Smart Apiculture Management Services

SAMS

Deliverable: Manual on Beehive Construction and Operation

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Smart Apiculture Management Services

SAMS

Imprint

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HOLETA	OROMIA AGRICULTURAL RESEARCH INSTITUTE, Ethiopia
ICEADDIS	ICEADDIS IT CONSULTANCY PLC, Ethiopia

Project website:www.sams-project.eu

LEAD PARTNER FOR THE COMPILATION OF THIS DOCUMENT

Oromia Agricultural Research Institute

IQQO
Oromia Agricultural Research Institute

AUTHOR OF THIS REPORT

Kibebew Wakjira
OROMIA AGRICULTURAL RESEARCH INSTITUTE, HOLETA BEE RESEARCH CENTER
Ambo Road
Holeta, Ethiopia
wkibebew@gmail.com

Project Coordinator contact:
Angela Zur
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
An der Alster 62,
20999 Hamburg, Germany
Angela.Zur@giz.de

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1 Executive Summary

Under SAMS project the objective set for work package 3 is to adapt HIVE System for local needs and usability. To achieve this objective one of the deliverable targeted was to develop manual on Beehive Construction and Operation. For this, analysis of the existing situation in each target project countries is conducted. In this analysis, some basic characteristics such as way bees build their combs in natural nests, distance between two fully grown combs (bee space) and comb thickness were considered. The species of bees for which the hives are going to be constructed considered because the size of the bees, which depends on their bee species (race), affects the comb spacing, cell size and hive volume. On top of these, local experiences about the types of modern beehive used in all the three target regions considered. Accordingly, in Germany (Europe), the species of honeybee exist are *Apis mellifera*. There is also a well developed hive system with the Dadant model under use for beekeeping in this region.

On the other hand, in Ethiopia and Indonesia, modern beekeeping and hive systems are at infant stage and beekeepers have limited access and knowledge to modern beehive equipment and bee management systems. The honeybee species found in Ethiopia are *A. mellifera*, while introduced *A. mellifera* and *Apis serana* species are found in Indonesia. Even though, the two countries are similar in having under developed beekeeping system, the history of beekeeping in these two countries is different. In Ethiopia, modern beekeeping extension was initiated in 1965 with the establishment of Holeta Bee Research Center (the then Holeta Beekeeping Demonstration Station) with the objectives of the demonstrating introduced improved beekeeping technologies (box hives, wax foundation printers, honey extractor, etc.) imported from abroad (particularly Germany) to the beekeepers and to offer beekeeping training for beekeepers and extension agents. Improved modern beehive such as Langstroth, Dadant, Foam, Zandar, and modified Zandar were introduced to Ethiopia in 1960s and demonstrated to the different beekeeping society in the station and training given to the participants later, formally organized beekeeping extension started in 1978. Encouraged by the conducive government investment policy, different private investors and organizations are involved in constructing of improved fame beehive. But, lack of knowledge in basic honeybee behavior and requirements resulted in use of faulty materials and hive specifications. This faulty materials and specifications used for hive construction and distributed to the field for beekeeping creating the biggest challenge and problem for adaption and dissemination of these improved technologies. As a result, despite more than 50 years history of improved beekeeping in Ethiopia, its development is stagnating.

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In Indonesia, *A. mellifera* honeybees were introduced about 40 years ago to join domestic honeybee species *A. cerana* for beekeeping. But apiculture sector is developing slowly due to the fact that beekeeping is not a priority in the governmental program. This aspect leads to a weak beekeeper rate, a low rate of modern beekeeping though there is available traditional knowledge especially for *A. cerana* in Indonesia.

In order to improve the beekeeping situation of the two countries, to strengthen international cooperation of the EU with developing countries in ICT, SAMS project targeted to develop a technologically enhanced low cost beehive system model and that is going to be locally produced and adapted to local conditions. Therefore, this manual on beehive construction and operation developed to overcome the complex problem related to lack of education and experience, which is the largest barrier for adaption and utilization of modern beekeeping technologies.

In developing this manual on beehive construction and hive operation, quick field survey was conducted to collect data on the bees natural comb spacing. Also some private and public workshops constructing bee hive were visited to consider the volume of beehive used by some beekeepers that adapt the technology. Bee species used for beekeeping, design and specification requirement from Europe and Indonesia are also considered in this manual development. Based on requirements, two hive types, Langstroth (for Ethiopia and Indonesia) and Dadant (for Europe) are proposed in this manual to be considered for SAMS hive system project implementation and for the future beekeeping development in the project countries.

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2. Introduction

2.1 The SAMS project

SAMS is a three years project supported by the European Union's Horizon 2020 research and innovation program with a budget of about 2.0 Mio EUR. The project with the focus on Smart Apiculture Management Services started in January 2018 and is implemented by the Deutsche GesellschaftfürInternationaleZusammenarbeit (GIZ) GmbH in collaboration with two partners from Ethiopia and Indonesia and one each from Austria, Germany and Latvia.

Bees play a key role in the preservation of our ecosystem, the global fight against hunger as well as in ensuring our existence. They have high potentials to foster sustainable development in different sectors but they are often used inefficient. In the context of the SAMS consortium, this effects the partner countries in different ways:

Three continents - three scenarios

(1)In Europe, consumption and trading of honey products are increasing whereas the production is stagnating. Beside honey-production, pollination services are less developed. Nevertheless, within the EU 35% of human food consumption depend directly or indirectly on pollination activities.

(2) In Ethiopia, beekeepers have limited access to modern beehive equipment and bee management systems. Due to these constraints, the apicultural sector is far behind its potential.

(3) The apiculture sector in Indonesia is developing slowly and beekeeping is not a priority in the governmental program. These aspects lead to a weak beekeeper rate, a low rate of professional processing, support and marketing and a lack of professional interconnection with bee products processing companies.

Therefore, the overall objective of SAMS is to strengthen international cooperation of the EU with developing countries in ICT, concentrating on the field of sustainable agriculture as a vehicle for rural areas. The SAMS Project aims to develop and refine an open source remote sensing technology and user interaction interface to support small-holder beekeepers in managing and monitoring the health and productivity in their own bee colonies. Highlighted will be especially the production of bee products and the strengthening of resilience to environmental factors.

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Specific objectives to achieve the aim:

1. Addressing requirements of communities and stakeholder
2. Adapted monitoring and support technology
3. Bee related partnership and cooperation
4. International and interregional knowledge and technology transfer
5. Training and behavioral responses
6. Implementation of SAMS Business cooperation

Based on the User Centered Design the core activities of SAMS include the development of marketable SAMS Business Services, the adaption of hive monitoring system for local needs and usability as well as the adaption of Decision Support System (DSS) based on an open source system. As a key factor of success, SAMS uses a multi stakeholder approach on an international and national level to foster the involvement and active participation of beekeepers and all relevant stakeholders along the whole value chain of beekeeping sector.

SAMS enhances international cooperation of ICT and sustainable apiculture between EU and developing countries in pursuit of the EU commitment to the UN Sustainable Development Goal (SDG N°2) "End hunger, achieve food security and improved nutrition and promote sustainable agriculture". SAMS increases production of bee products, creates jobs (particularly youths/ women), triggers investments and establishes knowledge exchange through networks. SAMS results are of major interest for stakeholders along the whole value chain of beekeeping aspects. In the long-term, it will have a positive effect on the local engineering capacity and innovation potential. By cooperation with other networks, SAMS technology will be promoted worldwide to beekeepers as well as data beneficiaries. Of course, this inter-sectoral and intercontinental cooperation aims to research causes and find solutions to fight the worldwide trend of decreasing bee colony population.

2.2 Scope of the task/deliverable

The Major focus of SAMS is on bee health and sustainable beekeeping as a key for sustainable agricultural development. The greatest value of bee health and beekeeping lies in the fact that bees pollinate agricultural and horticultural plants. When a bee has found the flowers of a certain kind of plant she will encourage her hive mates to use this source. The bees will visit these flowers as long as food (pollen and nectar) is available. This flower constancy makes bees exceptionally valuable to plants which need to be cross-pollinated. If there are enough bee colonies in the area at flowering time, the plants will give higher yields and the quality of the fruits will also be improved.

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However, for the bees to be successfully carryout the pollination service, the beekeepers should maintained them in standard hives that sock the balance between the requirements of the colony and ease and convenience for the work of beekeepers. In this regard, modern beehives like Langstroth, Dadant and other types, which are widely used in professionalized honey producing countries like Europe have proven to help in monitoring bee health and have ten times higher productivity and production potential than traditional hives widely used in developing countries. Risks of depleting honey production threatens livelihoods of beekeepers, but degradation of pollination power of suffering bee colonies threats overall agricultural production and affects entire population.

Standard modern hive to which advanced ICT and remote sensing technologies in SAMS could be fitted and help increase production of bee products and help controlling of health of bee colonies, the golden insects. Meanwhile, beehive construction is not a simple task and needs quality materials, precision of specifications and educated and experienced carpenters but almost all absent, which remain the largest barrier for utilization of the technology in developing countries like Ethiopia. Because of lack of experience and manual on the requirements and construction guide, beekeepers who tried to adapt modern beekeeping forced to use unsuitable hives with wrong specifications and low quality materials for beehive constructions. In beehive construction, hive makers ignore the correct comb spacing by positioning combs too widely or too narrowly spaced. As a result, honeybees are much more prone to absconding contrary to the case in European. Under the current task, overview about modern beehive, definition of different hive parts along with their importance, tools and required materials are described to develop this manual on hive construction and operation,.

Even though, there is a large variety of hives throughout the world, only Langstroth and Dadant considered in developing this manual for the sake of simplicity in construction and required material in puts. On top of this, these hive systems are well under use in different parts of the world and hence can be easily adapt by the major stakeholders along the whole value chain for construction and ease of management if properly constructed. In this task, it is not the intention to look at all the details of each hive type, but procedure of hive construction and operation explained by using Langstroth hive. Under hive operation and bee management, all activities of beekeeping activities starting from preparing wax foundation to honey harvesting, with activities like transferring colonies, hive inspection, and hive supering and management of colonies during different seasons in between are considered.

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3. Overview about modern beehive

The word modern beehive in this manual is used to describe an artificial, man-made box structure to nest or house a honeybee colony of *A. mellifera* or *A. cerana* species. It is made of stackable boxes that held frames in which honeybees will make their honey combs. The hive needs to sock the balance between the requirements of the colony and ease and convenience for the work of beekeepers. The interchangeability of similar parts of the beehive like frames, outer covers, bottom board, and inner covers shall be important for modern beekeeping.

The difference between traditional and modern beehives is that traditional hives simply provide an enclosure for the bee colony and no internal structures for the bees to build honeycombs and no convenience for the work of beekeepers. Honeybees construct their own honeycombs fixed on the hive wall. This makes honey harvesting very difficult or totally impossible without destroying the combs. But in modern beehive, bees construct their honeycombs in frame for easy removal without colony disturbance and extraction of the honey for re-use of the combs. In using modern hives, there is a possibility to expand the size of the beehive by stacking boxes (supers), so that the hive can grew with the colony.

The total hive system consists of a bottom board with an entrance for the bees, boxes which containing frames for brood and honey and inner and external covers for weather protection. There are different hive types (Langstroth, Zander, Foam, Dadant and Modified Zander etc.) almost all of which are similar in having boxes arranged bottom up for easy manipulations. The bottom or lower box is used for the queen to lay eggs, and the above boxes (supers) to serve as honey storing room for the bees. In each box, there are vertically hanging frames on which bees build their combs. Between the frames and other parts are specific spaces, called bee space for the movement of individual bee for comb construction, brood rearing, and storing foods. In order to understand the process of hive construction, it is necessary to define some terminologies related to different hive parts.

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4 Different parts of a beehive and their definitions

For the purpose of easy understanding of some parts in the process of beehive Construction, the following definitions were adopted.

4.1 Bee Space

Bee space is path or corridor bees need to move between the combs and around the nest, a vital path to allow bees walk freely. In Modern frame hives, bee space is the distance between the outside end of each frame and inner hive wall opposite to it, between adjacent surface of completed and sealed worker brood combs, and between the top of frames in the lower box and the bottom of the frames in the upper box (Jones, 1997, 1999). Therefore, bee space is an optimum distance between two surfaces in a beehive essential for the normal movement and functioning of bees.

4.2 Comb/ frame spacing

Comb spacing or frame spacing in a modern box hive is the distance between the adjacent comb midribs or sheets of foundation in the frames. It is determined by the bee space, which in turn is determined by the size of bee races under consideration.

4.2 Brood chamber

Brood chamber is a four-sided wooden box of rectangular cross-section without a top or a bottom, in which the brood frames are placed. It holds 10 frames in which foundation sheet fixed on which bees build wax onto for various purposes.

4. 3 Honey chambers/supers

Honey chambers are four-sided wooden box of rectangular cross-section without a top or a bottom in which the frames of similar size are placed. It is similar to the brood chamber but placed above it when in use. It holds 10 similar frames with that of brood chamber where the bees will store honey. One can stack as many honey supers on top of the hive as needed but at least two for one hive.

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4.4 Frame

A frame is a structure made up of a top bar, a bottom bar and two sidebars in which the bees develop comb to rear brood, store pollen, nectar and/or honey. Frames are constructed in such a way that a series of them may be placed in a vertical position in the brood chamber or the honey chambers/supers so as to leave space (=bee space) in between themselves and hive body for bees to move freely.

4.5 Bottom board and Mite floor

Bottom board is a four-sided wooden box of rectangular cross-section screened with 3 x 3 mm wire greed at the middle and with perfectly sealed bottom, on which all hive parts placed to keep bees for all the required activities. It has ledge around three sides that raises the hive parts leaving an open slit in the front, which is primary covered by the entrance block (Fig 10).

Mite floor is a four-sided rectangular board for different pest management. It is prepared from waterproof plywood, on which sticky glue will be placed to trap particularly small pests like varroa mites and larvae of small hive beetle that crawling out intended for pupation process in the soil as part of protecting bees from re-infestation of the pests.

4.6 Entrance Reducer

Entrance reducer is a small piece of wood block at the hive entrance usually provided with slot of suitable size for bees to enter and leave the hive for foraging and other activities. It fits between the bottom board and the first super (brood chamber) and to protect bees against bigger pests and robbers.

4.7 Outer cover

Outside lid is a wooden plate with four sides covered by smooth metal sheet of 0.5 mm and always placed on the last upper hive chamber (brood or super). The outside cover/ roof lid is wider than the rest of the hive chambers with an overhang of 65 mm so that water drips beside the hive rather than running down the side of the hive chambers or possibly into the hive.

4.8 Inner/inside cover

Inside cover is a four-sided box of rectangular cross-section without a top and bottom with a water proof plywood separator screen at the middle with a passage hole for the bees to visit upper part of the inner cover. The inner cover will serve as a feeder to supply bees with sugar syrup or pollen patty during dearth period and also for various beekeeping activities. The size of the passage hole can be with a dimension of 50 mm x 80, but can be of different size.

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5 Approaches followed to develop this manual

Two separate quick studies were conducted to develop this manual on beehive construction

5.1 Measuring bee space, comb thickness and cell depth of combs from natural bees' nests

A quick study on bee space, Comb thickness and depth of each hexagonal cell were investigated in the naturally constructed combs from traditional hives by considering fully grown combs. Measuring of bee spaces (or gaps) left between two combs was conducted by selecting fully grown (brood and /or honey) combs, the cell depth was by measuring the total length of a single cell of fully grown combs. The bee spaces and inside cell depths were measured with the help of digital caliper (Figure 1). To be representative, data were collected from 3 major agro-ecological climatic zones, dry-hot low land, humid-warm mid-high land and cold high land zones with altitudinal ranges ≤1700 m, between 1700 m to 3000 m and ≥3000 m above sea level, respectively. For each agro-ecological zone, 12 bee colonies which assumed to represent the different ecotypes in these agro-ecological zones were randomly selected and measurements of distance between two fully grown combs, Comb thickness and cell depths conducted. Accordingly, 5 bee spaces and Comb thickness each and 30 cell depth (15 cells on either side of a comb) for each colony. Studying the dimensions of different hives under construction in various workshops and correlating the dimensions with the requirements of the local bee races done.

Figure 1. Measuring depth of honeycombs obtained from traditional hives using digital caliper

5.2 Assessing some local workshops for different hive dimensions

The second part of the study was to see whether the frame hives that are under construction and in use are in line with the nature and need of the local honeybees. The investigation of bee-

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spaces in the frame hives was to develop the standard frame spacing in box hives made in the country.

Dimensions of the different parts of the box hives (including the frames) that were made at different rural technology centers and private workshops were taken to compare frame spacing in the hives to the natural comb spaces and then to be readjusted to the need and nature of the local honeybee races. A total of 40 movable frame hives and 200 frames were taken from: Bako Rural Technology Research Center (BRTRC) from Bako west Shoa, Selam TVET (STVET) from Addis Ababa, Dedessa Metal and Wood work (DMWW) from Jima and Agelegelote Sechi Wood and Metal work Cooperative (ASMWC) from Kefa.

The two studies generally helped to determine the distance between two adjacent combs and required Comb thickness of full depth combs built by the local honeybees. From the two studies, frame spacing and dimension required in hive construction for local use in the future identified.

Table 1. Result of the study indicating bee space, cell depth and calculated comb thickness from traditional hives for three different altitudinal ranges

Measurements	Altitudes≤1700 m Mean ± SD	Altitudes between 1700 to 3000 m Mean ± SD	Altitudes≥3000 m Mean ± SD	Average of the three zones Mean ± SD
Bee space (mm)	9.27 ± 0.33	9.70 ± 0.27	11. 18 ± 0.21	10. 15 ± 0.27
Comb thickness (mm)	24.34 ± 0.31	24.58 ± 0.39	26.23 ± 0.2	25.05 ± 0.25
Cell depth (mm)	13.02 ± 0.15	13.07 ± 0.02	13.22 ± 0.14	13.11 ± 0.10

The result of the natural comb from the nest study showed that the measured values are not influenced much by the altitude ranges and different ecotypes. There is no significant difference for the measured parameters (bee space, cell depth and comb thickness). From the result of comb thickness (about 25 mm) and bee space (about 10 mm), it is possible to see that natural Comb spacing is 35 mm (25 mm + 10 mm = 35 mm). Therefore, local honeybee colonies need

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frame spacing of about 35 mm in which combs of the indicated cell depth will be constructed. This finding is also in line with comb spacing for most *A. mellifera* races which ranges from 32 mm to 38mm (Crane, 1990). However, frame space (sidebar width) of hives constructed currently at different workshops and used by beekeepers are out of this range except for STVET workshop which is in range of natural comb spacing (Table 2).

Table 2. Brood and honey chambers and frame dimensions bee space, space between tops and bottoms of frames in box hives constructed at four different workshops.

Measurements	BRTRC Mean+SD	STVET Mean+SD	DMWW Mean+SD	ASMWC Mean+SD	Average dimentions
Brood and honey chambers dimensions (mm)					
Length (External)	502±2	482.5±4	505±0	498±2	495±9
Length (internal)	481±1	456±3	476±3	479±2	473±10
Width (external)	430±1	400±2	432±2	422±2	421±1
Width (internal)	409±1	380±1	411±1	410±0	403±10
Height (external and internal)	242±1	238±1.6	233±1	230±1	236±4
Frame dimensions (mm)					
Top bar (external)	485±0. 7	460±0.9	481±1.1	483±0.5	477±6
Top bar (internal)	469±1.5	445±1	465±3	468±2	462±10
Bottom bar (external)	451±0.1	430±0.8	451±0.3	451±0.8	445±2
Bottom bar (internal)	430±2.1	415±1.5	435±4	436±2.2	430±9
Height (external)	221±0.1	210±0.2	220±0. 2	220±0.1	218±3
Height (Internal)	180±0.5	168±2.1	180±1.2	178±2.3	177±5
Side bar width top	39±1.0	37±1.0	39±0.8	40±0.9	38±0.8
Side bar width bottom	30±2.0	28±0.9	26±1.5	27±1.0	27.7±2

Despite these differences, local honeybees are observed to tolerate and perform in the different hives from these workshops. This tolerance can be possible if the local honeybees can increase the size of cell depth of comb which observed under natural condition to accommodate the resulting comb spacing. This is also another indication that local honeybees can tolerate wide

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range of comb spacing. On the other hand there is a serious problem of expanding improved beekeeping in the country because of lack of a standard to follow modern beehive construction (Workneh, 2007). A study carried out by Tolera *et al*. (2012) on determining the efficiency of different beehives with the objective of selecting better performing type of beehive from five different types (Langstroth, Zander, Foam, Dadant and Modified Zander) showed that Langstroth is found the best beehive for all practical beekeeping activities followed by Zander compared to the others. It was recommended from the study that using of Langstroth hive by considering the size of local honeybees will help expanding improved beekeeping and exploiting the existing potential. Therefore, based on the previous recommendation and the current natural comb spacing study results, designing of different beehive parts dimensions and manual on hive construction and operation developed.

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6 Recommended dimensions for beehive constructions for different regions

6.1 Frame and its dimension

Based on the study result for bee space, cell depth and comb thickness from traditional hives from the local bee colonies (Table 1) and frame dimensions constructed at four different workshops (Table 2), the proposed dimensions of different frame parts are given in Table 3 and 4. The top bar shall extend equally on both sides of the frame. A frame shall have top bar, two sidebars and bottom bar (Figure 2).

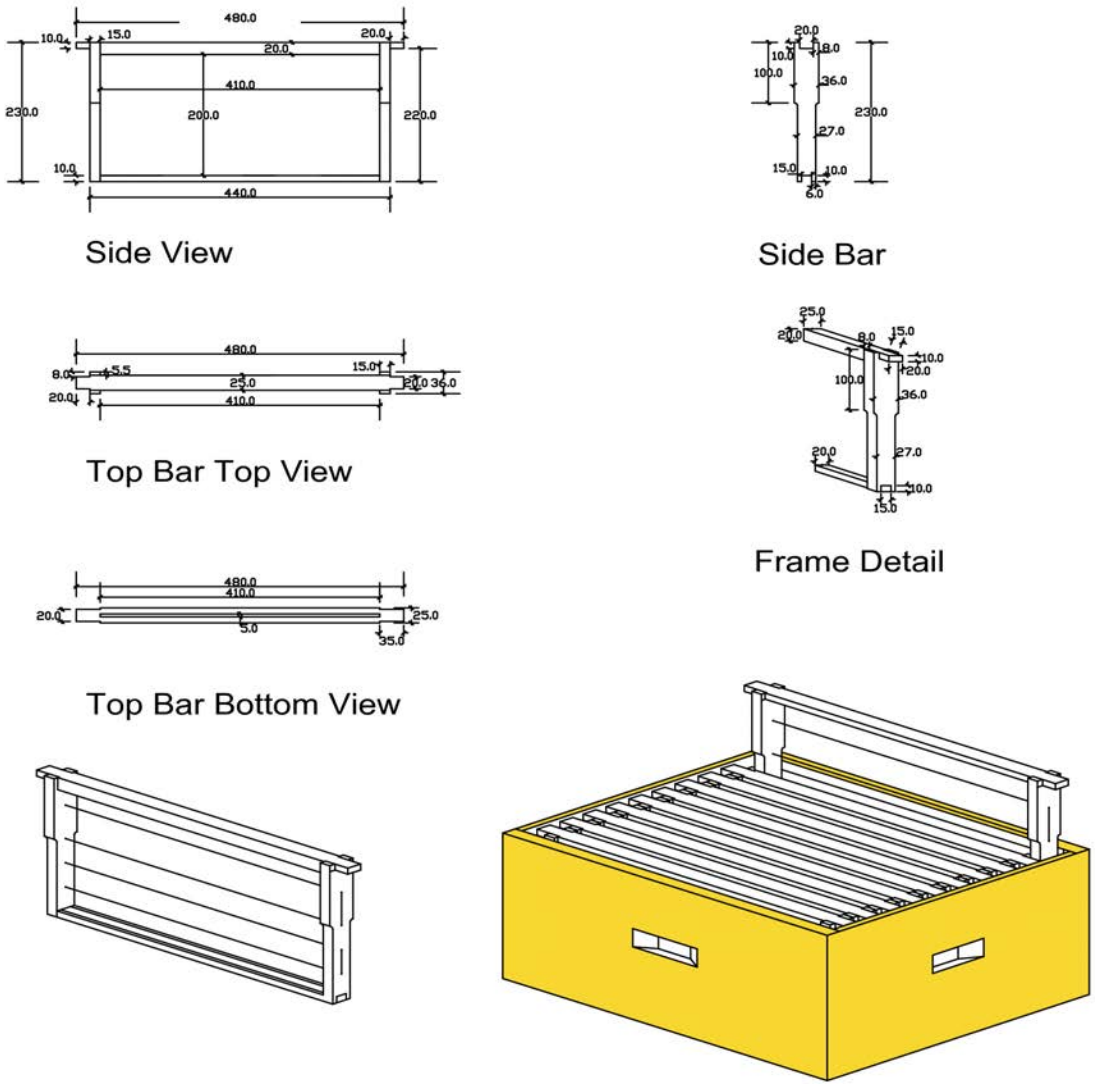

Figure 2. Standard frame with its dimensions for construction guide

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Top bar

From the different workshops the average length of top bars is almost 480 mm. To determine the width of a top bar, considering the comb thickness is a logical decision. From Table 1, average comb thickness is about 25 mm and this can be considered as the width of top bar. So the top bar shall be 20 mm thick, 25 mm wide and 480 mm long. It shall be made of well-seasoned wood to prevent swelling and shrinking. Cutting notch of 5 mm deep on the two sides and 10 mm deep on the bottom at 35 mm from the two ends to fit the top bars into the side bars (Figure 2). Then the ends of the top bars shall be joined into the side bars by these notches for facilitating hang for the frames. It is important to use grooved top bar frames to facilitate fixing of foundation, which otherwise warp if not inserted into the 5 mm deep groove.

Bottom bars

Based on the top bar size, the bottom bar shall be 20 mm wide, 10 mm thick and 440 mm long. It shall be made of well-seasoned wood as well. To fit perfectly to the side bars, cutting notch of 2.5 mm deep on the two sides at 15 mm from the two ends is important to fit the bottom bars into the side bars (see Figure 2). Then the ends of the bottom bars shall be joined into the side bars by these notches.

Side bars

The side bars are important parts of the frame to determine the bee space in the hive. So the side bars should be of shoulder type. It shall be 15 mm thick 36 mm wide at the top and 27 mm wide at the bottom to provide the required bee space. This space is in similar range for honeybees' natural comb spacing result (Table 1). It should have a total length of 230 mm having four holes for wire reinforcement at 57.5 mm. The hole shall be made at the center of the two side bars. This will give the holes at 37.5 mm away from the top bar and 47.5 mm away from bottom bar while the remaining holes shall be at distance of 57.5 mm from each other. To facilitate the fitting of top and bottom bars with the side bars, cut two 10 mm deep at 15 mm wide from the center and remove the cut from the center by leaving of two forks on the sides.

6.2 Dimensions and requirements of brood and honey chambers

The dimension of brood and honey chambers and their quality have direct impact on the bee colonies and increasing productivity of beekeepers. In this manual, the Langstroth movable-frame hives are selected as standard hive for beekeeping in Ethiopia and Indonesia while Dadant hive which is also based on Langstroth selected for Europe. These hives provide simplicity of construction and ease of manipulation, permitting rapid inspection and interchange of hive parts. In terms of wood quality, the required lumber shall be from all season wood like pine and Juniper for all construction with the finished wood thickness of 20mm, except for the top cover and floor

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of the bottom board which is better to use 19 mm plywood. Plywood is less affected by changes in temperature and moisture. All wood pieces must be flat. The constructed hive bodies shall give the required reliable protection of bees from adverse weather conditions (cold, wind, rain, etc.) and has to have reasonable longevity of service. Based on the study result regarding the dimension of hives from four different workshops from Ethiopia (Table 2) and proposed dimensions for Europe and Indonesia, the average dimensions of Internal and external length, internal and external width and depth are given in Table 3. By using table saw, cut a notch, called rabbet, 15 mm deep and 10 mm wide into the shorter side to hold the frames so that the fence of 15 mm of 10 mm thick will remain to cover the hanging frames in each chamber. There shall be fixed hand holder 25 mm thick, 40 mm wide and 150 mm long on all the four sides of the outer faces of the chambers for lifting off the hive parts during hive operations.

6.3 Entrance block dimension

Entrance block is a block placed in front of the hive on the bottom board to reduce entrance gate of the beehive. Its dimensions are 390 mm long 50 mm high and 19 mm wide for the Langstroth and will be adjusted based on dimensions for Dadant. For the entrance pass for the bees, 15mm wide and 150 mm long cut shall be made in the middle of the 390 mm length. Entrance block can be removed during the hot season for air circulation.

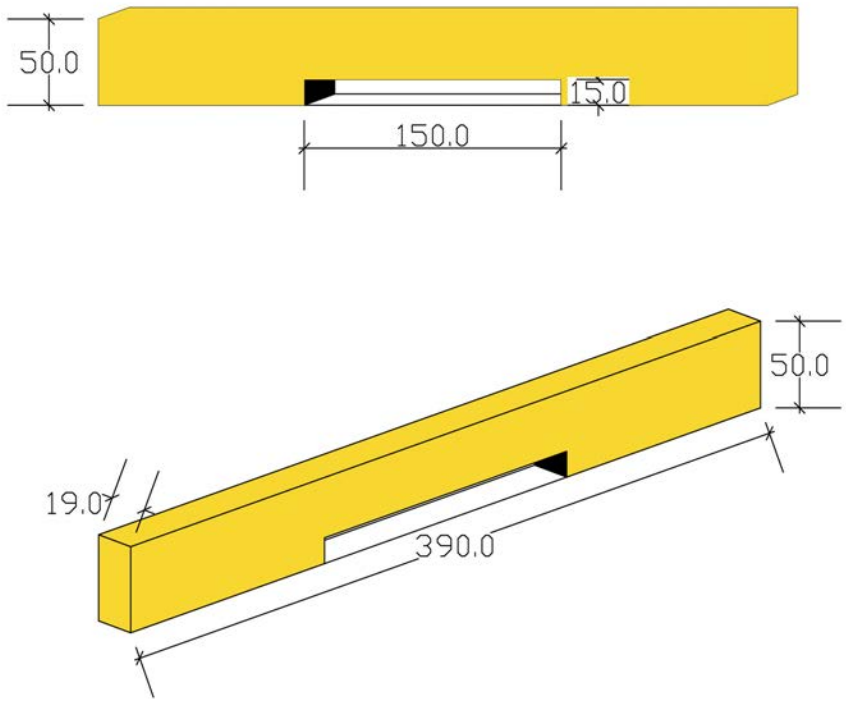

Figure 3. Entrance block and its dimension for beehive

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6.4 Bottom board dimension

Bottom board is simple design of flat rectangular box on which hive body rests. Its dimension is given in Table 3. For Langstroth hive cut two pieces of wood 585 mm long and 40 mm high and one piece of wood 370 long and 40 mm high. Create a 5 mm wide and 5 mm deep groove 10 mm from the edge of the pieces slotting for placing mite board. Also cut one piece of wood 370 long and 25 mm high but no groove here. This 25 mm wide wood piece is to create an open back silt at bottom back of the bottom board designed primary to be covered by placing mite board made of 5 mm thick plywood on which a sticky glue will be paced for pest control like varroa mite and larvae of small hive beetle. This thin 5 mm plywood shall be fitted to 370 mm long and 20 mm wide piece of wood with 6 mm wide and 5 mm deep groove at its center to facilitate placing and removing of the mite board. To start construction of the bottom board, align these four wood pieces to form a rectangle, sandwiching the shorter pieces inside the longer ones. Nail together the two sides using 5 cm of the galvanized nails. Attach a piece of 19 mm waterproof plywood to cover the bottom, using galvanized nails of appropriate size. To facilitate stage for entrance block and create landing board for bees, form a small 80 mm x 370 rectangle on one side (front) and bigger rectangle 505 mm x 370 mm on another side of the bottom board, by inserting a piece of wood size 370 mm long, 40 mm high and 20 mm wide between the 585 mm long sides. Then, cut rectangular wire greed of 390 mm x 485 mm of mesh size between 3 x 3 mm to perfectly stretch over the bigger rectangle of 505 mm x 370 mm to screen bees from a sticky mite floor. Varroa mite and other small pests that drop to the bottom of the hive fall through the wire mesh and are prevented from crawling back up. The smaller box created at the front to serve as stage for entrance block and landing board for bees shall be covered by 370 mm long and 85 mm waterproof plywood of 5 mm thick. Then, this assembled system shall be equipped with wooden rims on the two sides and back, the front left to be covered by entrance block. The dimensions of the wood rims shall be of two pieces of 585 mm long, 20 mm high and 20 mm wide and one 370 mm long, 20 mm high and 20 mm wide atop the wire grid and nail in place using trim nails. These wooden rims shall form a pivot on which the hive parts rest. The rims also create a gap at the bottom of the brood chamber for the bees to freely move and allow air circulation.

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Table 3. Brood and honey chamber box dimensions of Ethiopia, Europe and Indonesia.

Measurements	Ethiopia	Europe	Indonesia for	
Brood chamber (mm)			*Apis mellifera*	*Apis cerana*
Length (External)	505	515	505	402
Length (internal)	465	475	465	362
Width	365	375	365	265
Height (both external and internal)	240	294	240	165
Honey chambers (mm)				
Length (External)	505	515	505	402
Length (internal)	465	475	465	362
Width	365	375	365	265
Height (both external and internal)	240	150	240	165
Bottom board dimension (mm)				
Length	585	600	585	500
Width	370	380	370	300
Height	60	60	60	60
Roof or Top cover/lid dimension (mm)				
Length external	550	560	550	450
Width	400	410	400	310
Ledge height	65	65	65	65
Wood thickness all	20	20	20	20

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Table 4. Brood and honey chamber frame dimensions of Ethiopia, Europe and Indonesia.

Measurements	Ethiopia	Europe	Indonesia	
Brood chamber Fame (mm)			Apis mellifers	Apis cerana
Top bar (external)	480	490	480	332
Top bar (internal)	410	410	410	280
Bottom bar (external)	440	450	440	300
Bottom bar (internal)	410	410	410	280
Height (external)	230	280	230	155
Height (Internal)	210	260	210	125
Side bar width top	36	37	36	30
Side bar width bottom	27	28	27	20
Honey chamber Fame (mm)				
Top bar (external)	480	490	480	332
Top bar (internal)	410	410	410	280
Bottom bar (external)	440	450	440	300
Bottom bar (internal)	410	410	410	280
Height (external)	230	140	230	155
Height (Internal)	210	120	210	125
Side bar width top	36	37	36	30
Side bar width bottom	27	28	27	20
Side bar thickness	15	15	15	15

6.5 Roof or Top cover/lid

The dimensions of the top cover are given in table 4. The key feature is that the cover is telescopic and extends down the sides of the hive body on which it is placed (Figure 4). This provides maximum protection and reduces the risk of rain seeping into the top chamber. The top covers side wall shall be from all weather quality wood, with the wood thickness of 20 mm. The

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roof under the telescopic cover shall be 19 mm thick waterproof Plywood or can from all weather well season wood but shouldn't be more than two pieces joined together. Waterproof Plywood is less affected by changes in temperature and moisture. The telescopic roof shall be suitably covered with a plain sheet of metal to protect against rain. The sheet shall extend down below the edges of the top cover (Fig 4). The overall thickness and quality of the hive cover is important as well as it is useful to cover the hive cover and provide excellent insulation from sun and cold for the bees.

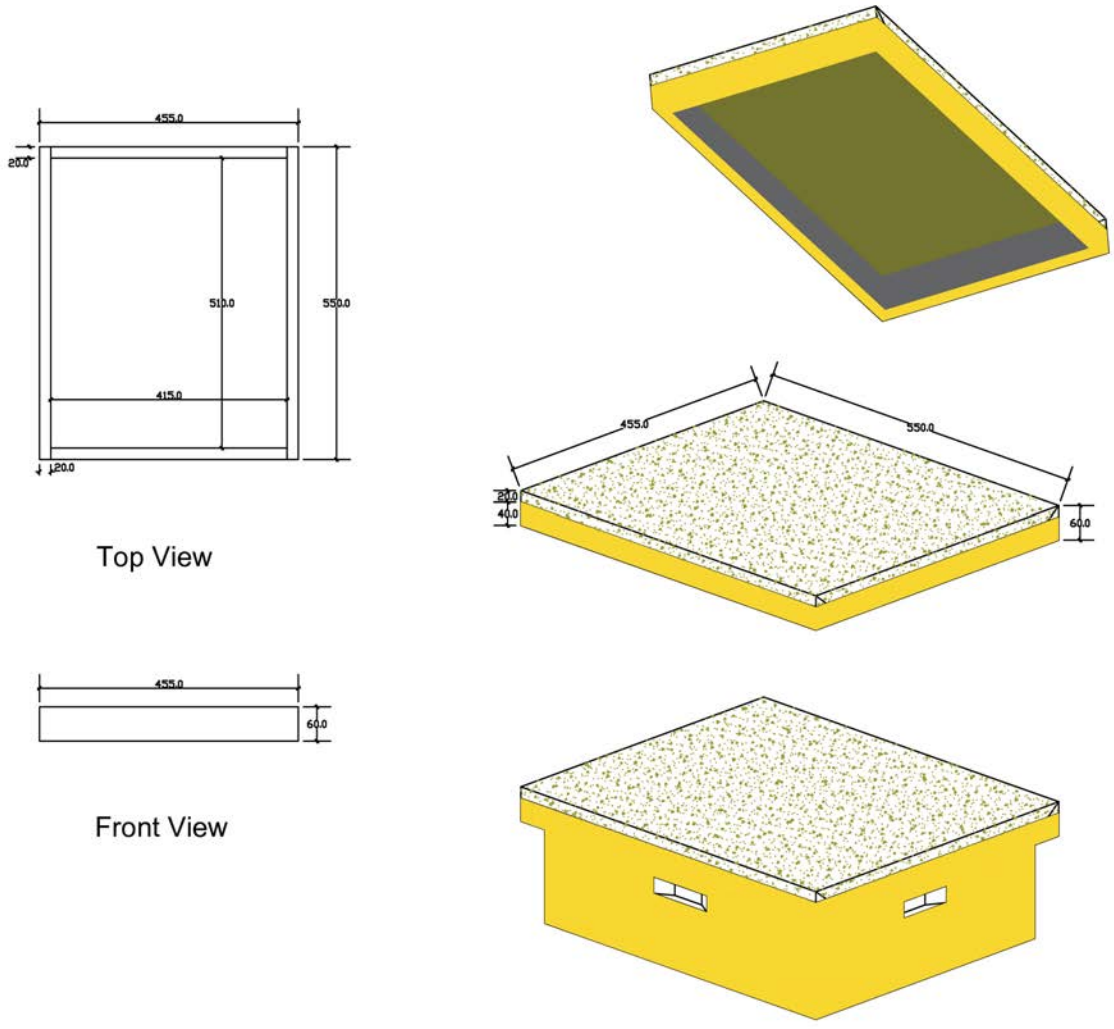

Figure 4. Different views of top hive cover for standard Langstroth hive

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6.6 Inner cover/lid

The dimension of the inner cover consists of plywood dimension to perfectly fit with wooden rims dimensions, similar to the outer hive chambers (Figure 5). For Langstroth hive, the wooden rims consists of two pieces of dimensions 505 mm long, 40 mm high and 20 mm wide and two pieces of dimensions 365 mm long, 40 mm high and 20 mm wide. Then by using table saw make a 10 mm deep by 5 mm wide groove at 10 mm distance from the edge of 40 mm high wood pieces. The groves are just to slide the 5 mm thick plywood into that groove. This gives wooden rims on one side (inside) is 10 mm thick which equals the bee space. The 25 mm high wooden rim on the outside shall be to provide sufficient room for pollen patty or sugar syrup feeding to bees on the top surface. At the center of the inner cover, a rectangular space of about 50 mm x 80 mm is cut and a tight ledge of 15 mm high and 30 mm wide erected to facilitate provision of feeds. This open space allows bees' access to the space between the inner cover and the hive lid during feeding.

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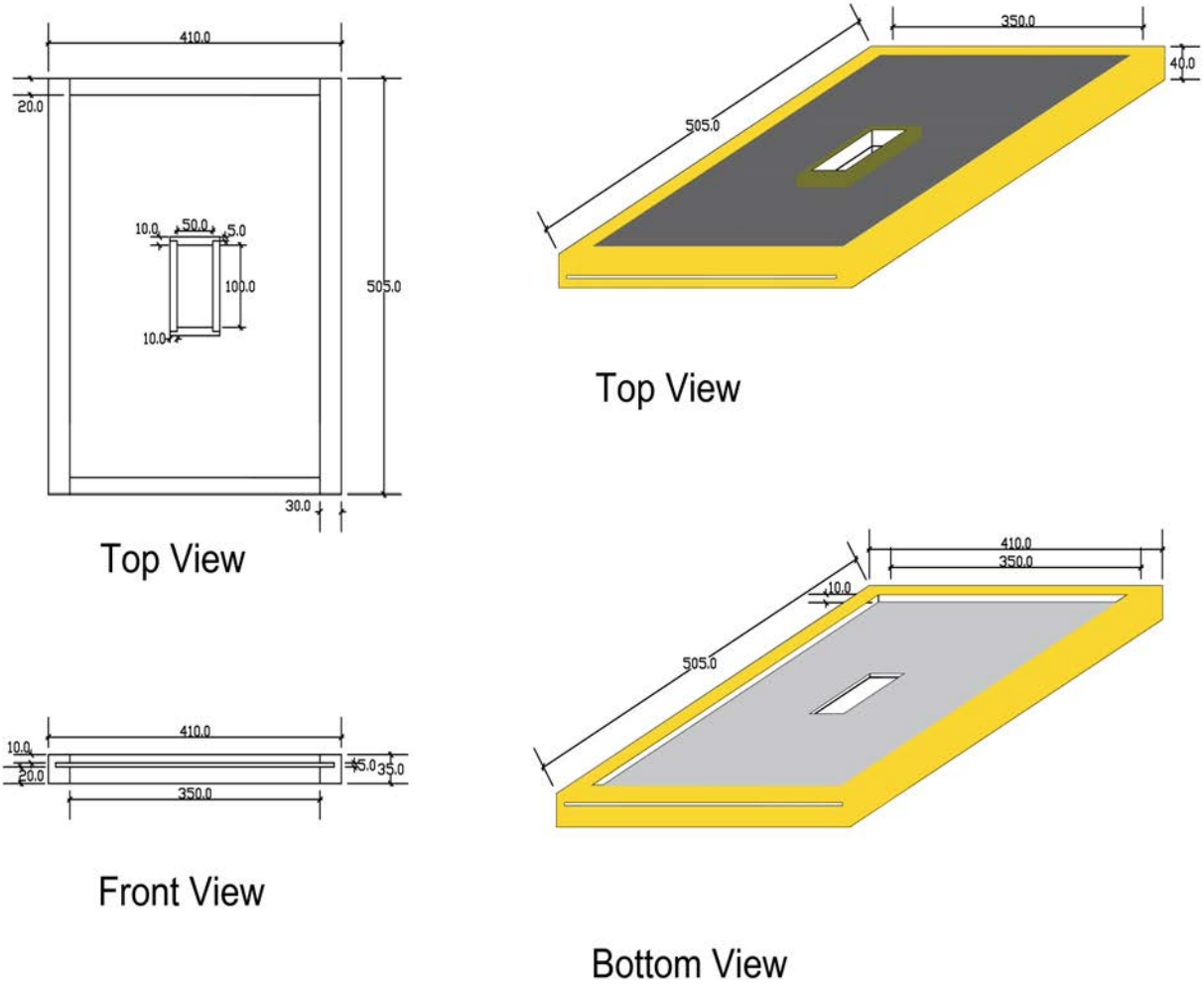

Figure 5. Dimensions and views of inner cover equipped with wooden rims on bottom and top parts.

NB: All dimensions stated in this manual shall be regarded as finished dimensions and shall be measured after the completion of finishing operations, such as, planning and sand papering

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7 Tools and Materials required for hive construction

7.1 Tools

Thicknesser machine for adjusting thinness and surface smoothing
Circular saw for cutting wood
Jointer machine for smoothing edges and creating side bar shoulders
Measuring tape,
Digital caliper
Framing square or drywall,
T-square
Table saw,
Saber saw (sword with a slightly curved blade that is sharp on one edge),
Putty knife or chisel,
Hammer,
Clamps,
Power Drill-drill with bits
Jigsaw
Chop saw
Sanding block
Carpenter's square (or a frame jig)
Carbide-tip blade

7.2 Materials

Waterproof wood glue
19 mm thick Waterproof plywood
5 mm thick Waterproof plywood
5 and 8 cm galvanized nails
3 cm hardened trim nails (small nails)
Cigar box nails (16 mm shoe nail)
Timber for frames
Timber for entrance block/reducer
Lumber of thickness 20 mm after finished

NB: Wood Timber/Lumber- recommended wood materials for beehive shouldn't be soft woods. Boards must be dry and no cracks or rot.

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8 Assembling a beehive

The most important parts of Langstroth and Dadant beehive are:

- A loose bottom board
- A bottomless brood chamber, in front of which is entrance block with the entrance passage for the bees; the brood chamber holds 10 frames, which are kept separated at the right distance by means of side bars
- Above the brood chamber is a queen excluder (not absolutely necessary), placed horizontally on top of the brood chamber
- Based on the population of the colony are one or more honey supers with 10 frames are placed on top of the brood chamber or on the queen excluder
- On top of the honey chambers is placed an inner cover of 5 mm thick
- The total hive system is then covered by an outer cover made of wood, covered with zinc or aluminum sheet. This outer cover should fit easily over the honey super or brood chamber.

A complete assembled beehive looks like the following sketch.

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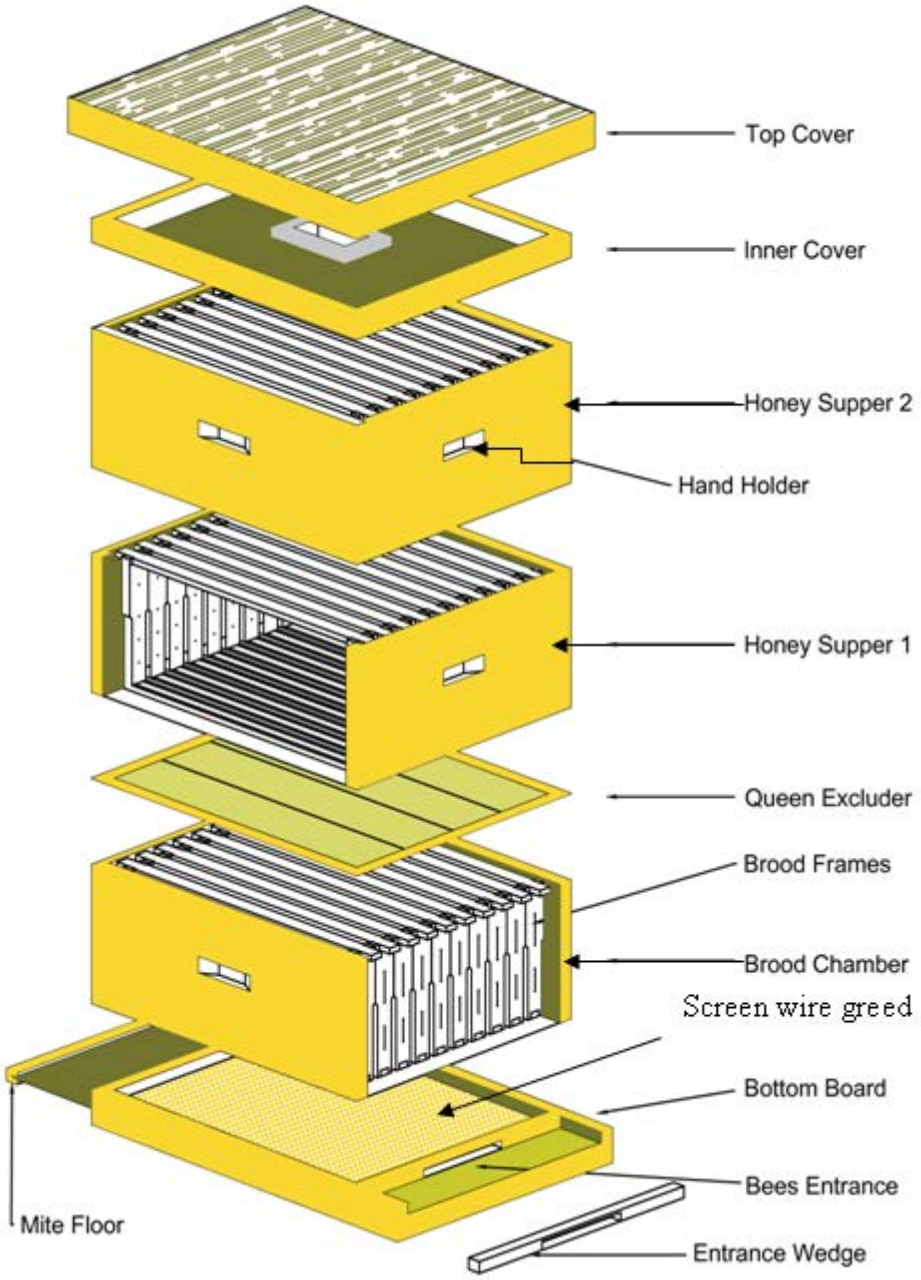

Figure 6. A complete assembled beehive sketch

If the required materials are fulfilled, its fabrication is simple. Construction of the beehive begins with the supers, the stackable boxes that held frames. During building them, it is very important to check the dimensions against the size of the frames intended to use.

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8.1 Smoothing and Cutting Lumber

All the wood for hive shall be well smoothened and all thickness must be prepared precisely. A small deviation from the required measurement may affect the balance between the requirements of the colony of honeybees and the ease and convenience for the work of beekeepers. Sand both flat sides to make fine smooth. After all the required smoothening and thickness achieved, cut the lumbers into the required pieces as indicated in table 3 to make outer cover, inner cover, chamber bodies and bottom board by using table saw. From each of the remaining wood timber, discard scrap or save for later uses.

8.2 Beehive frame construction

8.2.1 Assembling and wiring frames

Frames and frame parts require precision to ensure proper services. Required frame dimensions are indicated in table 4. Top and bottom bars and side bars thickness and dimensions shall be as described for standard use. It is important to dado (make groove) 5 mm deep centered on bottom side of top bar frames to facilitate fixing of wax foundation, which otherwise warp if not inserted into this groove.

8.2.2 Nailing

Use only specified frame nails (30 mm) to ensure that the frames remain square and hang properly in the super with the correct bee space all round. To increase durability and overall strength of frames, wood glue shall be used prior to nailing. Then assemble the frame, and drive 2 cigar box nails (16 mm) into the end bar at two corners of a side bar. In building a deeper frame, the builder shall use a square (or a frame jig). It's certainly important to use a carpenter's square to check that the frame is perfect and true, than just eyeball it. Assembling starts out by applying a dab of glue to each end of the top and bottom bars (Figure 7). After complete nailing and checking the frame, it becomes important to cross nail the side bars and top bar for durability. It is not a must but through time in the process of using, the top bar pulls off the frame as we are trying to pry it up from the hive. So it is advisable to cross nail, just by driving a nail through the side (end) bar into the top bar, one on each end. It needs to get the angle right. If the angle is too slight, the nail will end up in the foundation groove and if too big, the nail will protrude from the top bar. So it is a bit tricky and worth extra time and effort to get the angle.

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Figure 7. Assembling of frames: A) applying glue, B) nailing C) checking frame angle by using carpenter's square.

8.2.3 Wiring

For maximum strength and longevity, use four horizontal standard food grade stainless steel frame wire (Figure 8). The wires should be drawn tight and secured with 16 mm cigar box nails.

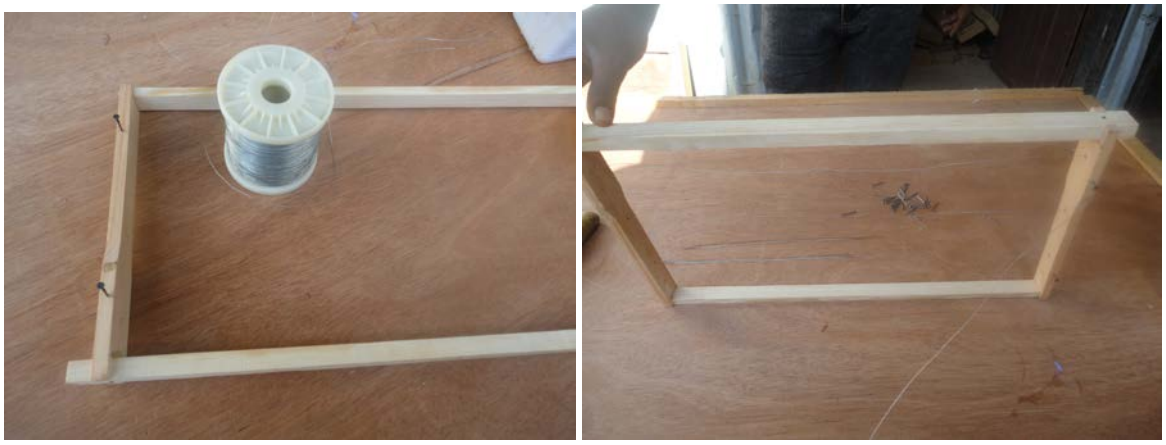

Figure 8. Wiring frames using food grade stainless steel frame wire.

8.3 Making brood and honey chambers

From a straight, well smoothed surface and edge lumber/timber, cut two pieces 505 mm long and two pieces 365 mm long for the sides of the hive chambers for Langstroth (Refer Table 3 and Figure 9 for the details). Split them to match the height of the frames plus bee space. In the case of Langstroth, rip each piece to a height of 240 mm. Use the table saw to cut a 15 mm deep by 10 mm wide notch out of short side of each of the wood pieces as specified under "Dimensions and requirements of brood and honey chambers" section. Complete the rabbet by making repeated

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cuts, moving the board away from the fence for each cut and crack away the slivers of wood. Then smooth the rabbet using a sander. Ten hive frames will rest atop these notches inside each super when the hive is assembled. Using the power drill fitted with the 3 mm bit, drill holes along the edges of the specified longer pieces. Drilling pilot holes first helps to avoid splitting the wood. Fasten a clamp at the bottom of the vertical sides to support them as you work.

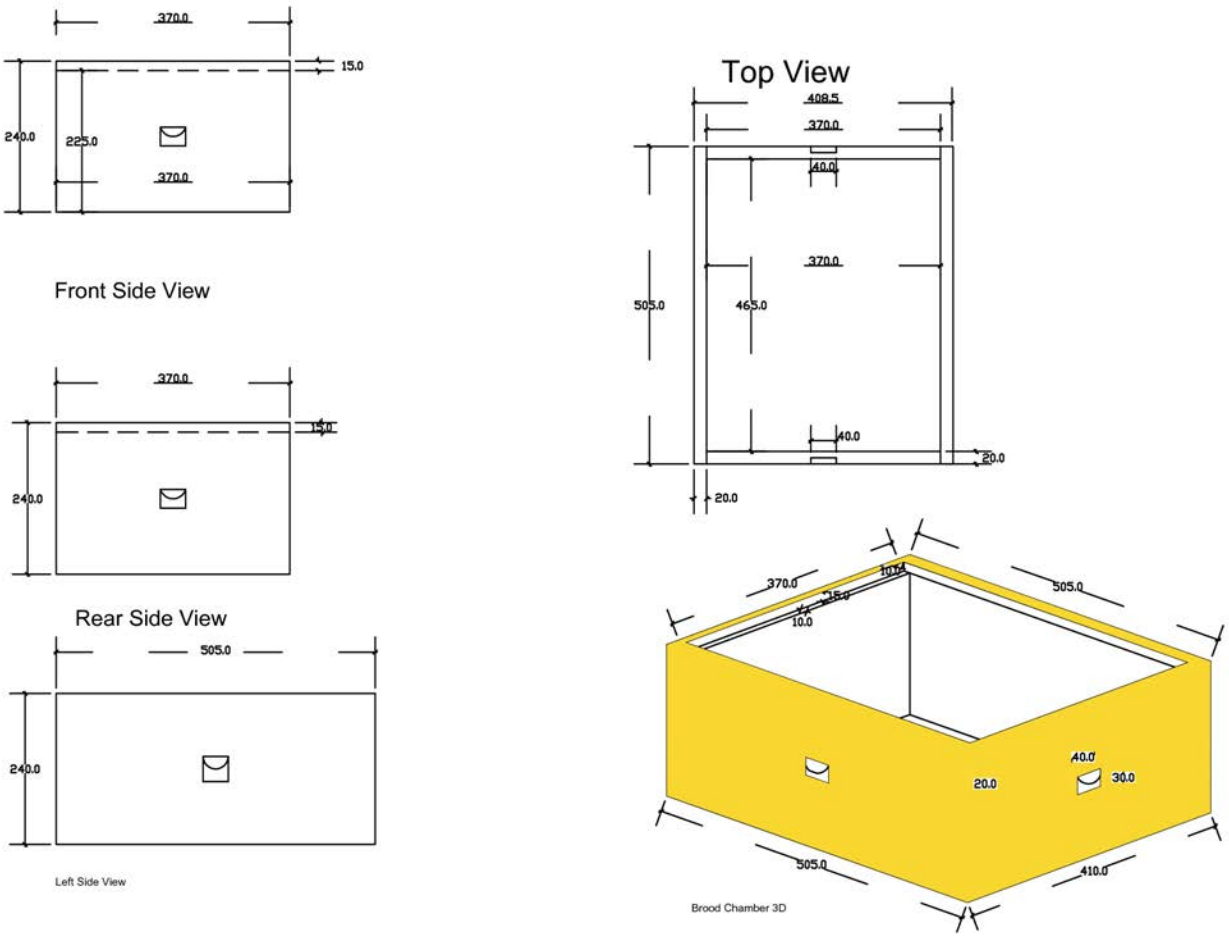

Figure 9. Dimensions and different views of hive chamber

Apply glue to the joints and then hammer a galvanized nail into each pre-drilled hole to fasten its sides to create a box by sandwiching the shorter pieces inside the longer pieces. Insert a frame to confirm that it slips easily into the super. It should hang from the rabbet and have a little play at each end. The super should accommodate 10 frames with 10 mm “bee space” in between. Make

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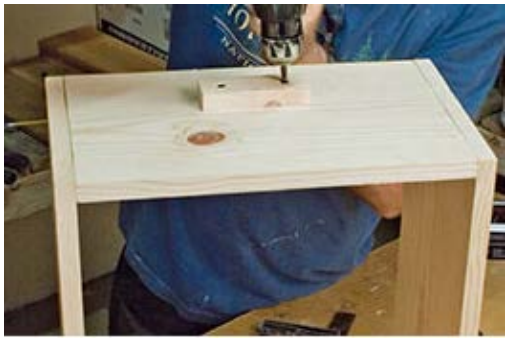
the handle piece using the power drill fitted with the 4 mm bit, drill 3 holes along the length of each handle piece, and attach to the supers using 40 mm long screws on each side. Repeat these steps with the remaining specified wood pieces to make more chambers/supers.



8.4 Making telescoping outer cover

Align the wood pieces specified in Table 3 by cutting the Lumber to form a rectangle, sandwiching the shorter pieces inside the longer ones. Nail together the two sides using 8 cm of the galvanized nails. Attach the telescoping top cover to plywood, using appropriate nails.

8.5 Making inner cover

Cut 5 mm thick plywood by using a box frame to serve as a guide. The size of the box shall be in accordance with a completed super for which the inner cover will be utilized. Sawing on the outside of the line, cut out the piece of plywood by using a carbide-tip blade. Use the table saw to make a 10 mm deep by 5 mm wide groove in the wood pieces specified under Inner cover dimensions to serve as wooden rims. Slide the 5 mm thick plywood into that groove (as you would fit a pane of glass into a window). Ensure that the plywood fits properly with the two wood pieces to form a perfectly flush frame and then disassemble. Using jigsaw cut an 80 mm by 50 mm rectangular area in the center of the inner cover (for ventilation, access for bees to the space between inner cover and out cover) cut and erect a tight ledge of 15 mm high using wood glue to facilitate provision of feeds for bees. Then, glue the prepared grooves on the wooden rims, insert the plywood, and reassemble. It is also possible to nail them together using trim nails.

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8.6 Making the bottom board

Cut out the bottom board framing pieces according to the specified dimensions in table 3 and section “Bottom board dimension”. Cut a 5 mm wide and 5 mm deep dado/groove 10 mm from the edge of the pieces slotting the placing mite board. Also cut one piece of wood 370 mm long and 45 mm wide but no groove. Align the short and longer height pieces to form a rectangle, sandwiching the shorter pieces inside the longer ones. Use a framing square to lay it out. Using the power drill fitted with a 3 mm bit, pre-drill holes along the edges of the longer pieces to prevent wood cracking. Nail them together using 5 cm of the galvanized nails. To facilitate stage for entrance block and create landing board bees, form a small 80 mm x 370 rectangle on one side (front) and bigger rectangle 505 mm x 370 mm on another side of the bottom board, by inserting a piece of wood size 370 mm long, 60 mm wide and 20 mm thick between the 585 mm long sides. Then, cut a piece of 19 mm plywood equal to the total area of the prepared frame size by using a circular saw equipped with a plywood blade or a carbide-tip blade. Attach this plywood piece to the bottom of the bottom board using galvanized nails of appropriate size. Then, cut rectangular wire greed of appropriate size to stretch over the area under brood chamber to screen bees from a sticky mite. The front entrance block stage and landing board for bees shall be covered by 5 mm thick Waterproof plywood. Then, this assembled system shall be equipped with wooden rims on the two sides and back, the front left to be covered by entrance block. The detail dimensions and procedures for Langstroth hive bottom board construction are given under the section “Bottom board dimension” and Figure 10 below.

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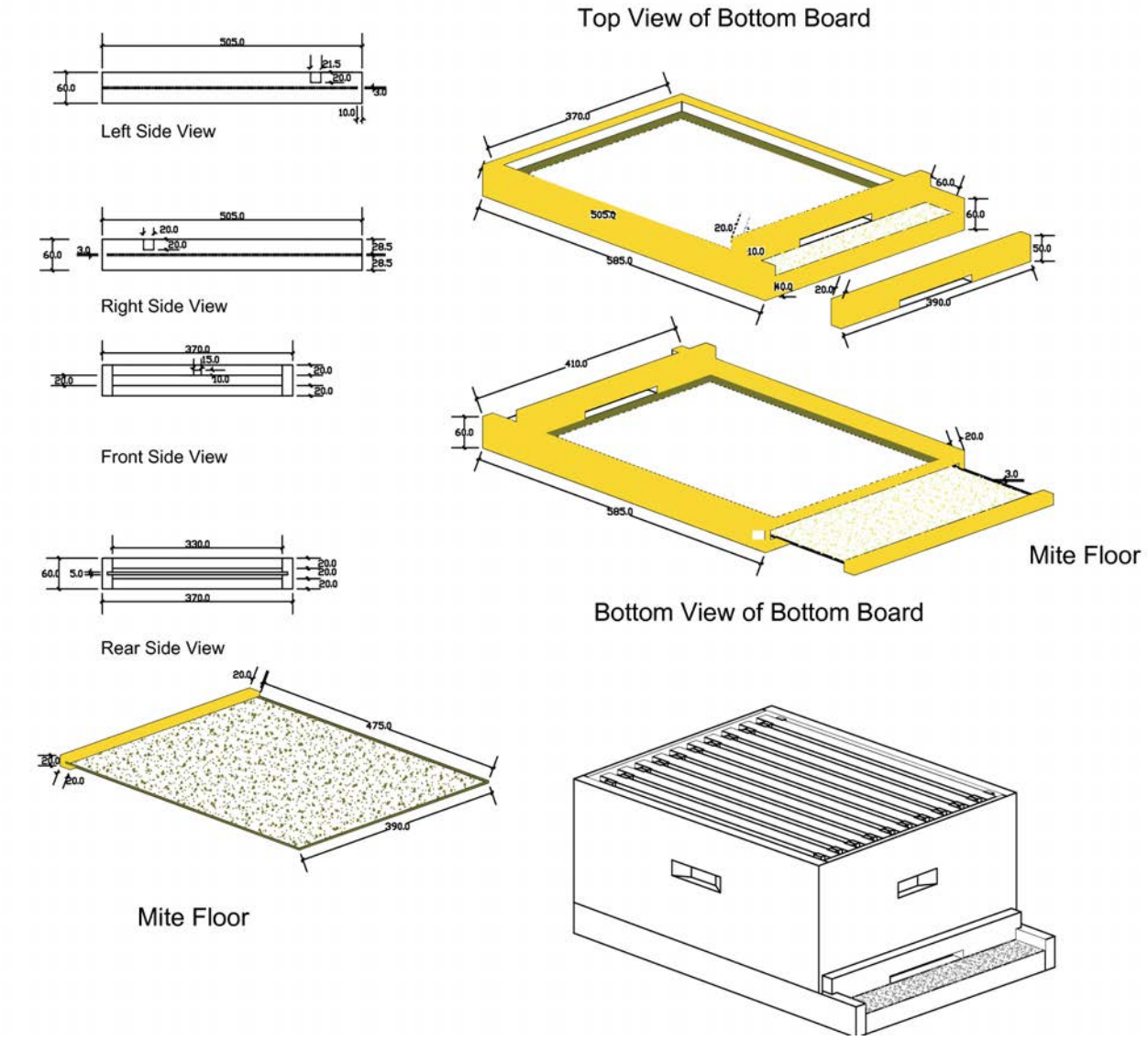

Figure 10. Dimensions and different views of Langstroth bottom board.

8.7 Finishing beehive construction

The different parts of the beehives shall have a smooth finish by sanding and all edges shall be trimmed square and smooth. Parts of the beehive exposed directly to weather shall be painted with a suitable protective paint. The paint shall be nontoxic and shall not have any odour disagreeable to the bees and products of hive. The color of the paint shall be white or yellow. All joints shall be sound and shall withstand normal use. For all types of beehives walls of chambers and roofs shall be joined by box corner joints, or tongue joints properly nailed. When specified

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nails used for joints, there shall be one nail at each point. The distance between two consecutive nails shall be not more than 75 mm.

8.8 Painting the hive

Painting a beehive is simple. Paint all the outside surfaces plus the top and bottom edges with biocide-free, non-synthetic paints based on natural substances (for example linseed oil) or food grade synthetic paints and leave the inside or only with beeswax, propolis or vegetable oil where the bees live. Painting the hive will help it stand up to the weather elements and last longer. Paint helps protect wooden hive parts from the rain, sun and other weather elements. Before painting the hive, it is important to coat the hive in an exterior primer first before putting on the final coat of paint. Oil based exterior primer for better weather protection is recommended, but any type of exterior primer will work. The color of the primer is not important. But primer is important to seal and protect the wood; it helps the final coat of paint adhere better, and helps the surface paint resist moisture and mildew.

When choosing a topcoat color, white or yellow is the classic color to pick for a hive. It is recommended to avoid black or another very dark color because these colors can cause the hive to get too hot if heavy sun, depending on the location.

Bottom Board and Inner Cover – Paint all the outside wood surfaces and leave the inside of bottom board but do not paint the inner cover.

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9 Hive operation and bee Management

A complete assembled beehive consists of frames hanged from the notches, stackable brood and honey chambers, bottom board, inner cover, and the telescoping cover. To reduce the entrance gate, entrance reducer can be placed on the landing board in front of the brood chamber. At the onset of active season, prepare wax foundation and attach to the frames. In each brood chamber, hang 10 frames with wax foundation from the notches.

9.1 Making embossed wax foundation sheet

Embossed wax foundation is a thin sheet of beeswax with the pattern of hexagonal cell bases embossed on each side of it. It is used in frame hive beekeeping to encourage bees a) to build straight combs within wooden frames; b) it saves bees' resources and labor in the construction of combs thereby allowing increased honey production; c) it facilitates honey extraction since combs in frames can be strengthened by reinforcement with wire. So to embed the wax foundation on horizontal wires, tight stretch the wire. To attach wax foundation on frame, place on the foundation sheet in frame with the stretched frame wire beneath the sheet. Then apply a small electric current to the stretched wire, causing it to heat up, so that it melts itself into the wax foundation. A 12-volt car battery or a transformer hooked up to the electrical system can be used. When the electric current heats the wires, apply a slight pressure to the wax foundation causing the wire to sink into the foundation. Promptly disconnect the current and keep the frame in place to allow the wax to congeal around the wire. Wires should not become too hot, or held for too long or they will burn through the foundation or even breakup. Frames with foundation that has been embedded should be given to colonies of honeybees and not be stored in cold rooms, because wax has behavior of expansion and pull loose off from the wires. Therefore, without under delay (in less than a day), attach the foundation to the frames and transfer bee colonies to the first complete hive parts (Bottom board, entrance cover, brood chamber, inner cover, and the telescoping cover). Insert the entrance reducer to discourage robbing by other bees and to control ventilation. As season progresses and colony population buildup, add more supers to the hive.

9.2 Hive inspection

In order to undertake inspection of established colony, first of all the beekeeper should have to be able to minimize the sting by using proper management and handling of honeybees. When approaching an established hive of bees with intent to open for inspection, the beekeeper does not move in to the line of flight of the worker bees leaving for and returning from the field. Always approach the hive from the side or from the back. In order to suppress (calm down) the

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bees, smoke of good quality shall be puffed into the entrance. A few good puffs of smoke create communication barriers in the guard bees and this in turn disorganizes the defense system of the hive. Using smoke also prompt the bees gorge themselves with honey and in this satiated condition they are less likely to sting. Wait one or two minutes for the smoke to penetrate to the corners of the hive to ensure that the disorganization of the colony is complete, before opening the hive.

The first step to open the hive is to remove the outer cover, which is usually the telescopic type. This cover has its inner cover underneath which when in position still effectively seals the hive. The bees usually seal the inner cover with propolis, a sticky resin material. To break the propolis seal and to open the hive, the operator shall is forced hive tool into the line of the union between the lid (inner cover) and the adjacent hive body and at the cover. As the lid is first raised a few puffs of smoke must be forced into this opening. In the case of well-sealed lids it may be necessary to pry (force open) each of the corners in turn before the lid can be removed without damaging it. If the top hive body needs no inspection the inner cover can of course, be left in position. In this way excessive bee flight is prevented.

After removing the outer cover, put up site down alongside the hive. This makes a convenient rest on which to place hive bodies. These hive bodies must be placed across the unturned cover so that as few bees as possible are squashed. The inner cover and most other types of covers other than the telescopic type have to be levered up to get them off. When the inner cover removed, the colony is exposed from the top. A puff or two puffs of smoke blown across the top of the frames will induce the bees to go down into the hive body.

Then by using hive tool (chisel), open the hive, put the hive cover up side along side of the hive and smoke horizontally and periodically, start inspection from the frame nearer to the operator/ set it down on one end against the hive until two or more frames drawn out from the hive, repeat the same steps with the next frames until all frames are examined. Please note two precautions: first, the queen should not fall down on the ground, second, the brood frames should not stay out for few minutes to protect the young brood against excessive cold, heat/direct sun light.

Finally the hive must be closed. Using occasional puff of smoke to control the bees carefully replaces the frames and covers in their respective places in the hive. Make sure that during this operation the queen is not injured and the bees are not squashed.

The major important things to be observed during internal established hive inspection are:

- The presence of the queen: the queen is mostly found around the warm brood, nearer to the egg laid, moreover, she could be recognized by the fresh eggs and newly hatched out larvae ;

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- Brood pattern: if the brood pattern is dense (combs are filled with eggs) the queen is said to be young, good, prolific or vigorous. On the other hand, if spotty brood pattern, many drones egg etc. are observed, the queen is said to be non vigorous and the brood is said poor pattern;
- Swarm preparation: when bees form several/numerous peanut shaped wax cells which contain immature queen and the hive is quite populous, it indicates swarm preparation;
- Starvation: when there is no stored food (pollen and nectar) the colony is in need of supplementary food;
- Health condition: it is important to observe the presence of any pests and diseases of bees in the hive (such as wax moth, ants, and any disease symptoms);
- Enough space: during opening, if the beehive is full with bees and combs, and if the upcoming seasons are also expecting more flowers, the colonies might give swarm and measures against should be undertaken;
- The arrangement of frames containing honey, pollen and brood. Frames of brood should be placed together in one area (at the middle) of the nest to optimize the proper brood temperature. The honey will naturally be stored in the upper portion of the combs or the brood comb if placed between pollen and brood if cold prevent the queen from expanding the brood in nest;
- Ripening of honey: honey is said to be ripened when at least ¾ or the comb mass is sealed (capped) with a newly secreted bees wax.

9.3 Preparation of colonies for honey production

The efficient beekeeper establishes a calendar known as his seasonal management plan based essentially on his knowledge of the dates when the major honey flows occur, and equally important, the extent to which these days may vary from one year to the next. This plan tells the beekeeper when changes are likely to occur within the hive or in the environment outside it allowing him to manipulate his colonies efficiently in advance of the time when they are actually needed. In the intelligent management of colony of bees there are practices, which do not come in any natural succession throughout the season, but may be necessary to employ whenever conditions require their use. Each of these practices is important and vital to the well being of the colony and to the production of maximum product even though the seasonal management in the dearth period, pre flow, honey flow and after flow periods may be occurring at about similar or different times. Beekeepers in any of the areas will be able to apply the same producers timed to their conditions.

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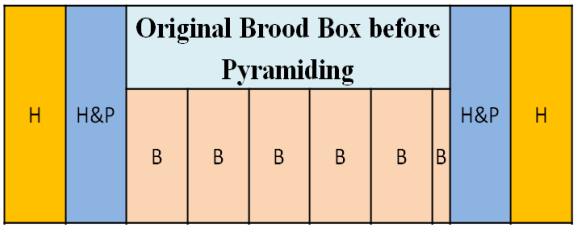
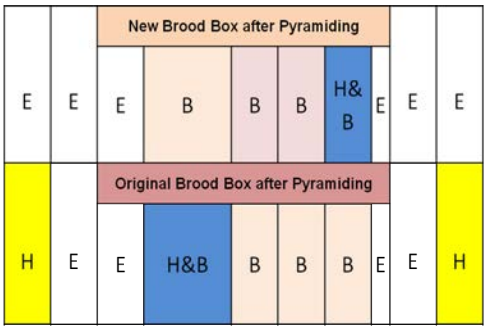
There are four phases of hive management, which are common to beekeeping operation in any part of the world.

1. The first phase is ensuring that the foraging capacity of bees in the colony is built up at the right time for the collection of nectar and pollen
2. The second phase is providing space for the storage and bees population expansions to accommodate the full growth cycle of the colony in the season,
3. The third phase is removing honey from the hive and extracting it from the combs
4. The fourth phase is preparing the colony to withstand the dearth period.

9.4 Providing space and swarm control

Following transferring at the onset of active season, population of the colony buildup and this can cause hive congestion and will result in unwanted swarming. Proper management aims at providing colonies with unrestricted room for brood rearing, ripening of nectar, and storage of honey, for the time of year concerned. As feeding continues and the population increases, it is critical to make sure the bees have an adequate amount of space in the brood area. Therefore, supering additional box hive with frames and foundation sheet on top of the brood chamber below the hive covers for the colony grows more and store honey. For super adding, it is good by Pyramiding to give the queen and workers instant access to two brood boxes thus increasing population while reducing overcrowding. In pyramiding, mixing of frames with wax foundation and grown out combs as shown in the following diagrams.





Where:

- ✓ H = honey frame
- ✓ H&P = honey & pollen frame
- ✓ B = brood
- ✓ E = empty frame (foundation)

Early Pyramiding (supering) can help relieve congestion and reduce the swarm impulse in a hive whose population is growing rapidly. If the bees will need lots of space to store surplus honey, it

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is possible to add more supers. But, time to add supers must be before the main flow when the bees are using 70% of the upper most boxes.

9.5 Harvesting the honey yield

The harvesting of the honey crop is undoubtedly the highlight of the beekeepers year. The crop is a reward for a year's hard work and imaginative planning. The bigger the crop the more efficient has his management. Ripe honey, as has been seen, is the end product of a long process during which the nectars of plant undergo chemical change and as lose considerable moisture. When the honey is ripe the bees cap it with a thin layer of beeswax. Thus any capped or sealed honey may be removed from the hive. During the nectar flow when nectar is coming in very rapidly it frequently happens that the capping is a little behind so that beekeepers take honey when the frame is about three fourths caped. Unripe honey may ferment if taken from the hive. Care must be taken in handling honey supers both before and during extracting. Honey should extract as soon as possible after removal from the bees in order to avoid granulation in the combs, absorption of moisture if the humidity is high and wax mouth damage. The empty supers must be given considerable care. They should be cleared of honey to avoid granulates contaminating the next crop. This may be done by placing them back on the bees or otherwise having the bees clean them out under controlled conditions to avoid robbing tearing of combs or spread of diseases. The empty supers must then be stored where wax moths or rodent will not be destroyed them if reduced for the colony.

9.6 Dearth period hive management

When the harvest has been removed, the bees should be examined without any delay, so that necessary tasks may be done to get the colony into good condition for the coming dearth period. Normally much brood will not available at this time, as the concentration on nectar gathering causes the queen to be pushed into the back ground and sometimes she stops laying altogether for awhile. Very often, after the supers have been removed, honey or brood is scarcely present in the hive. From the inspection if the colony is weakened measures should be taken to strengthen the colony, such as reducing supers and regular feeding colonies.

9.7 Procedures of reducing hive volume

This is one of the dearth period beekeeping activities. Reducing hive volume helps the bee colony to maintain the internal heat temperature easily so that the bee colony will easily cover the entire combs. This also helps to protect the colony from various pests infestation like wax mouth.

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9.8 Feeding honeybees

Beekeepers should be trained to keep some honey for the bee colonies to sustain for the next season however; there are some occasions when supplementary feed for short period of time will be necessary. The following are the main one;

a) Bad weather, which prevent the bees from forage during nectar flow.

b) Newly established natural swarm for making comb and brood rearing

c) Stimulation of brood rearing in order to increases the population in anticipation of active season of nectar flow

d) Counter balance for pesticides and herbicides applications when the hive is forced to be closed for a day or two.

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