

## GENERAL INTRODUCTION

*Siphonochilus aethiopicus*, commonly known as wild ginger, is a member of the family Zingiberaceae and has a restricted distribution to South Africa, Zimbabwe, Malawi and Zambia. Wild ginger originated in north-eastern India. The plant (Fig. 1) is easily cultivated in the warm parts of South Africa and attempts have been made for the large scale production of rhizomes (Fig. 2) through tissue culture, in order to reduce the pressure on wild populations (Van Wyk, van Oudtshoorn & Gericke, 2000).



Fig. 1. Mature plant of wild ginger (Van Wyk, van Oudtshoorn & Gericke, 1997)



Fig. 2. Mature rhizomes of wild ginger (Van Wyk *et al.*, 1997)

Wild ginger is a perennial herb with tubers (Langenheim & Thimann, 1982). It is a deciduous plant with large, hairless leaves (Fig. 1) developing annually from small, distinctive, cone-shaped tubers (Van Wyk *et al.*, 2000). Langenheim & Thimann (1982) stated that the inflorescence can be a compact spike or an open raceme or the plant can bear solitary flowers, each flower or cluster of flowers joined by a conspicuous bract. The spectacular flower (Fig. 1) appear at ground level in early summer, from end of October to early December. They are broadly funnel-shaped, pink and white in colour with a small yellow blotch in the middle (Van Wyk *et al.*, 2000).

Van Wyk *et al.* (2000) reported that most plants are bisexual and they have much larger flowers than female plants. The small, berry-like fruits are borne below or above the ground. The leaves and rhizomes have a smell similar to that of real ginger, *Zingiber officinale*. Van Wyk *et al.* (2000) also reported that the rhizome (Fig. 2), which is cone-shaped and narrows to a tapering point, is dug up and sold. Rhizomes harvested during the growing season will have roots on them and are used as such.



Those taken during the dormant period, when the plants are leafless, have no roots on them.

Watt & Breyer-Brandwijk (1962) found that tubers of wild ginger yield 2 % of oil made up of 93% orange flower scented oil and 7% heavier oil with the odour of crushed ivy leaf, as cited by Hutchings, Scott, Lewis & Cunningham (1996). Van Wyk *et al.* (2000), on the other hand, reported that wild ginger contains volatile oil with  $\alpha$ -terpineol (a natural antiseptic) and various other monoterpenoids, but the main compound is a highly characteristic sesquiterpenoid. The similarity between wild ginger and true ginger appears to be superficial only, as none of the terpenoids of ginger oil are present in the essential oil of *Siphonochilus*.

According to Van Wyk *et al.* (1997), monoterpenoids and sesquiterpenoids in the oil are most likely responsible for the reported benefits against colds and influenza. Volatile oils are generally used for their decongestant, antiseptic and diuretic effects. Watt & Breyer-Brandwijk (1962) reported that overdose of medicine from wild ginger is said to stupify horses, as cited by Hutchings *et al.* (1996).

According to Van Wyk *et al.* (2000) and Hutchings *et al.* (1996), rhizomes of wild ginger have been used to relieve colds (to clear the nasal passages), coughs, influenza and hysteria. It can also be taken for pain relief. Several other traditional and cultural uses have been recorded, including the treatment of asthma and dysmenorrhoea (Van Wyk *et al.*, 2000).

Watt & Breyer-Brandwijk (1962) reported that wild ginger is used by the Swazi for malaria and chewed by women during menstruation, probably to relieve pain, as cited by Hutchings *et al.* (1996). They also reported that the cold rhizome infusions of wild ginger species are administered to horses as prophylactics against horse sickness. According to Van Wyk *et al.* (2000), rhizomes and fleshy roots are very popular in traditional medicine in southern Africa to the extent that concern has been expressed about regional extinction.

Because wild ginger is becoming extinct, determining the agronomic potential of the plant as well as finding indigenous knowledge of the plant is of utmost importance. The objective of this study was to investigate the benefits of mulching (such as moisture retention and weed control) and the effect of spacing on yield and quality of wild ginger and to gather indigenous knowledge about the plant through a questionnaire survey.

## 1.1.1. Definition and structure

A rhizome is a woody or fleshy elongated stem that usually grows horizontally just below the ground, bearing leaves above the ground and roots into the ground.

There are several examples of rhizomatous plants that are used primarily for medicinal purposes.

Including ginger (*Zingiber officinale*), turmeric (*Curcuma longa*), and ginger root (*Alpinia officinarum*).

Species: *Zingiber officinale*, *Curcuma longa*, *Alpinia officinarum*, *Alpinia purpurata*, *Alpinia zerax*, *Alpinia*

*officinarum*, *Alpinia*

*officinarum*

## 1.1.2. Anatomy of rhizomes

There are two types of rhizomes:

(i) The stoloniferous rhizome (e.g. *Alpinia*)

(ii) The pachynormous rhizome (e.g. *Zingiber*)

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## CHAPTER 1

### LITERATURE REVIEW

#### 1.1 RHIZOMES

##### 1.1.1 Definition and structure

A rhizome is a woody or fleshy elongated stem that usually grows horizontally below the ground, forming leaves above the ground and roots into the ground (Van Wyk *et al.* 1997). There are several examples of medicinal plants that are used primarily for their rhizomes, including ubani (*Agapanthus spp.*), bulrush (*Typha capensis*), piles root (*Sansevieria hyacinthoides*) and ikhathazo (*Alepidea amatymbica*). Mathew & Swandels (1994) and Hartmann, Kester, Davies & Geneve (1997) defined rhizome as a specialized stem structure in which the main axis of the plant grows horizontally at or just below the ground surface.

Edmond, Senn, Andrews & Halfacre (1975) and Hartmann *et al.* (1997) described two general types of rhizomes:

##### i) The pachymorph e.g. Iris and Ginger

The rhizome is thick, fleshy and shortened in relation to length. It appears as a many-branched clump made up of short, individual sections. It is determinate, which means that each clump terminates into a flowering stalk, growth will only continue from lateral branches. The rhizome tends to be oriented horizontally with roots arising from the lower side.

##### ii) The leptomorph e.g. Lily-of-the valley

The rhizome is slender with long internodes. It is indeterminate, which means that it grows continuously in length from the terminal apex and lateral branch rhizomes. The stem is

symmetrical and has lateral buds at most nodes, nearly all remaining dormant. This type does not produce a clump but spreads extensively over an area.

Intermediate forms between these two types is called **mesomorphs**.

### 1.2.2 Growth pattern

Hartmann *et al.* (1997) reported that rhizomes grow by elongation of the growing points produced at the terminal end and on lateral branches. Length also increases by growth in the intercalary meristems in the lower part of the internodes. As the plant continues to grow and the older part dies, the several branches rising from one plant may eventually become separated to form individual plants of a single clone (Hartmann *et al.*, 1997).

Hartmann, Kester & Davies (1990) reported that rhizomes exhibit consecutive vegetative and reproductive stages, but the growth cycle differs in the two types of rhizomes. For example, in the pachymorph rhizome of *Iris*, a growth cycle begins with the initiation and growth of a lateral branch on a flowering section. The flowering stalk dies, but these new lateral branches produce leaves and grow vegetatively during the remainder of that season. Growth of the underground stem, storage of food and the production of a flower bud at the end of the vegetative period is dependant upon photosynthesis. In general, plants with this structure flower in the spring and grow vegetatively during the summer and fall (Hartmann *et al.* 1990).

Hartmann *et al.* (1997) reported that plants with a leptomorph habit as a general rule, grow vegetatively during the beginning of the growth period and flower later in the same period. The length of time during which an individual rhizome section remains vegetative varies with different kinds of plants. For example, bamboo is divided into clump growers (pachymorphs), which have constricted rhizomes and running bamboos (leptomorphs), which spread rapidly by vigorous rhizomes that grow several feet or more (Hartmann *et al.* 1997). According to Hartmann *et al.* (1990), pachymorphs are more desired ornamentally. Some bamboo species remain vegetative for many years, but they change abruptly and the entire plant produces flowers.



## 1.2 MULCHING

Thorpe (1989) and Andrews (2002) defined mulching as a covering material that act as a blanket and also helps to prevent moisture in the soil evaporating during hot weather. Waggoner, Helgersen & Deroo (1960), McDonald & Helgersen (1990), and Adams (1997) reported that for centuries, mulching has been recognised as a beneficial practice in agronomic systems, where it often enhances growth and yield of annual and perennial crops, as cited by Green, Kruger & Stanosz (2001). According to Ingels (1985), mulching refers to the application of loose aggregate materials to the surface of a planting bed and the materials may be organic or inorganic (Table 1.1).

Table 1.1 Soil temperature and tomato yield with straw or black plastic mulch

	Not irrigated		Irrigated daily	
	Straw mulch	Plastic mulch	Straw mulch	Plastic mulch
Average soil temp (°C)	24	37	24	35
Tomato yield (Mg/ha)	68	30	70	24

Soil temperature measured at 5cm below the soil surface, average of weeks 2 - 10 of the growing season (Tindall *et al.*, 1991)

### 1.2.1 Advantages of mulch

Mulching with straw (Table 1.1), sawdust, woodchips or other material helps conserve soil moisture and controls weeds and erosion (Reiley & Shry, 1979). These materials should be added deeply enough to shade the ground and to prevent the surfacing of weeds. A fine material such as sawdust should be applied only to 5 or 8 cm, but coarse, open material such as straw should be up to 10 or 13 cm thick. Mulching is necessary for moisture retention, weed control, organic matter supply and moderating the temperature for the roots. Mulching also improves the appearance of the area. Trees in the landscape may be mulched with attractive materials such as hardwood bark, pine bark, cocoa hulls and tanbark (Reiley & Shry, 1979).

Mulching with a light covering of weed-free straw or hay helps to hold moisture and prevent the seed from washing away during watering or rainfall. Straw also helps to hide the seed from birds. Mulches applied evenly and lightly may be left in place and the grass allowed to grow through. Peat moss or other fine material do not make satisfactory mulch. These materials become packed too tightly, resulting in the seed being planted too deeply. On terraced areas or sloping banks, cheesecloth, burlap or commercial mulching cloth helps to hold in moisture and keep the seeds in place. Grass is able to grow through these mulching materials, which may be left to rot (Reiley & Shry, 1979).

Halfacre & Barden (1979) reported that in certain plants, excessive soil temperatures could be detrimental. By providing a layer of 10 to 15cm of mulch on the soil surface, soil temperatures are suppressed considerably in the summer. Most mulches are organic in nature and type used depends largely on cost and availability.

#### 1.2.2 Disadvantages of mulch

Janick (1972) and Andrews (2002) found that some of the problems associated with mulching materials arise from their tendency to act as sources and harbours of plant pests-weeds, disease-producing micro-organisms and rodents. Because of the disease problem, the refuse of the plant being protected should not be used as mulch. Straw that has been improperly handled may contain weed or grain seed, which may contribute to the weed population the following spring.

According to Janick (1972), fresh straw should be spread and moistened during warm weather to induce germination before being used. Many mulching materials are highly inflammable and present a fire hazard. Straw mulch in particular should not be placed too close to buildings. The partially decomposed fresh leaves make unsatisfactory mulch because they tend to pack closely and may smother plants. When the organic mulches decompose, it eventually contributes to the plants nutrients and the high carbon content of many of these materials may contribute to nitrogen deficiency (Janick, 1972).



### 1.2.3 Temperature effect

#### 1.2.3.1 Soil temperature

Temperature of a soil greatly affects the physical, biological and chemical processes occurring in that soil (Brady, 1990). In cold soils, chemical and biological rates are slow. Biological decomposition can come to a near standstill, thereby limiting the rate at which nutrients such as nitrogen, phosphorus, sulfur and calcium are made available. Also, absorption and transport of water and nutrient ions by higher plants are adversely affected by low temperature (Brady, 1990).

#### 1.2.3.2 Absorption and loss of solar energy

Solar radiation is the primary source of energy to heat soils (Brady, 1990). Dark soils usually are high in organic matter and hold large amounts of water, which requires comparatively more energy to be warmed than light soil and also cools the soil when it is evaporated. Whether the soil is bare or is covered with vegetation or mulch is another factor that markedly influences the amount of solar radiation reaching the soil (Fig. 1.2). Bare soils warm up more quickly and cool off more rapidly than those covered with vegetation or with plastic mulches (Brady, 1990).

#### 1.2.3.3 Movement of heat in soils

Brady (1990) stated that the significance of conduction with respect to field temperatures is not difficult to comprehend. It provides a means of temperature adjustments, but, because it is slow, changes in subsoil temperatures lag behind those of the surface layers. Moreover, temperature changes are always less in the subsoil. In temperate regions, surface soils (Fig. 1.1) in general are expected to be warmer in summer and cooler in winter than the subsoil, especially the lower horizons of the subsoil.

## i) Mulch

Brady (1990) stated that soil temperatures are influenced by soil cover and especially by organic residues or other types of mulch placed on the soil surface. In hot weather, they keep the surface soil cooler than where no cover is used (Fig. 1.2) while during cold spells in the winter, they moderate rapid temperature declines. Mulches tend to buffer extremes in soil temperatures.

According to Brady & Weil (1999), disturbance of the leaf mulch, changes in water content due to reduced evapotranspiration and compaction by machinery are all factors that influence soil temperatures through thermal conductivity.

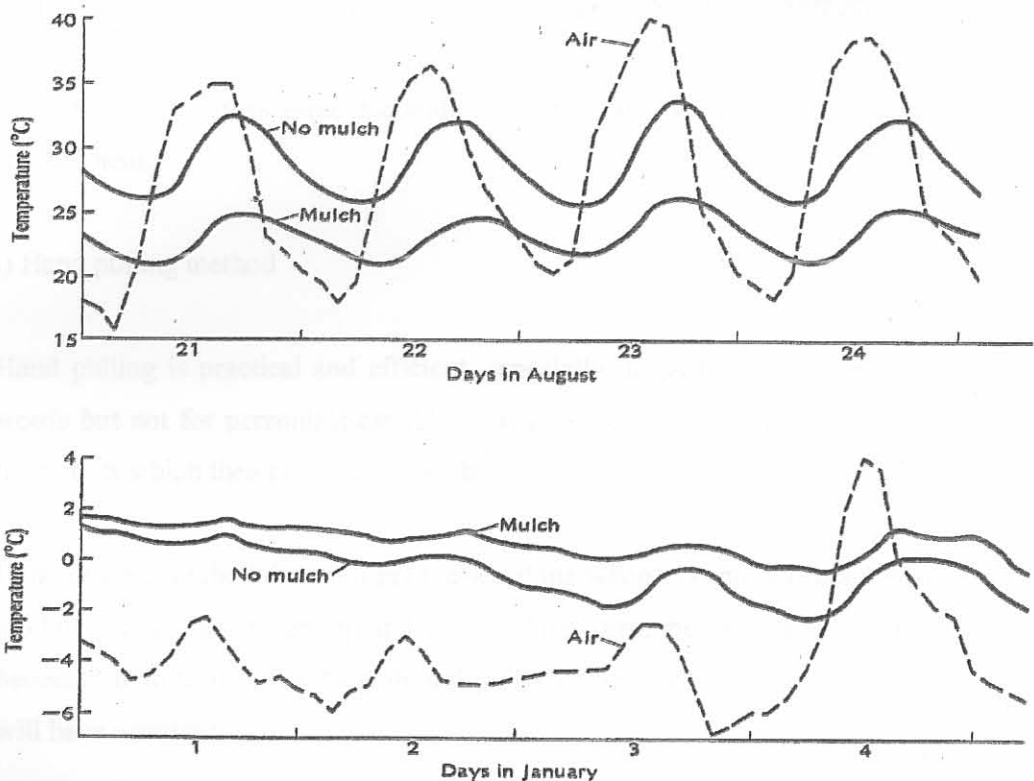


Fig. 1.2 a) Influence of straw mulch on air temperature at a depth of 10 cm during an August hot spell in Bushland, TX. Soil temperatures in the mulched area are consistently lower than where no mulch was applied  
b) During a cold period in January the soil temperature was higher in the mulched than in the unmulched area (Unger, 1978)

#### 1.2.3.4 Soil temperature data

Brady (1990) reported that temperature of the soil at any time depends on the ratio of the energy absorbed to that being lost. The constant change in this relationship is reflected in the seasonal, monthly and daily temperatures. Brady (1990) found that considerable seasonal and monthly variations of the soil temperature occur, even at the lower depths (Fig. 1.1). The surface layer temperatures vary more or less according to the temperature of the air, although these layers are generally warmer than the air throughout the year. In the subsoil, the seasonal temperature increases and decreases lag behind changes registered in the surface soil and in the air (Fig. 1.1).

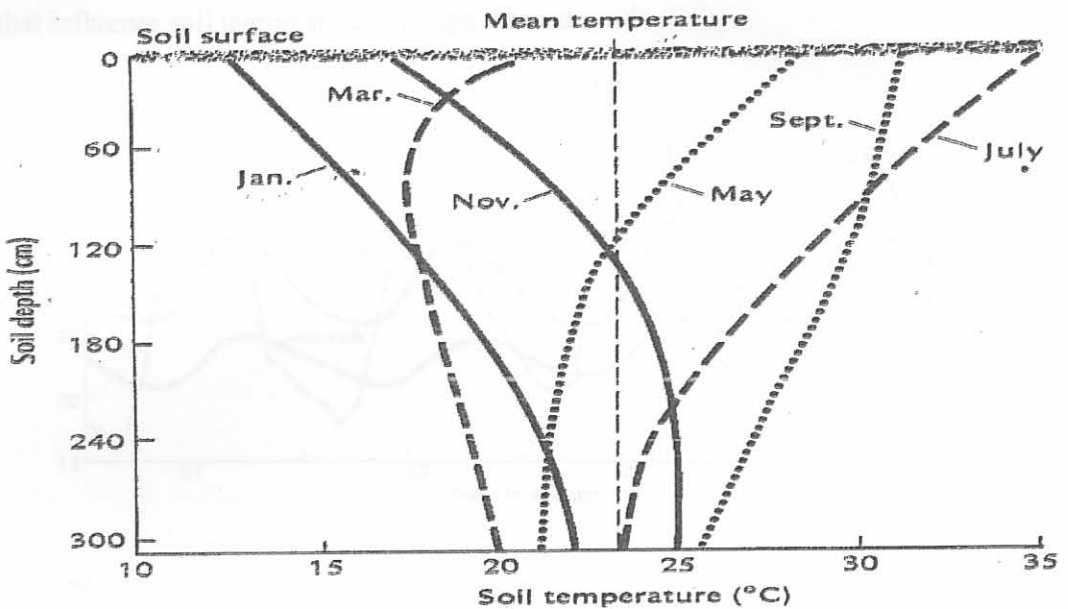


Fig. 1.1 Average monthly soil temperatures for six months of the year at different soil depths at College Station (1951-1955) (Fluker, 1958)

#### 1.2.3.4 Soil temperature control

Brady (1990) described two kinds of management practices, which have significant effects on soil temperature, namely, those that keep some type of cover or mulch on the soil and those that reduce excess soil moisture:



## ii) Moisture control

The other method of controlling soil temperature is through management practices that influence soil moisture (Brady, 1990). Poorly drained soils in temperate regions that are wet in the spring have temperatures 3 to 6°C lower than comparable well-drained soils. Only by removing this water can temperature depression be alleviated. Water removal can be attempted by the installation of appropriate drainage systems, using ditches and underground tiles.

### 1.2.4 Weed control

A weed is a plant growing where it is not desired (Zimdahl, 1993). The Oxford English Dictionary defines a weed as a wild herb growing where it is not wanted.

Zimdahl (1993) gives three methods of controlling weeds, which are not harmful to environment:

#### i) Hand pulling method

Hand pulling is practical and efficient, especially in gardens. It is very good for annual weeds but not for perennials capable of vegetative reproduction because shoots separate from roots which then produce a new shoot.

Hand pulling method does not get the job done when it is most needed. Most people are too busy or too lazy to go out and weed before weeds become obvious. By the time they become obvious and easy to grab and pull, the yield reduction due to weed competition will have occurred.

#### ii) Hand hoeing

Hand hoeing has been used for mechanical weed control for many years. It is still done regularly in beets, lettuce and onions and it is probably the most common method in

gardens. Hand hoeing will control the most persistent perennials if it is done often enough. Hand hoeing can be efficient and is widely used, although it takes a lot of time.

If human labour is abundant and cost is not important, hand weeding is an acceptable method of weed control. If human labour is not abundant or if it is expensive, hand weeding is expensive and not efficient.

### iii) Mulching

Mulch excludes light and prevents shoot growth. Thick wide mulches are required to control perennials that creep to the edge and emerge. Mulches increase soil temperature and may promote better plant growth. Several different materials have been used for mulch, including straw, hay, manure, paper and black plastic. Mulches are used mostly in high-value crops and in crops where laying the mulch can be mechanized. As the amount of wheat straw mulch increased in a wheat-corn-fallow dryland production system, weed growth decreased.

## 1.3 SPACING

Spacing is the distance between-row and within-row of planted crops (Widders & Price, 1989). In different spacings of sweet potato, for example, 15cm, 30cm and 45cm with 96cm between rows, the total number of leaves per plant was greatest in plants growing at 45cm spacing between 4 and 18 weeks after planting (Somda & Kays, 1990). According to Stoffella & Bryan (1988), plant populations and plant arrangement can have a pronounced influence on plant development, growth and marketable yields of many vegetables crops.

Sundstrom, Thomas, Edwards & Baskins (1984) reported that marketable bell pepper yields from two-row beds spaced 1.2m apart were higher than yields from beds 1.8m apart, but yields were not significantly different between 23 and 30cm within-row spacing. Stoffella & Bryan (1988) reported that higher plant populations generally decreased root and shoot weights at anthesis and final harvest growth stages with bell pepper. Plant

height increased with higher plant populations, while stem diameter, root and shoot weights generally decreased as plant populations increased.

The recommended distances between beds for bell pepper are 1.5 to 1.8m for two-row beds and 0.8 to 1.2m for one-row beds. Spacing within-row is recommended at 23 to 30cm with one or two plants per hill, depending on planting location and number of rows per bed (Stoffella & Bryan, 1988). Stoffella & Fleming (1990) reported that plant spacings for a double-row, raised bed planting system recommended in Florida were 38 to 61cm between rows, 25 to 30cm between plants in a row and 1 to 1.5m between bed centers. Generally, use of low plant populations has increased cabbage head size but reduced marketable yields per hectare. Higher planting density has a negative effect on yield of a crop, since crops will produce poor quality products. Low planting density gives quality yield of produce. High plant population per area influence fast growth of crops but with poor yield. The plants always compete for sunlight, water and nutrients, so it is of importance to have good or sufficient spacing for both between-row and within-row of crops.

If crops are spaced too closely, they will have to compete with neighbouring plants for water and nutrients. If spaced plants too far apart, you waste valuable garden space and leave room open for weeds (Ellis, 1990). Climate is a factor to be considered. Wider spacing is recommended for planting in unusual dry climates, because plant roots need to search further for water. If your soil is not very fertile, heavy feeders will also benefit from wider spacing. Overcrowded conditions result in competition for moisture and nutrients, which leads to weak, unhealthy plants (Ellis, 1990).

Default & Waters (1985) reported that increasing plant population densities in broccoli and cauliflower also increase the yield and the profit potential. Default & Waters (1995) also stated that when increasing plant populations it also increase the competition among plants and subsequently reduced marketable yield. Potatoes may be planted entirely by hand or using a potato planter, generally on ridges 0.9m apart. Spacing of the potato seeds within rows varies from 20 - 30cm (Kochlar, 1986).



## 1.4 INDIGENOUS KNOWLEDGE

### 1.4.1 Indigenous knowledge as a phenomenon complex

Seeland (1997) reported that knowledge may be called indigenous if it originates from, and is bound to local experiences and takes its local world perhaps not as the only one in existence, but as the most relevant. The opinion that there is a locally meaningful world characterizes an indigenous world-view. 'Indigenous' or 'local knowledge of forests' is a holistic view of what is revealed to human perception through, and as, forest life. The term indigenous means something that originates locally, and is performed by a community or society in this specific place.

Cohen, Normann, & Snyman (1993) and Warren, Slikkerveer & Brokensha (1994) defined indigenous knowledge (IK) as the community knowledge systems, communication methods and associations that serve as bases for agriculture, irrigation, animal husbandry, aquaculture, food preparation and storage, engineering, ecology, environmental management, education, health care, social support and welfare networks, finance, marketing, labour mobilization and a wide range of other livelihood sustaining activities, as cited by Mazur (1996).

Indigenous knowledge (IK) is human life-experience in a distinct natural and cultural amalgamation, within a unique local and contemporary setting (Seeland, 1997). In a traditional society, the local context is taken as the universal frame in which knowledge matters. This context is formed from physical facts, social interactions among people in the surroundings they perceive as their world, and of the spirituality connected with its space (Seeland, 1997).

### 1.4.2 Indigenous knowledge movement

Indigenous knowledge (IK) is dynamic. Rau (1991) refers IK as generated by people to serve their own needs both in response to their changing physical, social and economic environment, as cited by Mazur (1996). There is increasing recognition of the importance of IK among indigenous peoples surviving in Northern countries.

IK respects the richness, variety and value of indigenous knowledge, which underlies successful development - whether or not its role is understood by outsiders. Warren (1993) stated that indigenous knowledge is the only viable manner for realising the widely concepts of participatory decision making, empowerment of local communities, capacity building of individuals and institutions involved in development at the local level and sustainable development, as cited by Mazur (1996).

It is also important to recognize that while IK has strengths, it also has weakness that need to be complemented by conventional western-oriented scientific methods and ideas. Indigenous knowledge is increasingly being recognized as a national resource, just as important as biodiversity.

#### 1.4.3 Comparing traditional medicine with modern medicine

Ferreira, Charlton & Impey (1996) give three reasons why the practices (of selling indigenous plants for medicinal purposes) must persist:

Firstly: Modern medicine does not have all the answers; it is especially poorly equipped to provide answers to everyday maladies with a strong psychosomatic undertone and chronic degenerative diseases associated with old age.

Secondly: The choice of traditional medicine rather than conventional medical treatment may be influenced by economic factors. For example, Maria, the market seller, reported that an elderly client was recently prescribed pills for arthritis by his doctor, which cost fifty rands a pill. The man was unable to afford the drugs and consulted Maria, who advised him to use a home remedy of feverfew and berg celery to treat his condition, which he apparently did with success.

Thirdly: The availability and accessibility of modern medical care and the relationships between the providers and the consumers of the care are also factors that either facilitate or impede health-care utilization. It may be surmised that traditional medical practices are common among populations that may be less receptive to institutions and services offered by modern medicine.

Self-treatments, using home remedies, enable practitioners to prepare their own medicine, which add to the credibility of their healing powers vis-à-vis those of modern medicine. Mayeng (1996) reported that another factor that has tended to mask the relationship between traditional and western medicine is the competition between the two.

In the battles of the 17<sup>th</sup> and 18<sup>th</sup> centuries between physicians, apothecaries and herbalists, the loser has always been traditional medicine. This happened and is still happening, because governments and pharmaceutical companies banded together to fight the traditional medicine groupings (Mayeng, 1996). They passed laws and acts banning the use of traditional medicine based on statistics claiming toxicity, deaths caused by such medicine and the allegation that traditional medicine was not standardized and pure. The unfair protection of western medicine has led to traditional medicine still being viewed unfavourably (Mayeng, 1996).

#### 1.4.4 South African traditional healers

It seems to be widely accepted that indigenous medicine knowledge is under threat and that it is essential to find mechanisms to record it for posterity (Mayeng, 1996). The urgency of documenting the knowledge differs, however, depending on the culture, history, presence of traditions of apprenticeship and perceived loss of biodiversity. Mayeng (1996) reported that the medicinal knowledge of the Griquas, Outeniquas and Namas was already very much remnant and urgent, focused programmes were needed to rescue this knowledge. The medicinal plant knowledge of Zulu, Sotho, Tswana and Xhosa peoples is less urgently threatened, because strong traditions of apprenticeship still exist.

Mayeng (1996) found that some leaders of traditional healers' associations were anxious to participate with academic institutions and non-governmental organizations in the process of documenting indigenous knowledge, while others felt that they should be given the resources to enable them to document the information by themselves, for themselves.



#### 1.4.5 Plants and plant use

Moerat (1994) stated that there was no data from which to draw firm conclusions but a novel approach that gives an indication of use has recently been adopted, as cited by Mckenzie, Moerat & Naidoo (1996). Mckenzie *et al.* (1996) reported that the procedure adopted was to interview herb sellers and Rastafarians in the Paarl and Cape Peninsula areas and record the plants collected (or bought), the plant parts used, the ailments treated and the location and season in which collected.