of essential oil production, however this is fundamental and cannot be totally ignored. This category would include matters such as:

- The selection of correct plant types for propagation;
- The investigation of pathogens and pests related to each plant species;
- The identification of “organic” methods of pest control and fertilization;
- The investigation of agricultural best practice with regards to planting, cultivating and harvesting

[72] Coetzee, C., E. Jefthas, and E. Reinten. 1999. Indigenous plant genetic resources of South Africa. p. 160–163. In: J. Janick (ed.), Perspectives on new crops and new uses. ASHS Press, Alexandria, VA.

PART 4 – AROMA CHEMICALS DERIVED FROM ESSENTIAL OILS

With regards to the fundamentals of essential oil production (and therefore excluding R&D related to Flavour and Fragrance applications and formulations), the following R&D needs have been identified:

- The development of distillation technologies that are best suited, both technically and economically to the South African environment.

- The development of methods of infield testing (e.g. to measure essential oil qualities in the field, useful in determining the best times to harvest plant material).

- The development of a body of knowledge around South African indigenous plants, as they relate to the F&F industry (particularly information relating to toxicity and allergens).

The first category concerns the development of standard distillation unit designs that suite South African conditions, mostly with regards to fuel sources and their method of use in the field. As has been stated previously the technology is public knowledge. However, there has been some learning with regards to dimension and configuration of units. The cost issue also needs some attention. Most stills have been built to user specification by an engineering works. Unless there is a larger demand for units it is unlikely that anyone will try and improve the still production process and reduce costs. This could be an area for some R&D spending in conjunction with a reputable engineering works and industry players. Another area is the design and production of mobile or portable stills. Various industry players (e.g. Teubes and Biosys) are considering this because the initial cost of a distillation unit is a barrier to introducing a new producer to the essential oils industry. The economics of such a mobile unit require that it be quite large and therefore requires significant innovation to optimize the design. In addition, the Consultant was advised that there was a minor issue which may be of some significance in projects where there is water scarcity. The condensing process relies on cold water. Unless the cold water is chilled it cannot be recycled and is disposed of. Some technically advanced installations have chillers and the water is recycled, alternative use is made of cooling towers. On some projects the warm water is simply disposed of and fresh cold water is used. This may not always be economically or environmentally appropriate. This matter may require some research.

The second category is concerned with addressing the problem that farmers face in the field. With most other crops the farmer can assess progress by physical examination of the plant or fruit. With essential oils there can be a marked difference in the yield and composition of the oil from one season to the next. Moisture, daylight and temperature can all significantly impact on the important components of the oil. International Industry expert, Brian Lawrence (who has a regular column in the Perfumer & Flavorist) routinely publishes comparisons

between various oils which show the huge variances in characteristics, often within the same crop but under different conditions or time of year. Since the quality of the oil is the farmer's main concern it would be helpful if ways could be found to give the farmer the ability to check the presence of certain of the key chemical components in the field. The process of getting a full laboratory analysis is costly and time consuming.

The third category is the most important of all, particularly if the end objective is to exploit the indigenous crops internationally. There has been a recent spate of legislation in the major international markets, which is aimed at regulating the inclusion of chemicals in food stuffs and other products used by people. This has been widely reported on[73]. As an example, the European Union (South Africa's largest trading partner for most essential oil products) has introduced labelling requirements that have caused large manufacturers to insist that the Flavour & Fragrance houses only include permissible ingredients in their formulations. This has introduced an additional element of conservatism into the Flavour & Fragrance industry. The main issues are toxicity and allergens. The majority of additives (be they flavors, colors or fragrances) are listed as to whether they are GRAS (Generally Regarded As Safe) or not. The process of GRAS is more or less like the process negating toxicity in clinical trials for pharmaceuticals. In addition, the EU has identified 26 allergens, 16 of which are present in essential oil products. A list of the essential oils and their percentage content of allergens is attached hereto as Appendix "E". Other key standards are those set by FEMA, which was established by industry in the USA to promote self-regulation in respect of additives used by food manufacturers. In the light of the above and in order to graduate from a raw material supplier to a knowledge based industry, it is necessary for South Africa to develop skills and knowledge concerning the international standards and to have its own processes for investigating and analyzing the chemical composition of local plant extracts and materials destined for Flavor and Fragrance application, particularly where this may be destined for the international markets. If these skills are not developed South Africa will remain a mere producer of raw materials, as opposed to being a quality supplier of flavour and fragrance compounds. A proactive approach would give local producers a platform for negotiations and provide buyers with added confidence in the industry. This approach would generally help South Africa establish itself as a serious player in the essential oils market.

9.6 International R&D - Case Study

The Australians are known for the deliberate manner in which they tackle development matters. Their treatment of the essential oils industry is no exception. Essential oils is a relatively new industry for Australia (other than eucalyptus oils). The Australian Rural Industries Research & Development Corporation (RIRDC) is a Government organization that

[73] Perfumer& Flavorist March/April 2004

promotes rural industry in Australia. In 2002, the RIRDC published its R&D Plan for Essential Oils and Plant Extracts for the period 2002-2006. The Essential Oils and Plant Extracts Programme has been running since 1990 and for the period 1990 to 2001 some A$ 11 million has been spent on about 70 projects falling into five research categories:

- Production (industry competitiveness – agronomy)
- Processing (value addition – extraction and processing)
- Training and development (encouraging associations, workshops etc)
- Communications and technology transfer (promoting adoption of research findings raising the general standard of industry through shared information)
- Markets (gathering market information and promoting sales and recognition of quality)

The content of the RIRDC Plan and the fact that it exists at all is of interest. The previous plan had dealt with the issues of:

- Increasing productivity (through plant breeding, agronomy and plant protection)
- Improving harvesting and post-harvest handling, and extraction
- Establishing a stable grower base
- Implementing quality assurance and control programs.

The priorities identified for the next period (i.e. for 2002-2006) were:

- Improved market information (particularly future trends)
- Improved products (encourage development and distribution of improved genetic material)
- Improved production systems (especially pest/weed/disease control)
- Regulatory approvals (regarding indigenous products, assist registration through organizations such as FEMA, by providing research information)
- Improved post harvest treatment of plant material (improve quality by sophisticated extraction and treatment so as to differentiate from low cost competitors)
- Develop the industry (overcome effects of fragmentation by supporting growers organizations, improved communication and setting of national standards)

The RIRDC had originally focused on some seven essential oil crops but has generated a secondary list of some twenty more that are now to receive more attention (interestingly the secondary list includes Buchu).

PART 4 – AROMA CHEMICALS DERIVED FROM ESSENTIAL OILS

The content of the RIRDC Essential Oils and Plant Extracts Program illustrates that the issues facing the South African industry are similar to those faced in other nations. What is challenging is the concerted effort that some nations put behind fledgling industries, not necessarily by way of subsidies or price protection but by helping create capacity, knowledge and competitive advantage. One of the key features of the RIRDC Program is the policy that there is full disclosure and dissemination of research findings, with the expressed objective of raising the overall knowledge-base of the local industry. It is suggested that South Africa adopt this type of approach to attractive industries such as the essential oils industry and other non-food crops.

10 ENVIRONMENTAL ISSUES

The primary impact of essential oil production is agricultural. Accordingly, the main environmental impact is during the agricultural stage. Although this stage of production falls outside the scope of this study the following points are noted:

- Soil erosion caused by poor agricultural practices;
- The use of non-organic fertilizers and pesticides;
- The impact of agriculture on natural fauna and flora; and
- Water usage.

None of the above are unique to essential oil crops and are dealt with already by the Departments of Agriculture and Environmental Affairs.

One environmental matter that does arise in respect of essential oils, where these are derived from cultivating indigenous plants, is the problem of introducing foreign plant materials into an area. This can negatively impact the biodiversity and integrity of eco-systems. This matter is currently adequately controlled by a system of permits, however it may require additional consideration if this segment of the industry were to grow significantly.

In the later stage beneficiation the handling of chemical compounds may have some environmental impacts but these are negligible and there are no high volume waste streams.

11 KEY SUCCESS FACTORS

As a result of the Study, the Key Success Factors (KSF's) , set out below, have been identified. These KSF's are critical to the successful development of the South African essential oil industry.

1. There must be a sustainable and significant **quantity** of essential oil being produced. Each oil has it critical mass, at which point a local supplier/s will get the attention of an international buyer. This requires:

    - Availability of good genetic material
    - Good production systems (nutrition and plant care)
    - Good post harvest treatment
    - Good distillation practices
    - Good storage and handling practices

2. The essential oils must be consistently of the correct **quality**. Besides the horticultural issues, there needs to be careful quality control with no indication of adulteration, contamination or degradation. The delivery of poor quality oils is unforgivable. The requirements here are similar to those relating to quantity. The two aspects go hand in hand.

3. There must be a **market focus**. For technical and marketing reasons, it is important for local players to have a good knowledge of the international industry. It is important to cultivate close relationships with international buyers, particularly the dozen or so large flavour and fragrance houses. The industry is characterised by close relationships and high levels of trust. Although "breaking into" a market may be difficult, once one is an accepted supplier customer loyalty is possible to maintain. Long term relationships must be valued over short term sales considerations. This requires:

    - A good reputation in the market place, both as individual companies and as a producing region (committed for the long term)
    - Knowledge of regulatory parameters and trends
    - The setting of national quality standards and testing procedures
    - Understanding of the market dynamics, nuances and segmentation
    - National marketing campaign and international presence

4. There must be a high level of **technical service**. The difference between suppliers of raw materials and suppliers of an end product is the knowledge requirement. With sufficient investment in chemistry and organoleptic skills and experience it is possible for a supplier to become a partner and thereby share in the knowledge and the rewards of the downstream industry. This requires:

    - Local commitment to ongoing research and development
    - Local commitment to skills development and training

In addition to the aforegoing, and as an illustration of how others view the industry, Biosys Plant Extracts (Pty) Limited has identified a number of key success factors[74] in establishing an essential oil business in South Africa. These are:

- Obtaining reliable market and technical information during the early stages of the project.
- Obtaining the planting stock with the correct genetic characteristics to obtain the oil with the correct chemical composition and in sufficiently high yields.
- Establishing a sufficient critical mass to form relationships with overseas buyers in international markets.
- Consistent quality and specifications of the essential oil
- Understanding the cyclical nature of the profitability of the local and international essential oil market.

Furthermore, in contrast, the American FOA has identified the following as the most crucial challenges faced by most developing countries endeavouring to grow industries in non-wood forest products (which of course can be converted into key success factors, which are captured above):[75]

- Poor harvesting (indiscriminate) and post-harvest treatment practices;
- Lack of research on development of high yielding varieties, domestication etc;
- Inefficient processing techniques leading to low yields and poor quality products;
- Poor quality control procedures;
- Lack of R&D on product and process development;
- Difficulties in marketing;
- Lack of local market for primary processed products;
- Lack of downstream processing facilities;

[74] www.biosys.co.za/genintro.htm
[75] "Processing, refinement and value addition of non-wood forest products" T de Silva and CK Atal, FOA

- Lack of trained personnel and equipment;
- Lack of facilities to fabricate equipment locally;
- Lack of access to latest technological and market information.

12 CONCLUSIONS

South Africa has a long involvement in the essential oil industry with regards to the production of major essential oils like eucalyptus and citrus oils, supplying some 5% and 2% of the world market respectively. These industries are however under severe pressure from the low cost producers (e.g. China and Brazil) and the strengthening of the Rand. South Africa has a fledgling essential oils industry in the production of the higher value minor essential oils (e.g. geranium, chamomile and lavender) that was pioneered by the CSIR.

It is estimated that South African production of essential oils and related plant extracts is between R 60 - 100 million, of which only R 10 - 15 million is attributable to the minor essential oils. Although there are some 100 local producers, only a dozen commercial producers and a couple of development projects consistently supply the market. The number of operational distillation units is estimated between 30 and 40, many of which are too small for economic production. Locally produced essential oils are generally sold to two or three of the local companies that have been able to penetrate the international export market. Low volumes of smaller quantities of oil are sold into the growing local aromatherapy market.

It is widely accepted that South Africa has many indigenous plants that have potential commercial value. However, to exploit these commercially on an international scale one needs to move from wild-harvesting to cultivation in order to ensure sustainability, in terms of quantity and quality. There is a common misconception that there is a ready market for new and novel products. The reality is that the market is very conservative and market acceptance of a new product must be coupled with an intensive development programme. The initial demand must be created, and issues such as safety, quantity and quality addressed. With regards to essential oils from indigenous plant materials, there are several plants showing some promise, including Artemesia and Cape Chamomile. However, it is only Buchu that has enjoyed any international success. Shortage of supply and an over-reliance on wild harvesting has however placed this industry under pressure in recent times.

The Study concluded that before a new producer can commercialise new aroma, fragrance and flavour compounds from indigenous plant material, it must first establish itself as an internationally recognized producer of accepted essential oils. The establishment of an essential oil industry in South Africa could therefore be seen as “school fees” in the creation of a longer-term indigenous aroma chemical industry.

Although there are no unique grounds upon which South Africa can claim competitive advantage in the global essential oils industry, there is a combination of factors that are in South Africa’s favour. These include:

- Being in the Southern Hemisphere – many growing regions are in the Northern Hemisphere; the seasonal effect makes Southern Hemisphere suppliers attractive.
- Traditional strong trade links with Europe, a major importer of flavour and fragrance materials.
- Being established as a world class agricultural producer in a wide range of products.
- A diverse climate with a range of biomes - thus allowing for a good selection of essential oil crops to be grown.
- Good quality soils – being largely uncontaminated by centuries of exploitation as is the case in the developed world.

However, in spite of these competitive advantages and substantial interest from international buyers, South Africa has not yet established itself in the international essential oils market.

The CSIR initiated the interest in the essential oil industry almost ten years ago, doing research work in conjunction with local commercial farmers. However, over time various technical difficulties were encountered and many producers began to feel that the CSIR's consulting terms were too onerous. As a result, an independent association, the South African Essential Oils Producer Association, was formed in 2000 in the Mpumalanga Province and now has a branch in each of the Kwazulu Natal and Western Cape Provinces. The Association has achieved some nominal success, but is generally considered by stakeholders to be under funded and disorganised. The Association endeavours to provide basic production information and support to growers. The Association has identified that the main industry constraints are achieving sufficient production volumes, so as to attract international buyers, and access to chemical analytical facilities to monitor and control quality.

The CSIR has reduced its involvement significantly, although it retains some peripheral involvement in that it supports some community development projects (e.g. Giyani in the Limpopo Province). No one organisation has taken over the CSIR's role as lead agent in promoting the essential oil industry from a research and development perspective. Each of the Agricultural Research Council and the National Botanical Institute has some peripheral involvement (the later in the case of indigenous plant species). There are several other institutions, most linked to Universities (such as the Natural Resource Institute at the University of Kwazulu- Natal), which have ad hoc programs that producers can draw support from. However, there is no concerted public research and development program and practically no publicly available information. There are various Government Departments (inclusive of the Department of Industry, the National Department of Agriculture and the Department of Science and Technology) that have newly established posts focusing on the essential oil industry, but these have not yet been co-ordinated. The fragmentation and lack of co-ordination in the industry are constraining factors on the growth of the industry.

One of the major contributing factors for the abovementioned fragmentation is that the essential oils industry falls across two industry sectors (the agricultural and chemical sectors). This has lead to some confusion as to how, and by whom, the industry should be supported.

The Study's analysis of the essential oil value chain identified four separate stages. It is not possible to consider the creation of an essential oil industry in South Africa without considering the complete value chain.

1. **Agricultural - Crop selection and Crop Cultivation**
   A large component of the value chain is agricultural. Industry stakeholders are unanimous in their view that unless the volumes of quality oils are increased the economies of scale required to encourage later stage innovation and beneficiation of essential oils will not materialise.

2. **Primary Processing (e.g. Drying, distillation)**
   This first step is aimed at achieving the best quality and quantity of product. Although the primary process currently utilized in South Africa is steam distillation, there is a trend internationally towards more sophisticated extraction processes. Although technology associated with primary distillation is relatively simple, good distillation practices are required to ensure the best yields and quality of oils. Furthermore, without fully understanding the manner in which the distillation process can affect quality it is not possible to improve processing thereby optimizing quality.

3. **Secondary beneficiation (e.g. Rectification, Fractionating, Formulations)**
   This area distinguishes a world-class supplier of essential oils from a mere "bulk producer" of essential oils. The strength of a local industry is therefore dependent on its ability to integrate its activities directly with the international flavour and fragrance houses. This requires continued exposure to the international players and an increasing level of technical sophistication.

4. **Sales and marketing**
   Most end users have a very specific specification for their ingredients and formulations are often developed around a certain source of the ingredients. "Breaking" into this market is therefore difficult. However, once relationships have been developed stability of off-take is assured, provided that the specifications continue to be met.

The issues confronting developing countries endeavouring to upgrade their essential oils industry are very similar. Analysis of these issues as well as the value chain above, has led

to the identification of a number of critical success factors for the development of a successful essential oils business and industry.

1. There must be a sustainable and significant **quantity** of the correct **quality** essential oil being produced. Besides horticultural issues, there needs to be careful quality control. Each oil has a minimum level of production (before international buyers will seriously consider a commitment) requiring the availability of good genetic material, production systems, post harvest treatment, distillation practices and storage and handling practices.

2. **Market focus** is critical. Close relationships with international customers, particularly large flavour and fragrance houses, are essential. This requires a reputation in the market place (both as individual companies and as a producing region committed for the long term), knowledge of regulatory parameters and trends, industry quality standards and testing procedures, and understanding of the market dynamics.

3. There must be a high level of **technical service**. Substantial chemistry and organoleptic skills and experience are required. This requires local commitment to ongoing research and development as well as skills development and training.

Consideration was given to the selection of essential oils that would make attractive options for commercial production in South Africa. Whilst it is theoretically possible to perform an economic analysis of all the oils that could potentially be grown in South Africa and then to rank these by profitability, there are so many variables that the exercise would be largely academic. Furthermore, agricultural decisions are quite complex.

The Study has therefore focused on the creation of a long-term sustainable producer base for a wide range of oils and compiled a Primary and Secondary list. The Primary List contains the mainstream crops with sufficient market knowledge and technical support available to see success in the short-term. The Secondary List contains oils that may be of interest to broaden the production base in South Africa. The list excludes bulk oils (such as eucalyptus and citrus) as South Africa already has a significant presence in these markets. Based on these lists, it is estimated that South Africa could generate an additional R125 million per annum in turnover over the next three to five years. Job creation resulting from the development of this industry will predominantly be in the agricultural sector; however it will provide approximately 10 jobs in the downstream chemical processing areas of analytical chemists, laboratory assistants and process operators.

Table 28: Proposed list of attractive essential oil crops

Proposed Primary List	Proposed Secondary List
Geranium Roman Chamomile German Chamomile Rosemary Oil (verbenone type and cineol type) Lemon Balm (Melissa) Marjoram Thyme oil Basil oil Lavender Oil Lavandin Oil Lemon grass Buchu	Spearmint Peppermint Parsley Seed Jasmin Tuberose Marigold Celery Seed Vetiver Cassie (Mimosa) Yarrow Dill Tarragon Coriander Fennel Vaerian Helichrysuam

The Study has therefore concluded that the further development of the essential oil industry would be a valuable complementor to an Aroma and Fine Chemical industry. Furthermore, the essential oil industry could act as a precursor to the successful commercialisation of a wider range of South African indigenous plant products. Whilst the basis for a profitable and sustainable essential oils industry in South Africa already exists, the industry has not yet reached critical mass and is not sufficiently mature enough to gain international prominence. However, there is a real opportunity to develop this industry in South Africa.

In order to realize this opportunity, the industry must be better supported. The consensus amongst industry players is that Government has a key role to play in developing the industry. This would primarily involve the areas of research and development, and the development and enhancement of education and information systems.

13 RECOMMENDATIONS

The essential oils value chain traverses a couple of industry sectors. The agricultural aspect of the value chain is the primary production platform for essential oils. Therefore, in order to do justice to the whole value chain, recommendations regarding the agricultural component are also presented.

Strategic Intervention: To motivate that the Government adopt a uniform and coordinated approach towards the development and financing of the essential oil industry, including the creation of a joint forum in which to formulate policy and strategy.

Specific strategic recommendations: Agricultural Issues

1. Clarify the role of Governmental Departments (for example, Department of Trade and Industry, Department of Science and Technology and National Department of Agriculture) with respect to their roles in the development and support of the essential oil industry.

2. Clarify the role of Governmental research institutions (for example, the National Botanical Institute, the Agricultural Research Council and the CSIR), with respect to essential oils and determine the manner in which the outputs of their research may be made available to the South African public.

3. Prepare an inventory of all information, relevant to essential oils, housed within government institutions including information relating to indigenous plant materials and their extracts.

4. Create a central database that allows South Africa to manage its knowledge base with regards to essential oils (and other potential non-food crop types) including information relating to the selection of plant material, results of growing trials, studies relating to the economics of essential oil production, chemical composition of plants and their extracts, etc.

5. Consider the development and support of regional producer centres, which will promote a multi-disciplinary approach to essential oil production. These should take advantage of the synergies afforded by the presence of tertiary institutions (producing graduates in agriculture, botany or chemistry and having laboratory facilities), the presence of suitable growing conditions and the presence of committed producers.

6. Consolidate any initiative regarding essential oils into a broader rural industries development strategy. Reference should be made to the experience of other countries, such as Australia's Rural Industries Research and Development Corporation.

7. Ensure publicly funded research is conducted with a view to determining and setting standards with regards to such factors as (1) the correct geno-types, (2) the correct growing conditions, (3) the correct harvesting and post-harvesting procedures (4) best practice with regards to distillation. Research could be conducted on the basis of public private partnerships where producers become "crop champions" for public research purposes. The results of such research should be publicly available to allow for the expansion of the industry and to promote international confidence in the South African industry. It should also form the basis for the development of skills training and development materials.

8. Establish a national or regional system of plant material banks to ensure that quality plant material is available for local production. This responsibility could be allocated to agricultural colleges and Agricultural Research Council divisions, probably part of the regional producer centres.

9. Develop courses in Good Agricultural Practices, particularly for previously disadvantaged communities, and particularly with regards to good harvesting and post harvesting practices, which can have significant impact on the yields received and the economic viability of the enterprise.

Specific strategic recommendations: Primary Beneficiation

1. Provide technical assistance and training in respect of the operation of distilling equipment, particularly with regards to quality control.

2. Support research into new extraction processes such as super critical fluid extraction with a view of developing a new extraction enabling technology.

3. Conduct research and development work in respect of cost effective "in-field" chemical analysis techniques.

Specific strategic recommendations: Secondary Beneficiation

1. Develop a national system of standards (corresponding to the ISO standards, but adapted where necessary) or a voluntary industry standard, which will promote the production of good quality oils. Standards should relate to the oils themselves and to the testing procedures. This could also include a voluntary certification process.

2. Create a national database for oil profiles and GC "fingerprints". This would be particularly useful in respect of indigenous plant extracts. This should go hand in hand with the generation of research that would support the registration of products with international regulatory bodies. South Africa could perhaps partner with a large trading partner like the European Union in the development of this competency.

Specific strategic recommendations: Marketing and customer relations

1. Consideration should be given to how best to prepare and publish essential oil production and trade statistics.

2. Develop an appropriate national marketing strategy for the industry.

Specific strategic recommendations: Commercial issues

1. Consult potential funding sources (such as the Landbank and the IDC) in the formulation of policy and strategy for the development of the essential oil industry.

2. Review the existing community projects, supported by government, in order to document the lessons learned and to assess their long-term viability.

3. Consider applying co-operative structures to the development of the essential oils industry, particularly as a vehicle for rural development initiatives as they combined individual initiative with communal support and co-operation.

4. Identify businesses involved in the secondary beneficiation stage for support in regional incubators. These could include businesses involved in the production of both synthetic and naturally derived chemicals.

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APPENDIX "A"

SAMPLE SAEOPA FACT SHEET

LEMON GRASS		
ESTIMATED INPUT COSTS PER HECTARE		
SOIL PREPARATION: estimated costs for 1 hectare. 1 Week soil preparation with standard tractor		
Fuel 5 litres/day = 25 litres @ R4,00 /litre Labour @ R120/day for tractor driver Fertiliser	R 100,00 R 600,00 R6 000,00	R 6 700,00
PLANTING		
50 000 plants @ R1,00/plant Labour 5 persons/day for 5 days @ R35/person d/day Water 2 kilo litres/day @ R4,00/kilo litre	R50 000,00 R 875,00 R 40,00	R50 915,00
TOTAL ESTIMATED ESTABLISHMENT COST (for the first hectare)		R57 615,00
THEREAFTER ESTIMATED COSTS PER HECTARE		R 7 615,00
IRRIGATION COSTS PER HECTARE		
Hosepipes* Drip Irrigation Floppie		R 9 050,00 R 9 000,00 R15 000,00
***Estimated costs for hose pipe irrigation**		
250m Dragline @ R50/metre Labour for one year @ R650/month	R1 250,00 R7 800,00	
ANNUAL MAINTENANCE COSTS 1 p/ha	R7 800,00	
Water 4 kilo litres/month for 6 months	R 100,00	R 7 900,00
ESTIMATED RETURNS ON INVESTMENT - 25 ha		
ESTABLISHMENT COSTS		
Year 1 Plant 1 ha and propagate plants Maintenance Year 2 Plant 25 ha Maintenance Year 3 Commence with commercial harvesting Maintenance Year 4-8 Commercial harvesting Maintenance	R 57 615,00 R 7 900,00 R190 375,00 R197 500,00 R197 500,00 R987 500,00	

TOTAL ESTIMATED COSTS		R1 638 390,00
ESTIMATED RETURNS		
Year 3 : 1 ha @ 30 tonnes/ha/annum lemon grass	R 22 950,00	
Year 4: 25 ha @ 30 tonnes/ha/annum	R 573 750,00	
Year 4- 8: 25ha x5 @ 30 tonnes/ha/annum	R2 868 750,00	
TOTAL ESTIMATED RETURN		R3 465 450,00

APPENDIX "B"

CSIR BASIC ECONOMIC RETURNS

The CSIR has supplied the following economics (*2002 figures and assuming R/$=9.8):

Non-organic geranium oil:

Plant material (kg/ha/annum)	40 000
Oil yield (%)	0.13
Oil yield (kg/ha)	45
Farm gate price ($/kg)	60
Annual income (R/ha)*	28 460

Lavender oil:

Plant material (kg/ha/annum)	4 000
Oil yield (%)	0.8%
Oil yield (kg/ha)	32
Farm gate price ($/kg)	75
Annual income (R/ha)*	23 520

Lavandin:

Plant material (kg/ha/annum)	4 500
Oil yield (%)	1.5
Oil yield (kg/ha)	65
Farm gate price ($/kg)	35
Annual income (R/ha)*	22 295

Organic Roman chamomile:

Plant material (kg/ha/annum)	6 000
Oil yield (%)	0.23%
Oil yield (kg/ha)	13.8
Farm gate price ($/kg)	280
Annual income (R/ha)*	37 887

Organic German chamomile:

Plant material (kg/ha/annum)	3 000
Oil yield (%)	0.15
Oil yield (kg/ha)	4.5

Farm gate price ($/kg)	550
Annual income (R/ha)*	24 255

Organic peppermint oil:

Plant material (kg/ha/annum)	20 000
Oil yield (%)	0.30%
Oil yield (kg/ha)	60
Farm gate price ($/kg)	25
Annual income (R/ha)*	14 700

Organic spearmint oil:

Plant material (kg/ha/annum)	20 000
Oil yield (%)	0.30%
Oil yield (kg/ha)	60
Farm gate price ($/kg)	25
Annual income (R/ha)*	14 700

Lemon grass oil:

Plant material (kg/ha/annum)	30 000
Oil yield (%)	0.30%
Oil yield (kg/ha)	90
Farm gate price ($/kg)	28
Annual income (R/ha)*	22 932

These revenue economics with a reasonably accurate cost figure per hectare may be used as a rough estimate to determine economic feasibility.

APPENDIX "C"

CHECK LIST FOR BUSINESS PLAN DEVELOPMENT

A. Initial Capital Outlay

A1.Distillation unit

- A commercial sized distillation unit (i.e. one ton still with boiler and condenser, covered site and mechanical hoist)) will cost in the region of R500,000. If production increases (usually above the 25ha mark) one can add an additional still. There are cheaper options (for example using mild steel instead of stainless steel or using a water/steam option instead of direct steam) however these significantly reduce yield quantities and qualities.
- The cost of the initial outlay is often enough to dissuade a farmer from entering the industry.
- For this reason, buyers who contract with farmers consider either assisting with financing or owning the unit (as in the case of a mobile distillation unit). Fixed distillation units are considered preferable and more cost effective in the long-run.
- Trials and pilot sits may be conducted without the construction of a distillation unit as material can be harvested and transported to an existing facility for the initial distillation for test purposes.
- Many farmers share distillation facilities with their neighbors on a contract basis.
- Generally speaking transporting material over 10 to 15 Km becomes uneconomic.
- Where there are sufficient farmers it is possible to run a distillation unit as a separate going concern – however producers do like to be in control of the distillation process as this impacts on yields and quality and therefore their returns.
- The boiler component of the distillation unit can be powered by electricity, diesel or coal/wood. This is most often driven by availability of fuel. However this can affect operational cost and therefore the cost per kilogram of product. Generally coal or wood is the cheapest and diesel the most expensive.

A.2 Irrigation

- If this has to be set-up from "scratch" it too can be a huge barrier to entry.
- Where water is readily available it generally costs between R10,000.00 to R15,000.00 per hectare to put in irrigation. Irrigation options are numerous ranging from flood irrigation to drip irrigation and centre pivots.
- The irrigation system will require maintenance and replacement over time.

- The irrigation system's pumps will be powered by diesel or electricity.

A.3 Equipment

- Basic equipment such as tractor, trailer and plough are required. This may cost some R300,000 to R500,000 if this equipment must be acquired.

A.4 Field preparation

- Generally speaking 50 000 to 80 000 plants are required per hectare.
- Planting is generally from seedlings, but in some cases (like Peppermint) this is done from seed.
- The initial seedlings can vary in price from a few cents to a few rands depending on scarcity of supply. It is customary for each farmer to create a nursery block to propagate seedlings for expansion. This can be done with the pilot phase.
- It takes a minimum of two years to move from pilot phase to the commercial phase. Perhaps even longer (three to five years)
- The land is prepared with fertilizer which costs within the region of R3000 to R6000 per hectare.

A5.Consulting/Training

- As with most specialized crops there is a need for training and consultants (this relates to the horticultural, plant nutrition and pest control aspects).
- In addition there is the need to liaise with buyers and those that know what qualities the market is looking for in an oil. This also involves period testing and interpretation of test results. The cost of a basic GC analysis as R400 per report. Consultants may charge up to R1000.00 to perform an analysis and to provide an interpretation of the results.

B. Ongoing Operational costs

B.1 Cultivation

- Labour costs are determined largely by the size of the area under crops, the extent to which it is mechanized and whether or not the production is "organic".
- Most often farmers begin with conventional farming methods and then transition to organic farming once they have a better understanding of the crops. There is an increase in labour costs during this transition but there is usually a drop in fertilizer costs.

- Organic crops fetch premium prices and lend themselves to labour intensity. This would form a good basis for a community project, provided that the horticultural skills are present.
- Fuel costs (diesel for tractors) and implement maintenance.
- Fertilizers and pesticides.

B2. Harvesting

- The main costs are labour and fuel.
- Some crops lend themselves to mechanical harvesting, others not.

B3. Distillation

- The main cost of distillation is the power. The source of power effects the costing, with coal being the cheapest and diesel the more expensive. However, on the whole distillation operating costs account for only 1% of the cost of the oil.
- Labour required is that involved in loading and unloading the vessel and then a supervisor supervising the distillation process.
-

B4. Tests

- Test of oil can be quite costly (R400/ per analysis).
- Many farmers also pay consulting fees for advice on their oil production.

C. Revenue Considerations

- The first parameter is the tonnage of plant material produced per hectare per annum. The South African climate must be used well, i.e. the possibility of getting 3 to 4 harvest a year must be exploited.
- Consideration must be given to interruptions associated with replanting either at the end of the economic life or upon crop failure.
- Furthermore, consideration must be given to a mix of crops to further increase productivity of other fixed assets (other than land, i.e. spread distilling across different periods) and to hedge against price fluctuations.
- The yield is the next key parameter. Depending on the crop yields can range from 0.1 to 2% of original plant material. If yields are increased the economics can be significantly improved.
- Organically certified oils earn premiums.
- One must taken into account currency exchange rates and distinguish between Euros and Dollars (being the currencies of the two main trading partners). These should be taken into account on any sensitivity analysis.

- Another consideration is timing, i.e. can the producer afford to store production and wait for an increase in prices.

APPENDIX "D"

SELECTION OF ESSENTIAL OILS FOR COMMERCIALISATION

List "A"	List "B"	List "C"
Geranium	Parsley Seed	Geranium
Roman Chamomile	Camomile	Roman Chamomile
German Chamomile	Peppermint	German Chamomile
Rosemary Oil (verbenone type and cineol type)	Lemon Grass	Lemon Balm (Melissa)
	Jasmin	Rosemary
Lemon Balm (Melissa)	Lemon Balm	Sweet Majoram
Marjoram	Marjoram	Thyme
Thyme oil	Thyme	Basil
Basil oil	Basil	Spearmint
Lavender Oil	Lavender	Peppermint
	Tuberose	Yarrow
	Buchu	Lemon grass
	Marigold	
	Celery Seed	
	Vetiver	
	Spearmint	
	Cassie (Mimosa)	
	Yarrow	
	Dill	
	Tarragon	
	Coriander	
	Fennel	
	Lavindin	
	Vaerian	
	Helichrysuam	

APPENDIX "E"

WORLD BANK
Sectoral Labor/Output Coefficients, 2000[76]
(Workers/million R)

Sector	Professional	Skilled	Semi – skilled	Informal	Total
Agriculture, forestry, and fishing	0.08	1.00	16.65	0.69	**18.42**
Mining and Quarrying	0.25	1.16	6.01	0.29	**7.71**
Food Processing	0.16	0.66	1.11	0.07	**2.00**
Textiles and apparel	0.52	1.82	9.28	0.45	**12.07**
Leather Goods and Footwear	0.27	0.63	6.61	0.29	**7.79**
Wood and Furniture	0.36	2.08	5.77	0.32	**8.52**
Paper and Printing	0.48	1.46	1.23	0.12	**3.30**
Petroleum products	0.15	0.25	0.30	0.03	**0.72**
Chemicals	0.42	0.68	0.82	0.07	**1.99**
Rubber, Glass, plastic	0.23	0.62	1.55	0.09	**2.49**
Basic Metals	0.22	0.66	1.19	0.08	**2.14**
Electricity and, gas and water	0.37	0.56	1.38	0.56	**2.87**
Construction	0.26	1.10	3.52	3.97	**8.84**
Machinery and Equipment	0.55	1.30	2.62	0.17	**4.64**
Trade	0.75	3.37	1.37	1.36	**6.85**
Tourism	1.12	9.27	1.80	0.47	**12.66**
Transport and Storage	0.18	1.30	0.66	2.43	**4.57**
Financial & business service	0.70	2.32	0.14	1.12	**4.28**
Medical and health service	1.08	1.08	0.10	0.45	**2.71**
Social and personal services	3.36	5.40	23.43	15.36	**47.55**
General gov. and Other products	6.53	8.09	2.51	0.37	**17.50**
Total	**1.01**	**2.25**	**2.95**	**1.21**	**7.42**

[76]Source: South Africa CGE model, published in "Policies to Promote Growth and Employment in South Africa" JD Lewis, July 2001, World Bank, Discussion Paper 16

APPENDIX "F"

Extact from Report :Export Development of Essential oils and Spices by Cambodia, CL Green (Feb 2002)

General design and operation considerations for distilleries

The following notes summarise some key topics.

Construction materials
The entire distillation unit may be constructed of mild steel and this is adequate for those oils which do not react and discolour with iron or are subjected to further processing.

A complete stainless steel unit is the option of choice for long equipment lifetime and for production of 'clean, water-white' oils.

Many distillers a compromise on construction material cost vs. oil buyers' quality needs by employing stainless steel in those parts of the unit which come into contact with oil vapour (the lid, condenser and collector) and using mild steel for the distillation vessel.

Vessel Lids
One of the common problems with most distillation vessels is that the lid is attached by bolts and with a gasket seal. The gasket usually wears out before the end of the season and steam escapes.

It is preferable to employ a 'water seal' lid that rests in a trough of water fitted to the outer top of the vessel. The advantages are no wear, ease / speed of fitting and removing the lid and, not least, safety. If pressure rapidly builds up within the vessel, it discharges safely by bubbling out through the water.

Condensers
Simple condensers can be made of a length of large bore pipe (straight, zigzag or coiled) that is immersed in a water tank. Efficiency is moderate to poor, especially with short pipes and static water tanks.

Modern condensers are of multi-tubular design and are fed with piped water. These are very efficient, easy to clean but are comparatively expensive to manufacture and need a pump for the cooling water.

It should be noted that new operators tend to run the condenser temperature far too cold and this results in poor oil and water separation in the Florentine collector flask with oil losses in the discharge water. The best oil separation occurs in warm-warmish water between 21-28^{o}C, according to the specific oil.

Florentine oil flasks

Inexperienced manufacturers tend to make oil collection flasks too small. They ignore the fact that the valuable product can be lost in the wastewater as a result of the inevitable variable distillate effluent rate, turbulence and poor oil separation. As a general rule, always use a collector much larger than is theoretically necessary.

The requisite size of the Florentine flask should be clearly specified to the manufacturer. For example, a 2,500 litre capacity vessel should be fitted with a flask of 100 litres and, preferably, incorporation a Denny anti-turbulence system.

Labour and the loading and discharging charges.

The greatest labour demand in a distillery operation arises in the associated activities of handling the disposal of spent charge, plus fuel handling operations if wood is used.

It is possible to use tipping stills for removal of the spent charge; i.e. the vessel is fitted on pivots and on up-ending the charge falls out under the pull of gravity.

However, most vessels are fixed in the upright position and to avoid tedious and time consuming manual removal of spent charge a mechanical hoist is employed. Before starting to load the charge, a set of three ropes or chains-linked to a central ring – are placed on the vessel grid and the ends are draped over the side. On completion of loading the charge, the ends of the rope/chains are linked at the top. Upon completion of distillation, the hoist is attached to the rope/chain ring and this pulls the charge out like a plug. For the larger size vessels, a series of rope/chain cradles can be used.

For safely, the hoist lifting power should be three or more times the weight of the fresh charge contained in the rope/chain cradle since the spent charge gains weight by absorption of condensed steam.

Baskets should never be used as containers for herb charge as they never fit tight to the vessel's sides and steam channels out through the gap (as the easiest route) instead of through the chare and oil recovery is very poor.

The layout of the distillery is critical to efficiency, particularly in relation to loading the herb charge and unloading the spent charge. Loading is best achieved by depositing the raw material at the level of the vessel lid. A ramp and platform should be installed for this purpose and, if vehicles are to be employed for carrying the crop, it should be of solid construction. Similarly, the gantry beam for a charge removal hoist should be extended over the side of the vessel lid platform to allow easy discharge into a vehicle parked at a lower level. Where there is a sloping topography on the distillery site, this can be used advantageously in the design of the layout for ease of crop handling.

Mode of utilization and output capability

Oil output capability is not simply determined by the installed capacity at the distillery. The intensity of equipment utilization is a major factor and output can be tripled by operation 24 hours a day rather than on a single 8 hour shift per day.

Under ideal conditions, a distillery is operated continuously for 10-11 months in a year. However, the ability to achieve this objective is highly dependent on the crop or crop mix grown and their seasonality.

APPENDIX "G"

Information on Chemical Composition of Selected Essential oils		
Proposed Primary List of oils	**ISO Numbers (no/Year)**	**Brian Lawrence (Perfumer& Flavourist) (date)**
Geranium	4731/1978	Jan/Feb 2003 Jan/Feb 1999 Jan/ Feb 1994 Mar/April 1992 Nov/Dec 1992
Roman Chamomile	-	Nov/Dec 1998 July/Aug 1993 Sept/Oct 1992
German Chamomile	-	-
Rosemary Oil (verbenone type and cineol type)	1342/1994 (R.officialis) 7733/1981 (cineole type)	Jan/Feb 1995 Nov/Dec 1992 Mar/April 1991
Lemon Balm (Melissa)	-	May/June 1999
Marjoram	4728/1998	Jan/Feb 2001 July/Aug 1994 Jan/Feb 1993
Thyme oil	4728/1992 (wild) 14715/1994 (Spanish)	Jan/Feb 1998 May/June 1995 Sept/Oct 1992
Basil oil	11043/1990	Nov/Dec 1998 July/Aug 1995 July/Aug 1992
Lavender Oil	3515/1994	May/Jun 2001 July/Aug 1994 Jan/feb 1993
Lavandin Oil	3054/1987 8902/1994	Jan/Feb 2001 Sept/Oct 1994 Mar/April 1993
Lemon grass	3217/1974 4718/1988	July/Aug 1998 Nov/Dec 1992
Buchu	-	July/Aug 1998

APPENDIX " H"

CHEMICAL COMPOSITION OF SELECTED ESSENTIAL OILS

It is estimated that of the world's essential oil production, some 75% is used "as is" in either flavours (50%), phytotheraphy/aromatheraphy (5-10%) and fragrances (20-25%). Only 20 to 25% is used for isolate extraction. The value addition associated with essential oils is their use in formulations. This work is the work of formulators with organoleptic qualifications and skills. The reasons for the limited further "reworking" of essential oils include:

- The additional costs do not yield significant benefits;
- The "allure" of essential oils is in their natural complexity;
- Where single molecules are required these are more economically produced synthetically.

Those essential oils that are used to produce isolates are usually the bulk essential oils like citrus, eucalyptus and peppermint.

The chemical composition of most essential oils are therefore of interest predominantly as an indicator of their organoleptic properties.

Most essential oils have over a dozen different chemical constituents. As an illustration, the table below highlights the top 5 constituents (by percentage composition) of a selection of essential oils grown in South Africa.

Oil selection	Top five chemical constituents
Geranium	Geraniol (10-30% Citronellol (10-40%) Linalool (5-10%) Citronellyl formate (5-10%) Isomentone (5-10%)
Roman Chamomile	Isobutyl angelate (15-35%) Isoamyl angelate (10-20%) 2-methyl-2-propenyl angelate (5-15%) isobutyl isobutyrate (3-7%) a-pinene (2-6%)
Rosemary Oil (cineole type)	1.8 cineole (20-50%) a-pinene (10-35%) Camphor (15-20%) Camphene (5-10%) borneol (5-12%) (Moroccan oils have more 1,8 cineole and French oils more a-pinene))

Rosemary Oil (verbenone type)	Verbenone (5-30%) a-pinene (10-20%) 1,8 cineole (0-15%) Camphor (3-10%) Borneol (2-5%)
Lemon Balm (Melissa)	Geranial (20-40%) Neral (15-30%) Geraniol (4-10%) Citonellal (2-15%) Geranyl acetate (1-4%) Neral acetate (1-4%) (Some strains produce excesses of Citronellal and Citronellol at the expense of geranial and neral)l
Marjoram (Spanish – Thymus Mastichina)	Two main types: 1) Linalool rich: Linalool (60-80%) 1,8 cineole (2-12%) Camphor (3-8%) Borneol (3-5%) a-pinene (1-3%) 2) 1,8 cineole rich: 1,8 cineole (60-70% Linalool (5-15% a-pinene (2-4%) b-pinene (2-6%) a-terpineol (2-3%) Other constituents
Majoram (Origanum majorana)	Carvacrol 40-80%) y-terpinene (3-5%) p-cymene (4-5%) a-pinene (1-2% thymol (1-2%)
Thyme oil	Thymol (15-70%) Carvacrol (1-15%) b-pinene (1-3%) Myrcene (2-4%) Limonene (2-4%) (Some contain high levels of y-terpinene and p-cymene)
Basil oil	Linalool (40-60%) Eugenol (2-20%)

	1.8 Cineole (1-10%) methyl cinnamate (5-30%) methyl eugenol (3-5%) (there are types which are high in methyl chavicol, in place of linalool)
Lavender Oil	Linalool (20-40% Linalyl acetate (20-40%) 1.8 cineole (2-5%) camphor (2-4%) terpinen-4-ol (2-6%)
Spike Lavender	1,8 cineole (20-30%) Linalool (25-35% Camphor (10-30%) Borneol (1-3%) Linalyl acetate (1-3%)
Lavandin Oil	1,8 cineole (3-7%) Linalool (20-40%) Camphor (5-10%) Borneol (1-3%) Linalyl acetate (20-40%)
Lemon grass (c. citrates)	Neral (10-35%) Geranial (15-50%) Geraniol (3-5%) Linalool (1-2%) Limonene (0-5%)
Buchu (A. betulina)	Isomentone (5-50%) Limonene (10-30%) Diosphenol (10-30%) 4-diosphenol (10-25%) menthone (2-25%) (Also containing novel sulphur hetreocyclics)

1. Citronellol and its esters

These are very important fragrance intermediates for soap and detergents and also when a rosy, fresh floral tone is required. Natural citronellol is obtained from geranium oil, known as rhodinol. This has only minimal production. Most commercial product is produced ***via*** synthetic routes ***via*** selective hydrogenation of geraniol/nerol. Citronellol is the dihydro analogue of geraniol/nerol.

2. Citronellal

Citronellal has a fresh, green citrus character, and is used in flavour and fragrances. Citronellal is prepared ***via*** extraction of citronalla or Eucalyptus citriadora oil. More than 80%

of the worldwide production, is however ***via*** the dehydrogenation or oxidation of citronellol (***via*** geraniol. Another use of citronellal is in the production of menthol, hydroxycitronellal, and methyoxycitronellal.

3. Geraniol/nerol and their esters

Geraniol and its esters have a mild sweet floral or rose character and very important fragrance and flavour ingredients. Geraniol/nerol are cis/trans isomers. They can be prepared by isolation from citronella oil or as is mostly the case, by various synthetic routes. Geraniol is produced from myrcene.

4. Linalool and esters

Linalool and its esters are very important perfume ingredients with a lavender or bergamot odour. They are also important intermediates for the synthesis of Vitamins A, E and carotenoids. Natural linalool is extracted from rosewood oil. Commercial linalool is produced in large quantities ***via*** a variety of synthetic methods. alpha-Pinene is converted by catalytic hydrogenation to cis-pinane, which is oxygenated with a peroxide to cis-pinanol. This pinanol subsequently is pyrolised at high temperature to linalool. Linalyl acetate is prepared by the esterification of linalool with acetic anhydride.

5. Alpha terpineol and esters

The lowest boiling and largest fraction from turpentine fractionation is alpha pinene. One use of alpha pinene is in the production of pine oil, which has a refreshing piney odour and finds high volume usage in cleaners, odourisers, and sanitisers. Synthetic pine oil is actually a mixture of terpene alcohols, chiefly alpha terpineol, along with smaller amount of other mono- and bicyclic terpene alcohols. Pine oil contains 50 – 80% terpineol. Globally 80 – 85% of the pine oil produced is made by hydration of alpha pinene with aqueous mineral acid at room temperature to terpin hydrate and subsequent dehydration of this hydrate with phosphoric acid and simultaneous steam distillation of alpha-terpineol. The remainder comes chiefly from sulphate turpentine fractionation.
Perfume grade alpha terpineol is a delicate floral, lilac-type odour, and is one of the most widely used of all perfume chemicals because of its low cost and stability. It also finds use in the flavour industry. Alpha Terpinyl acetate has a herbaceous bergamot-lavender odour and considerable quantities of it are used in low cost fragrances for household products.

6. Myrcene

The greatest use of myrcene is as an intermediate in the commercial production of terpene alcohols: geraniol/nerol, and linalool, which serve as intermediates for the production of large-volume aroma and flavour chemicals. It is also used in large quantities in the manufacture of specialty aroma compounds (myrcenol and its derivatives).

APPENDIX "I"

ESSENTAIL OILS CONTAINING ALLERGENS

0 %	0-5 %	5-10 %	10-25 %	25-50 %	50-75 %	75-90 %	90%
angelica seed cedarwood guiacwood myrrh parsley patchouli sandalwood spike lavender	star anise armoise benzoin cardamom carrot camonile copaiba estragon eucalyptus galbanum ginger labdanum rosemary teatree vetiver	olibanum eucalyptus nutmeg pine sage tagette red thyme ylang 2	citronella clary sage spear-mint	bergamot caraway geranium lavandin petitgrain rose ylang 1 ylang 3 ylang extra	lemon lime mandarin neroli	cinnamon(leaf) cinnamon(bark coriander litsea	bitter orange clove (leaf) clove (bud) eugenol grapefruit sweet orange tangerine

Source: EFEO, Perfumer& Flavourist, March 2004

Essential Oils: Percentage Allergens

Of the 26 published allergens, essential oils contain some 16 of them. The relevant allergens are:

- Benzyl alcohol
- Benzyl Salicylate
- Cynnamyl alcohol
- Cinnamic aldehyde
- Citral
- Coumarin
- Eugenol
- Geraniol
- Isoeugenol
- Anisyl alcohol
- Benzyl benzoate
- Benzyl cinnamate
- Citronellol
- Farnesol
- Limonene and
- linalool

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TERMS OF REFERENCE

Aroma Fragrance Fine Chemicals formulations are used globally for imparting attractive taste and aroma to processed foods and beverages and adding pleasing scents to perfumes, toiletries and detergents. The worldwide industry generally earns returns in excess of the chemical industry average. The industry's close association with the health, personal care and food and beverage markets, means that its revenues are relatively stable, largely insensitive to commodity cycles and relatively recession-resistant.

The industry can be segmented, broadly, into three areas, namely: (i) natural and synthetic aroma and flavour fine chemicals production, (ii) compounding of these chemicals into formulations tailored to meet specific customer requirements, and (iii) use of the formulations in the production of personal care and pharmaceutical active ingredients.

Certain large international flavour and fragrance houses exist, which specialize in compounding flavour and fragrance chemicals, and which, for historical and strategic reasons, also produce selected aroma and flavour chemicals for captive use. In addition, some also manufacture personal care active ingredients from captive and purchased aroma chemicals.

Success in the formulation and compounding business is dependent on an ability to offer a basket of products, the creativity of flavourists and perfumers, branding and marketing skills, and an ability to respond quickly to ever-changing trends in consumer preference.

Commencing in the late 1980's, AECI Limited had identified certain aroma and flavour fine chemicals, which it believed could form part of a new fine chemicals business that the company wanted to develop. AECI carried out an intensive research and development programme, over a period of more than ten years, aimed a developing competitive manufacturing technologies for selected aroma and flavour fine chemicals.

During 1998, AECI decided to scale down its wide-ranging in-house research and development programme, and outsourced further work on aroma and flavour fine chemical technology development to the CSIR.

Together with the CSIR, AECI developed an AFFC portfolio with the original intention of becoming a leading global producer of selected products, supplying a basket of strategic aroma chemicals to specific flavour and fragrance houses for formulation and compounding. The AECI portfolio was constructed around the synthesis of petrochemical feedstocks.

During 2001, in line with a wide-ranging business transformation process, AECI took a strategic decision to exit from its fine chemicals development programme, and to offer the know-how and technology, which had been developed, to interested parties. AECI reached agreement with the CSIR during 2003, that AECI would transfer the rights to the

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range of aroma and flavour fine chemical technologies to the CSIR, in exchange for sharing of the benefits which may arise from licensing or sale of any of the technologies.

The CSIR now owns the technologies in respect of the proposed portfolio of AFFC and the Fund for Research into Industrial Development, Growth and Equity (FRIDGE) proposed a study with the following broad objectives:

- To review the AECI proposed Aroma Fragrance Fine Chemicals portfolio for potential commercial development;

- To include a study on the potential use of effluent from the paper and pulp industry as a raw material for Aroma Fragrance Fine Chemicals products;

- To include a study on the potential synergy between developing synthetic Aroma Fragrance Fine Chemicals production facilities and developing South African natural sources of Aroma Fragrance Fine Chemicals.

The products proposed for commercialization by AECI were selected on the basis that they were large volume aroma and flavour chemicals, serve actively growing end-use markets, had low risk of substitution, and did not require lengthy and costly registration processes for product approval.

The technology developed by AECI, and now owned by CSIR, was aimed at producing the following portfolio:

p-Hydroxybenzaldehyde (pHB)	precursor for PAA, RK, vanillin, ethyl vanillin and 3,4,5-TMB. precursor for pharmaceutical active ingredients
p-Anisaldehyde (pAA)	flavour and fragrance ingredient precursor for p-anisyl alcohol. precursor for sunscreen active ingredients precursor for pharmaceutical active ingredients
Raspberry ketone	flavour and fragrance ingredient
p-Anisyl alcohol	flavour and fragrance ingredient. precursor for pharmaceutical active ingredients
l-Menthyl acetate	flavour and fragrance ingredient
Vanillin	flavour and fragrance ingredient. precursor for pharmaceutical active ingredients
Ethyl vanillin	flavour and fragrance ingredient
3,4,5-Trimethoxybenzaldehyde	precursor for pharmaceutical active ingredients
m-Cresol	feedstock for l-menthol, produced as a co-product of PHB production
Zingerone	flavour and fragrance ingredient

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The above listed products are strongly inter-related in terms of market areas and customers. This synergy offers an investor the opportunity to access markets and customers, which may find a basket of related products from one supplier attractive.

The stated objectives of the study are:

- The study should clearly indicate the following:
    - Labour requirements and number of jobs expected to be created
    - The attractiveness of local manufacture of synthetic aroma, fragrance and flavour chemicals with specific emphasis on the products already identified.
    - The potential and attractiveness of producing specific aroma, fragrance and flavour compounds from indigenous plant material.
- The study should also explore the potential to use effluent from the paper and pulp industry as a raw material for this product stream. In this regard the logistical and location considerations of a manufacturing facility, or facilities, need to be addressed.
- The study should investigate the following aspects of the project:
    - The feasibility of the manufacturing potential products from indigenous plant material and potential markets.
    - The feasibility of supplying potential regional and international markets with synthetic aroma, fragrance and flavour chemicals.
    - Identify potential technology constraints and costs, and research needs and costs.
    - Recommend government interventions that may be required to ensure success of investment projects.
- The study should also analysis present and future economic developments and their implications on the viability of the commercialization of these technologies in an internationally competitive manner. This will include reviewing the capacity, preferred location of a potential business, or businesses, as well as the relevant value chains, and the investment implications of such economic developments to local or international investors.
- The study should recommend the design of an appropriate suite of investment incentives, within the context of the incentives offered by the Government, to improve the attractiveness of an investment in the proposed product portfolio.

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MILESTONE DECISIONS DURING THE STUDY

As the project progressed the following issues arose that required direction to be given by the Study's Counterpart Group:

- The original scope of the Study (per the Request for Tenders) did not include the study of the potential of the menthol technology package. Presumably this was because AECI had already disposed of the technology prior to referring these matters to FRIDGE. The technology currently resides with Mbuyu Biotech, a joint venture involving CSIR. There is a strong relationship between the product and technologies referenced for the Study and the menthol technology package. It was proposed that the Consultant take the menthol potential into account. This was agreed. (Milestone One)

- The original scope of the Study (per the Request for Tenders) as it related to Aroma Chemicals from the by-products of the paper and pulp industry, appeared to have been confined to the production of the chemicals listed (i.e. vanillin and perhaps ethyl-vanillin). This would be produced from Kraft Black Liquor (KBL). The Consultant proposed that Crude Sulphonate Turpentine (CST) derived from the paper and pulp industry should also be considered as a source for the production of Aroma Chemicals. This was agreed. (Milestone One)

- The original scope of the Study (per the Request for Tenders) did not include the study of the essential oils industry per se (except perhaps in so far as it related to indigenous flora). However, it was identified that essential oils would be the most likely route for the commercial exploitation of indigenous flora and accordingly the Consultant proposed that this important sector be the focus of the investigation into the potential of natural sources of Aroma Chemicals. This approach was agreed. (Milestone One)

- With regards to the Aroma Chemicals derived from petrochemical feed stocks, the Consultant was requested not to focus on specific sources of meta-para-cresol, neither to focus on specific industry partners (investors) but to keep the analysis generic. (Milestone Two).

- With regards to essential oils the Consultant was instructed not to focus too much attention on the agricultural issues surrounding essential oil production. This would be the focus of another study. The Consultant noted that it would not be practical to perform an economic feasibility on a particular essential oil or basket of essential oils as a large component of the feasibility would require consideration of the agricultural costs of production. It was agreed that the Consultant should focus on the broader strategic issues surrounding the development of the essential oils industry and its potential impact on an Aroma Chemicals value chain. (Milestone Three)

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- With regards to Aroma Chemicals derived from the paper and pulp industry, the Consultant identified that the tapping of pine forest for gum turpentine could also be a source of material for the production of turpentine derived Aroma Chemicals. It was agreed that this was outside the scope of the current project, but that the Consultant should provide whatever information was readily available to it. (Milestone Four).

STAKEHOLDER LIST

IDC co-ordinator	Hloni Monyeki	011-269-3597
CPG Chairperson	Mary Tsatsi	012 428-7959 / Cell 0824640530

Item	Organisation	Contact name	Contact Details	Comments
	Petrochemical			
1	CSIR: Biochemtek	Fanie Marais	0116052310	Several meetings
2	Consultant	Aubrey Parsons	011 726-2376 Cell 083 300 431	Initial meeting
3	AECI	Andre Engelbrecht	011 806 8885	
4	Merisol	Joe Makhoere/Ahmed Karachi	016 960 3733	Initial meeting
6	Chemin Incubator	Joe Kruger	041- 503 6700	Initial meeting
7	SASOL	Herman Berry	Tel: 011 344 0206	Initial Meeting and research assistance
8	Mbuyu Biotech	Paul Abrahams	011 605 2943	Held meeting to discuss menthol project
	Paper and Pulp			
9	CSIR: Biochemtek	Fanie Marais	0116052310	Meetings: documentation and project discussions
10	CSIR: Biochemtek	Michael Barkhysen	0116052310	Initial meeting: vanillin
11	CSIR: Biochemtek	Shavindra Sukdeo	011 605 2174	Initial meeting: vanillin
12	Clive Teubes	Clive Teubes	011 792-4451	Initial meeting; emails
13	Mondi	Ciska Terblanche	035 902 2111	Contact made
14	Mondi	Tony Scheckle	031 304 7837	Meeting held
15	Sappi Lignotech	Craig Hogan ex AECI Project	039 9736 008	Contact made
16	Paul Statham	Ex AECI Vanillin Project	011 709 8985	Contact made
17	Sappi	Kobus Geldehuys	013 734 611	Contact made, amount of CST from Ngodwana
18	Sappi	Chris Davies	011 360 0271	Contact made, Technology Director Sappi
19	Associated Motor Carriers	Mike Hunter: Forest Operations	035 580 7950/082 657 5558	Telephonic discussions
20	Associated Motor Carriers	Arlenee	035 787 7017	Telephonic discussions
21	Industrial Oleochemical Products	Gillian Lee	031 461 3740	Telephonic discussions
	Indigenous Flora and Essential Oils			
22	CSIR: Biochemtek	Fanie Marais	0116052310	Several meetings
23	CSIR: Biochemtek	Marthinus Horak	0128413295	Currently off ill (Met with Vinesh Maharaj)
24	CSIR: Biochemtek	Shavindra Sukdeo	011 605 2174	Initial meeting
25	SAEOPA	Karen Swanepoel	0827858700 Tel 013 753 3064	Several telephone discussions and meeting in April
26	SAEOPA	Willie Alberts	829636142	Meeting in April
27	Biosys	Robin Learmonth	012 841-4025	Several meetings
28	ARC	Kobus Coetsee	021 8085430	Telephone interview (Now Ex-ARC)
29	Flavourcraft	Ryan Ponquett	031 719 0618	
30	Symrise	Johan Esterhuizen (Sales)/ Rud	011 921 5911	Telephone : Re Local Market
31	Sharon Bolel	Sharon Bolel	011 487 1661	Telephone interview
32	SAAFFI	Michael Gristwood	Tel/Fax: +27 11 447 2757	Initial meeting
33	DEAT			Outside of scope
34	Teubes (Pty) Ltd	Clive Teubes	011 792-4451	Several discussions

STAKEHOLDER LIST

IDC co-ordinator	Hloni Monyeki	011-269-3597
CPG Chairperson	Mary Tsatsi	012 428-7959 / Cell 0824640530

Item	Organisation	Contact name	Contact Details	Comments
35	Cranbrook Flavours	Hennie Jooste	011 392-6650	Telephonic interview
36	Giyani Project - Limpopo Province	Vinesh Maharaj	012 841-3295	Initial Meeting/subsequent meetings
37	Chemin Godisa Incubator	Joe Kruger	041- 503 6700	Initial Meeting and several telephone calls
38	SAAFost	Aubrey Parsons	011 726-2376	Initial meeting
39	Firminech	Bruce Perkins	011 653 0700	Telephone call: Re Local Market
40	IFF	Robert Fletcher	011-922-8800	Telephone call: Re Local Market
41	Proctor and Gamble	Denzel Pillay	011-700-5000	Telephone call: Re Local Market
42	Lever Ponds	Robert Waugh	031-571-9600	Telephone call: Re Local Market
43	Quest International SA	Raj Rama	011 613-6211	Meeting re local market
44	Quest International SA	Tony Scott	011 406 8700	Telephone call: Re Local Market
45	Wesgro	Sector Research Section	021 418 6464	Information received
46	Grassroots Natural Products	Norman Collins	023 232 0526	Telephonic interview
47	Cape Organics Producers Association	Eddie Redelinghuys	021 872 5962	
48	George Oils	Pancho Ndabele	011 881 8299	Out of business
49	Ecocert	Ralph Peckover	021 545 0409	Telephonic interview
50	Producer	Kleinste Van Rensburg		Visit
51	Ekuseni Essential oils- Production	Hennie Duplessis	031-712 2656	Visit
52	Ntala - Producer	Hanneke Hibbert	013 753 3839	Visit
53	Ekuseni Essential oils- Marketing	Jean duplessis	082 461 7385	Telephonic interview
54	Producer	Ian Macdonald	832284535	Telephonic interview
55	Producer	Jarrett Peck	332129045	Telephonic interview
56	Producer	Prof Earle Graven	836330149	Telephonic interview
57	Producer	Chris Rumble	832287695	Telephonic interview
58	Bio Africa	Steph	082 534 4807	Telephonic interview
59	Institute of Natural Resources	Myles Mander	033 346 0796	Telephonic interview
60	TRAFFIC (ES Africa)	David Newton	011 486 1102	Telephonic interview
61	Claman	Ronelle Roberts	011 591 2640	Telephonic interview
62	Cape Fynbos Essential oils	Salome van Eerden	028 314 1614	Telephonic interview
63	Natchem Aromatech	Jean Serra	011 452 1760	Telephonic interview
64	University of Potchefstroom	Prof Breedt	018 482 1241	Telephonic interview
65	University of Witwatersrand	Pro Alvaro Viljoen	011 717 2169	Telephonic interview/ Meeting
66	Afriplex		021 872 4976	Telephonic interview
67	Cedara (KZN)	Dr Maria Defiguera	033 355 9156	Telephonic interview
68	Carst&Walker	Uru Maganol	011 359-4800	Telephonic interview
69	Highland Esential Oils	Flippie Pienaar	051 943 0317	Telephonic interview
70	Herbs A Plenty	Elmarie de Bryn	021 874 1684	Telephonic interview
71	National Dept of Agric	Thabo Ramashala	012 3196079/2 / 072357 3845	Initial Meeting
72	DWAF (Irrigation - Walter vd Westhuizer	Gauteng	012 392 1300	Telephone contact

STAKEHOLDER LIST

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CPG Chairperson	Mary Tsatsi	012 428-7959 / Cell 0824640530

Item	Organisation	Contact name	Contact Details	Comments
73	DWAF (Irrigation)	National	012 336 8245/8066	Telephone contact
74	DST	Dr Lusunzi	012 317 4330	Telephone contact
75	DST	Geof Mashambye	012 317 4341	meeting arranged
	GENERAL			
76	Antioxidants and Aroma Fine Chemicals	Geoff Blewitt	035 797 6001	Discussion
77	IFEAT (head office UK)	Louise Kopor	Fax no 0944712500965	email
78	Rooibos limited		274822155	Info obtained
79	Proctor & Gamble	Denzel Pillay	011 700 5000	Telephonic interview
80	Lever Ponds	Robert Waugh	031 571 9600	Telephonic interview
81	Johnson& Johnson	Deedee Sampson	043 709 3211	Telephonic interview
82	Beacon	Tom Larkin	031 460 7200	Telephonic interview
83	BAT	Hanro Steenkamp	021 888 3765	Telephonic interview
84	Nestle	Elize - Buyer	011 889 6579	Telephonic interview
85	Adcock Ingram	Judy Dunner	011 971 4559	Telephonic interview
86	MLG Tobacco	Mr Chirag	011 661 5777	Telephonic interview
87	Sara Lee	Mr Horsley	031 719 7111	Telephonic interview