Studies on Management and Improvement of Traditional Beehives in Kadugli Province

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Dedicated to my father and mother to my wife Zienab and children to the soul of Talib Musa El Amin who was killed in El Dundour village, he was my honest assistance during the research period.
Abstract

Sudan has different climatic zones. This partially created suitable environments for honeybee in many regions one of which is south Kordofan region that has high potentialities for beekeeping.

The main objectives of this study was to evaluate the traditional beekeeping, to enovate some improvements in the design and management of the traditional tangal hive to work as top-bar hive instead of the primitive fixed comb cylindrical hive used locally.

Four different hive types were compared in this study. These were single chamber Langstroth hive, Tanzanian system top-bar hive, traditional hive and the improved (Top-bar) tangal.

The parameters used were, hive occupation by bee swarms absconding, honey production, hive life span, pest and disease and hive managreal problems.

During the study period that continued for two years from July 1995 to June 1997 the results obtained showed that the honey bees in the study area preferred the traditional hive in which occupation percentage reached 100%, then the improved tangal 985.3%), followed by the Langstroth hive (75%) although statistically no significant difference between the three mentioned types, but there was a significant difference between the three types and the top-bar Tanzanian hive which scored only 58.3%. This low occupation percentage was probably not due to hive system, but possibly due to the weak walls of the top-bar hive that didn't withstand the adverse environmental conditions.

The study revealed that bee colonies in the area have a seasonal swarming cycle in most parts of the year (August – March) that coincide with the flowering season of the main pollen and nectar producing trees in the area sidir tree in the rainy season and Talh and Habil after the rains.

A clear seasonal absconding cycle occurred in all tested hives that started after honey harvesting season in March, and continued to July.

Two honey flows were observed in the study area the first one during August – September coinciding with sidir tree flowering. The second and the main honey flow season was during December – February coinciding with blooming of the Talh, Habil and others trees.
The improved tangal exceeded the other hive types in the mean honey production followed by traditional top-bar and last was the single-chamber Langstroth mainly due to the small area of the brood chamber because no honey super was added. But statistically there was no significant difference between the mean honey yield of the improved, traditional and top-bar hive during the second year, when strong colonies were established.

The traditional beekeepers still preferred their local tangals than the improved tangals and modern hive simply because they want to harvest honey with little effort and without any risk during the night time.

Finally south Kordofan has high potentialities for modern beekeeping due to uncountable wild bee colonies and the dense forage, but a good protection is needed due to high theft cases.
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Introduction

1-1 Climate of the South Kordofan:

South Kordofan is situated in Sudan's western savannah region. This region forms part of the savannah or Sahel belt of the tropics of the northern hemisphere, and has a continental climate which is classified as "hot semi-arid" (Nuba Mountains Agricultural Corporation Report 3, 1985).

The main influence on the climate of the region are the annual migration of the zone of maximum isolation and the associated inter-tropical convergence zone (ITCZ). The ITCZ moves from north to south and back again each year according to the position of the earth relative to the sun's zenith.

The cool season, or "shitta" is associated with dry northwesterly trade winds and takes place when the zone of maximum isolation is in the southern hemisphere. This season is followed by the pre-rains hot season "The sief" as the ITCZ moves north and convective gusts disturb the northeasterly trades. The wet season "The Khareef". Occurs between June and September, reaching its peak in August as the moist south-easterly trade winds are drawn towards TICZ. The "Khareef" is followed by the post-rainy hot season "The deret" as the ITCZ moves southwards. However the temperature during the "deret" do not reach the same levels as these during the "sief", since isolation is less due to persistent clouds after the "Khareef".

During much of the year the average maximum temperatures vary between 30°C and 35°C with a peak of about 40°C in the three months prior to the rainy season. Minimum monthly temperatures average between 17°C and 20°C in the midst of the dry season (November to March), rising to 23°C during the rainy period.

Relative humidity is low (20% - 30%) in the dry season, but it leaps upward abruptly to about 80% at the onset of the rainy season.

The winds are generally moderate (2 to 3 m/sec) blowing constantly throughout the year. The rainfall increases from the north towards the
south within a range of 450 – 800 mm per annum although a marked special variability can lead to reversal of this pattern in any given year. The rainy season extends from late May to mid October, although storms occasionally occur outside of this period. Precipitation takes the form of isolated storms until mid-June when the planting rains commence. July and August are the peak rainfall months, there is a slight decline in September, and the rains usually end by mid-October.

1-2 Vegetation of South Kordofan:

The availability of plants providing nectar and pollen are essential for honey production. Major flowering periods occur principally in south Kordofan during the rainy season from August to October and after the short winter season during January and March. The more dominant indigenous tree species in south Kordofan are Acacia species as A. mellifera "Kiter", A. Senegal "Hashab", A. Seyal "Talh", beside broad leaved trees of the family Combretaceae as Terminalia, Combretum, and Sterculia, Adansonia digitata "Tablidi" Blanites aegyptiaca "Higleg", zizyphus spina-christi "sidir" are abundant. Borussus aethopum "Daleib" and Hyphene thebacia "Dom" are abundant in Nuba Mountains waddis. (Table No. 1) shows the essential plants and their flowering periods.

In the preserved forests in Kadguli, E Dallang, Mendi, Al Faid and El Dundour some species of trees were planted e.g. Azdrachata indica "Neem" Tectona grandis "Teak" Khaya senegensis "Magogany", Ceiba pentardra and Eucalyptus species.

Tall and short annual grasses and herbs form a thick ground cover. Cultivated crops yielding both nectar and pollen as cotton, crucifers, oilseeds, citrus, banana, guava, mango, cucurbits and onion, beside maize and sorghum as pollen source are widely grown in south Kordofan state.

1-3 Traditional Beekeeping in Sudan

In a questionnaire in 1995 prepared by the Arab Organization for Agricultural Development in Khartoum about beekeeping situation and constrains in Arab countries, (appendix 2) stated that Sudan has only 500 modern hives and about 100000 traditional hives. The modern beekeepers
were only 20 where as the traditional beekeepers were 9980 in Sudan. This study showed that in all Arab countries the average honey yield per year of modern hive was about 8kg, and that of the traditional have was only 2kg per hive per year.

1-4 Beekeeping in South Kordofan :-

Beekeeping in south Kordofan can be divided into two categories :-

a- Honey hunting :-

This is practiced in different areas in south Kordofan, during the dry season mostly in the southern pars as Talodi, Kadogli El Leery, Tarogy and other places. When conditions are suitable for honey hunters they go searching for wild bee colonies in tree crevices, termite mounds, soil cracks or even large colony locally called "Umdalo" on a shady tree branch or colony hidden among dense long grasses. Mostly honey hunters were guided by the bee eater bird indicator indicator which locally named "Kiryma". When such a colony is found, it is subjected to heavy smoking, but sometimes the highly aggressive colonies will be killed by fire, then collecting all the hive contents as the honey, pollen and brood combs. The later is mostly eaten by the honey hunters after being mixed with honey, and it is called locally "Merimendi". In case the attacked colony was not completely burned, it migrate to a suitable new site, and again it may be subjected to another attack by a honey hunter during the same honey flow season. So thousands of wild bee colonies are destroyed seasonally by honey hunters or by the bush and grass fires. The bush and grass fire cases increased largely during the last ten years due to insecurity that happened in the state, and the absence of fire-guards whom were previously working with the dissolved Nuba Mountains Agricultural Corporation (NMAC).

b- Traditional Beekeeping in Kadugli province

The main hive type used by the traditional beekeepers in Kadugli province is the fixed-combs log hive that made from the African palm tree logs "Daleib". This hive locally called "Tangal, croot or Daleib". The traditional beekeepers are the only honey producers during the rainy season honey flow. At this time the honey hunters are not able to search
wild bee colonies, because all forests will be covered with dense shrubs and tall grasses.

Another ancient type of hive used in some hilly areas of the Nuba Mountains where *Adenium hongkrel* "Shagar Elsim" tree was growing. The beekeepers insert a sharp stick deep in this tree trunk near the ground level. After a time the plant tissues around the stick dries, and the beekeeper dig out the dried material leaving a hollow stem with the outer layer still alive. The hole opening is then closed with a stone leaving a small entrance. Bee swarms enter this hollow trunk and a permanent bee hive will be established.

As mentioned by old men from "Kanga" village west of Kadugli city, many of these traditional hives are still working in those areas and produce honey during the autumn season in September and October.

During 1970's and 1990's intensive research was conducted on the Sudanese honeybee using modern beekeeping technology. This was investigated by El Sarrage (1977), Gasma (1982), Abdalla (1988), Nagi (1990), Mogga (1994) and others.

This study was conducted on Sudanese honeybees also, but the experiments were carried out in south Kordofan, Kadugli province in a remote area called El Dundour where a true traditional beekeeping activity is practiced. In this area and the other near places, the native beekeepers have their own methods and experiences of beekeeping beside they all participate in honey hunting carried out in the area during honey flow seasons from February to March, every year. In this area thousands of primitive or traditional (Tangals) hives are owned by the men beekeepers, because women do not have a hive. The beekeepers believe that trapping wild bee swarms and transferring them to log hives up the trees is of great danger to beekeeping in their area. So when I explained to them the objectives of my research, the first thing they said during a meeting in the village in 15 May 1995 "if you want to do your research in our area, you should accept our local beekeeping traditions and the most important point of this is "No one of the beekeepers should trap a bee swarm and transfer it to his hive, but we all share the chances and leave the swarms alone to pick their suitable hives". They completed that in
case I accept their tradition I can start with their assistance to work, or otherwise I should search for another area for my experiments. I accepted their tradition, and three men each from a different tribe - this point was also important for any stranger who wants to stay in such areas - agreed to assist me to conduct the research. Later on each of the three men became responsible for an apiary site, participated in locating the site which was chose to his farm or tangal hives in order that close observation and protection could be properly carried out. These three natives with other four guards of El Dundour preserved national forest assisted me in searching, cutting and preparing the traditional and the improved tangals used in this research.

The main objectives of this research was.

1- Survey and categorization of traditional beekeeping conditions, vegetation and climate.

2- Survey and evaluation of the environmental potentialities of beekeeping in Kadugli area.

3- Evaluation of the traditional beekeeping management and hives.

4- Evaluation of hive productivity, manpower, time and inputs devoted to the practice compared to other activities.

5- Manipulation and management of the traditional methods and physical assets especially the hive themselves, management innovation including:

a- Economic evaluation of the hive

c- Improvement of traditional hives include design, shape and size etc.

d- simplicity and acceptability of the hives by the traditional beekeepers.
Literature Review

Beekeeping or apiculture is practiced throughout the tropics, and often offers a possibility for income increase to small farmers in the tropics (Black 1963). Roberts (1969), stated that beekeeping developed in three defined phases:

1- honey hunting
2- bee-culture in fixed comb hives, and
3- bee—culture in movable framers

Farrer (1968) reported that in Africa where a richer nectar flow is accessible, relatively small quantities of honey are produced by the tropics races of honeybee. Bee culture is practiced uneconomically with traditional hives.

Morse and Hooper (1986), stated that of the four tropical regions in (Africa, Asia, America and the Pacific islands), Africa has the oldest tradition of beekeeping, and the one that survives most vigorously, in the main with primitive hives.

2-1 Honeybee Races:

Morse and Hooper (1986) stated that the domestic honeybee *Apis mellifera* has an original area of distribution which is unusually large. Before interference from man, this bee occurred on the whole continents of Africa and Europe and in the Middle East. All the bees from the different regions give fully fertile hybrids when crossed. Thus they belong to the same species.

Ruttner et al (1986) stated that, generally the species *Apis mellifera* is divided into three groups of geographical races, European Oriental and African.

European races are

*Apis mellifera Iberia, Apis mellifera carnica,*

*Apis mellifera ligustica, Apis mellifera mellifera,*

*Apis mellifera sicula and Apis mellifera adami* from the island of Crete; is quite different from all the other European races but similar to
the bees of west Anatolia. It is variable in colour, short cover hair, broad tomenta and very low cubital index.

The Oriental races are: *Apis mellifera caucasica*, *Apis mellifera syriaca*, *Apis mellifera cypria*, and *Apis mellifera yemenitica* of Oman and Yemen. This race is the smallest type of *Apis mellifera* so far known, and it does not belong to the oriental group of races. It is very similar to the small bees of Africa.

Africa is a continent of bees and it has a number of bee races well adapted to frequently extreme conditions. The continent is divided into two parts by the Sahara which also separates different bee races.

a- African races north of the Sahara are *Apis mellifera intermissa*, *Apis mellifera sahariensis* and *Apis mellifera lamarckii*.

b- The African races south of the Sahara have a number of characteristics in common, that include high tendency to swarm and to abscond, easily provoked to attack and small body size. The races that can be defined by statistical morphometric methods are:

- *Apis mellifera adansanii* in west Africa
- *Apis mellifera secutellata* in East Africa,
- *Apis mellifera litorea* on the coast of the Indian Ocean from Kenya to Mozambique, *Apis mellifera monticola* on the mountains of East Africa at altitudes higher than 2000m and *Apis mellifera unicolor* on the island of Madagascar. The last race south of the Sahara is *Apis mellifera capensis* occurring in a restricted area on the Cape of Good Hope. This race has a unique position among all the races of honeybees in that, when made queenless, the worker bees start to lay eggs within 4 – 5 days, and from these unfertilized eggs, develop female bees and not drones as in other races. Queens can be reared from worker-laid eggs and thus the possibility of self-remedy exists for queenless colony (Ruttner 1986).

In 1975 Ruttner designated the Sudanese honeybees as a separate group, and gave them the name *Apis mellifera nubica*, however, in 1988 Ruttner renamed these bees as *Apis mellifera yemenitica*, a name he...
applied to bees of Yemen, Oman Saudi Arabia, Somalia and Chad as well.

El-Sarrag (1977) found that there are two races of honeybee in Sudan, *Apis mellifera nubica* scattered on Sudan International boundaries with Ethiopia, Kenya and Uganda, and *Apis mellifera Sudanensis* scattered all over the Sudan till the western boundaries with Chad, Central Africa and Zaire.

Rashad et al (1984) suggested that there were two honeybee subspecies in Sudan namely, *Apis mellifera Sudanensis* (Rashad) and *Apis mellifera nubica*. Rashad et al (1984) studied morphometric of honeybees from eight provinces of the Sudan. They classified the bees into two subspecies namely *Apis mellifera sudanesis* the yellow banded bees, distributed over all the Sudan between latitude 3˚N and 16˚2˚N and *Apis mellifera nubica*, the mixed subspecies distributed along the international boundaries of Sudan, Ethiopian and Uganda.

Wille (1977) classified the bees in Khartoum, Gezira and Blue Nile provinces by colouration into three :-

1- Khartoum, Wad Medani and Abu Naama bees with yellow colouration in the first three abdominal segments and yellow post scutellum.

2- Demazin bees with yellow colouration in the first three abdominal segments and mostly black post scutellum.

3- Demazin bees with very black and no trace of yellow colouration.

The first recorded importation of honeybees to Sudan was made in April (1928) by King who introduced two nuclei of Cyprion honeybees from the apiary of Egyptian Ministry of Agriculture. *F₁* Carnio-Egyptian honeybees were also imported from Egypt in successive by El Kidir, El Sarrag and other Entomologists (Bee Fiel 1983). The latest large importation of bees which receives extensive distribution including eastern and northern regions was in 1987, (Mogga 1988).

Lord and Nagi (1987), reported that the dwarf Asian honeybee *Apis florea* was discovered at Khartoum in gardens at the vicinity of the international Airport in 1985. By 1987, over 80% of reported cases of honeybee nests established within residential quarters in Khartoum
belong to *Apis florea*. Not aided by man, within seven years of its discovery *Apis florea* has advanced 150 kilometers south east along the Blue Nile river by February 1992. It was suggested that the initial colonies of *Apis florea* was brought in, through an air flight, possibly between 1983 – 1984.

### 2-2 Raising the Hive, for Protection

Morse and Hooper (1986), reported in a follow up study in U.S.A, that bee swarms were offered a variety of bait hives of various designs and shapes to determine if bees could make choices. The results show that the nest preferred by honeybee is quite different from that given by man. One conclusion from these studies is that honeybees have wide range of adaptability. They added that, in their study 75% of the trees in which bees were found and observed nesting were alive, and the mean volume was a 45 litres. In tests in which bees were offered boxes of various sizes it was noted that the bees preferred nests near this value.

### 2-3 Bee Hives

Hive is the name given to any container in which bees are kept by the beekeeper (Morse and Hooper 1986). Practically all the hive types used by traditional beekeepers are hung on tree branches whether by ropes or wires or placed between the branches. Morse and Hooper (1986) reported that all the data on honeybee biology suggest it is important to elevate colonies as much as convenient. They added that in African tribes that have been keeping bees for centuries, hang their nest boxes 15 or more feet above the ground. They stated that in a follow up studies in the eastern United State in which bees were offered nests 3 and 15 meters above the ground the bees preferred the latter.

Originally the hive was made of any suitable material easily available in the area, and therefore varied quite considerably in size and shape. Morse and Hooper (1986) reported that different hive types had been used in different parts of the world, as pottery or sun-baked pipes in Egypt and other Arab countries, horizontal hives made from planks of wood and from hollowed-out logs in northern Europe. In Britain and
Western Europe hives were constructed in basketwork plastered or cloomed, with a mixture of mud and cow dung, beside flat-tapped skeps and wooden boxes, open topped skeps, were used.

El Sarrag (1977) mentioned that the natives in the Sudan use a number of different hives, but all are hollowed and long for example, log hives, woven and clay pots.

In 1918 trials were made to improve the hives used by the natives in Sudan. King (1920) recommended Khartoum hive, but this hive as well as the native hive proved unsatisfactory since swarms of honeybees are not always attracted to inter them. Moreover, they were clumsy and liable to break. Their material would not withstand the weather and became soft and rotten after one year. The queen excluder devised in Khartoum hive was not available to the natives (El Sarrag, 1977).

As an alternative to Khartoum hive, King recommended Omdurman hive. In 1932, this hive proved to be satisfactory, because it withstand the weather, could be used for several years, beside it enables the owner to collect honey several times (El Sarrag, 1977). Since 1936 different types of hives were used in Sudan. In 1961 the Langstroth standard hive was introduced by Prof. Khalifa to the faculty of Agriculture, University of Khartoum for educational purposes. This hive which is getting popular today was successful (Bee File 1969).

2-4 Bees Defensive Behaviour

The honeybee and all social Hymenoptera sting only to defend its home (Walter [1979]). The number of honey bees defending a colony varies considerably during the course of season. They are fewer during nectar flow than when nectar is not available. Beside other factors such as disturbing bees, may cause bees to abandon their work and take defensive measures. Environmental conditions affect the disposition of the colony. Workers are more defensive on cloudy days or if the colony is located in deeply shaded area. The colony is more defensive in the fall after nectar flow than in the spring. Dark colour affects the colony more than light ones (Walter, 1979).
Disturbed bees pursue the intruder a long way off the colony. Start (1971), evaluated the aggressiveness of Africanized and Italian bees and their crosses and concluded that at least 11 genes control the aggressive behaviour.

Mammo (1976) and Brondeburgo et al (1976) during their studies on African honeybees noticed that everytime they moved the colonies from low land and hot area to a high land and cold area, the aggressiveness of African bees decreased. When the colonies were returned to the low land and warm area, the bees became as aggressive as before. They thus concluded that this behaviour was much influenced by the environment to which the bees were exposed.

Paterson (1966) reported that manipulation of adansonii colonies was not easy, especially when the colony reached the honey production stage.

El Sarrag (1977) studied the temperament of some Sudanese honeybee colonies, and found that the native colonies were more aggressive than the F1 Carniolian colonies. He stated that honey harvesting was a true battle.

Gasma (1982) concluded that Sudanese honeybee colonies are very aggressive. Even working in the apiary made them aggressive. Usually this aggressiveness was even initiated by colonies that were not opened for inspection.

Benson (1985) stated that smoke had little effect on Africanized bees and they were able to attack a person at a distance of 100 feet from the apiary.

Tomasko (1987) reported that during most of the dearth period, Sudanese bee colonies were small with little stored honey. These and newly collected colonies were manageable, exhibiting minimal defensive behaviour. Meanwhile, strong colonies with stored honey were highly defensive, unlike the European races which were extremely easy to handle during a honey flow.

Abdalla (1988) stated that the Sudanese honeybees become very aggressive when the colony build up to 10 combs covered with bees. The Sudanese honeybees tend to sting over the protection clothing. When
manipulating colonies, the bees used to sting all moving objects around the apiary. The bees sting the observer 40 meters away from the site.

Mogga (1988) stated bee colonies in rock crevices were very defensive and a large bee population persisted following him nearly one kilometer away. Equally those from the forest and rich savannah were very defensive once disturbed. He concluded that Sudanese bees are very aggressive especially when colonies were populous and placed near each other.

Gasma (1988) observed that in Kabum area in western Sudan during mid September and beginning of October, the native honeybees were highly aggressive, and the colonies when handled even with most care and proper smoke, easily get out of control rushing out of the hive to sting everything in sight, and they remain aggressive for the rest of the day.

Concalves (1975) reported 62 comments on African bees A. mellifera adansonii some of them are :-

1- Swarms sometimes attack and sting without provocation.
2- Stings of African honeybees produce severe effects compare to stings from other bee races.
3- There are many animals even people killed by stings of African bees.
4- Migratory apiculture is complicated by the tendency of African bees to ball and kill the queen when the hive is carried for long distance on a truck or otherwise seriously disturbed.

Walter (1979) stated that statistics on deaths caused by honeybee stings are difficult to obtain. The World Health Organization (WHO) tabulates mortality data and grouped them into 150 categories of which death caused by bees and other venomous animals are not identified. Barr (1971) reported that Hymenopterous insects were responsible for 229 death between 1950 and 1959. of these 124 were caused by bee stings.

2-5 Honeybee Absconding and Migration:

Fletcher (1975) found that for tropical bees there are a number of absconding causative factors. These include disturbance by predators or
excessive manipulation, wax moth infestation and heavy wasp or bird predation at the nest entrance.

Butler (1967) reported that although absconding is rare in temperate zone races of honeybee, it is relatively common in tropical honeybees.

Smith (1960), Butler (1967) and Fletcher (1973) showed that there are two basic types of absconding.

a- disturbance caused by predators, pests, manipulation by beekeepers, fire, inferior nest site etc.

b- Seasonal absconding thought to be induced by dearth of sources or other seasonal factors such as high winds, rainfall, or high temperature.

Woke (1977) studied absconding and its relation to brood rearing in A. mellifera adansonii. He found that absconding colonies usually left behind a few hundred eggs, but very little brood.

Winston (1979) studied the absconding behaviour of Africanized honeybee in south America. He stated that colonies that had swarmed just prior to the absconding season and that had low numbers of workers particularly young workers, had a relatively high probability of absconding during the wet season.

Devies (1986) stated that the chief factors responsible for absconding were insufficiency of food in the brood nest to tide over unfavourable periods, invasion by ants, wasps or wax moth, frequent disturbance, desertion of new site, incorrect location of colonies and persistent swarming.

Smith (1965) reported that the most common causes of absconding are lack of water, exhaustion of food stores, over heating and continuous pest attack. He also stated that an established colony of bees, whether mellifera, adansonii or indica will not abscond if they can get water, have plenty of food stores, and secure from attack by pests, are in strong healthy condition and in a well ventilated hive shaded from the full heat of the midday and afternoon sun.
2-6 Honey:

Honey is an extremely variable mixture of many substances. It's composition will depend upon the permutation of the species of flowers from which the nectar was collected. Even the same species of flower may vary its output, depending upon the soil and climate in which it is growing (Burgett, 1986).

Honey may vary in colour from water-white to dark amber. The soil in which the nectar plant is growing and the weather conditions at the time the nectar is produced both affect honey colour. Dark honeys are generally strongly flavoured, while light honeys are mild, but again there are many exceptions. (Burgett D. 1986).

White et al (1962) analyzed 504 samples of honey (including 14 samples of honey dew) from 47 states over two crop years. The honeys tested were both blends and those thought to come from pure sources. All honeys, except the honey dew honeys, showed average percentage composition as follows: water 17.2, fructose 38.19, glucose 31.29, sucrose 1.31, other sugars 8.8, total acid 0.57, ash 0.169, nitrogen 0.041, undetermined 2.43. The average honey had a pH of 3.91. While this represents one of the more massive attempts at honey analysis, several individuals have analyzed honey samples from a great variety of countries and feral types.

Burgett D, (1986) stated that in some people's view the quality of honey is reduced by heating and extended storage, and the quantity of hydroxymethyl furfuraldehyde (HMF) produced by the chemical breakdown of fructose in the presence of free acids. This is sued in some countries as an indicator of the amount of heat to which honey has been subjected during bottling, and the length of time it has been stored.

Different ways are used to remove the bees from the framers of honey. Each method of removing honeybees has advantages and disadvantages, and as one travels from one beekeeping area to another a great variation in methods will be found. The honey bees removing methods are brushing bees, using bee escapes, using repellents which drive bees away from the comb, and the chemical repellents are propionic
anhydride, Benzaldehyde, Butric anhydride, carbolic acid or phenol and mechanical bee blowers (More Grant D. 1986).

Morse and Hooper (1986) mentioned that on a world wide basis most honey is consumed as table honey. In some countries, notably the United States, about half of the annual production is used by the baking industry. It is estimated that 95 – 97 percent of the world production is used in these two categories.

Burgett D. Michael (1986) stated that honey is graded according to flavour, moisture content, colour and foreign matter. In certain European markets emphasis is placed on the activity of the natural enzymes present. Additionally, a few people are concerned with the pollen content of honey as an indication of both purity and source.

2-7 Honeybee Pests and Predators :

Many different animals are honeybee pests and predators. Several insects and spiders are classified as occasional bee pests, or may use the bee hive as home or for shelter. Earwigs, cockroaches, pscooids, some beetles, some flies and spiders are often found inside hives. Such creatures feed outside the hive and do not require control measures. Other insects may enter a hive to live part of their live there, feeding on bees, honey pollen or bee wax (Morse and Hooper 1986).

Roberts (1971) stated that in Uganda the most serious pest on honeybees was the greater wax moth Galleria mellonella L. but ants were serious and wide spread enemies. Gasma (1982) mentioned that there was great damage caused by the wax moth in Sudanese honeybee colony. Papadopolus (1975) from Rodesia presented some observations on A. mellifera adansonii one of them was that, it has numerous enemies and when attacked it quickly cover the entrance.

Abdalla (1988) in his study concluded that the major pest attacking the colonies was the wax moth Galleria mellonella L. and the small black ants.

Mogga (1984) reported that the Sudanese honeybees suffer from a number of pests in the different climatical zones. In the forest and rich
savannah zones, snakes and monkeys were occasional pests, the wax moth was a major pest in the poor savannah and the semi-desert.
Materials and Methods

This reach was conducted on the Sudanese honeybee and carried out is south Kordofan, Kadugli province in El Dundour area, where the native beekeepers have their own inherited methods and experiences of beekeeping. In this area the traditional beekeepers prohibit to any one of them or others to trap wild bee swarms and transfer them to already prepared hive. They think that practice is of great danger to beekeeping in their area. So they requested this after their acceptance to conduct the research in El-Dundour area "please give us a promise that you will not try to trap any bee swarm and then transfer it to your hive, but share us the same chance and wait till the bee swarm enter your experiment hive alone ,"This is our tradition in this area".

The research objectives in this study was to leave the bee swarm to make a choice between the hive types, and to see which hive type mostly preferred by bees. So I accepted their point of view and respected their agreement.

3-1 Materials :
3-1-1 Description of the Study Area :

El-Dundour area where is about 61 kilometer at the eastern side of Kadugli city, the capital of south Kordofan state (figure No. 1). This village was established during early 1960's when the nomadic "Hawazma" tribes began settling near the newly planted El Shihatta preserved forest in an area over 2000 feddans. This preserved forest previously belonged to Forests Administration and now Forests National Corporation (FNC) and provided water and work for the people in the area. During that time their only work was to cut Borassus aethispun "Daleib" tree and spilt the trunk into poles, then transplant wood trees instead.

By time different people settled in the village made use of the scrap upper portions of the trees to make a primitive honeybee hives locally called "Tangal". Later El Dundour and the neighbouring villages on the west as Bagaaya, El Kibayba, Remaly and Abusafifa, beside Umdarafy
on the East became the most famous traditional beekeeping areas in south Kordofan. Thousands of traditional hives are used to produce many kintars of good quality honey in two honey flow seasons each year. The honey flow is governed to a large-extent by the environmental conditions prevailing in the area.

Due to security reasons in south Kordofan during 1980's, all the natives in the above mentioned areas migrated to Kadugli and other parts of the country in March 1989. during 1992 people started returning to their previous areas, except Umdarafy village. Beekeepers found that most of their traditional hives "Tangals" were damaged, and they started again to prepare new ones. Since beekeeping ranked second to farming or animal grazing in these areas as an income source, beekeeping activity started vigorously again in Kadugli province during 1990's.

During 1995 a questionnaire was made in El Dundour and Bagaaya village among the traditional beekeepers. The results showed that, the average number of tangals per beekeeper was 17 tangals. The averaged yield of honey per tangal per year was 44 libs. The estimated average income per beekeeper was 187000 Sudanese Dinars per year.

The main reasons for choosing El Dundour area as a research site were:-

1- The big number of experienced beekeepers using the tangal hives.
2- The presence of El Shihetta preserved forest where facilities can be provided by the Forests National Corporation to conduct the research,

3-1-2 Experimental Apiary Sites :-

Three suitable sites near El Dundour village were chosen with the assistance of three native beekeepers as experimental apiary sites. These three beekeepers accepted to guard and protect the sites, and as a reward each of them will share the honey produced from his site during and after the research period, beside a complete bee-suit.

These apiary sites were as follows :-
a- Site No. 1 :-
It was about 1.5 kilometer west of El Dundour village and at the north-west side of the preserved forest. The dominant vegetational cover in the area were mainly, Borassus aethiopum "Daleib", Combretum glutinosum "Hbail", Ziziphus spina Christi "Sidir", Tamarindus indica "Ardeib", Acacia seyal "Talh", Balanites aegyptiaca "Heglig", Kigela Africana "Um Shutur", Anogesissus Leiocrpus "Sahab" and Dichrostacys cinerea "Kada" trees. The planted trees in the preserved forest were Khaya senegalensis "Mahogany", Dalbergia sisso "sisso", Ailanthus excelsa "Ailanthus", Azdrachta indica "Neem" and Eucalyptus camaldulensis "Khafour". The permanent water source was "Id" where the natives dug water wells for their animals drinking about 750 meters to the west of the apiary, beside the Nursery well that belongs to (FNC) where El Dundour people take their drinking water about 600 meters to the east of the site.

b- Site No. 2 :-

It was about 1.5 kilometer south east of El Dundour village. Some native tangals were found in the area. The dominant trees in the natural forest were Talh, Heglig, Sidir, Habil, Ardeib, Daleib, Ficus sycomorus "Gumaiz" and Acacia siberiana "Kuk". The permanent water source was waer wells "Id" for cattle and sheep herds, and it's distance was about 500 meters from the site.

c- Site No. 3 :-

It was south east of the village near to the second site. The distance between the two apiaries was about 500 meters. The perminant water source was the same "Id" providing water for the second site. The dominant trees in the natural forests were Habil, Higlig, Sidir Kuk, Daleib, Gumaiz, Ardeib, Talh and Piliostigma reticulatum "Kharoub".

The three experimental apiary sites were furnished with hives hanged up the trees during the period 9 – 11 June 1995.

3-2 Tools and Equipment :-

3-2-1 Bee Hive Types :

Four different hive types were used in this reseach. Each hive type consisted of a total number of 12 hives as follows :-
a- Langstroth Hive (L) :-
A single chamber Langstroth hive with standard dimensions, fitted with 10 Hoffman's frame type were used in this research. The dimension of the Langstroth hive was as follows :-

- Width of outer cover: 43 cm
- Length of the outer cover: 52 cm
- Length of the chamber (outside): 50.5 cm
- Length of the chamber (inside): 45.5 cm
- Height of the chamber: 26 cm
- Width of the chamber (outside): 41 cm
- Width of the chamber (inside): 38.5 cm
- Width of the frame (outside): 25 cm

Bee wax foundation was fixed only to the upper half of Hoffman's frames used in this experiment, because of the unavailability of enough bee wax sheet to furnish 120 frames. The inner cover was excluded, and a 4 inches deep outer cover was used, giving the optimum bee space above the frames. The bottom board was attached by nails to the underside of the chamber to ease its fixing between the tree branches.

b- The Top-bar hive (TB)

Empty straight-sided imported tea boxes were purchased from the local market. The box was big enough to be cut horizontally by a hand saw to give two hives each was fitted with 13 top-bars with the following dimensions, :-

- Length of the hive (outside): 50 cm
- Length of the hive (inside): 44.8 cm
- Width of the hive (outside): 39. cm
- Width of the hive (inside): 38 cm
- Height of the hive: 24 cm
- Length of the top bar: 38 cm
- Length of the outer cover: 52 cm
- Width of the outer cover: 43 cm
- Width of the top-bar: 3.2 cm
The outer cover of the both Langstroth and Top-bar hives were protected from rains and sun heat by a plastic sheet cut to the dimensions of the outer cover and fixed tightly on it.

Wax starter strips of about 1 cm wide were fixed on the centre of the underside of the top-bars. Small eight holes 1 cm wide were made on both sides at the bottom of the top-bar hive for bees entrance and exit.

c- Traditional "Tangal" Hive (TT):

These are the traditional hives made from the hollow-out dry logs of Borassus aethiopum "Daleib" and called locally by the natives as "Tangal, Carroot or Daleib".

The "tangals" used in this research were similar to the ones used by the traditional beekeepers. The dimensions of the tangal hives have different length and width. The ones used in this research are 130 cm long and diameter of 25 cm on the narrow end and 32 on the wide one. The dry logs were hollowed out by digging out the decayed materials and then setting fire inside for extra smoothing of the inner walls. The two sides openings were covered with rounded tin sheet lids. Previously the natives used a woven lid made of green "Daleib" tree leaves. Before raising the hives up the trees, melted bee wax was rubbed on the inner walls to attract the bee swarms to enter the hive. Then the two sides openings were covered firmly by the tin lids through which 4 holes were left for bees movement. Wet cow dung was used to close all the spaces left between the lid and the hive walls to prevent bee-pests from entering.

d- the improved tangal hive (IT):

The idea of the improved tangal hive, was to make use of the upper larger portions of "Daleib" tree trunks, not usually used by the traditional beekeepers, because these wide portions are so large for bee swarms to enter them. The idea behind the use of the "Daleib" and other trees, wider logs is to make movable combs top-bar hives, from these available, cheap and durable materials. This could be a forward step in the improvement of the traditional beekeeping in Kadguli province.

The length of the improved tangal was 130 cm and the diameter was 35 cm on the narrow end and 40 cm or more on the wide end. Since these improved top-bar tangal were made from different Daleib trees, their
diameter could not have the same dimensions. To make the improved tangal accommodate 25 movable combs a distance of 24 cm was left on both ends of the 130 cm long log. A rectangular upper hive cover was made 82 cm long and 40 cm and 46 cm wide respectively on the narrow and wide end of the log, using a handsaw. (Plates 1-4). This cut opening was wide enough for fit 25 top bars cross. The width of the top bars was 3.2 as recommended for the African bee races. The top bar length ranged from 20 to 32 cm in each hive and varying from one hive to another due to the naturally tapering shape of the Daleib tree trunks. The top-bars were supported by 2 long wooden bars one bar on each side. The bar length was 84 cm and its width was 2 cm and fixed about 2 cm below the opening rim. The correct space between the combs is maintained by keeping the top-bars fitting tight against each other. A narrow slit on either side of the hive between the outer most top-bars and the lids was left. This allow the bees to come up and patrol over the top-bars and can make additional honey combs on the underside of the cover above the top-bar. One cm on both ends of the top-bar was left without wax starter, so that the combs don't reach the hive walls.

The hive side opening were covered with tin sheet lids firmly fixed with nails, four small holes were left on each lid for bees movement. Wet cow dung was used to close the small openings between the lids and the hive walls. The rectangular cover replaced, and used as a hive cover through which hive manipulation was carried out without removing the side covers that trimly fixed with nails.

3-2-2 The following Equipments were used during the research:

Because it was necessary to climb up the trees to fix the hives between the tree branches, so an iron ladder 4 meters high was used. Also the ladder was used on the routine work on the trials throughout the research period for hives inspection and honey harvesting etc. Four sets of bee-suit were prepared to work with the aggressive bees. Each bee suit consist of an overall, veil, hand gloves and long neck shoes.

A typical bent-nose Pengham smoker was used for hive smoking during hive manipulation. This smoker was used by many traditional
beekeepers in the area during honey harvesting. Dry cow-dung was preferred as the best smoking material in this study. Six hive tools were made locally to be used in opening the hives, scrap off the propolis and burrcombs and wax, and to move the frames and top-bars during hive inspection. A bee brush was used in removing bees off the combs during honey harvesting. Three plastic buckets were purchased to be used in carrying the smoker, tools and other necessary equipment needed for hive manipulation, beside that it was used for honey harvesting. A twenty meters fiber rope was used for lifting the hives up the trees, and used during hives manipulation to pick up and lower the bucket with necessary needs and honey. Different nails length were used in fixing hive parts, and hive lids. The wires were used in fixing all these hives between the branches, and thin wires were used in Langstroth hive frames for foundation wax. One inch wood sheets were used in preparing the top-bars for the top-bar hives and the improved tangals and the Langstroth hives and their frames.

3-3 Methods:
Hives were taken to their sites using a vehicle. The ladder and a fiber rope were used to raise up and fix the hives on the trees. A wire was used to tie the hives between the branches. Four men were needed to carry this job. Hives were completely set up by 11 June 1995.

3-3-1 Apiary Protection:
Three beekeepers, natives from El Dundour village agreed to take the protection job of the apiary sites during the research period. They were given one third of honey yield each, beside each of them was offered a compete bee suit and training.

3-3-2 Hive Occupation:
The hive is the beekeepers principal tool. In this experiment wild bee swarms were offered four different hive types to determine if bees could make choices and thereby prefer one hive type more than the other. The preferred hive type was determined by the early bees entering and the
number of hives occupied each month during the year. Each apiary site
was provided with table contains the following :-
   1- Hive type serial number
   2- Date of swarm entering (occupation date)
   3- Date of absconding cases
   4- Absconding causal factor/factors
   5- Inspection date
   Each hive was observed once a week for occupation and absconding.
   Data about hive occupation was collected and analyzed to compare
between the hive types using T Test procedure method.

3-3-3 Honey Production :
   The quantity of surplus honey at the end of the honey flow was
harvested from each hive. Only ripen sealed honey combs, were
harvested filtered then weighted and statistically analyzed.

3-3-4 Hive Life Span :
   Hives in the apiary are subjected to different conditions, weather,
predators or human factor etc., so the more durable hive that resist the
adverse conditions and have longer life span, could be better than others.
During the research period from July (1995) to June (1997) all the lost
hives were recorded and the real causes of damage were known. A
damage hive is that could not be used again and consider a loss in the
apiary.

3-3-5 Hive's cost :
   Although beekeeping requires less capital and time compared to
other agricultural investments. The most suitable hive to the beekeeper
can evaluated from an economic point of view. Hence a cost-base
comparison between the experimental hives was made.

3-3-6 Acceptability of the hive by traditional beekeepers :
   The best hive type is the one most accepted by the beekeepers and
coincide with the prevailing management methods and produces more
honey. Four beekeepers participated in different hive types preparation, inspection and honey harvesting were asked their opinions about the hive they preferred and why? The results were recorded.

3-3-7 Hive fixation level effect on bees:
All hive types in this study were fixed in different height levels, although these heights were not systematically arranged, but observations concerning bees occupation, pest attack and theft etc. were recorded.

3-3-8 Bee pests in the area:
Inspection of Sudanese bees colonies was taken at 12 days intervals for two years. The pests that attack bee colonies were observed and recorded.

3-3-9 Bees defensive behaviour:
No scientific procedure was applied, but general observations about this phenomena were recorded.

3-3-10 Honey hunting activity in the area:
This was investigated among the honey hunters in the area during the dry honey flow season and the observations recorded.
Results

Four hives were tested. These were the traditional tangal (TT), the improved tangal (IT) the tea box top-bar (TB) and a single-chamber modern Langstorth hives (L).

The parameters used were hive occupation or preference, honey production, hive's life span, hive's cost and acceptability by the local beekeepers.

A- The traditional beekeeping in Kadugli province

It was impossible to estimate the number of traditional beekeepers in Kadugli province. A questionnaire was conducted in 1997 in El Dundour and Bagaya village to estimate the number of beekeepers, number of traditional hives, average honey yield per hive, and the beekeepers income from honey per year.

The results obtained showed that the beekeeper in the area own 17 tangals in average, the traditional hives produces 44 Lbs of honey per year. The total income in the year per one beekeeper estimated as 14800 Dinar. So traditional beekeeping although it is a second job for both nomads and farmers in the area, but it is a good income sources.

B- The traditional hive (TT) :

i- Occupation :

Tables 2 and 3 show the monthly and mean number of hive types occupation during the first and second year respectively.

It is clear that during the first month of the trial July 1995, there were three TT hives occupied as the biggest number occupied between the tested hive types. In September the occupied TT became four and this later number was doubled in November to reach eight TT hives occupied. This number was also achieved by the IT hives in November 1995. In December 1995 all the tested TT 12 hives had been occupied i.e. 100% occupation and this percentage had not been reached by any other tested hive type during all the study period. This highest occupation continued
without change during January and February 1996 the end of the honey flow season.

   ii- Absconding :

Absconding cases from TT hives started by one case after the end of honey harvesting in March 1996. Another absconding in April and a third in May, and the absconding cases increased until it reached 6 in July 1996. The remained 6 occupied TT hives stayed without change until September 1996. Three empty TT hive that had been absconded previously were reoccupied again in October 1996 and the highest TT occupation in the second year reached 10 hives (83.3%) during December 1996 - Feb. 1997. After the honey harvesting, one hive was absconded in March 1997 and the same absconding cycle repeated until it reached the lowest occupation number (6) in June 1997. Generally speaking the traditional tangal hives are well adapted and highly accepted by wild bee swarms in the study area.

   iii- Management :

The fixed comb traditional tangal widely used by the beekeepers in Kadugli province is very limited in the scope of management which can be applied to it. Management of these hives consist merely of baiting them by rubbing hot bee wax inside or standing the hive over a small fire with a piece of bee wax smoldering in the embers. The hive is then fixed in a tree and left for a swarm to find it. If a hive is not occupied during the first swarming season, the baiting is renewed at the beginning of the next swarming season.

Nothing is done to the hive until honey-collection season. In the case of hives occupied by bees only that season, the size of the colony is often not sufficiently large to enable the beekeeper to collect honey without seriously impairing the ability of the colony to service the subsequent period of dearth. In case of hives occupied for more than one season enough surplus combs are available to enable the beekeeper to collect a crop.
In south Kordofan where the honeybees are inclined to defend their hive vigorously, always the beekeepers prefer to collect the crop at night. But in this study tangal hives were harvested by day wearing the full bee suit, but still the bees attack vigorously.

Generally speaking traditional hives are preferred by the Sudanese honeybees, and suit the management methods followed by the beekeepers in the study area.

c- The improved hive (IT) :-

i- Occupation :
Tables 2-3 and figures 2-3 showed that the highest occupation percentage in IT hive in the first year was 75% during December and February. It reached 83.3% in the second year during October-February. The monthly means were 8.17 and 6.333 for TT and IT respectively in the first year. The monthly mean occupation was 8.417 and 8.583 for TT and IT hives respectively in the second year.

Generally there was no significant difference in hive occupation between TT and IT hive during the study period.

This indicated that the improved hives are also well adapted and accepted by wild bee swarms in the study area.

ii- Absconding :
One improved hive was abscond in March after the honey season. The total cases of absconding of IT hives reached 3 during the rainy season in the second year.

Generally absconding observed to occur mostly in March after the honey season and reached the peak during the rainy season July – September period. This rhythm happen in all the tested hive types.

iii- Management :
The management of the improved hive is not different from any other top-bar hive, but the time needed for hive inspection and honey collective was more than what is needed for the traditional hive due to the inconvenience placing of the hives high up the trees.
It worth mentioning that the local beekeepers in the area were not accepted the idea of the improved hive design method because it needs daytime management and has less life span as they said.

**D- The top-tar hive (TB) :-**

**i- Occupation :**

The maximum number occupied of this hive type was 7 (58.3%), during January and February 1997 and this was the least number of occupation compared to other hive types in the same period. Accordingly there was a significant difference between TB and the other 3 hive types occupation. The walls of the TB hives appear thin and cracked so its ability to protect bees from sun and rains was the least among other hive types. One TB hive was damaged due to termites infestation within a week in the first year, a case that did not occur in the other hive types tested in this study.

**ii- Absconding :-**

One hive absconded in March and another one in April during the first year. A third hive absconded in July to make the occupied TB hive the least number (25%) among the other hive types during the same period. TB hives proved unsuitable in the area because of their weak resistance to adverse environmental conditions. The number of damaged hives was the largest among the other hive types during the study period.

**iii- Management :-**

This hive was made from empty tea boxes. These hives were designed to work as movable combs hives by using Tanzanian top-bar hive design method.

This hive design was simple and its management is easy. Generally the inspection time of this hive type was less than it was taken to inspect the improved hive (IT), due to the less number of combs, and the average inspection time was ten minutes.

The main observations on the TB hive were :-
i- The TB hives occupied were the least among the other types tested during the study period. TB hives maximum occupation percentages was (58.5%).

ii- The TB hive has weak wood walls.

iii- The TB honey combs mostly break due to their big size and the heavy weight when full of honey.

E- Langstroth hive (L)

This is the ideal movable frame hive used internationally. Due to the research financial conditions and the study area situations, honey yield in this hive was not considered as a parameter since a honey super was not added during the honey flow seasons. Only a single chamber (the brood chamber) was used, beside that the foundation wax was fixed only to the upper half of Hoffman's frame used in the single-chamber tested hives.

i- Occupation:

This hive type was the only type that remained unoccupied for three months after hives had been set (July-September 1995) table 2. From October 1995 to December 1995 seven hives were occupied. The maximum occupied number was attained in February 1996 (75%), tables 2 and 3. During the rainy season in July August and September 1996 the Langstroth occupied hives was the same number (50%) similar to the traditional and improved hives.

Generally speaking there was no significant difference between this modern hive type and the locally used hives with regard to hive preference by bee swarms. This modern hive was well accepted by the wild bee swarms in the study area.

4-2 Hive occupation rhythm :-

It is clear that the least monthly occupation cases in all the tested hives was in the period July to September, and the highest occupation cases occurred in the period December to February during the two years of study, tables (2 – 3).
The rate of hives occupation by bee warms increased from October onwards (in 1995) to reach the maximum in February (1996). Also occupation cases during the second year (1996 – 1997) increased rate from October to reach the peak in January and continued without change in February (1997).

The number of occupied hives in the apiary started decreasing due to bee absconding in March after the honey season, till the lowest occupied hives reached in July 1996.

4-3 Hive occupation rhythm :

Hives occupation cases started in a lower rate in August, then in a higher rate in October to reach the maximum in February. Colonies absconding started during the period March to July. Then reoccupation starts again in August onwards due to swarms formation.

Generally speaking the most suitable time to trap bee swarms is during the period from October to February each year in the study area.

4-4 Absconding of bee colonies :

Bee colonies absconding pattern, that occurred seasonally in the hives is presented in (table 4. figure 4).

The results obtained showed that there was an obvious absconding rhythm happened during the two years of the study period (Figure 4).

No brood was left in the hives from which colonies absconded. Also it was observed that the queen in common, stop laying eggs and then bees abscond.

4-5 Honey Production :-

The quantity of surplus honey produced by the tested hives was estimated during the study period. At the end of honey flow the sealed honey combs were harvested then honey extracted, weighed and recorded for each hive type (table 6, figure 6).

The amount of the honey stored by the bee colonies in the different hive types showed that the total yield in March 1996 of the traditional hives was 18.5 lbs, followed by improved hives yield 15.5 lbs, then top-
bar hives 9.5 lbs, and the least production was of the Langstroth hive that was only 4.5 lbs.

The total honey yield during August honey flow showed that improved hives yielded 14.5, followed by traditional hive 12 lbs, the third was Langstroth hive 4 lbs, and finally top-bar hive only yielded 2 lbs.

During the second year honey was harvested in February 1997 and the results obtained showed that improved hives produced 17.5 lbs followed by traditional hives 8 lbs, then the top-bar hives 5 lbs and the least production was Langstroth hives 3 lbs.

The main honey flow ended in March 1997 and the tested hives honey yield showed that traditional hives yield was 71 lbs, second was the improved hive 65 lbs, then Langstroth hive 49 lbs, and finally was top-bar hives 38 lbs.

The means of the total honey produced by the different types of the tested hives indicated that the improved hive mean during the study period was 14.063 lbs, followed by the traditional hive mean 13.638 then the top-bar hives mean 13.625 and last was Langstroth hives mean was 8.643. table 6.

When comparing the honey production per hive type during the first year 1996, it was clear that honey production in March 1996 was higher than honey production in August 1996. The mean honey production per hive type in the traditional hive was 3.813 lbs, higher than improved hive (3.75 lbs) but there was no significant difference. Top-bar hive mean in 1996 was 2.875 lbs, and the lowest mean was Langstroth hive 0.929.

During the second year 1997 when most of the colonies were strong, honey was harvested in February and March 1997 from all the hives tested, but the honey produced in March was greater than that produced in February.

The average honey production per hive type in the second year 1997 explained that during a good honey flow no significant differences in honey production per the different tested hives. (Table 6) Still the single-chamber Langstroth hive gave the least mean honey yield.
4-6 Honey flows in the study area :-

That there were two honey flows in El Dundour area one during the rainy season during August to September, coinciding with the major nectar and pollen source sidir trees. The beginning of the honey flow during the rainy season is largely affected by the time and quantity of the early rains. During the year 1995 heavy rain fall occurred in the study area during May. These rains continued heavily to the extend that all the waddis and low lands flooded. That situation caused an early and heavy blooming of sidir trees in the area during June 1995. The local beekeepers were asked to inspect their hives in July to harvest the expected surplus honey. But because this was an unusual case to them they didn't care, until by chance a strong storm uprooted a tree where three tangals hives were hanged. When these tangals were inspected so as to be transferred to another tree, a good honey crop was harvested from these tangals. This convinced the beekeepers to change their minds, and harvested a good honey crop during July 1995.

The second honey flow during the dry season observed coinciding with the flowing of the major nectar and pollen sources during December-Feb period. The major flowering trees in the natural forests in this period are: "Talh" Acacia seyal, "Targtarg" Bsewellia papyrifera, "Habil" Combretum spp, "Dabkar" Createra adansonii, "Humid" Sclerocanya birrea, "Haraz" Acacia albida and "Baggis" Gardenia lutea. The major flowering trees in the planted preserved forests are Ailanthus, Mahogany and Kafour frees.

Generally it was observed that honey flows in the area the area are noticed when the established colonies become active in foraging and a sealed honey cells strips are formed along the upper portion of the wax combs in the brood area, followed by the queen's egg laying in the cells below.

4-7 Hive life span :

Hives in the apiary are subjected to different factors that affect their life span and durability.
The results in (figure 5), and (table 5) showed the major factors that probably caused hives loss. Human beings interference in different ways caused 9 cases of hive loss and that was mainly due to theft. The more affected hive type by these theft cases were the wood-made hive types i.e Langstroth and To-bar hives. Of these 4 top-bar and 5 Langstroth hives were completely destroyed. The climate condition, mainly strong storms caused destruction of 4 traditional hives. Termites infestation destroyed one top-bar hive.

4-8 Hives cost:

Hives are the most expensive components of beekeeping activity. Table 7 showed the different hive type cost.

It is clear that Langstroth hive was the most expensive hive costs 10700 dinar/hives. This is because most of it's needs not available in the local market and mostly these needs should be imported e.g. foundation wax, wire and embedder

The improved tangal hives ranked second in hive cost 3400 dinars/hive. The main additional costs were due to the preparation of the accurately measured top-bars, bee wax and the hard work needed to cut the hive cover and to arrange the top-bars beneath the hive cover.

The top-bar hive ranked third in cost wise although it was prepared from a low quality and cheap boxes. The most expensive issue was the top-bar and the cover of the hive.

The least cost was that of the traditional hive 1400 dinars/hive as all the hive preparation needs were available locally.

4-9 Acceptability of the hives by the beekeepers:

A major goal of this research was to convey the real feedback of the traditional beekeepers about the different hive tested in the area. To reach this goal, four good beekeepers each owned more than 40 occupied tangals were invited to attend preparation of the hives. These beekeepers also participated in the routine hive's inspection every 12 days and honey harvesting at the end of honey flows. Their opinions about each tested hive are given below:
A- Langstorth (L) Hive:

1- This hive needs accurate measurements, wax foundation, wires, embedder, queen excluders, bee escapes, brushes and others, and all are not available locally and, should be imported.

2- Wearing bee-suit is a must to manage these hives during the day time, but bee-suit is expensive and not available to them.

3- Manipulation of the hive during the day subjected beekeepers to problems and risks due to free movement of people and animals in the forests that are attacked by the aggressive bees.

4- All Langstroth hives subjected to theft cases were completely lost, so the whole apiary may be lost because theft phenomena is a reality and could not be controlled in the seen future.

5- Langstroth honey frames need special equipments as honey extractor which are difficult to provide or otherwise they would not benefit the use of the modern hive.

6- Hanging this modern hives up the trees is not advisable and not practical, but it is difficult to protect them in their normal hive stand in the danger of pests and fires beside the necessary weeding operations that should be carried during the rainy season.

7- All the beekeepers investigated in the area agreed that the modern Langstroth hive is not suitable to their prevailing conditions because of the high cost, special training and equipment needed. In addition their honey yield was not high to justify its high cost and the special management method, although it was accepted by the bees.

B- The Improved hive:

After preparation, setting, inspection and honey harvesting of the improved hive, the main comments of the beekeepers are summarized below:

1- The accurate measurements of the hive's cut parts and the top-bars are difficult to provide locally.
2- The saw-cut around the hive cover may leak by the rain's water to inside the hive.
3- These tangals are occupied by strong colonies, that are risky to manipulate during the day.
4- all the three beekeepers who were put on the full bee-suit refused to attend the first time inspection of the traditional and improved hives, thinking that these strong colonies can not be manipulated during the day.
5- The honey combs established on the underside of the improved hive's cover and above the top-bar, insure the possibility of using a very large log to work as brood and honey chambers in one log divided by the top-bars. Also this means that available small logs are not suitable to be used as top-bar hives because the space would not be suitable for the establishment of a strong colony. Also the possibility to attach another log by one way or another to serve as a honey super may be tried. This honey chamber could be attached above the lower occupied log, and during the honey flow worker bees can use the upper attached log as a honey supper passing above the top-bars of the brood chamber to the honey super above.

C- Top-bar hive :
Inpsite of the lower number hives occupied in this type, but the hive management was easy. The wax combs have the same size but larger than the improved hive combs and the mean honey yield was good in the second honey flow season.

The main problems related with this hive were :-
1- The thin, and weak wood used in the box construction wouldn't resist the rains i.e. it cracked and easily attacked by termites. This resulted in the lowest occupation percentage mainly during the rainy season when most top—bar hives absconded.
2- More than 90% of the tea box top-bar hive were completely lost during the third rainy season in July 1977.
3- The traditional beekeepers in the study area are convinced that top-bar hive management is suitable to them provided that hard wood is used for the hive construction, and bee-suit, smoker, and hive tool can be provided for day time manipulation.

D- The traditional tangal:

The beekeepers are familiar with this hive. The only change in tangal hives management during the study period, was the day time manipulation instead of the night time, are change in the time and use of bee-suit are not convenient to the beekeepers.

Generally speaking the traditional beekeepers in the study area still believe that their traditional hive "Tangal, Daleib or Caroot" is the more suitable hive type to them. It supers the tested hive types in many points e.g. it's low cost, acceptance by bee swarms, long life span, it's night time manageability don't subjected them to any problem or hazards. Beside it gives good honey yield with little care and damaged hives can be replaced immediately without additional expenses.

4-10 Bees defensive behaviour:

I couldn't forget the bees attacking case in October 1995, when the aggressive bees attacked my legs through the sockets and a medical care was needed for the poisonous case.

During the research period it was observed that, the aggressive behaviour increases during the rainy season August – September, when the bees attacking the intruder away from the apiary and this aggressive behaviour appears even from the untouched hives. The bees unaffected by the smoking, sting the gloves overall and hit on the veil violently pursue the intruder up to 500 meters away from the apiary.

This behaviour was not so during the dry season. When the aggressive behaviour appears mostly after the smoking and opening of the inspected hive. The smoking of the hive have a positive effect on the aggressive bees during this period. The bees mostly return after a short distance, 100 meters away from the apiary.
It was observed that those beekeepers having more traditional hives, were unable to harvest their hives themselves because a beekeeper couldn't harvest more than two hives each night and mostly other beekeepers participated in honey harvesting on a rent base.

Generally the aggressive behaviour of the Sudanese honey bees is a limiting factor of beekeeping in the study area, due to unavailability of the suitable bees protection equipments.
Discussion

5-1 Hive types :-

A scientific paper about beekeeping situation in the Arab countries was prepared by the Arab organization for Agricultural Development in Khartoum 1996. It reported that 25% of the total number of beehives in the Arab countries are still traditional ones. Traditional beekeepers composes 31% of the total beekeepers. This beekeeping pattern in the Arab countries reduces the annual honey yield per hive not more than 2-3 kg per year (Appendix table 2).

The dominant traditional beehives in the Arab countries as reported mainly the sun-backed clay pots, clay pipes, log hives, cylindrical wood hive, and wood-box hives. The dominant modern hives in these countries is the Langstroth hive, but Dadant hive also scattered in some countries as Jordan, Saudi Arabia, Libya and Algeria.

In case of the Sudan the traditional beehives composes 99.5% of the beekeeping and the traditional beekeepers almost 99.8% of the total beekeepers in the country (Arab Organization Report 1996).

In this study a research was made to compare a new design of the improved traditional hive with the modern Langstroth, tea box top-bar and the traditional Tangal-hive locally used by the natives in some parts of Kadugli province as El Dundour area.

The parameters were the acceptability of the hive by bee swarms, hive management, honey production, hive life span, hive cost, and the acceptability of the hive types by the local beekeepers. Observations on honey flow time, trees visited by honeybees, bees aggressiveness and honey hunting activities also reported.

5-2 Hive occupation :

The traditional beekeepers in south Kordofan are not accustomed to bee swarms trapping. Trapping the warms and re-hived them is prohibited by the traditional beekeepers in the study area.

During the study period, bee swarms were given free choices to occupy the preferred ones among the four tested hive types.

The results obtained in the first year (table 2) indicated that the traditional hive occupation achieved 100% i.e. all the 12 tested hives were occupied during December – February period. This percentage was not achieved by any of the three other hives tested during all the study period.
During the second year (table 3), 10 traditional hives were occupied during the period October – February. Here 83.8% occupation of the traditional hive was reported.

The improved hive occupation was not exceeded 75% during December – February and in April in the first year. The maximum occupation rate of the improved hives was achieved in the second year when 10 hives were occupied (83.3%). Two improved hives were not occupied at all during the study period.

No Langstroth hive was occupied during the first three months of the research (July – September) in the rainy season. The maximum occupation rate 75% of Langstroth hive was achieved in December in the first year (table 3). Three Langstroth hives totally not occupied.

Tea box top-bar hive achieved only 50% occupation rate during December – February in the first year. The occupation rate of TB hive increased to reach its maximum 58.3% during January – February in the second year. Five TB hives totally not occupied during the study period, one of these boxes was destroyed due to termites infestation in the first 3 months of the research.

The statistical analysis of those results (Appendix table 4) by using the T Test procedure showed that there was no significant difference in occupation between the traditional (TT), improved (IT) and Langstroth (L) hives i.e. they are similarly preferred by Sudanese bee swarms. But there was a significant difference between the three mentioned above hives and the Tea-box Top-bar (TB) i.e. TB was the least preferred by the bee swarms during the study period. These results agreed with El-Sarrag (1977) who stated that the satisfactory hives attracts the bees to enter it, since it withstands the weather and not become soft or rotten in a short time. Also these results agreed with Smith (1965) who stated that a hive is not superior to any other in itself, but it may be in its suitability for the method of management.

I can conclude that generally the design used to change the traditional hive to work as improved hive using Top-bar hive design method is applicable and could be considered a forward step in the improvement of the primitive hive "Tangal" used by the traditional beekeepers in El-Dundour area.

This new hive design method give a cheap. Easily managed hive made from local available materials, and moreover it is accepted by the bee swarms similarly to the traditional well adapted tangals.
5-3 Hive occupation rhythms:

The ideal method for hive occupation with bee swarms in the apiary, is to catch the swarm in a trap box and then transferred it to the permanent hive as it is applied in most parts of the Sudan.

This ideal procedure couldn't be applied in the study area since the beekeepers in the area prohibited this application by their traditions.

The rate of hive occupation by the swarms occurred in a similar way or rhythm in the tested hives during the two years of the study period. This rate started with a few cases in August increased clearly in October to reach the peak in December coinciding with the swarming season. No swarms were watched or occupied any hive in January and February during the two years of the study. As soon as honey harvesting time starts in March at the end of honey flow, absconding starts.

This indicated that hive occupation is coinciding with the seasonal swarming that usually increased after the rainy season during October and continued to reach the peak in December. Then colonies are established and the bees collect nectar and pollen during the honey flow.

These results agreed with Mogga (1988) who started that seasonal or reproductive swarming took place at different times of the year in the country depending on climate conditions. In the central Sudan swarming occurred between August and October. These results also agreed with Gasma (1984) who reported that there is one swarming season in Kabum area in Western Sudan, this was during October and November. Also Abdalla (1988) mentioned that swarming in Kosti, Medani and Shambat area mainly during January and March.

Generally I concluded that the suitable time to set up bee hives in the apiary for the swarming bee is during October – February in Kadugli area.

5-4 Absconding and migration of bee colonies:

Many entomologists reported that absconding is rare in temperate zone races of honeybee but it is relatively common in the tropical races.

The results obtained in this study showed that during the two seasons about 27 absconding cases from the tested hives were reported (table 4). The rates of absconding according to hive type were like that 8 TT, 7 IT, and 6 absconding cases for each TB and L hives. The largest absconding case was (12 colonies) during March and the lowest was one case
occurred each in January and February. No absconding cases were reported in June, September, October, November and December.

The major causes of colonies absconding in this study were wax moth *Galleria Melonella* 11 cases mainly during March – May period. Followed by human factors 9 theft cases during the honey flow season January – March period. Predators caused 4 cases and absconding because of hunger were 3 cases during July and August.

These results indicated that the major pest of bees in Kadugli area were the greater wax moth and human disturbance when water source is secured in the apiary. Also it indicated that the availability of pollen and nectar sources (Appendix table 1) most of the year reduces seasonal absconding induced by dearth of sources because the later factor was responsible of 11% only from the total absconding cases occurred during the study period.

These results agreed with Smith (1965) who reported that the most common causes responsible of absconding were lack of water, exhaustion of food stores, overheating and continuous pests attack. Also these results agreed with Devis (1985) who stated that the chief factors responsible for absconding were insufficiency of food, invasion by ants wasps or wax moth, frequent disturbance, desertion of new site, incorrect location of colonies and persistent swarming. Gasma (1984) also reported that most of the Sudanese colonies absconding before completing a season.

I concluded that there is an obvious absconding rhythm occur seasonally during January – May period in Kadguli area and this is caused mainly by pests invasion and human disturbance beside hunger sometimes.

### 5-5 Honey flows in Kadugli area

Honey flow is noticed by the increasing forage activities of bees and a notice increased of nectar and pollen stored in the wax cells in the hive.

It was observed that there are two honey flows in Kadugli area. The major honey flow is during the dry season December – February period coinciding with blooming of the dominant trees in the area mainly Talh, Habil, Haraz tragtrag and other trees differ from place to another (table 1).

This honey flow observed to start earlier in the southern parts of the state and somewhat delaying in the northern parts. This resulted in the earlier honey harvesting time in the southern parts of the state e.g. in
Talodi areas honey harvesting time is February whereas in the northern parts honey is harvested in March.

The second honey flow is affected by the starting time and the quantity of the rainfall. Early and heavy rainfalls occurred in May 1995 in El Dundour leaded to early flowering of Sidir, *Ziziphus Spina chriti* trees which are the major source of pollen and nectar in the wet honey flow seasons. This early flowering of "Sidir" trees during June – July provided unexpected earlier honey production that year in July.

Observations in Kadugli area revealed that the normal flowering period of "Sidir" tree is during August – September mostly.

The expected honey time usually during September – October. Also bees foraging activity observed to be affected by weather factors. Heavy rainfall during "sidir" flowering period may adversely affect honey yield and vis versa. This is why honey yield during the rainy season is fluctuating year by year in Kadugli area.

Also it was observed that in 1995 the early flowering of "Sidir" trees in July leaded to early Sidir fruiting in the mid rainy season. These Sidir fruits subjected to high Lepidoptera larvae infestation ended with a poor Sidir fruit season.

Generally two identified honey flows were observed in Kadugli area. The first honey flow is coinciding with "Sidir" flowering time during the rainy season. The second honey flow coincide with the flowering time of "Talh", "Habil" and other trees visited by bees during the dry season. The latter honey flow is the major one in south Kordofan, and large quantities of honey are collected from the wild colonies by honey hunters or from traditional and primitive hives by the local beekeepers.

5-6 Honey production:

Honey production is the first goal of beekeepers in the Sudan. This production largely affected by the availability of nectar and pollen sources beside the suitability of the weather factors for bees during the honey flow time.

It was clear that less honey was produced by all types of the hives tested, during the first season in both March and August honey flow time (table 6). But the quantities produced in March were higher than what produced in August in the same season.

This indicated that less honey is produced during the rainy season than that in the dry season.
During the second season less honey was harvested in February, but all types of hives produced good honey in March.

On the other hand the average honey yield of the traditional, improved and Top-bar hives were not significantly different during March honey flow when all the colonies are well established and strong. Since no honey supers were added to Langstroth hives in the honey follows during all the study period Langstroth hive produced less honey in the brood chamber and it was promising.

Generally I concluded that the improved hive tested in this study, can be considered a forward step in the improvement of the traditional hive since ti was accepted by the bees easily managed and produces good honey similar to traditional hive or may exceed it.

**5-7 Hive life span :-**

The environment factors largely affect the hive life span. Traditional beekeepers in El-Dundour area told that, they have some tangals still working for more than 20 years. So always well adapted hive withstand the climatic factors.

It was observed in this study, that some environmental and human factors affect the hives and caused their loss. Theft of honey is a normal phenomena in the area, and forced some beekeepers to abandon this activity after their failure to prevent it by different means. All the hives tested were subjected to theft cases. Table 7 shows that 5 TB and 4 Langstroth hives were completely destroyed and considered a loss in the apiary due to theft.

The destruction of wood hives by thieves was due to lack of knowledge about these hives management. They found that the easy way to collect their honey is done by destruction of the wood hive.

The familiar traditional and improved hives were also subjected to 5 theft cases for each type during March honey flow, but no hive was lost. They all remained in their places in a good condition after collection of their honey by the thieves.

Being the most expensive of the apiary needs the familiar and adapted hives were advisable to beekeepers in the study area. The second factor caused hive loss was the storms. This factor caused a loss of 4 traditional and one improved hive, this was solved by firm fixation using wires on big-sized trees to minimize the hive movement during the storms.
Termites infestation destroyed one Top bar hive. Generally TB hives made from the empty tea boxes proved unsuitable in the area.

5-8 Hive cost:
Hives are the most expensive issue in beekeeping. To establish an apiary with minimum expenses, the durable and cheap hives should be selected.

In this study Langstroth hive cost was 10700 Dinars. This was already 3 times the improved hive, 4 times the Top bar and more than 7 times of the traditional hive cost.

These results explained that lost of one Langstroth hive can affect the beekeeper economy. The hive cost, hive acceptance by swarms and it's durability can judge the suitable hive type.

Generally the low cost, durability, acceptance by bees, beside the honey production made that beekeepers in the area were advised to use traditional and improved hives.

5-9 Acceptability of the hive by beekeepers:
A major goal of this study was to know the opinions of the traditional beekeepers about the tested hives. The comments of the four beekeepers participated n this study are given below:

i- Langstroth hive was not suited them because of the high cost of the hive. Complex management and day manipulation creates problems, honey theft cases lead to complete loss of the hive. Extraction of honey needs special equipment otherwise they not benefit the use of this modern hive. Fixing the hive high between the tree branches is not practical and it is difficult to provide protection when being put on the normal hive stand.
ii- Tea box Top-bar hive idea is accepted because it is cheap. The design is simple and easily managed. No special equipments needed to extract honey.

On the other hand they rejected this hive because of it's short life span, the inferior wood used to construct the hive cracked in a short time. The low acceptance by bee swarms. The day manipulation creates problems and hazards.

iii- Improved hive : The main comments about this design were : the positive sides are long life span, acceptance by swarms, easily managed, produce good honey, liable to increase when larger logs are used and extra space is provided above the top-bar for surplus honey storage.

The negative points related to improved hives were :-
- The correct measurements, and the hard work needed to cut the hive cover is difficult.
- This hive mostly occupied by strong colonies impossible to manipulate without good bee-suit that not available.
- The saw-cut around the hive cover leaks the rains water to inside the hive. This was solved by rapping the hive with plastic sheet.
- The time needed to inspect the hive is longer compared to other types due to the large number of the Top-bars inside.

5-10 Bees defensive behaviours :

Sudanese honeybees known to be highly aggressive. This behaviour of the Sudanese races considered by the entomologist as the limiting factor suppresses beekeeping development in Sudan.

The calm foreign honeybee races as Carniolan were imported from Egypt several times for educational or investment purposes but they were dwindled.

In this study it was observed that the aggressive behaviour of the bees increases during the rainy season August – October period. The bees start attacking the intruder before reaching the apiary and attacking him for more than 500 meters away from the apiary site in spite of the dense green ground cover.

During the dry season the bees showed less aggressive behavior. The bees start to attack after being smoked and opening of the hive. They follow the intruder not more than 100 meters and it need less time to settle in the hive than that happened during the rainy season. I think this
is mainly because the colonies became populous before the swarming season that started by the end of the rainy season.

These results agreed with Gasma (1984) who stated that even working in the apiary made the bees in Kabum area very aggressive, and this aggressiveness was initiated by colonies that were not opened at all. Also this is agreed with Tomasko (1987) who stated that Sudanese strong colonies with stored honey were highly defensive unlike the European races which were extremely easy to handle during a honey flow.

5-11 The effect of hive fixation on bees:

In this study hives were fixed in different levels up the trees. These fixation levels were not systematically arranged, since the suitable place for the hive that convenient for the operator was selected. Those levels ranged between 2.5 - 9.5 meters.

Generally the observations showed that the higher levels 7 meter and above were preferred than the lower ones by the bee swarms. Also most of the theft and absconding cases occurred on the lower hive's levels. Those hives placed less than 5 meters some of them not occupied during all the study period and those occupied during the swarming season, were absconded before completing the season due to disturbance.

These results agreed with that stated by Morse and Hooper (1986) reported that in a follow up study in the eastern United States in which bees were offered nests 3 and 15 meters above the ground, the bees preferred the latter.

I can conclude that traditional beekeepers are advised to select higher levels to fix their hives in order to provide them better protection and occupation chances.

5-12 Honey hunting activity in the area

Traditional beekeeping with primitive hives is practiced in restricted areas in south Kordofan. The major part of honey production in south Kordofan comes from honey hunting activity that practiced widely during the dry honey flow season in January – March period.

At that time the dense ground cover is removed by fires or animal herds movement.

Honey hunters start their activity earlier during the honey flow, impatient to give time for surplus honey storing by the wild bee colonies. So the early collected honey mostly of inferior quality mixed with brood
and pollens, whereas the late collected honeys are ripen honeys although mixed with wax particles when not been warmed in fire.

During good honey seasons honey hunters mostly destroyed big number of wild colonies. This due to the use of direct fire flames to conquer the highly aggressive bees before honey collection. Mostly they squeeze the honey combs in the forest leaving the wax in place.

It was observed that good honey season mostly followed by a weak one. Sometimes not swarms are seen in the coming season. This supposed to be the result of the destruction of big number of wild colonies in the previous honey season. Traditional beekeepers in the area have a say that "forging of camel herds in the forest cause bee colonies to abscond due to camel's urine smell". This needs further investigation.

Unfortunately no specific role is played by the local agricultural authorities towards beekeeping in the state inspite of the large potentialities of beekeeping in south Kordofan area.
Summary and conclusion

Sudan is a wide country has different climatic zones and rich natural resources. This diversification creates suitable environments for honeybees in wide parts of the country.

Thousands of wild bee colonies are living in forest. Beside that few colonies were kept by the traditional beekeepers in primitive hives of different types in the different areas. A very few colonies were hived in modern wood Langstroth hives for educational or investment purposes.

The major objectives of this study were to highlight the potentialities of beekeeping, and to improve management and the design of the tangal hive used in Kadugli area. In order to increase honey quantity and quality beside the other bee products can be achieved.

The idea of the improvement of the traditional hive "tangal" aimed to make use of the discarded African palm tree stems "Daliab" that usually not used by the local beekeepers because of their large size.

This improvement based on the top-bar hive design idea. This improved hives then could be easily managed and inspected as a top bar hive.

A comparison was made between four different hive types. These beehives were the traditional tangal, improved tangal, Tea box Top-bar and Langstroth hive.

The traditional tangals tested, have an equal length of 130 cm and diameter of 25 cm. average. The side openings through which honey is harvested were fixed with a tin lids, with four holes in each for bee entrance and exit.

The improved tangals were long hives of 130 cm long and diameter of 35-40 cm. a rectangular piece of about 85 cm long and 40-46 cm wide was cut out with a hand-saw. This area was enough to locate 25 Top-bar, 3.2 cm wide. This cut out piece was used as the cover. The side openings were nailed with tin lids, leaving four holes for bees movement, in each lid. A wax starter ½ cm was made on the middle of the lower surface of the top-bars used in both improved and Tea box Top-bar hives tested.

The Top-bar tested hives were made of empty tea box being divided into two equal parts each become a hive. Each hive fitted with 13 Top-bars each was 38 cm long and 3.2 cm wide and small holes were left on the hive side for bees movement.
Langstroth hive with standard dimensions fitted with 10 Hoffman's frame type. The foundation wax was fixed on the upper half only of the frame. No honey super was added to Langstroth hive during the study.

Four excellent local beekeepers were invited to participate in hives preparation, inspection and honey collection. Their comments were then summarized.

The parameters investigated were hive occupation, absconding, honey yield, honey flow time, hive cost, hive life span and bees pests.

The results of the research showed that no significant difference in hive preference between traditional, improved and Langstroth hives. But there is a significant difference between these three mentioned and the tea box top-bar hive. The least preference of TB hive by the swarms was due to the failure of the hive inferior wood to withstand the climate conditions.

The swarming season in the area starts in August, increases in October to reach the peak in December.

Absconding observed to start after honey time in March and continue to July. The main causes of absconding were the human disturbance, pest invasion principally the greater wax moth and hunger.

Two honey flows were reported. The rainy honey flow during August – September coinciding with the flowering of "Sidir" trees. The dry honey flow during December – February coinciding with the flowering of Talh, Habl Tragtrag and other trees.

No outstanding honey production was reported to any hive type. During the major honey flow all the hives except Langstroth produced nearly the same quantities of honey.

Langstorth hive was well accepted by bees and it is promising in the area.

The comments of the traditional beekeepers about the tested hives showed that they are not welling to change their familiar tangals, with other new ones. Their rejection of the new hives TB, L and the improved mainly because of the day time manipulation of these hives and the problems created by the aggressive bees to people and animals.
Table 1 Major nectar and pollen trees and shrubs visited by bees and considered as essential honey source in south Kordofan, Kadugli province (El Dundour area).

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Local name</th>
<th>Flowering date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Combretum spp</td>
<td>Habil</td>
<td>Jan – Feb</td>
</tr>
<tr>
<td>2 Createra adansonii</td>
<td>Dabkar</td>
<td>Jan – Mar</td>
</tr>
<tr>
<td>3 Khaya senegalensis</td>
<td>Mahogany</td>
<td>Feb – Mar</td>
</tr>
<tr>
<td>4 Sclerocanya birrea</td>
<td>Humid</td>
<td>Feb – Mar</td>
</tr>
<tr>
<td>5 Acacia siberiana</td>
<td>Kuk</td>
<td>Mar – Apr</td>
</tr>
<tr>
<td>6 Albizia amara</td>
<td>Arad</td>
<td>Mar – Apr</td>
</tr>
<tr>
<td>7 Zizphus spina Christi</td>
<td>Sidir</td>
<td>Aug – Oct</td>
</tr>
<tr>
<td>8 Cordia Africana</td>
<td>Gembil</td>
<td>Oct – Nov</td>
</tr>
<tr>
<td>9 Acacia albida</td>
<td>Haraz</td>
<td>Oct – Nov</td>
</tr>
<tr>
<td>10 Gardenia lutea</td>
<td>Baggis</td>
<td>Nov – Mar</td>
</tr>
<tr>
<td>11 Ailanthus excelsa</td>
<td>Ailanthus</td>
<td>Dec – Jan</td>
</tr>
<tr>
<td>12 Boswellia papyrifera</td>
<td>Targtarg</td>
<td>Dec – Mar</td>
</tr>
<tr>
<td>13 Acacia seyal</td>
<td>Talh</td>
<td>Dec – Feb</td>
</tr>
<tr>
<td>14 Eucalyptus spp.</td>
<td>Kafour</td>
<td>Dec - Jan</td>
</tr>
</tbody>
</table>
Table 2 Monthly hives occupation during the first season (July 1995) – June 1996

<table>
<thead>
<tr>
<th>Months</th>
<th>Hive types occupied per month</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TT</td>
</tr>
<tr>
<td>July 95</td>
<td>3</td>
</tr>
<tr>
<td>August</td>
<td>3</td>
</tr>
<tr>
<td>September</td>
<td>4</td>
</tr>
<tr>
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<td>November</td>
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<td>December</td>
<td>12</td>
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<td>February</td>
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<td>April</td>
<td>10</td>
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<td>June 96</td>
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<tr>
<td>Mean</td>
<td>8.167</td>
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D.G. | A | A | B | B |

* 12 hives tested in each type

TT = Traditional (Tangal, Daleib or Caroot) hive
IT = Improved (tangal) hive
TB = Tea box Top-bar hive
L = Langstroth hive
Table 3 monthly hive occupation during the second season July 96 – June 79

<table>
<thead>
<tr>
<th>Months</th>
<th>TT</th>
<th>IT</th>
<th>TB</th>
<th>L</th>
<th>Total per month</th>
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<td>8</td>
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<td>5</td>
<td>25</td>
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D.G. A A C B

* 12 hives test in each type

TT = Traditional (Tangle, Daleib or Carroot) hive
IT = Improved (tangal) hive
TB = Tea box Top-bar hive
L = Langstroth hive
<table>
<thead>
<tr>
<th>Months</th>
<th>Number of hives absconded and causes</th>
<th>Total</th>
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<td>November</td>
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<td>-</td>
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<tr>
<td>Total</td>
<td>11</td>
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</table>
Absconding per hive type per season

<table>
<thead>
<tr>
<th>Hive type</th>
<th>Number of absconded colonies</th>
<th>Total</th>
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<tbody>
<tr>
<td></td>
<td>1st season</td>
<td>2nd season</td>
</tr>
<tr>
<td>TT</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>IT</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>TB</td>
<td>2</td>
<td>4</td>
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<tr>
<td>L</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Total</td>
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Table 5 Beehives loss factors

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<tr>
<th>Hives loss causes</th>
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<th>%</th>
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<tr>
<td></td>
<td>TT</td>
<td>IT</td>
<td>TB</td>
</tr>
<tr>
<td>Weather condition (storm)</td>
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<td>1</td>
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<td>Human (theft)</td>
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<tr>
<td>Termites</td>
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<tr>
<td>Total</td>
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Table 6 Honey production per hive type

<table>
<thead>
<tr>
<th>Hive type</th>
<th>No. harvested</th>
<th>Honey Yield in /Lbs</th>
<th>Total</th>
<th>Mean per Hive</th>
<th>D.G</th>
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<tr>
<td></td>
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<td>Aug 96</td>
<td>Feb 1997</td>
<td>Mar 97</td>
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<tr>
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<td>14.5</td>
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<td>9.5</td>
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<td>5</td>
<td>38</td>
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<td>4</td>
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<td>48</td>
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<td>33.5</td>
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<td>Hive type</td>
<td>Average honey yield in Lbs</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>First season</td>
<td>Second season</td>
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Table 7: The Tested Beehive's Cost

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<th>Hive Type</th>
<th>unit</th>
<th>Cost in Sudanese dinar</th>
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<td>1</td>
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<tr>
<td>Improved hive</td>
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<td>3400</td>
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<tr>
<td>Top-bar hive</td>
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<td>2500</td>
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<tr>
<td>Traditional hive</td>
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<td>1400</td>
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Figure 6: Bee hive's cost
Figure 2 Monthly hive types occupation during the first year (July 1995 – June 1996)
Figure 3 Monthly hive type occupation in the second year during (July 1996 – June 1997)

<table>
<thead>
<tr>
<th>Hive type</th>
<th>Mean monthly occupation</th>
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<td>TT</td>
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<tr>
<td>IT</td>
<td>30%</td>
</tr>
<tr>
<td>L</td>
<td>24%</td>
</tr>
<tr>
<td>TB</td>
<td>17%</td>
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</table>
Figure 4 Monthly hive occupation rate during the season
Figure 5 Bee colonies absconding rhythm
Appendix Table: 1
Phonological table for species scattered in south Kordofan and their flowering time

<table>
<thead>
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<th>Botanical Name</th>
<th>Local Name</th>
<th>Flowering Date</th>
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</thead>
<tbody>
<tr>
<td>1  Combretum glutinsoum</td>
<td>Habil</td>
<td>Jan – Feb</td>
</tr>
<tr>
<td>2  Ceiba paentandra</td>
<td>Cotton hairy</td>
<td>Jan – Mar</td>
</tr>
<tr>
<td>3  Crateva adansonii</td>
<td>Dabkar</td>
<td>Jan – Mar</td>
</tr>
<tr>
<td>4  Diospyros mispiliformis</td>
<td>Gughan</td>
<td>Jan – Feb</td>
</tr>
<tr>
<td>5  Dalergia melenaxylon</td>
<td>Babanus</td>
<td>Feb – Jul</td>
</tr>
<tr>
<td>6  Dalbergia siso</td>
<td>Sisso</td>
<td>Feb – Mar</td>
</tr>
<tr>
<td>7  Hyphaine thebecia</td>
<td>Dom</td>
<td>Feb – Apr</td>
</tr>
<tr>
<td>8  Khaya senegalensis</td>
<td>Mahogany</td>
<td>Feb – Mar</td>
</tr>
<tr>
<td>9  Lonchocarpus laxiflorus</td>
<td>Khashbash</td>
<td>Feb – Mar</td>
</tr>
<tr>
<td>10 Scleroecama birrea</td>
<td>Humeid</td>
<td>Feb – Mar</td>
</tr>
<tr>
<td>11 Celtis integrofolia</td>
<td>Mohajria</td>
<td>Feb – Mar</td>
</tr>
<tr>
<td>12 Acacia syberiana</td>
<td>Kuk</td>
<td>Mar – Apr</td>
</tr>
<tr>
<td>13 Albizia amara</td>
<td>Arad</td>
<td>Mar – Apr</td>
</tr>
<tr>
<td>14 Anogesissus leiocarpus</td>
<td>Sahib</td>
<td>Mar – Jul</td>
</tr>
<tr>
<td>15 Balanites aegyniaca</td>
<td>Hgelig</td>
<td>Mar – Apr</td>
</tr>
<tr>
<td>16 Borassus aethiopum</td>
<td>Daleib</td>
<td>Mar</td>
</tr>
<tr>
<td>17 Cassia sieberiana</td>
<td>Umkashawa</td>
<td>Mar – Apr</td>
</tr>
<tr>
<td>18 Acacia comply cantha</td>
<td>Kakamut</td>
<td>Mar – Apr</td>
</tr>
<tr>
<td>19 Kigela Africana</td>
<td>Um shutur</td>
<td>Mar – apr</td>
</tr>
<tr>
<td>20 Psuido cedrela kotschyii</td>
<td>Drouat</td>
<td>Mar – Apr</td>
</tr>
<tr>
<td>21 Steroperum kuthianum</td>
<td>Kashkash Abid</td>
<td>Mar – Apr</td>
</tr>
<tr>
<td>22 Albizia aylemeri</td>
<td>Eriera</td>
<td>Apr</td>
</tr>
<tr>
<td>23 Cassurina equistitifolia</td>
<td>Caussurina</td>
<td>Apr – June</td>
</tr>
<tr>
<td>24 Acacia mellifera</td>
<td>Kitir</td>
<td>Apr – May</td>
</tr>
<tr>
<td>25 Dichroastachys cinereva</td>
<td>Kadad</td>
<td>Apr – Jun</td>
</tr>
<tr>
<td>26 Prosopis Africana</td>
<td>Absurug</td>
<td>Apr – Aug</td>
</tr>
<tr>
<td>27 Sterculia setigera</td>
<td>Tartar</td>
<td>Apr – Jun</td>
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<td>28 Techtona grandis</td>
<td>Teak</td>
<td>Apr – Aug</td>
</tr>
<tr>
<td>29 Terminalia brownie</td>
<td>Darot</td>
<td>Apr – June</td>
</tr>
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<td>30 Acacia gerradii</td>
<td>Salgam</td>
<td>May – Jun</td>
</tr>
<tr>
<td>31 Tamarinadus indica</td>
<td>Aradeib</td>
<td>May – Jun</td>
</tr>
<tr>
<td>32 Adansonia digitata</td>
<td>Tabaldy</td>
<td>Jun – Jul</td>
</tr>
<tr>
<td>33 Xeromphis nilotica</td>
<td>Shad morfain</td>
<td>Jun</td>
</tr>
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<td>34 Oxytenathera abyssinica</td>
<td>Gana</td>
<td>Jul – Aug</td>
</tr>
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<td>35 Ziziphus abyssinca</td>
<td>Nabi El fil</td>
<td>Jul – Oct</td>
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<td>36 Piliostigma retiulatum</td>
<td>Kharob</td>
<td>Aug – Sep</td>
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<td>Common Name</td>
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<td>Ziziphus spina Christi</td>
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<td>Acacia senegal</td>
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<td>39</td>
<td>Amblygona carpus andongensis</td>
<td>Absuruj</td>
</tr>
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<td>40</td>
<td>Acacia albida</td>
<td>Haraz</td>
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<td>41</td>
<td>Acacia nilotica</td>
<td>Sunt</td>
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<td>Gumeiz</td>
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<td>Gerdinia lutea</td>
<td>Baggis (abungaway)</td>
</tr>
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<td>46</td>
<td>Larnea humiliis</td>
<td>Layeun</td>
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<td>Nauclea latifolia</td>
<td>Karmadoda</td>
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Appendix table 2
Shows Bee Colonies in Modern and Traditional Hives and the number
Beekeepers in Arab Countries

<table>
<thead>
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<th>country</th>
<th>Number of Bee Colonies</th>
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</table>

Source: Questionnaire of Arab Organization for Agricultural Development on situation and constrains of Beekeeping in Arab countries in 1995 – Khartoum
Appendix table : 3
Shows total number of Bee Colonies in Arab Countries and their Honey Production

<table>
<thead>
<tr>
<th>Item</th>
<th>Number of Bee colonies</th>
<th>Colony production Honey/kg</th>
<th>Production in (Tonns)</th>
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<tr>
<td>Modern Beekeeping method</td>
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<td>------</td>
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<tr>
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<td>1.944</td>
<td>1.111</td>
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Plate (9) single chamber langstroth hive

Plate (10) Langstroth hive frame
Place (7) Tea – box to – bar hive

Plate (8) Movable comb of tea – box top – bar hive
Plate (1) *Borassus aethiopum* (Dableib) tee forest in south Kordofan

Plate (2) Cutting the logs for traditional hives
Plate (3) Marking and cutting the improved hive cover

Plate (4) Arrangement of the top –bars in the improved tangal hive
Plate (5) Using wet cow - dung to close the spaces between hive lid and inner walls

Plate (6) Moveable top – bar comb of the improved tangal hive
الطرح

الملخص

بالموارد غنى و البيئات المتناعى للطرائف المتارمي قطراً مطابق

السودان الطبيعية.

حيث العسل لحل صلاحية البيئات الميقات كثيرون جعل التنوع هذا وبيوت الجبال وكهوف الأشجار جذوع داخل خلايا في البرية الأطواع المختلفة بديئية خلايا في منها يرتب بينما وغيره الأبيض النمل خشبية خلايا في يرتب الأطواع من جداً قليل بينما، واالأشكال بغرض حدثة الاستثمار او الدراسة.

وملائمة الطبيعية المقدرات عكس هي الدراسة لهذه الرئيسيات الأهداف كادقلي بمحافظة التقاليد وادارة التصميم وتحسين العسل حل للتدريب جانبي.

تتحسب فكرة الأشجار جذوع من الاستفادة أساس جأت التقاليد النحل خلايا تكون في جملة العسل والادارة الفحص.

ذلك جدًا في سلاسة الفعل 83 وعصر طوال سما 46 وسما 43 ومنال وبعدها العريضة بالجهة سما 43 ومنا على الاستدارة كاملاً الجدار تترك مع الالوانية.

العمليات يسهل ماما المتراكبة بالأطرال المرشحة الأقلمة لتم مناه العسل وقطعية وادارة الفحص.

ذل ذلك جدًا في علوية فتحة يعمل حسني ببعيدة الأطوار.

3.2 سما 30 - 32 لحية الثلج يترك 25 فر كثودية ثانية لل.
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2 2

– 1995/6/13

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– 1997/6/13

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نتشاق نظام صلاحية علي التأكيد مع الخشبية. ذلك ويعزى الوعي الأعلى الأطراف.

الخريف فتره في الأول بالمنطقة للفضي MOVمش مونيات ونتائج اوضحت أغسطس - الأزهار بدأت سبتمبر.

ديسمبر الشتاء فتره خلال والثاني يتع lider الأزهار مع وافقت الأشجار.

اكتوبر في ويدت أغسطس في يبدأ بالمنطقة التطور للدراسة اوضحت معدل عليه الأحادية،

والي={`

الخليفة بين معنى فروق ووجود الدراسة اوضحت النمو في الرييسي قوته.

الراكب 9

والتقليدية الخلية بين معنى في الدراسة اوضحت سوء حفل التأريخ والجهري والحرار والطريق والطريق والهبل الأزهار مع وافقت الأشجار.

الاكتوبر في والتكاليف الأشجار والخليفة، خلافه، خلاف، والدراسة،

والخليفة، خلاف، والرسالة، خلاف، والدراسة،

وردقية بالندورات، خلاف، والدراسة،

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