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Bee Hives and Bee Equipment Construction

Training and Learning Guide

Level 4

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

AGRI-JOBS 4 YOUTH!

GFA CONSULTING GROUP

TVET CDACC KENYA

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TVET CDACC TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION COUNCIL KENYA for competence certification

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Foreword

The provision of quality education and training is fundamental to the Government's overall strategy for social-economic development. Quality education and training will contribute to the achievement of Kenya's development blueprint and Sustainable Development Goals (SDGs). Reforms in education are necessary to align the sector to the provisions of the Constitution of Kenya 2010. This triggered the formulation of the Policy Framework on "Reforming Education and Training in Kenya" (Sessional Paper No. 1 of 2019). A key provision of this policy is the radical change in the design, development and delivery of Technical and Vocational Education and Training (TVET) which is the key to unlocking the country's potential for industrialization. This policy requires that training in TVET be competency-based, curriculum development be industry-led, certification be based on demonstration of competence and that mode of delivery allows for multiple entry and exit in TVET programs.

The State Department for Vocational and Technical Training (VTT) has a responsibility of facilitating the process of inculcating knowledge, skills and attitudes necessary for catapulting the nation to a globally competitive country. This necessitates a paradigm shift to embrace Competency-Based Education and Training (CBET) so as to address the mismatch between skills acquired through training and skills needed by the industry as well as increase the global competitiveness of Kenyan labour force. The TVET Act No. 29 of 2013 and the Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya, emphasises the need to reform curriculum development, assessment and certification to respond to the unique needs of the industry.

This training and learning guide has been developed to support the implementation of CBET curriculum in Bee Hives and Bee Equipment Construction Level 4 and is intended to guide the trainee through the learning process. It is my conviction that this guide will play a critical role in supporting the development of a competent human resource for agriculture sector's growth and sustainable development.

Principal Secretary,

The State Department for Livestock,

Ministry of Agriculture, Livestock, Fisheries and Cooperatives.

Preface

Kenya Vision 2030 is anticipated to transform the country into a newly industrialising, "middle-income country providing a high-quality life to all its citizens by the year 2030". The Sustainable Development Goals (SDGs) number four that focuses on inclusive and equitable quality education and promotion of lifelong learning for all, further affirm that education and training are important drivers to economic development for any country. Kenya intends to create a globally competitive and adaptive human resource base to meet the requirements of a rapidly industrialising economy.

TVET CDACC has a responsibility of facilitating the process of inculcating knowledge, skills and attitudes necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency-Based Education and Training (CBET) to address the mismatch between skills acquired through training and skills needed by the industry as well as increase the global competitiveness of Kenyan labour force. The TVET Act No. 29 of 2013 and the Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya, emphasises the need to reform curriculum development, assessment and certification to respond to the unique needs of the industry.

To effectively implement CBET curriculum in Bee Hives and Bee Equipment Construction Level 4, this training and learning guide has been designed and organised with clear interactive learning activities for each learning outcome of every unit of learning. The guide further provides information sheet, self-assessment items, tools, equipment, supplies, and materials necessary for the particular learning outcome. This is aimed at imparting the relevant knowledge, requisite skills and the right attitude for work.

I am grateful to the trainers involved in the development of this training and learning guide.

The Chief Executive Officer,

TVET CDACC.

Acknowledgement

This training and learning guide has been designed and developed to support the implementation of Competency-Based Education and Training (CBET) curricula in Kenya. It has been developed by GFA Consulting Group GmbH which was contracted to implement Component 1 (ATVET and Extension Component) of the Youth Employment in the Agri-Food Sector in Western Kenya (YEA) Project. YEA is one of the constitute projects of Agri-Jobs **4 You**th Initiative which is implemented by the German development agency *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) and commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ). The initiative is implemented in partnership with the Kenyan Ministry of Agriculture, Livestock, Fisheries and Cooperatives (MoALFC).

We recognise the critical role of experts in Bee Hives and Bee Equipment Construction drawn from the private sector, Government institutions and national Technical and Vocational Colleges under listed in the list of contributors, for the technical inputs in the development of this training and learning guide. Some of the content of this guide is borrowed from earlier Apiculture Management Manual KNQA level 6, previously developed through the Technical and Vocational Education and Training Curriculum Development, Assessment and Certification Council (TVET CDACC).

Special gratitude goes to TVET CDACC for working together with the consortium of consultants comprising international and national curriculum experts contracted by the GFA Consulting Group GmbH, for successfully guiding development of this guide as well as ensuring it is aligned to both the national Occupational Standards (OS) and CBET curriculum.

Finally, we convey our sincere appreciation to private sector farms / firms and their employees for allowing and authorising use of photographs, to complement the technical content in this training and learning guide.

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Acronyms

ATVET	Agriculture Technical and Vocation Education and Training
CBET	Competency Based Education and Training
CDACC	Curriculum Development, Assessment and Certification Council
Cm	Centimeter
DACUM	Developing a Curriculum
GI	Galvanized Iron
GIZ	*Gesellschaft für Internationale Zusammenarbeit*
H	Height
KNQA	Kenya National Qualification Authority
KNQF	Kenya National Qualification Framework
KTBH	Kenya Top Bar Hive
L	Length
LG	Learning Guide
Mm	Millimeters
MoALFC	Ministry of Agriculture, Livestock, Fisheries and Cooperatives
NEMA	National Environment Management Authority of Kenya
OS	Occupational Standards
PPE	Personal Protective Equipment
SDGs	Sustainable Development Goals
TLG	Training and Learning Guide
TVET	Technical and Vocation Education and Training
VTT	Vocational and Technical Training
W	Width
YEA	Youth Employment in the Agri-Food

Background Information

This training and learning guide will enable the trainee acquire competencies to undertake bee hives and bee Equipment construction at Kenya National Qualification Framework (KNQF) level 4. It provides practical and theoretical learning activities, simplified content, illustrations and self-assessment items to guide the trainee in the learning process. It also has web-links and references for further reading as well as the responses to self-assessment. The guide further provides suggested methods of training delivery for use by the trainer.

This training and learning guide has been developed with the support of GIZ's Youth Employment in Agri-Food Sector in Western Kenya (YEA) implemented by GFA Consulting Group GmbH. The development of the Guide is in line with the functions of TVET CDACC as stipulated in Article 45 (1a) of the TVET Act No. 29 of 2013 and the Sessional Paper No. 2 of 2015 that embraces Competency-Based Education and Training (CBET) system. This guide therefore intends to provide guidelines for Competency-Based training in Bee Hives and Bee Equipment Construction Level 4.

The Bee Hives and Bee Equipment Construction Level 4 qualification consists of competencies that a person must achieve in order to construct bee hives and equipment as well as fabricate bee hives and equipment.

Purpose of developing this Guide

Bee Hives and Bee Equipment Construction Level 4 curriculum development process was initiated using the Developing a Curriculum (DACUM) methodology where jobs/occupations were identified. Further, job analysis charts and occupational standards were generated in collaboration with the industry players under the guidance of TVET Curriculum Development Assessment and Certification Council (CDACC). The outcomes of the process were national Occupational Standard (OS) and curriculum for Bee Hives and Bee Equipment Construction Level 4. The curriculum was further broken down into units of learning. To effectively implement the curriculum, a training and learning guide is thus important in imparting relevant knowledge, requisite skills and right work behaviour/attitude to enable trainees to fit in the industry after training.

Layout of the Guide

Beyond this background information section, the training and learning guide is organised into chapters. Each of the core units of learning is presented as a chapter on its own. Each chapter presents the introduction of the unit of learning and a summary list of the learning outcomes in the curriculum. For each learning outcome, the following components are presented in this guide:

- **Performance standards**

  These are obtained from the performance criteria statements in the related element of the corresponding unit of competency in the Occupational Standards (OS).

- **Suggested training delivery**

  This section is meant to advise the trainer on the methodology of imparting knowledge, skills and attitude to the trainee with regards to the performance standards of the learning outcome. It is deliberately structured to put emphasis on trainee-acquisition of competency in an environment where the learner plays an active role. It also gives the resources and time required to effectively deliver training for a specific learning outcome.

- **Information sheet**

  The information sheet is a section under each learning outcome that provides the subject matter in relation to the definition of key terms, methods, processes/procedures/guidelines, content, illustrations (photographs, pictures, video, charts, plans, digital content and simulations) and case studies.

- **Learning activities**

  For each learning outcome, the learning activities are presented to cover the performance criteria statements and the trainee's demonstration of knowledge in relation to the range in the occupational standards and content in the curriculum.

- **Self-assessment**

  Self-assessment is linked to the performance criteria, required knowledge, skills and the range as stated in the occupational standards. This section poses questions and assignments to trainees to help them gauge whether they have acquired the required competencies and gives them an opportunity to reflect on what they have learnt.

- **Tools, equipment materials and supplies**

  This guide also presents tools, equipment, supplies and materials required for each learning outcome as guided by the performance criteria in the occupational standards and content in the curriculum.

- **References**

  References, relevant web-links and addendums are provided for further study.

- **Responses to self-assessment questions**

  The section provides answers to the self-assessment questions and assignments earlier presented to the trainees.

The units of learning units of competency comprising Bee Hives and Bee Equipment Construction qualification Level 4 include the following basic and core units of learning:

Table 1: Basic Units of Learing

Unit of Learning Code	Unit of Learning Title	Duration in Hours	Credit Factor
AGR/CU/APIHE/BC/01/4/A	Communication Skills	20	2
AGR/CU/APIHE/BC/01/4/A	Occupational Safety and Health Practices	25	2.5
AGR/CU/APIHE/BC/01/4/A	Numeracy Skills	35	3.5
AGR/CU/APIHE/BC/01/4/A	Digital Literacy	60	6
AGR/CU/APIHE/BC/01/4/A	Entrepreneurial Skills	30	3
AGR/CU/APIHE/BC/01/4/A	Employability Skills	20	2
AGR/CU/APIHE/BC/01/4/A	Environmental Literacy	20	2
Total		**210**	**21**

Table 2: Core Units of Learning

Unit of Learning Code	Unit of Learning Title	Duration in Hours	Credit Factor
AGR/CU/APIHE/CR/01/4/A	Construct Bee Hives and Bee Equipment	150	15
AGR/CU/APIHE/CR/02/4/A	Fabricate Bee Hives and Bee Equipment	100	10
AGR/CU/APIHE/CR/03/4/A	Industrial Attachment	300	30
Total		550	55
Grand Total		**760**	**76**

1 Bee Hives and Bee Equipment Construction

Unit Code:

AGR/CU/APIHE/CR/01/4/A

Related Unit of Competency in Occupational Standards:

Construct Bee Hives and Bee Equipment

1.1 Introduction to the Unit of Learning

This unit specifies the competencies required to construct bee hives and bee equipment. It involves preparing to construct bee hives and bee equipment, constructing bee hives and bee equipment and completing construction of hives and equipment.

1.2 Summary of Learning Outcomes

In this unit of learning, there are ten learning outcomes as listed below:

1. Prepare to construct bee hives.
2. Construct Kenya Top Bar Hive.
3. Construct Langstroth hive.
4. Construct catcher box.
5. Construct observation hive.
6. Post-construction of hives and catcher box.

1.2.1 Learning Outcome 1: Preparing to Construct Bee Hives

1.2.1.1 Introduction to the Learning Outcome

This learning outcome outlines the competencies required to identify types of bee hives, identify materials and equipment for construction of hives and wear personal protective equipment.

1.2.1.2 Performance Standard

- Type of hives identified (Traditional – log, bark, bricks, mud, and reeds. Improved hives – Kenya Top Bar Hive and Langstroth hive).
- Materials and equipment for construction of hives are identified as per the type of hive.
- Personal protective equipment is worn as per the occupational health and safety procedures.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources Required
Identify types of bee hives.	• Guided thinking: guide a brainstorming session on the identification of types of bee hives. • Prompting and cueing: lead the trainees to identify different types of bee hives from the visuals provided. • Interactive lecture: facilitate an interactive lecture on the advantages of different types of bee hives. • Question and answer: facilitate a question-and-answer session on disadvantages of different types of bee hives.	• Photos of bee hives • Marker pens • Charts • Bee hive and equipment workshop
Identify materials and equipment used in bee hive construction.	• Demonstration: lead trainees to watch a video of materials and equipment and their uses. Alternatively show pictures. • Group discussion: cue the trainees to classify materials, tools and equipment and describe their use.	• Laptop • Projector • Photos of tools
Identify the PPEs to be used in bee hive construction.	• Group discussion: cue trainees to identify PPEs and their use. • Question and answer: facilitate a question-and-answer session about their use.	• Photos of PPEs
Duration: 15 hours		

1.2.1.3 Information Sheet

Definition of terms

A bee hive is an artificial structure used to house/rear honeybees.

Types of bee hives

There are two categories of bee hives:

- Traditional bee hives
- Modern/improved bee hives.

a) Traditional bee hives

Traditional bee hives are simply enclosures provided for the bee colony with no internal structures for the bees to build honey combs. Honey bees construct their own honeycombs fixed on the hive wall. These are not convenient to beekeepers' work. They make honey harvesting very difficult or totally impossible without destroying the combs.

Examples of traditional bee hives are:

- Log hives
- Clay pot hives
- Mud hives
- Basket hives
- Bricks hive
- Reed hives.

i. Log hive

They are hives from tree trunks made into hollow logs. The ends of the log are sealed leaving a few small holes to provide entry and exit for the bees.

Figure 1: Log hive

ii. Mud and clay pot hives

These are hives modelled from the clay soil. Mud hives are extended, long cylinders made with a blend of dung straw and unbaked mud. Some holes are left on the pot for ease of entry and exit of bees from the hive.

Figure 2: Pot hive

iii. Basket hives

These are hives woven from reeds, grass, straws or any other fibrous materials. This is basically a basket which is hollow inside. The bees build their combs however they choose. During harvesting of honey, the entire hive is destroyed.

Figure 3: Basket hives (Left) and Reed hive (Right)

iv. Reed hive

These are bee hives made of reed-grass. They are hollow inside and the bees make their combs by attaching them to the sides.

b) Modern/improved bee hives

They are of two types;

- Movable comb hives: also known as Top Bar Hives, where bees build their comb attached to a top bar that can be lifted out of the hive. They have no frames. A common example is the Kenya Top Bar Hive.
- Movable frame hives: have movable frames, which hold wax sheets that serve as a starting point for the bees to build honeycomb. Common examples in Kenya are the Langstroth and modern log hives.

i) Kenya Top Bar Hive (KTBH)

A top bar hive is a single frameless structure in which the combs hang from the removable bars. It has movable parts, namely:

- Queen excluder,
- Top Bars, and
- Lid.

A Top Bar hive is divided into two chambers, brood chamber and super. A queen excluder separates the two chambers.

The brood chamber in the Kenya Top Bar hive is usually found near the hive entrance. It houses worker-made cells where the eggs, larvae and pupae develop. Some of the cells in this part of the hive also hold pollen, nectar or honey that are used to feed the developing larvae. There are a total of nine (9) top bars in the brood chamber. Queen excluder that separates the brood chamber and super chamber prevent the queen from accessing the supers. This stops her from laying eggs in the honey supers hence production of clean honey free from broods. The super has a total of sixteen (16) top bars. The honeybees store surplus honey in the super.

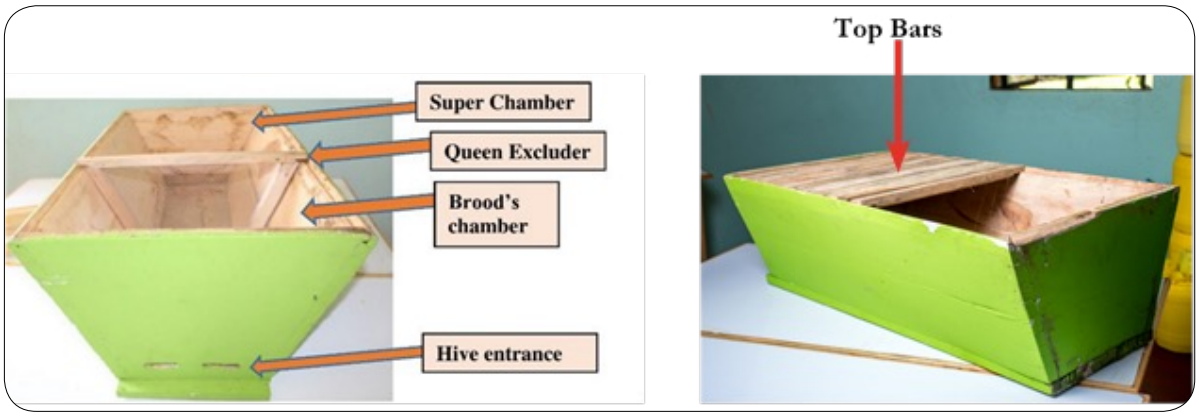


Figure 4: Internal parts of a KTBH

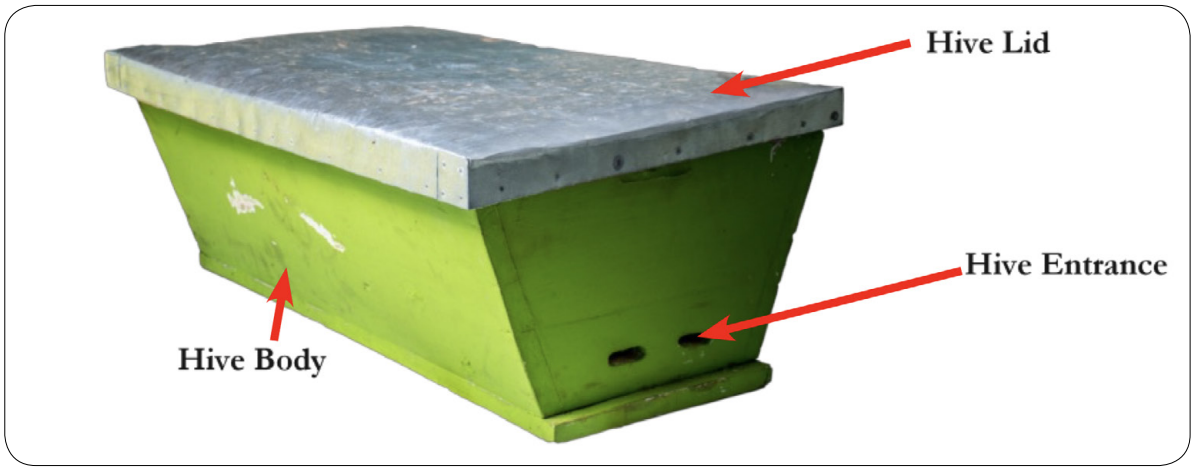


Figure 5. External parts of KTBH

Advantages of KTBH

- They are easier and cheaper to make/buy than the frame hives.
- Honey extraction is easy and cheap compared to frame hives.
- Management/inspection is easy compared to the traditional bee hives.
- Top bars can be easily replaced if damaged.

Disadvantages

- Combs in the top bar hive are not supported and can break if not handled carefully.
- Combs are destroyed during harvesting of honey, forcing bees to build new combs.
- When the hive is full, other honey supers cannot be introduced which can lead to swarming because of overcrowding.

ii) Langstroth Hive

Langstroth hives are made by stacking rectangular boxes with removable 8 or 10 frames for the bees to build combs. Having removable frames allows beekeepers to cause less disturbance to the bees during harvesting and inspections without destroying the honeycomb structure.

In a Langstroth hive, the bees build honey combs into frames, which can be moved easily. The frames are designed to prevent bees from attaching honeycombs where they would either connect adjacent frames, or connect frames to the walls of the hive.

Langstroth hive consists of the following parts:

- **Brood chamber -** This is a four-sided wooden box without a top or a bottom, in which the brood frames are placed. It holds 8 or 10 frames in which foundation sheet is fixed for bees to build wax.

- **Honey super -** A honey super is a four-sided wooden box 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 8 or 10 similar frames to that of brood chamber where the bees store honey. One can stack as many honey supers on top of the brood chamber as needed but at least two supers for one hive is recommended.
- **Frames -** A frame is a structure made up of a top bar, a bottom bar and two sidebars and pop wire 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 supers so as to leave space (bee space) in between themselves and hive body for bees to move freely.

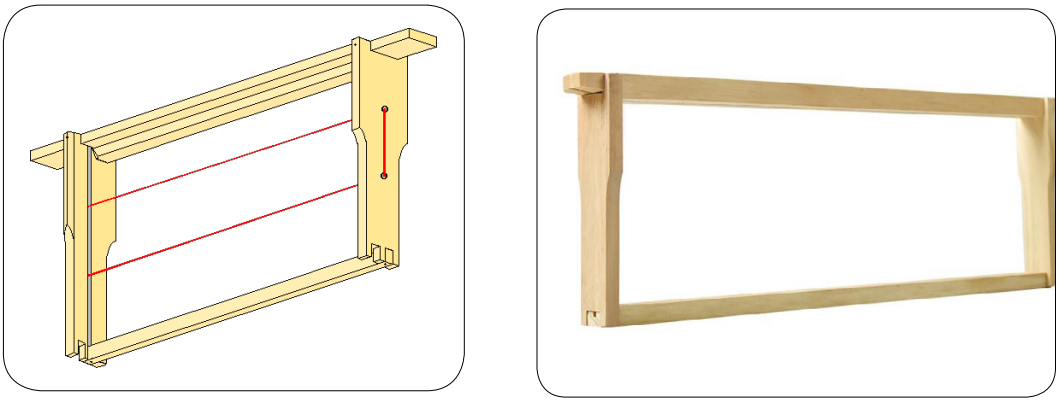


Figure 6: Left - A frame with pop wire (Source; Davis A Cushman), Right – A frame without pop wire

- **Bee space -** Bee space is a path or corridor bees need to move freely between the combs and around the nest. In simpler terms, this is the space between two adjacent combs and between the hive body and the combs that allows free movement of bees.
- **Bottom/ Floor board -** The bottom board is a four-sided wooden tray with a perfectly sealed bottom, onto which all hive parts are placed. It has a ledge around three sides that raises the hive parts leaving an open slit in the front, which is primary covered by the entrance block.
- **Entrance reducers -** An entrance reducer is a small piece of wood block at the hive entrance that allows a suitable size of bees to enter and leave the hive for foraging and other activities. The slot also protects bees against bigger pests and robber bees. It fits between the bottom board and the brood chamber.
- **Inner/ Inside cover -** This is a four-sided box with a water proof plywood separator screen at the middle and a passage hole for the bees to visit the upper part of the inner cover. The inner cover serves 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 vary, though it is often 5cm x 8cm.

- **Hive/Outer cover** - The 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.

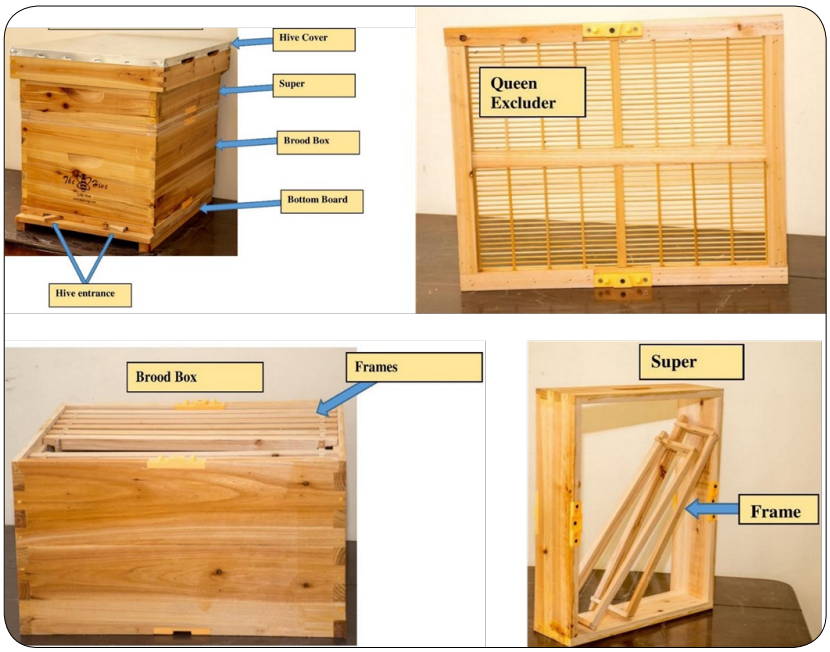


Figure 7: Parts of a langstroth hive

Advantages of Langstroth hives

- It has frames that makes combs very strong especially when being transported from the apiary to the processing room.
- Honey is extracted using the centrifugal honey extractor without destroying the combs, enabling the bees to fill the cells with honey within a short time after harvesting.
- The hive has space where new honey supers can be easily added to control swarming and increase honey production.
- By using a queen excluder between the brood chamber and supers, honey is separated completely from the brood and pollen, which leads to high quality honey production.

Disadvantages of Langstroth hive

- Frame hives are more expensive to make than the traditional and top bar hives.
- Frame hives need a centrifugal extractor to extract honey. Extractors are expensive to purchase.
- Frame hives require a greater level of investment and skills to manage.

- They are more complicated to make and manage, as they require more spares and machines to achieve standard specifications.

Note:

- KTBH hive is best especially when a beekeeper intends to collect more wax, this is because a whole comb is crushed to extract honey and what remains is beeswax.
- For a Langstroth hive there is more production of honey than in KTBH because there is no destruction of combs after honey extraction. The frame with intact combs are taken back to the hive hence bees start to put in honey immediately rather than developing combs afresh which takes a shorter time.
- Langstroth hive leads to production of a clean honey without wax remains.

Table 3. Difference between modern and traditional bee hives

Modern bee hives	Traditional bee hives
They have moveable parts, i.e. frames/top bars, lid and queen excluders.	They have fixed parts
Combs are fixed onto frames and top bars.	Combs are fixed onto the hive roof.
Inspection and management of the hive and harvesting of honey is easy because of movable frames/bars.	Inspection and management of the hive and harvesting of honey takes more time because combs are attached to the walls of the hive.
Ease of pest control.	Pest control is difficult.
Harvesting is done selectively without destroying the brood and comb without honey.	Combs with broods and those without honey are all destroyed during harvesting.

Identification and assembling of materials and equipment for construction of bee hives

Materials:

The following materials should be identified and gathered for construction of bee hives:

- Timber
- Paint
- Wood glue: used in joining wooden parts
- Wood preservative
- Stainless steel pop wire
- Coffee wire
- Pencil: used for marking the wood
- Nails and screws
- Galvanized plain iron sheet
- Plywood

Timber (lumber)

Pine or cedar is recommended for all construction, except for the top cover and floor of the bottom board which use 1.3cm (1/2 inch) plywood. Plywood is less affected by changes in temperature and moisture.

Characteristics of timber suitable for hive construction include;

- The timber to be used should be friendly to the bees in terms of aroma and weather resistance capability.
- Must be durable/able to last for several years without replacement.
- Must be suitable for carpentry; it must not split too easily and must not be so hard that wood working equipment is damaged.
- Must be flat though small knots may be acceptable, provided they are not close to the edges or where handholds are to be cut.
- Must be properly seasoned, otherwise shrinkage and warping of the hive will occur.

Tools and equipment:

The following are the tools and equipment for construction of bee hives:

Carpenter's working bench

It is a specialized table for carrying out wood works. It has to be heavy and robust to withstand the force of work.

Figure 8: Working bench

Tape measure

It is a flexible ruler used to measure sizes of the materials for constructing bee hives and bee equipment. A standard tape measure is at least 25 feet long.

Wood saw

Used to cut timber to the required dimensions.

Tinsnips

Used for cutting the plain galvanized iron sheet.

Figure 9: Tape measure

Figure 10: Wood saw

Figure 11. Tinsnips

Plain galvanized iron (GI) sheets

They are iron sheets used as spacers between the frames and for making the top lid of the hives.

Hammer

A hammer is a tool used to deliver an impact to a small area of an object such as nails. The claw hammer is the most common. The claw on one side of the head is used to remove the nails from the timber. The finished head, which is rounded is used for driving nails into the timber.

Nails

A nail is a small object made of metal, which used for joining the timbers strongly. Nails are of different gauge and sizes, specifically suited for the work being carried out.

Wood plane

Used for planing timber to required thickness and smoothness.

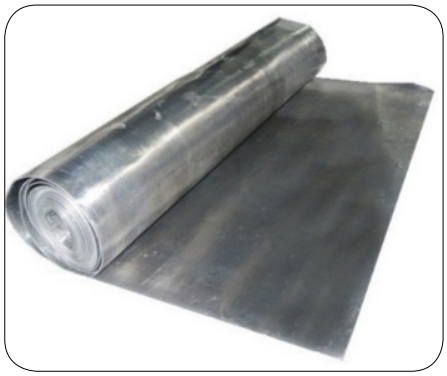


Figure 12: Plain GI sheet

Figure 13: A claw hammer

Figure 14: Wood plane

Wood glue

Used when joining the timber parts.

Rebate plane

Used to cut rebates or square corners.

Source: Finetools.com

Figure 14: Rebate plane

Paint brush

Used for application of paint to the hive.

Artist brush

Used for writing names, numbers or tags on a hive.

Combination pliers

Used to tighten wire when constructing a frame hive or remove nails among other uses.

Figure 16. Artistic brush

Figure 17: Combination pliers

Brace drill

This is used to drill holes into the timber.

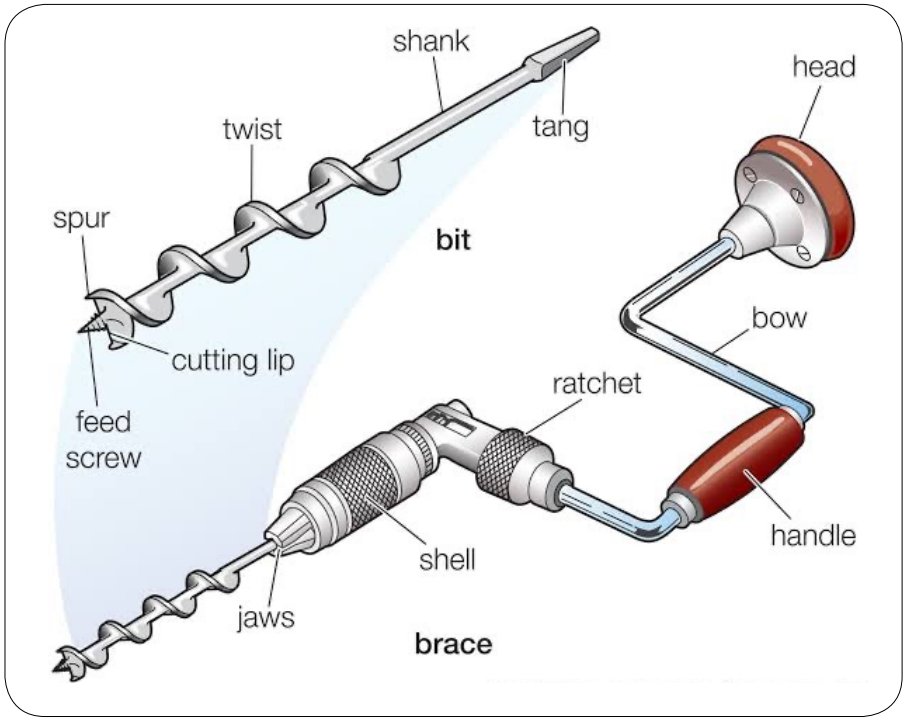


Figure 18: Brace drill

Hand electric drill

This is electrically powered and is used for ease of drilling holes.

Figure 19: Hand electric drill

Other materials include:

Multi-purpose wood working machine

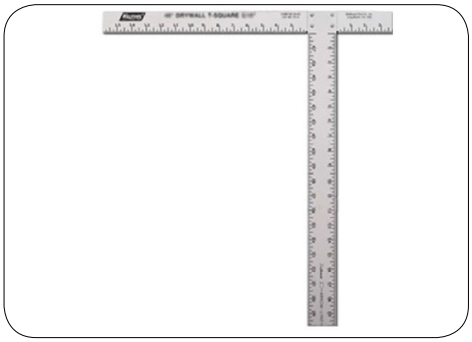
Used for adjusting thinness and surface smoothing.

Jointer machine

Used for smoothing edges and creating side bar shoulders.

Vanier caliper

Used to measure the dimension of timber.

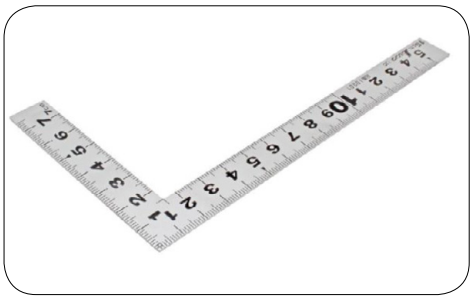


T- Square

Used as a guide for cutting timber on horizontal lines and to make right angled cutting.

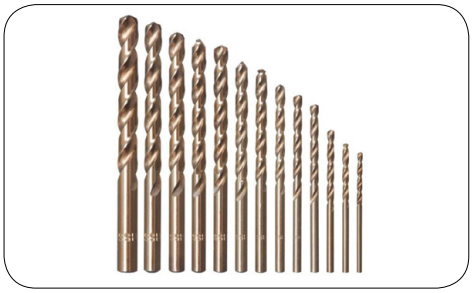
Chisel

Used for carving or cutting a hard material such as wood.



Carpenter's square

Used as a straight-edge, finding and establishing right angles and marking cut-off work on wide stock.



Drill bits

They are designed to drill holes in a variety of different common materials such as timber.

Woodwork clamp

Used to temporarily hold work securely in place.

Sanding block

Used for making wood surface smoother for a fine finish.

Personal Protective Equipment (PPEs) in bee hive construction

Personal Protective Equipment is worn to minimize exposure to hazards that cause serious workplace injuries and illness. These injuries and illness may result from contact with chemicals, mechanical, radiological, electrical, physical or other workshop hazards.

PPEs are categorised into the following:

- Head protection (They protect against falling/ flying objects and overhead objects),
- Hearing protection,
- Foot protection,
- Eye protection,
- Hand protection, and
- Body protection.

Head protection (helmets)

A helmet is a form of protective gear worn to protect the head from injury. More specifically, a helmet complements the skull in protecting the human brain.

Ear guards (hearing protection)

They protect the ear drum against loud noise from tools and machinery, as well as poorly maintained equipment that produce loud noise.

Foot protection

These protect the feet against falling or rolling objects, sharp or heavy objects, wet and slippery surfaces, hot surfaces and electrical hazards.

Examples of foot protection are safety boots, gumboots etc.

Hand protection (gloves)

They protect the hands against sharp or hot objects, chemicals or electrical hazards.

Examples are leather gloves and canvas gloves.

Eye protection

They protect eyes against blowing dust or particles, metal shavings, acids or caustic liquids and welding lights.

Examples of eye protection are safety goggles, facemasks, face shield etc.

Body protection (overall/apron)

They protect against body injuries while some aid in high visibility. They cover or replace personal clothing.

Examples are overalls/coveralls, isolation gowns, aprons, scrub sets, reflector vests, hats, chaps with sewn trousers and pants.

Figure 20. Helmet

Figure 21. Ear guards

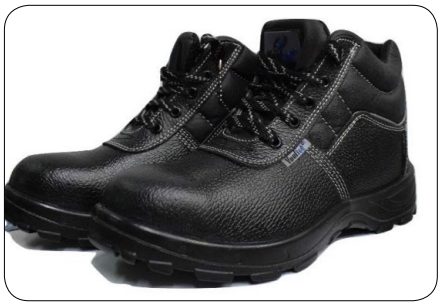


Figure 22: Safety boot

Figure 23: Hand gloves

Figure 24: Face shield (Left) and protective/safety goggles (Right)

Figure 25: Overall and a reflector jacket

Other safety measures to be undertaken in workshop include;

- Avoid wearing loose clothing.
- Avoid passing your hand over machine moving parts such as blades.
- Operate all machinery following the manufacturer's direction.
- Follow all the safety measures put in place in the workshop.
- Handle the tools and equipment in the right manner and store them appropriately to avoid any injury.

1.2.1.4 Learning Activities

1	2	3
Identify materials and equipment for construction of hives and other accessories as per the type of hives and bee equipment.	Use personal protective equipment as per the occupational health and safety procedures.	Assemble materials and equipment for construction of bee hives as per the requirements.

1.2.1.5 Self-Assessment

1. Which are the two categories of bee hives used in beekeeping?
2. Which among the listed four is the odd one out?
   - ☐ A. Log hive
   - ☐ B. Pot hive
   - ☐ C. Tree hive
   - ☐ D. Basket hive
3. Which are the two main types of modern hives?
4. Which are the three main components of a Kenya Top Bar Hive?
5. What are advantages of a Langstroth hive?
6. List the materials, tools and equipment required for construction of bee hives and what are their function?
7. What are the four characteristics of timber suitable for hive construction?

Notes:

1.2.1.6 Tools, Equipment, Supplies and Materials

• Timber	• Pair of pliers
• Nails	• Stainless steel pop wire
• Tape Measure	• Pencil
• Carpenter's hammer	• Book
• Wood plane	• Coffee tray wire
• Carpenter's square	• Wood glue

1.2.1.7 References

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1.2.2 Learning Outcome 2:
Constructing Kenya Top Bar Hive

1.2.2.1 Introduction to the Learning Outcome

This learning outcome outlines the competencies required to construct the Kenya Top Bar Hive (KTBH). This involves assembling materials and equipment for construction, seasoning of timber, identifying hive components and their measurements, cutting timber as per component standard specification, constructing hive components, cutting the lid material as per the specification, assembling hive components and construction of queen excluder.

1.2.2.2 Performance Standard

- Materials and equipment for construction are assembled as per the requirements.
- The timber is seasoned as per work place procedures.
- The timber is planed to the recommended thickness.
- Components of the hive and their measurements are identified.
- The timber is cut/ split to size as per the component standard specification.
- Different hive components are constructed as per standard specification.
- The lid material is cut as per standard specification.
- Queen excluder is constructed as per the standard specification.
- Bee entrance holes are drilled on one end as per the workplace procedures.
- Various components are assembled according to the workplace procedures.
- Hive hanging wires are fixed as per workplace procedure.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources required
• Assembly of materials and equipment for construction.	• Interactive lecture: facilitate a lecture on the assembly of materials and equipment. • Group discussion: prompt and cue trainees to identify and assembly materials and equipment.	• Marker pens • Charts • 3-D objects
Seasoning of timber. • Methods of seasoning. • Methods of conversion. • Timber preservation.	• Demonstration: lead trainees to watch a video of a procedure on timber seasoning. • Group discussion: guide trainees' thinking in classifying different methods of seasoning.	• Laptop • Projector • Marker pens • Charts

	• Interactive lecture: facilitate a lecture on advantages and disadvantages of different methods of seasoning. • Interactive lecture: facilitate a lecture on the methods of timber conversion. • Group discussion: prompt and cue trainees to explain the reasons for, types of preservatives and methods of preservation.	
• Planing of timber	• Explanation: Instruct trainees on how to plane timber to size. • Demonstration: demonstrate the planing of timber to size. • Explanation: instruct on face side and face edge marks.	• Marker pens • Charts
• Identify components of hive and their measurements	• Group discussion: guide the trainees to identify the components of the hive.	
• Cut/split timber to size as per the component standard specification.	• Demonstration: demonstrate the cutting of timber to size.	• Marker pens • Charts
• Construct the hive components.	• Demonstration: demonstrate the construction of hive components.	• Drawings and photos
• Cut the lid material as per the standard specifications.	• Explanation: issue direct instructions trainees to cut the lid material.	• Marker pens • Charts
• Construct the Queen excluder as per specification.	• Observation: lead trainees to watch a video on the procedure of construction of the queen excluder.	• Laptop • Projector
• Drilling of bee entrances on one side.	• Explanation: give direct instruction on the drilling of bee entrances.	
• Assembly of various hive components.	• Demonstration: lead trainees to watch a video of assembly of components.	• Laptop • Projector
• Fixing of hive by hanging wires.	• Explanation: give direct instructions trainees on how to fix the hive hanging wire.	• Marker pens • Charts
• **Duration:** 30 hours		

1.2.2.3 Information Sheet

The Kenya Top Bar Hive (KTBH) is a box made of wood whose top end is covered with a number of inter-changeable bars of equal width and length. The KTBH was documented and recommended for use by Kenyan farmers in 1974. The hive incorporates three features; that of log hive elliptical shape, the Greek basket hive with a series of parallel bars and the removable frame hive comb inter-changeability. To meet the requirement of comb movability, the KTBH is made to slope inwards to form a trapezoidal shape of about 120º with the ends of the hive and the bottom board. To maintain the principle of inter-changeability, majority of the frames and bars used worldwide have a standard length of 48.3cm.

Identification and assembling of materials and equipment for construction of Kenya Top Bar Hive (KTBH)

For the KTBH to be fully constructed, the following materials and equipment should be identified and assembled.

Materials and supplies

- Timber (well-seasoned)
- Paint
- Wood glue
- Stainless steel pop wire
- Coffee wire
- Pencil

Tools and Equipment

- Wood plane
- Rebate plane
- Iron (plain) sheets
- Groove cutter machine
- Galvanized plain sheet of 26 mm gauge
- Metal shear/scissors
- Nails of different sizes
- Carpenter's square
- Carpenter's hammer
- Carpenter's saw
- Carpenter's drill
- Paintbrush
- Wood saw

PPEs

Staying safe in the workshop should be a top priority. Each person in the workshop has a shared responsibility to use equipment safely and take the right steps to avoid any potential hazards in the workshop.

Wearing the right protective gear (PPEs) is one of the measures you can take to avoid and prevent laser cutting hazards – but it is not as simple as donning an apron and gloves.

PPEs includes clothing worn or equipment used by workers that protect them against hazards in the workplace. PPEs include among others; head, respiratory, eyes, ears, hands and feet protective gear, as discussed in the first unit of learning above.

Seasoning of timber for construction of KTBH

Seasoning of timber is the process in which moisture content in the timber is reduced to the required level. By reducing moisture content, the strength, elasticity and durability of the timber are enhanced. Fresh timber has a high moisture content and should be placed under the shade to dry.

Reasons for seasoning timber

- To make timber safe from attack by fungi and insects. Seasoned wood dried to a moisture content of less than 15% below the fibre saturation point will ultimately prevent the onset of stain fungi decay.
- To decrease the weight of timber, hence lowering the cost of transport and handling.
- To increase the resistance power of the timber.
- To make timber suitable for gluing i.e. effectively joining two members of timber with the aid of glue.
- To reduce the tendency of timber to crack, shrink and warp.
- To impart hardness, stiffness, strength and better electrical resistance to timber.
- To make timber easily workable.
- To make timber fit for receiving treatment of paints, preservatives, varnishes, etc.

Methods of seasoning

Seasoning can broadly be divided into the following two categories:

- Natural seasoning
- Artificial seasoning.

a) *Natural seasoning*

In this method, the seasoning of timber is carried out by natural air hence it is sometimes referred to as air seasoning, as shown below.

Source: https://www.google.com

Figure 26. Natural seasoning of timber

The following procedure is adopted in the natural seasoning:

1. Clear and level the ground where stack is to be constructed for good drainage.
2. Construct rows of brick or concrete pillars as a platform to raise the timber about 30cm from the ground.
3. Cut and saw the timber into suitable sections of planks or scantlings. The timber in log form is not usually fit for the process of seasoning.
4. Sort out the timber pieces according to lengths and thicknesses. Then arrange them in layers. Place together wood with layers of the same thickness and length to avoid timber becoming warped or cracked.
5. Stack the timber pieces either horizontally or vertically.
6. Protect the stack from fast blowing wind, rain and extreme heat of sun. Preferably, the stack should be covered by a roof of suitable material.
7. Similar stacks may be constructed. The minimum distance between adjacent stacks should be at least 60cm.

b) Artificial seasoning

This is seasoning by artificial means using methods such as boiling, use of chemicals, electricity, kiln seasoning and water.

- *Boiling* - timber is immersed in water and then boiled for about three to four hours. It is then dried very slowly under a shed.
- *Chemical seasoning/salt seasoning* - The timber is immersed in a solution of suitable salt. It is then taken out and seasoned in the ordinary way. The interior surface of timber dries before the exterior one, reducing chances of formation of external cracks.
- *Electrical seasoning* - This method uses high frequency alternating currents.
- *Kiln seasoning* - In this method, the drying of timber is carried out inside an airtight chamber or oven.
- *Water seasoning* - In this method, the pieces of timber are immersed wholly in water, preferably in running water of a stream. The timber is then taken out of water and allowed to dry under a shed with free circulation of air.

The following are the reasons for adopting the artificial over natural seasoning:

- The defects such as shrinkage, cracking and warping are minimized.
- The drying is controlled and there are practically no chances for the attack of fungi and insects.
- The drying of different surfaces is even and uniform.
- It considerably reduces the period of seasoning.
- There is better control of circulation of air, humidity and temperature.
- The wood becomes more suitable for painting, gluing, etc.
- The wood with desired moisture content may be obtained by the artificial seasoning.

Preservation of timber after seasoning

This is done to increase the life of timbers and to protect the timber from the attack by destroying agencies such as fungi, insects, etc. Types of preservatives used include;

- **Chemical salts:** These preservatives are odourless, have good penetration and are non-inflammable. The treated surface can be painted or varnished after drying
- **Oil paints:** The timber surface is coated with 2 or 3 coats of oil paint. The wood should be seasoned, otherwise the sap will be confined and it will lead to the decay of timber. The oil paints preserve timber from moisture and make it durable.

Methods of timber preservation

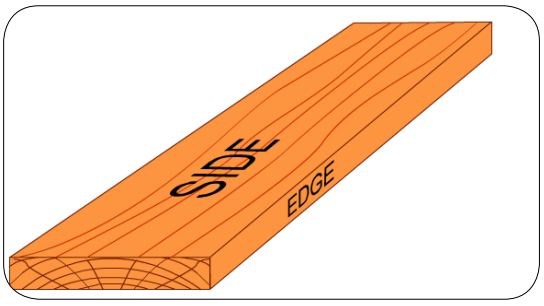
They include;

- Brushing, spraying, and pouring
- Dipping
- Cold soaking
- Hot and cold open tank treatment
- Injecting under pressure.

Planing of timber

Planing is the process of making wood surfaces flat and smooth to create an even thickness throughout the wood as well as attain a fine finish. It is done using a thicknessing planer (thicknesser) which trims boards/timber to a consistent thickness throughout their length.

When planing safety and efficiency is very key. There is need to create face side and face edge, i.e. two flat adjacent surfaces that are square to each other, then marking the thickness and width with a marking gauge and planing down to the marked lines. This will happen in both hand and machine planing.



Source: technologystudent.com

Figure 27: Face edge and face side of a timber for planning

The batch of wood should be sawn roughly to width and length. Have at least 1cm excess on the length and 6cm on the width (possibly more if the piece is badly curved). The piece of timber to be planed should be properly marked to guide during the process.

There are two procedures in planning timber into the right thickness: surfacing and thicknessing.

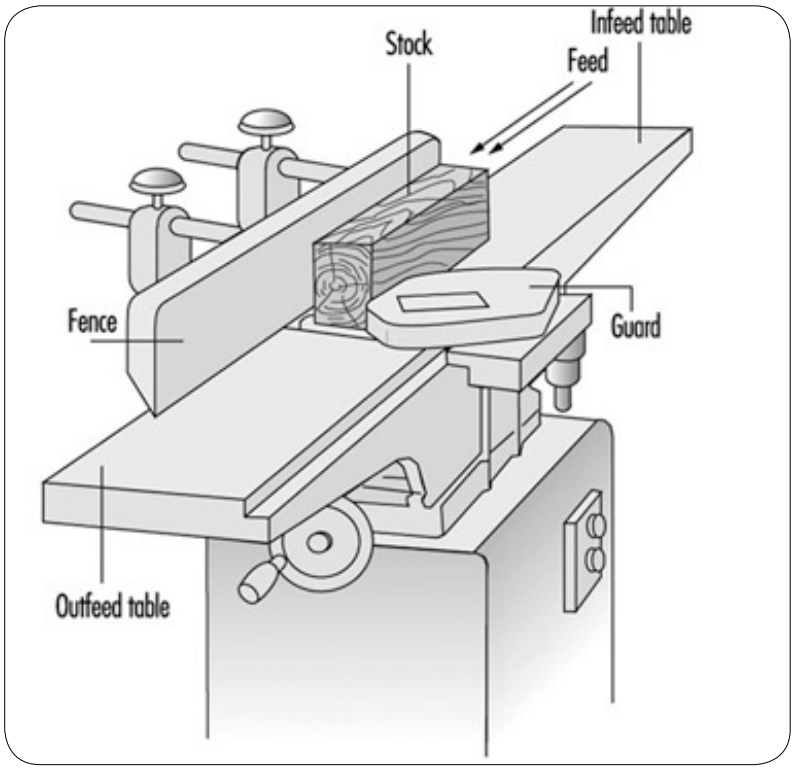
i) Surfacing (surface planing)

Surface planing is a machining process used to produce a smooth and even surface finish on a timber. It involves the use of a planer, a machine equipped with a rotating cutterhead, to remove material from the surface of the workpiece.

Procedure:

- Move the planer over the timber or vice versa in a linear or rotary fashion, allowing it to remove material from the surface as it passes over it. The amount of material removed can be adjusted by varying the feed rate and/or the cutting speed.

Adjust the blade height in order to skim the desired thickness from the board. Raise or lower the blade height by adjusting the crank located at the side of the planer. The surface planing process can be used to produce a variety of surface finishes. For finer finish, increase the speed to have more cuts done per inch while for rougher finish, reduce the rotating speed to have fewer cuts per inch.



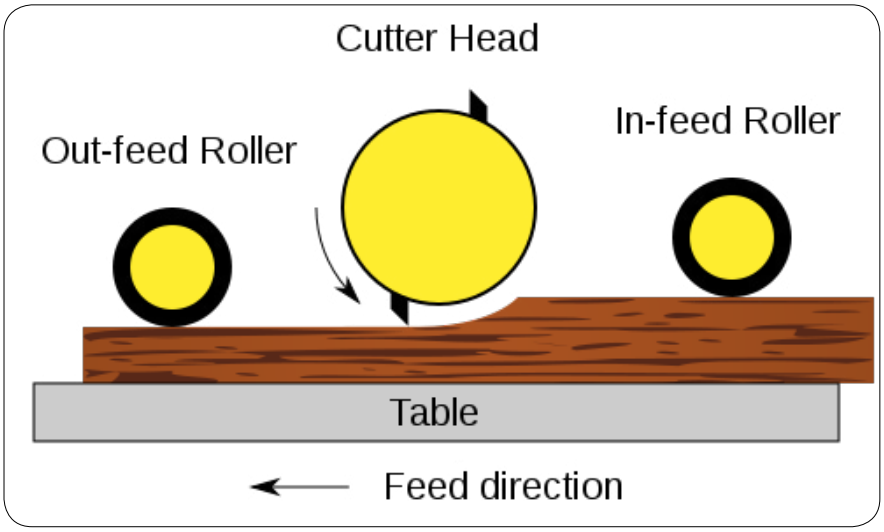
Source: iloencyclopaedia.com

Figure 28: Surface planer

To watch a video on surfacing follow the link: https://youtu.be/vxyQJCMLCsI

ii) Thicknessing

This entails planing and smoothening timber to an exact size. Even after surfacing wood can often be warped, a planer thicknesser will rectify any irregularities. A planer thicknesser gives a higher level of accuracy, and using the machine means it is possible to create adjacent 90° sides.



Source: Wikipedia

Figure 29: Set up of a thicknesser planer

Procedure of thickenessing

1. Select the best tool: The most popular choice for thicknessing wood is a planer, which is a power tool that cuts wood with a rotating cutter head.
2. Set the depth: With the planer, adjust the depth setting so you do not cut too deeply into the wood. Generally, set the depth to the thickness of the wood you want to achieve.
3. Make the passes: Once the depth is set, you can start making passes with the planer. Slowly feed the wood into the planer, making sure to keep the wood flat against the bed. Make as many passes as necessary to achieve the desired thickness.
4. Check the thickness: After the passes, check the thickness of the wood with a ruler or caliper. If the thickness is not consistent, make additional passes with the planer.
5. Sand the surface: Once the desired thickness is achieved, sand the surface of the wood to remove any rough edges or burrs using a sanding block. This will help ensure a smooth, even surface when the wood is finished.

Note:

A surfacer planer can be used as a thickness planer. To achieve the desired thickness, pass the board through the machine a number of times. The machine can skim 0.2-0.3cm, which is already considered as an aggressive amount.

A manual planer can still be used in carrying out planing in absence of planing machine or during small scale planing.

General procedure of wood planning

1. Prepare the work area: Clear the space where you plan to plane the wood and make sure it is free of any debris or obstructions.
2. Set up the planer: Adjust the plane and ensure the blade is securely fastened. Check the depth of the blade and set it according to the thickness of the wood you are working with.
3. Secure the wood: Attach the wood to a workbench or other secure surface.
4. Plane the wood: Place the plane flat against the wood and push it along the grain in one smooth motion. Repeat until you achieve the desired result.
5. Finish up: Check the wood for any rough spots or imperfections and plane them away.
6. Finally, remove the wood from the workbench and clean up the work area.

Components of the KTBH

The various components of KTBH are;

- Lid
- Hive body
- Queen excluder.

These components are further discussed in the first unit of learning. They have different dimensions as shown in the Figure 30.

Taking measurements and cutting components for construction of KTBH

Before taking measurements and cutting the various components, the timber should be planed properly as earlier discussed. Well planed wood is easy to work with and fits well in a joinery work. Construction of hive components is as follows;

i) Assembly of the top lid:

Materials: thin planks of wood, roofing materials (galvanized iron sheet), paint.

Tools and equipment: handsaw/ wood cutter machine, screws, sandpaper, tape measure, hammer.

Steps:

1. **Cut the timber for making the lid frame**
   - Cut the planks of timber to the desired size as shown in the figure below.
   - The timber thickness should be 2cm.
   - Cut two pieces of timber measuring 92cm x 4.5 cm and another two pieces measuring 52cm x 4.5 cm.

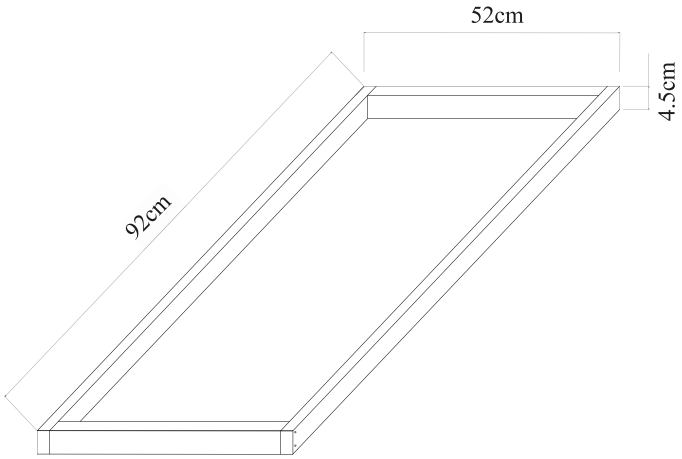


Figure 30. The KTBH wooden top cover

2. **Assemble the lid's frame**
   - Join the ends of the shorter planks to those of the longer planks to form a rectangular frame (long planks attached to short planks as shown in figure above) and drive screws into the joints.
   - Make sure the screws are evenly spaced and tightened securely to ensure the planks are attached firmly to each other.
   - Sand the edges and surface of the frame to remove any rough spots and to make it smooth.
3. **Attach the plywood:** Using a hand saw, cut a piece of plywood measuring 92cm x 52cm. Place the cut plywood over the frame. Use 1 inch nails to affix the plywood onto the frame.
4. **Attach the plain galvanized iron sheet**: Cut a piece of plain galvanized iron sheet of 65cm by 100cm using metal shears. Place the frame centrally onto the metal sheet and bend the overlapping edges of the sheet onto the sides of the frame. Affix the metal sheet on the wood frame using 1inch nails or screws.

ii) Assembly of the hive body

Materials needed: 2cm thick planks of timber, wood glue, paint.

Tools and equipment: handsaw/ wood working machine, screws, sandpaper, tape measure, hammer, nails, electric hand drill or brace drill.

When constructing hive body the following parts should be measured and cut separately then assembled. These parts are;

- Side A
- Bottom board
- Side B
- Front side
- Back side.

Steps:

Well-seasoned quality timber planed to a thickness of 2cm is measured and accurately and cut as per the dimensions indicated below.

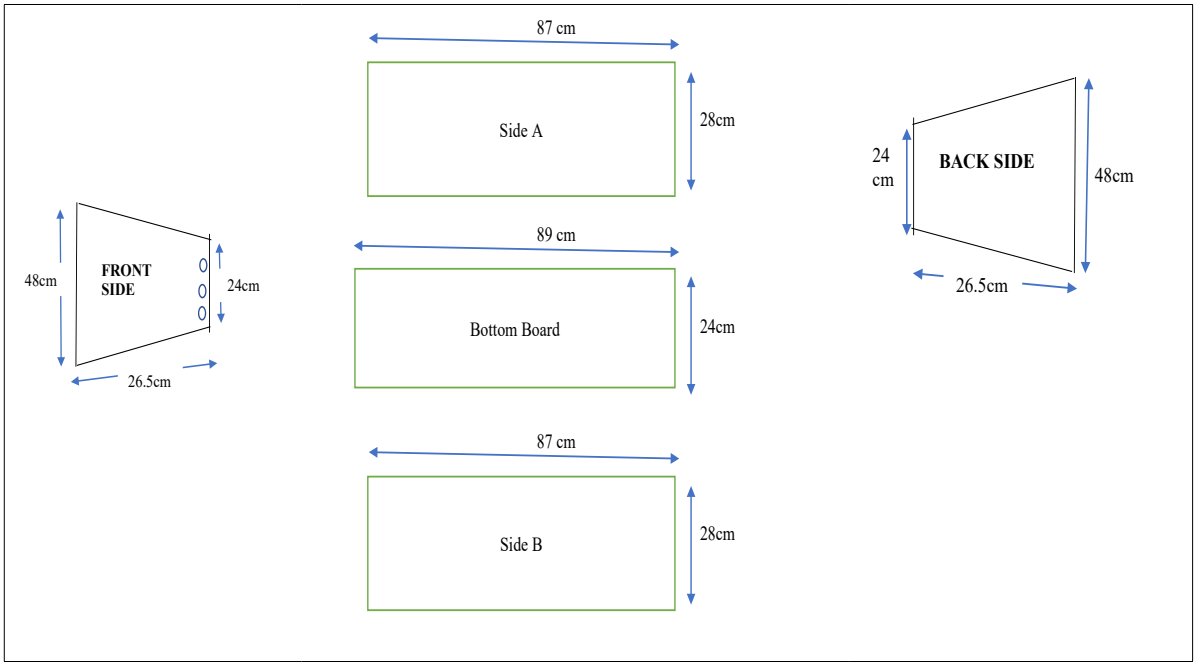


Figure 31: KTBH construction plan

Assembling the hive body

- Glue the trapezoidal end panels (front and back side) to the long sides (side A and B) such that the outer surfaces of the end panels are flush with the edge of the longer sides A and B. Affix them using deck screws or nails. Use a total of six screws on each joint area. The top edges of the end panels and side boards should be flush with each other.

- Turn the hive body upside down and staple the hardware cloth to cover the opening that runs along the entire length of the hive body.
- Affix the bottom board on the bottom side of the hive using screws and wood glue. On the front side of the hive, the bottom board should slightly protrude to provide the landing bay for the bees.

Note:

Painting the exposed exterior wood of the hive body with a good quality outdoor paint (latex or oil) greatly extends the life of your woodenware. Painting is also used for ease of identification of the hives. The paint should be light coloured such as white yellow, etc. Painting

iii) Cutting top bars

Tools, equipment and materials;

- Chisel
- Hammer
- Tape measure
- Saw
- Well planed wood of 2cm thick.

Steps:

- Obtain a well planed wood (2cm thick) and cut 26 pieces of 48cm (or 48.3cm) length by 3.2 cm width
- In the middle part of the wider side of each bar a tongue or groove of 0.5cm wide and 0.5cm depth is made on inner side of the bar using a chisel as shown in the diagram below.
- The tongue should start from 3.5cm from either side hence making a tongue of 41cm long.

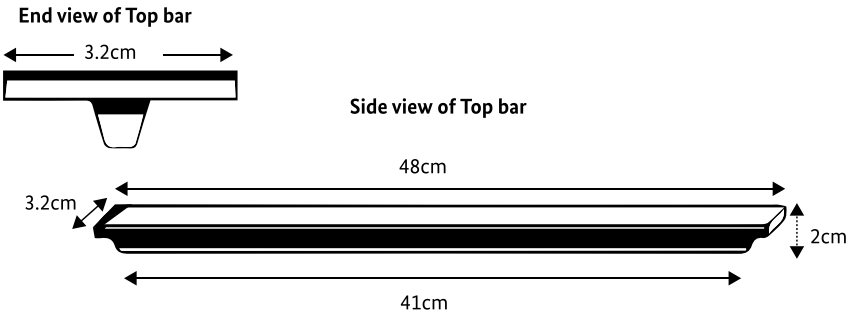


Figure 32: Top bar dimension

- A total of 26 bars should be cut.
- On the tongue/groove of each bar a thin coat of beeswax is smeared on top, this is the starter strip that gives the bees a starting point to build honey comb on the top bar. When melting beeswax avoid using open flame as beeswax is highly flammable.

Arrange the top bars into the hive body. The bars rest on the top edge of the hive body. Never paint your top bars because paint could be toxic to your bees. Leave all interior parts of any hive unpainted, unvarnished, and all-natural.

iv) Assemble the queen excluder

Materials:

- A top bar
- Nails
- Coffee-tray wire/plastic mesh
- Scissors/wire cutters.

Steps:

i. Groove one top bar in the middle (length-wise).

ii. Cut 3 pieces of wood from a well-planed timber of 2cm thickness. The wood should have length of 24cm and the other 2 pieces measuring 26.5cm. Each piece should be of width 2cm.

iii. Join the cut wood to the top bar as shown below to form a queen excluder frame.

iv. Nail a piece of coffee tray wire in the groove.

v. Ensure that the queen excluder fits well in the hive body. The excluder can be removable or fixed.

vi. Fix the excluder after the 9th bar from the hive entrance.

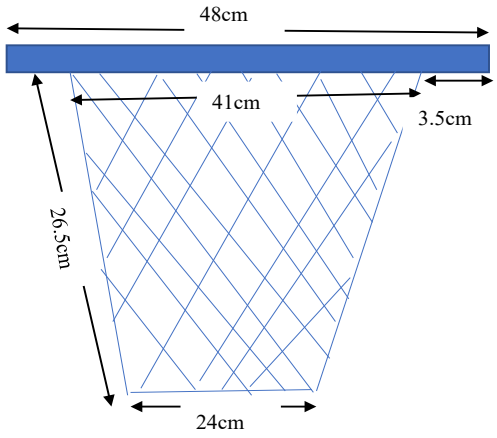


Figure 33: KTBH queen excluder dimension

v) Cut the inner cover

The inner cover is optional when constructing top bar bee hives.

Materials and tools

- Saw
- Plywood
- Wood chisel
- Hammer

Steps:

- Cut a flat piece of plywood measuring 89cm by 24cm.
- Make a small hole in the middle of the inner cover to allow bees access on top of the hive.
- Place the inner cover over the top bars before positioning the top lid over the hive.

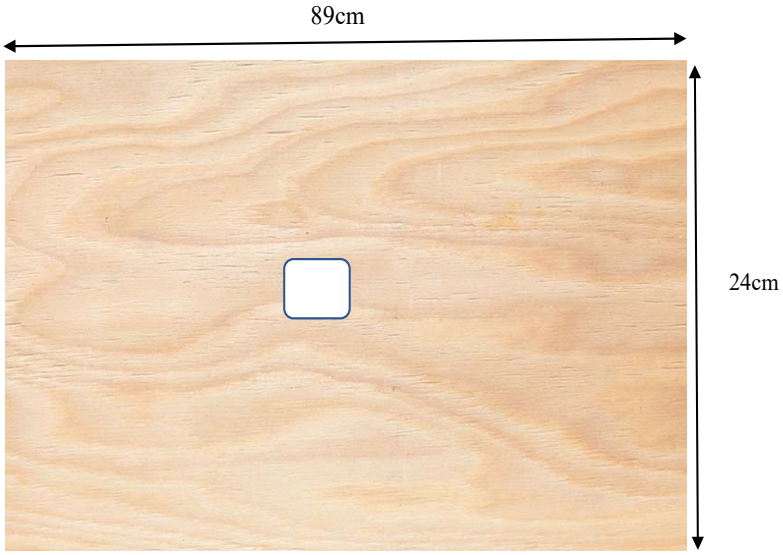


Figure 34: Dimensions of the KTBH inner cover

vi) Drilling bee entrance holes and fixing hanging wires

- Drill holes on both sides (width wise) of the KTBH as indicated in Figure 35.
- Loop strong wires through the drilled holes.
- The wires should be strong enough to hold the weight of the hive when full of honey.
- Grease the wires to prevent crawling pests from accessing the hive.
- The KTBH is hung onto a horizontal bar or tree branch by use of the hanging wire loops.

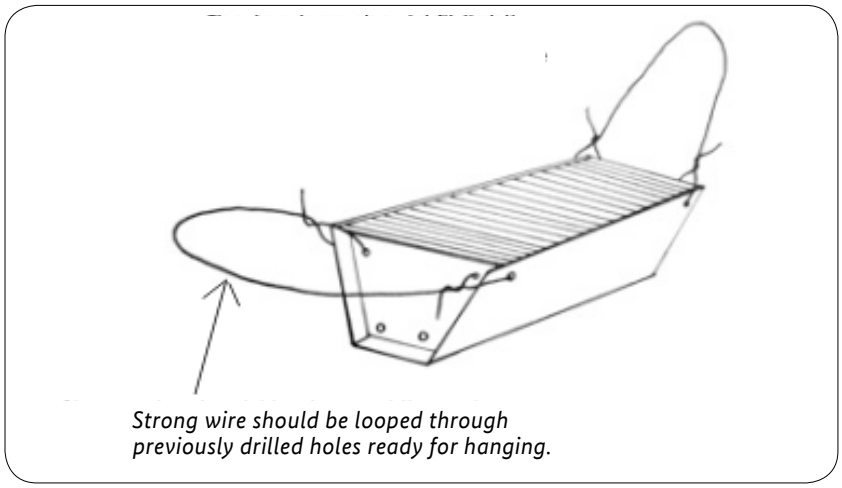


Figure 35: Fixing of hanging wire

Figure 36: Complete assembled KTBH

1.2.2.4 Learning Activities

1. Construct KTBH as per specification.
2. Use personal protective equipment as per the occupational health and safety standards during KTBH construction.
3. Assemble materials and equipment for construction of KTBH as per the requirements.
4. Construct and evaluate quality of KTBH as per standard specifications.

1.2.2.5 Self-Assessment

1. What are the dimensions of the top lid when constructing KTBH?
2. List the parts for the construction of hive body of KTBH
3. What is the width and length of a standard top bar for the KTBH?
4. At which bar is a queen excluder placed in the hive?
5. Describe the procedure of constructing a queen excluder.
6. Define timber seasoning.
7. List any three (3) reasons for seasoning timber for hive construction.
8. Name the two categories of timber seasoning?
9. What are the five various methods of artificial seasoning?
10. What is conversion of timber?
11. What are the three objectives of preserving timber?

Notes:

1.2.2.6 Tools, Equipment, Supplies and Materials

• Timber	• Artist brush
• Nails	• Paint
• Coffee tray wire	• Wood glue
• Carpenter's square	• Wood plane
• Carpenter's hammer	• Iron (plain) sheets
• Carpenter's saw	• Groove cutter machine
• Carpenter's drill	• Tape measure
• Paintbrush	• Book and pencil.

1.2.2.7 References

Gebiso, T. (2015). Adoption of modern bee hive in Arsi zone of Oromia Region: Determinants and financial benefits. Agricultural Sciences.

Gobena, W. E. (2017). Pre-scaling up of transitional locally made bee hive technology package in West Shoa Zone, Oromia Region, Ethiopia. Journal of Agricultural Economics, Extension and Rural Development.

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National Bee Keeping Institute (Kenya). Bee Keeping Manual.

1.2.3 Learning Outcome 3:
Constructing Langstroth Hive

1.2.3.1 Introduction to the Learning Outcome

In this learning outcome, you will learn how to construct Langstroth hive. It involves identifying components of the hive and their measurement, cutting/ splitting the timber to size as per the component specification, and assembling the various components.

1.2.3.2 Performance Standard

- Materials and equipment for construction are identified and assembled as per the requirements.
- The timber is seasoned as per work place procedures.
- The timber is planed to the recommended thickness.
- Components of the hive and their measurements are identified.
- The timber is cut/ split to size as per the component specification.
- Different hive components are constructed as per standard specification.
- The lid material is cut as per standard specification.
- Queen excluder is constructed as per the standard specification.
- Various components are assembled according to the work place procedure.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources required
• Identification and assembly of materials and equipment for construction.	• Interactive lecture: facilitate a lecture on the assembly of materials and equipment. • Group discussion: guide trainees to think on how to assemble materials and equipment.	• Marker pens • Charts
• Seasoning of timber. - Methods of seasoning. - Methods of conversion. - Timber preservation.	• Demonstration: lead trainees to watch a video of procedure of timber seasoning. • Group discussion: prompt and cue trainees to classify different methods of seasoning. • Interactive lecture: facilitate a lecture on advantages and disadvantages of different methods of seasoning. • Interactive lecture: facilitate a lecture on the methods of timber conversion.	• Laptop • Projector • Marker pens • Charts

	• Group discussion: prompt and cue trainees to explain the reasons, types of preservatives and methods of preservation.	
• Planing of timber	• Explanation: give direct instruction to trainees on how to plane timber to deferent sizes. • Demonstration: demonstrate the planing of timber to size. • Demonstration: demonstrate face side and face edge marks. • Demonstrate: demonstrate planning body posture.	• Marker pens • Charts
• Identify components of hive and their measurements	• Group discussion: prompt and cue trainees to identify the components.	• Marker pens • Charts
• Construct the hive components	• Demonstration: demonstrate the construction of hive components.	• Drawings and photos
• Cut the lid material as per the standard specifications	• Explanation: give direct instructions to trainees on how to cut the lid material.	• Marker pens • Charts
• Construct the Queen excluder as per specification	• Demonstration: lead trainees to watch a video of procedure of construction of the queen excluder.	• Laptop • Projector
• Assembly of various hive components.	• Demonstration: lead trainees to watch a video of assembly of components.	• Laptop • Projector
Duration: 30 hours		

1.2.3.3 Information Sheet

Identification of materials and equipment of construction of a Langstroth hive

Materials, tools and equipment that should be assembled for construction of Langstroth hive are same as those explain in Chapter one (1) Learning Outcome one (1) under sub-topic Materials and Equipment for Construction of Bee Hives

Assemble materials and equipment for construction of Langstroth hive

For the tools and equipment used in construction of Langstroth hive, refer to Unit of Learning one (1) - Construct Bee Hive and Bee Equipment, Learning Outcome one (1) - Prepare to Construct Bee Hive; under sub-topic-Materials and Equipment for Construction of Bee Hive.

Construction of the Langstroth hive require the following materials

- Waterproof wood glue
- Waterproof plywood
- Galvanized nails
- Well-seasoned planed timber of 2cm thickness.

Procedure of seasoning timber

Seasoning of timber is the process by which moisture content in the timber is reduced to the required level as described in Chapter one (1) - Learning Outcome two (2) on constructing KTBH.

Procedure of planing timber to the recommended thickness and cutting into size

Planing is the process of making wood surfaces flat and smooth to create an even thickness throughout the wood as well attain a fine finish as described in Chapter one (1) Learning Outcome two (2) on constructing KTBH.

Components of a Langstroth hive

Langstroth hive is made up of various components which serves different purposes as discussed in Chapter 1 - Learning Outcome 1.

Construction of different Langstroth hive components

- A langstroth hive is made up of the following parts;
  - Outer cover
  - Inner cover
  - Super/honey chamber
  - Queen excluder
  - Brood box and
  - Bottom board.
- Wood for Langstroth bee hive construction should be planed properly to a thickness of 2cm.
- A caliper can be used to measure thickness of the wood.
- Well planed wood is easy to work with and give a fine finish of the bee hive.
- Wood should be cut accurately as per the dimensions of each Langstroth part.
- Cutting can either be done mechanically by use of wood cutter machine or manually by use of wood saw. All the necessary precautions should be taken to avoid injury during the operation.

Langstroth components are constructed as follows;

Hive cover

- The dimension of the frame of the hive cover should be 57cm length x 50cm x 4cm width and a thickness 2cm.
- The frame is then fitted with plywood top measuring 57cm by 50cm.
- The top of the cover is fitted with iron sheet preferably of gauge 32.
- This ensures the hive is protected from rain.

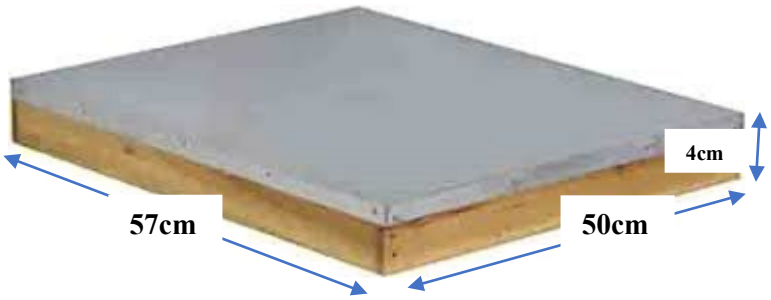

Figure 37: Langstroth top lid dimension

Inner cover

- Plywood cut to size 48cm by 48.5cm.
- Inner cover its optional when constructing bee hives.
- To construct inner cover, cut a flat piece of plywood measuring 48cm x 48.5cm.
- Make a small hole in the middle of the inner cover to allow bees access on top of the hive.

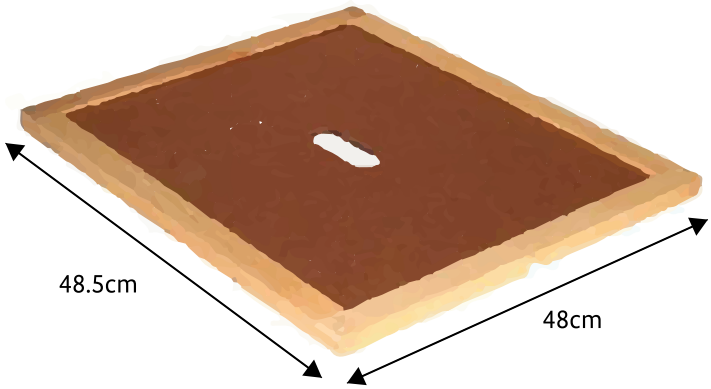

Figure 38: Langstroth inner cover dimension

Honey super

- Measure and cut 2 pieces measuring 42.5cm by 14cm wood from a well planed timber of 2cm thickness.
- Make a rebate of 2cm in depth and 1cm in length as shown in figure below
- Measure and cut 2 pieces of measuring 50.5cm by 14cm wood from a well planed timber of 2cm thickness.
- Make a rebate of 2cm in depth and 1cm in length as shown in figure below.
- Combine the four pieces using screws/nails to make a super chamber as shown in the figure below.

The supers should be fitted with frame spacers to accommodate 11 frames.

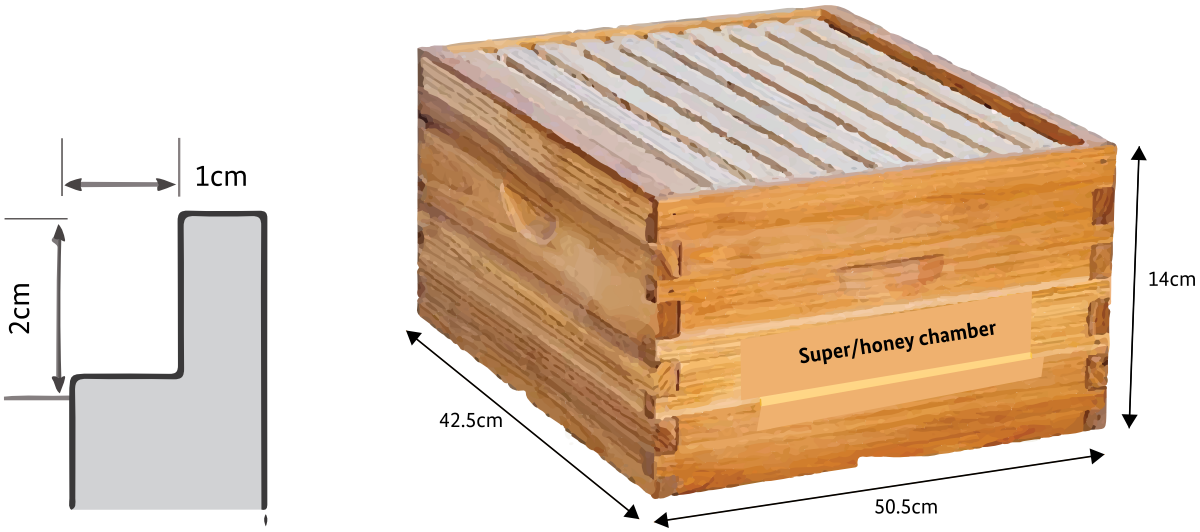

Figure 39: Super/Honey chamber

Queen excluder

- A coffee tray wire (or plastic mesh) is used to construct queen excluders.
- Using a metal shear, cut coffee tray wire to size 42cm x 50cm.
- Prepare a frame to fit the coffee tray wire on the edges.
- The frame dimensions are 2.5cm width and 0.2cm thickness.

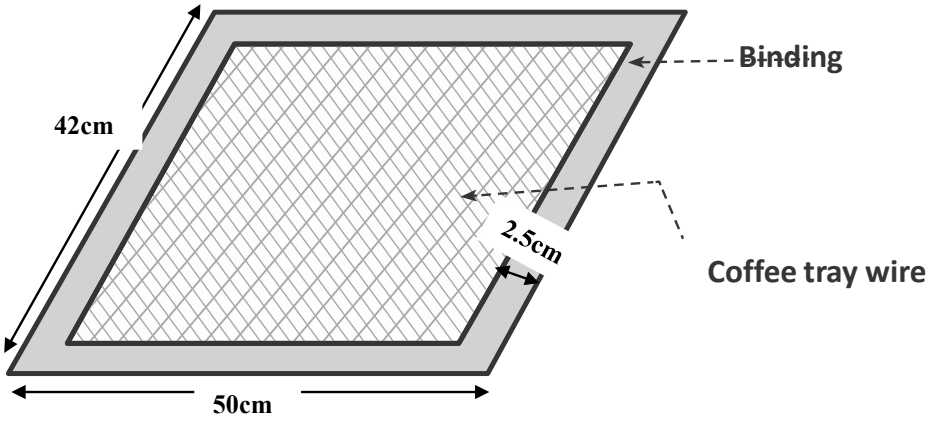

Figure 40: Langstroth queen excluder construction plan

Brood box

- The dimensions of a brood box is 42.5cm (L) x 50.5 cm (W) x 28cm (H).
- The brood box is fitted with a bottom board which leave 1cm gap from bottom line.
- The brood box has a top rebate inside on the sides of 42.5cm.
- The rebate size is 2cm in depth and 1cm in length.
- Frame spacers helps accommodate frames.

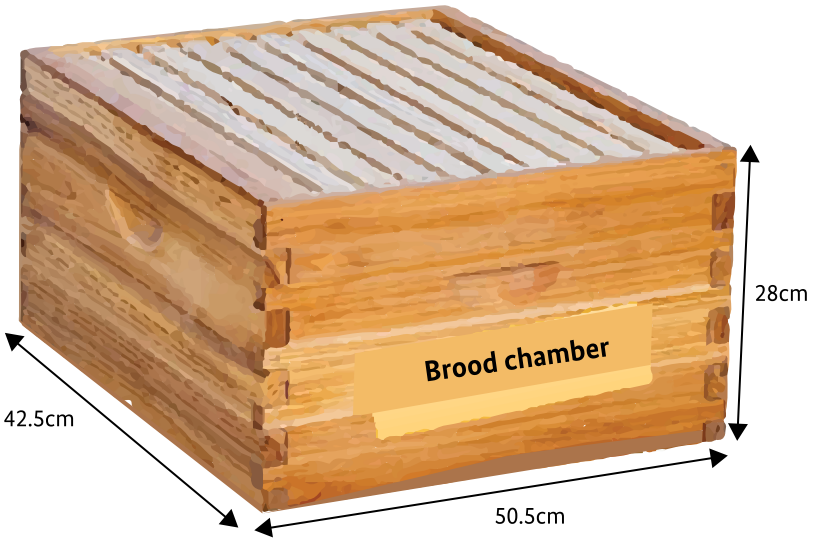

Figure 41. Brood box

Frames: The frame dimensions is as shown in the Figure 42.

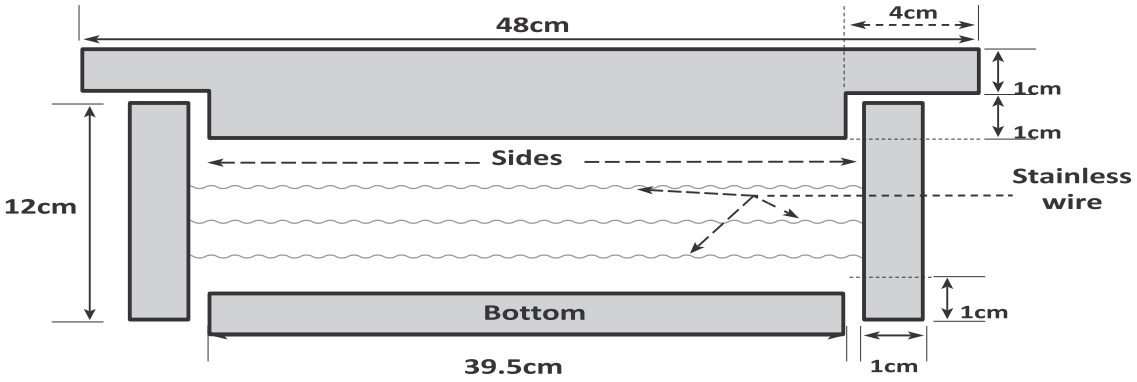

Figure 42: Frame construction plan

- The frames are fitted with stainless steel wire.
- For supers it should be fitted with 2 stainless wires of gauge 0.47mm.
- For brooder frame is fitted with 3 stainless wires of gauge 0.47mm.

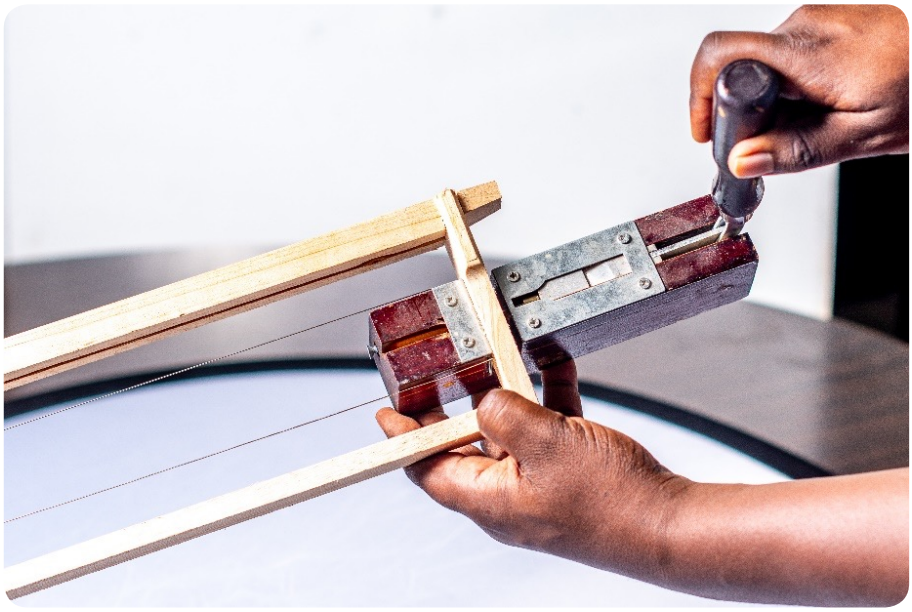

Figure 43: Making holes for wiring the frame

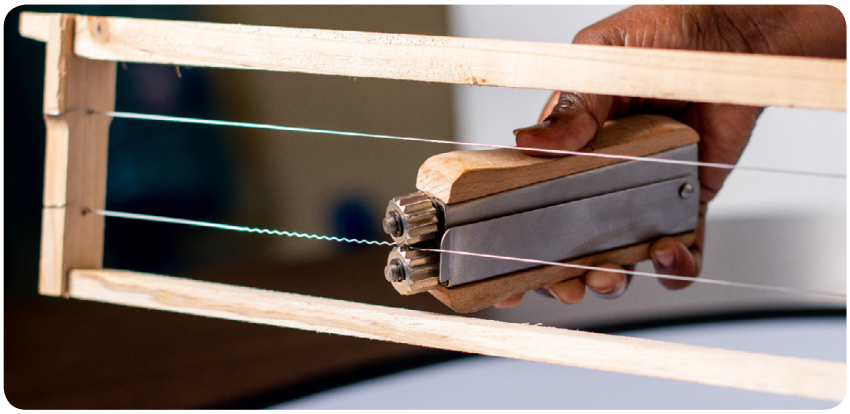

Figure 44: Tightening of the frame's wires

Wax foundation sheet:

- Super frame is fitted with comb foundation sheet.
- Brood frame is fitted at least ½ of the comb foundation sheet.

Note:
The wire used in a frame should be rust-resistant.

Construction of bottom board

The bottom board should have a width of 42.5cm and a length of 66cm. the height should be 4cm.

1. **Cut the pieces:**
   - Cut two pieces of lumber measuring 66cm long.
   - The thickness of the timber should be 2cm.
   - The width of the timber should be 4cm.
   - Cut 1 piece of timber measuring 42.5cm length and 4cm width.
   - Cut another piece of the same dimension and make some holes for bees' entrance.
2. **Assemble the frame:**
   - Using wood glue and nails, assemble the two pieces of lumber into a rectangle frame, making sure the corners are square.
   - On the bottom side of the frame affix a cardboard/timber measuring 66cm by 42.5cm.
3. **Add the entrance reducer:**
   - Attach the entrance reducer piece to one end of the bottom board using wood glue and nails.

4. **Install the screening:**
    - Cut a piece of hardware cloth to fit the bottom board, then staple it to the bottom of the board to provide ventilation.
5. **Finish the board:**
    - Sand the edges and surfaces of the bottom board to remove any rough spots and splinters.
6. **Paint or varnish:**
    - Apply a coat of paint or varnish to protect the wood and extend its lifespan.

Note:
Always use food-grade materials for any parts that come into contact with the bees or honey.

Assembling Langstroth hive components

Assemble the hive components as follows;

- Place a bottom board on the bottom of the hive.
- On top of the bottom board place a brooder box fitted with frames.
- Place a queen excluder.
- Place one or several super chambers.
- On top of the super chamber place an inner cover.
- Place the top lid after placing the inner cover.

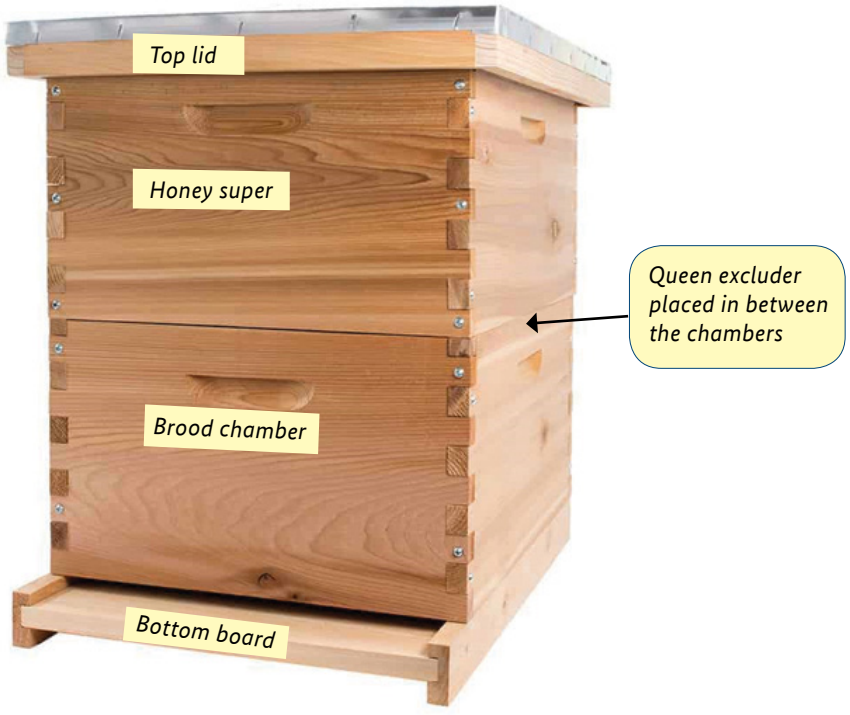

Figure 45: Assembled components of the Langstroth hive.

1.2.3.4 Learning Activities

1	2	3	4	5
Construct Langstroth hive as per specifications.	Put on personal protective equipment as per the occupational health and safety standards during Langstroth hive construction.	Assemble materials and equipment for construction of Langstroth hive as per the requirements.	Construct and evaluate quality of Langstroth hive as per standard specifications.	Store Langstroth hive constructed as per the workplace procedures.

1.2.3.5 Self-Assessment

1. What are the dimensions of the Langstroth hive cover?
2. Which are the six components of a Langstroth hive?
3. What is the measurement for an inner cover of a Langstroth hive?
4. The two procedures of planing timber into the right thickness are..... and .....
5. What do you understand by the term bee space?
6. What is the procedure of constructing super?
7. How do you construct queen excluder?
8. Which type of wire-material and what gauge is used in frame construction.

Notes:

1.2.3.6 Tools, Equipment, Supplies and Materials

• Timber	• Groove cutter machine
• Nails	• Paint
• Coffee tray wire	• Paint brush
• Stainless steel wire	• Artist brush
• Wood glue	• Carpenter's brace drill
• Carpenter's square	• Pliers
• Carpenter's saw	• Iron sheets (plain sheets)
• Wood plainer	• Wood screws

1.2.3.7 References

Gebiso, T. (2015). Adoption of modern bee hive in Arsi zone of Oromia Region: Determinants and financial benefits. Agricultural Sciences.

Gobena, W. E. (2017). Pre-scaling up of transitional locally made bee hive technology package in West Shoa Zone, Oromia Region, Ethiopia. Journal of Agricultural Economics, Extension and Rural Development.

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1.2.4 Learning Outcome 4:
Constructing Catcher Box

1.2.4.1 Introduction to the Learning Outcome

This learning outcome outlines the competencies required to identify type of catcher box, planing of timber, identifying components of catcher box and their measurements, drilling of the bee entrances and assembling of catcher box components

1.2.4.2 Performance Standard

- Type of catcher box identified and assembled as per the hive to be stocked.
- Materials and equipment for construction are assembled as per the requirements.
- The timber is seasoned as per work place procedures.
- The timber is planed to the recommended thickness.
- Components of the catcher box and their measurements are identified.
- The timber is cut/ split to size as per the component standard specification.
- The lid material is cut as per standard specification.
- Bee entrances/holes are drilled on one end as per work place procedures.
- Various components are assembled according to the workplace procedures.
- Hanging wires are fixed as per workplace procedure.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources required
• Identify types of catcher boxes	• Interactive lecture: facilitate a lecture on the identification of types of catcher boxes.	• Marker pens • Charts
• Assembly of materials and equipment for construction	• Interactive lecture: facilitate a lecture on the assembly of materials and equipment. • Group discussion: guide trainees' thinking to assembly materials and equipment.	• Marker pens • Charts
• Seasoning of timber - Methods of seasoning - Methods of conversion - Timber preservation	• Demonstration: lead trainees to watch a video on timber seasoning. • Group discussion: prompt and cue trainees to classify different methods of seasoning. • Interactive lecture: facilitate a lecture on advantages and disadvantages of different methods of seasoning. • Interactive lecture: facilitate a lecture on the methods of timber conversion.	• Laptop • Projector • Marker pens • Charts

	• Group discussion: trainees to explain the reasons, types of preservatives and methods of preservation.	
• Planing of timber	• Explanation: give direct instructions to trainees on how to plane timber to deferent sizes. • Demonstration: demonstrate the planing of timber to size. • Demonstration: demonstrate face side and face edge marks.	• Marker pens • Charts
• Identify components of catcher box and their measurements	• Group discussion: prompt and cue trainees to identify the components.	• Marker pens • Charts
• Cut/ split timber to size as per the component standard	• Demonstration: demonstrate cutting of timber into sizes.	• Marker pens • Charts
• Cut the lid material as per the standard specifications	• Explanation: give direct instructions to trainees on how to cut the lid material.	• Marker pens • Charts
• Drilling of bee entrances on one side.	• Explanation: give direct instruction on the drilling of bee entrances.	• Photos
• Assembly of various catcher box components.	• Demonstration: lead trainees to watch a video of assembly of components.	• Laptop • Projector
• Fixing of catcher box by hanging wires.	• Explanation: give direct instructions trainees to fix the catcher box hanging wire.	• Marker pens • Charts
Duration: 30 hours		

1.2.4.3 Information Sheet

Definition of terms

Catcher box: This is a structure made in form of bee hive but small in size containing five top bars or frames.

Catcher boxes, or catcher hives, are used to catch bees from other colonies that are swarming. The catcher boxes are convenient to use during bee removal, since its weight is lighter than that of a brood box and is easier to handle and carry. It is also more cost-effective to catch swarms with a box than to purchase a swarm. Bees that move into a catcher box by themselves tend to remain for a longer period of time than a swarm that has been forced into the box during a bee removal, which tend to abscond a few days later.

Types of catcher box identified and assembled as per the hive to be stocked

They are two types of catcher boxes:

KTBH catcher box

Figure 46: KTBH catcher box

For honeybee colony in a KTBH catcher box is transferred to a Kenya Top Bar Hive where the top bars in catcher box are replaced with top bars in a KTBH.

Langstroth catcher box

For honeybee colony in a Langstroth catcher box is transferred to a Langstroth hive where the frames in the catcher box are replaced with the frames in a Langstroth hive.

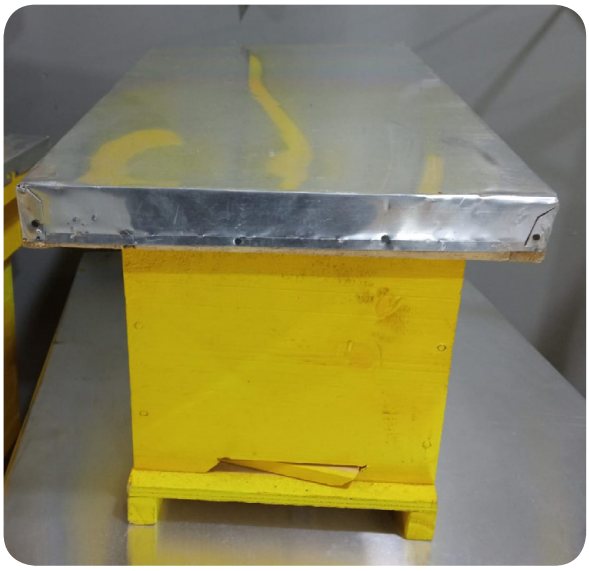


Figure 47. Langstroth catcher box

Figure 48. Set up Langstroth catcher box

Materials and equipment for construction of catcher box are assembled as per the requirements

There are various materials and equipment required for construction of catcher box. These materials and equipment are similar to that of construction of bee hives and are explained in details in Chapter one (1) - Learning outcome one on subtopic; materials and equipment for construction of bee hives.

Procedure for seasoning timber

Seasoning of timber is an important process in construction of catcher box. This is discussed in details in Chapter one (1) - Learning outcome two (2).

Procedure for planing timber to the recommended thickness

Planning of timber is discussed in depth in Chapter one (1) - Learning outcome two (2).

Components and dimensions of catcher box

a) Construction of KTBH catcher box

KTBH catcher box components include;

- Lid
- Hive body
- Top bars

The wood should be planed properly as earlier discussed, a well planed wood is easy to work with and fits well in a joinery work. Construction of hive components is as follows;

i) Constructing of top lid:

Materials needed:

- Thin planks of wood,
- Roofing materials (galvanised iron sheet)
- Paint.

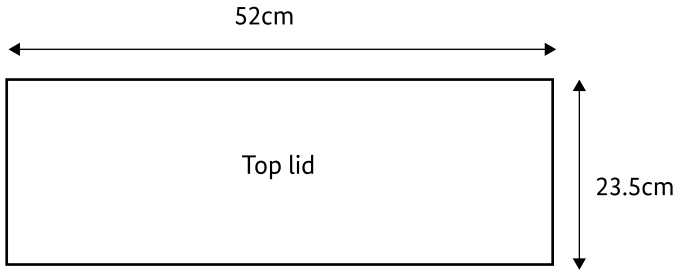
Tools and equipment:

- Handsaw/ wood cutter machine
- Screws
- Sandpaper
- Tape measure
- Hammer
- Nails

Steps:

1. Cut the wood:
    - Cut the planks of wood to the desired size as shown in the figure below.
    - The wood thickness should be 2cm.
    - Cut two pieces of wood with a length of 52cm and other 2 pieces with 23.5cm length.

2. Assemble the lid's frame:
    - Place the cut planks on top of each other (long planks attached to short plank as shown in figure below) and drill screws through the top plank and into the underlying planks.
    - Make sure the screws are evenly spaced and tightened securely to ensure the planks are attached firmly to each other.
    - Sand the edges and surface of the frame to remove any rough spots and to make it smooth.



3. Attach the roofing material:
    - Cut a piece of roofing material into 52cm by 23.5cm using metal shears.
    - Affix the sheet strip on the wood frame using 1 inch nails or screws.
    - A corrugated iron sheet is used to keep the hive water proof.
    - The roof is made wider and longer than the hive so that the hive is totally protected from the rain.

ii) Constructing hive body:

When constructing hive body, the following parts should be constructed separately then combined together. These parts include:

- Side A
- Bottom board
- Side B
- Front side
- Back side.

The parts should be measured accurately as per the indicated dimensions. The wood should be planed to a thickness of 2cm, use a clipper to measure the wood thickness.

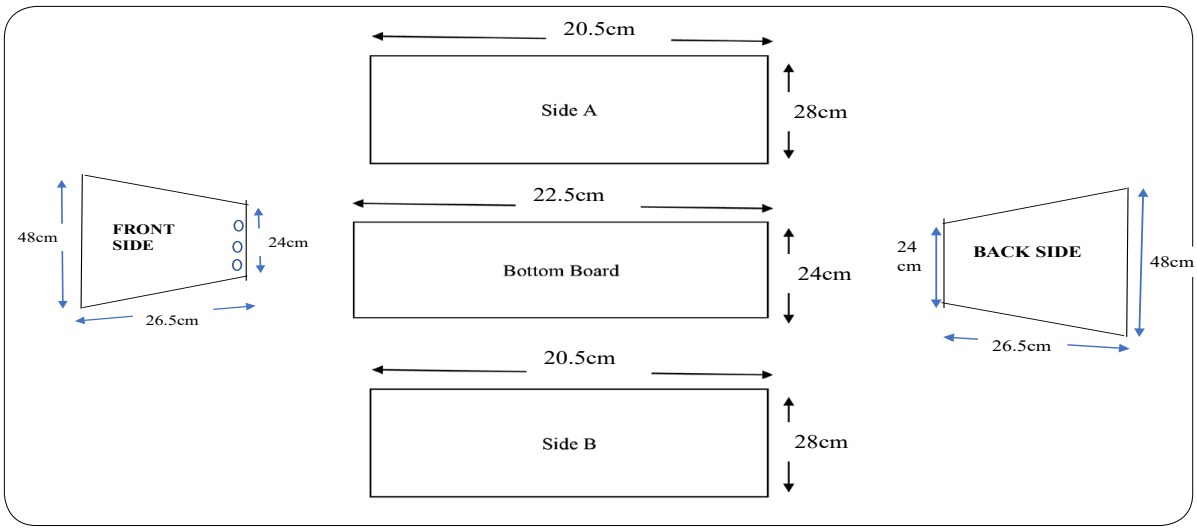


Figure 49: Catcher box hive body construction plan

Constructing parts of a hive body

Materials needed:

- Thin planks of wood
- Roofing materials (galvanised iron sheet)
- Paint

Tools and equipment:

- Handsaw/ wood cutter machine
- Screws
- Sandpaper
- Tape measure
- Hammer
- Nails

Steps

Side A and B

- Cut 2 pieces of planed wood measuring 20.5 cm by 28cm.
- The wood thickness should be 2cm as achieved during planing.

Bottom board

- Cut a piece of planed wood measuring 24cm by 22.5cm.

Front side and Backside

- The V-shaped end panels (Backside and front side) should measure 48cm on the longer side and 24cm on the shorter side.
- The length between the longer and the shorter side should be 26.5cm.
- On the bottom side of the front side part drill holes of 1cm diameter using a drill.

Joining the parts

- Glue together the V-shaped end panels (front and back side) to the long sides (side A and B) and then affix them using deck screws or nails. Use a total of six screws on each end panel. The top edges of the end panels and side boards should be flush with each other.
- The front-end piece of the hive should be nailed 2cm back into the hive, leaving a small lip at the front to be used as landing bay for the bees.
- Turn the hive body upside down and staple the hardware cloth to cover the opening that runs along the entire length of the hive body.
- Affix the bottom board on the bottom side of the hive.

Note:

Painting the exposed exterior wood of the hive body with a good quality outdoor paint (latex or oil) greatly extends the life of your woodenware. Painting is also used for ease of identification of the hives. The paint should be light coloured such as white yellow, etc.

Constructing top bars

Procedure for construction of top bars for KTBH catcher box is similar to that of a KTBH hive. KTBH catcher box requires contraction of 5 top bars. On how to construct top bars please refer to KTBH top bars construction.

b) Construction of Langstroth catcher box

Components of Langstroth catcher box include;

- Lid
- Hive body
- Frames
- Bottom board.

The difference between the catcher box and the main hive is the length, catcher box is relatively smaller and can only accommodate five (5) frames only. Langstroth catcher box is single layered and does not have queen excluder.

Timber for construction: The wood should be planed properly to a thickness of 2cm as earlier discussed, a well planed wood is easy to work with and fits well in a joinery work. Construction of hive components is as follows;

Langstroth catcher box components are constructed as follows;

Hive cover:

- The dimension of the frame of the hive cover should be 45cm length x 24.5cm
- Width 5cm height and a thickness 2cm.
- The frame is then fitted with plywood top measuring 45cm by 24.5cm.

- The top of the cover is fitted with iron sheet preferably of gauge 32.
- This ensures the hive is protected from rain.

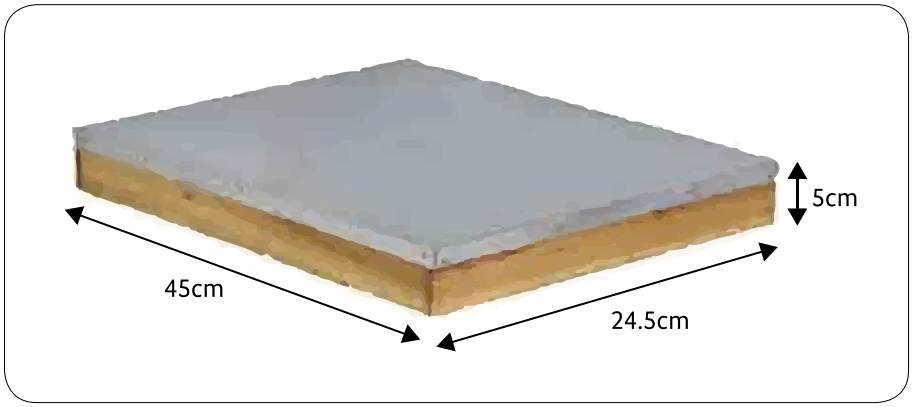


Figure 50: Dimension of a top lid (Langstroth catcher box)

Inner cover:

- To construct inner cover, cut a flat piece of plywood measuring 40.5cm x 21.5cm. Make a small hole in the middle of the inner cover to allow bees access on top of the hive.

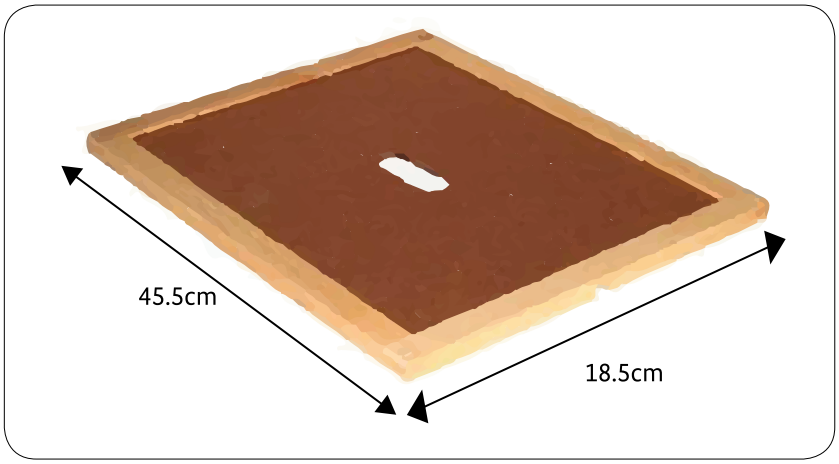


Figure 51: Dimensions of the inner cover of a Langstroth hive

Construction of hive body (brood box):

- Measure and cut well planed timber as per the diagrams below. In each diagram cut 2 pieces.
- Using rebate machete in the inner side of the pieces. The rebate size is 2cm in depth and 1cm in length.
- Join the cut pieces using wood glue and screws/nails.

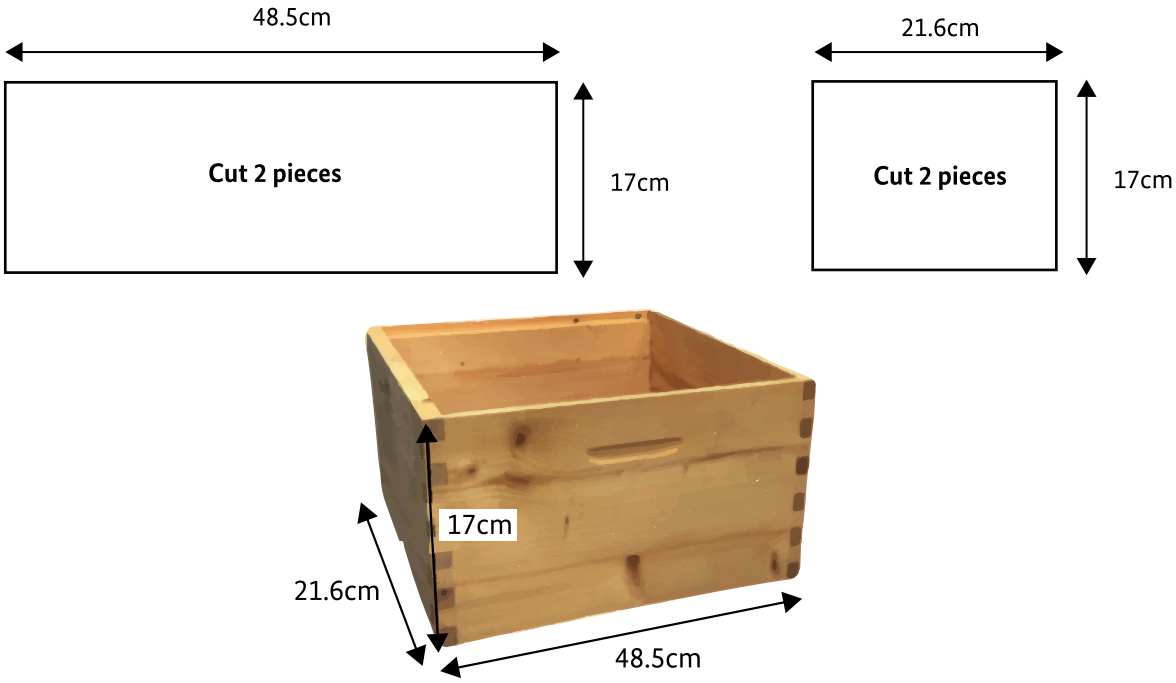


Figure 52: Dimensions of a Langstroth catcher box

Frame construction

Frames in catcher box and the main hive are similar. In constructing frames refer to Unit of learning 1, Learning outcome 3.

1.2.4.4 Learning Activities

1	2	3	4	5
Construct catcher box as per specification.	Use PPEs as per the occupational health and safety standards during catcher box construction.	Assemble materials and equipment for construction of catcher box as per the requirements.	Construct and evaluate quality of catcher box as per standard specifications.	Store catcher box constructed as per the workplace procedures.

1.2.4.5 Self-Assessment

1. What are the two types of catcher boxes used in beekeeping?
2. What are the three uses of catcher boxes?
3. What are the main parts of a KTBH catcher box?
4. What are materials required in preparation of construction of KBH catcher box lid
5. What is the dimension of bottom board, front side (at the hive's entrance) and the long side of the KTBH catcher box?
6. Which are the components of a Langstroth catcher box
7. What is the dimension of a rebate in the construction of a hive's body. 2cm in depth and 1cm in length?
8. What is the dimension (Length, width and height) of a Langstroth's catcher box's body?

Notes:

1.2.4.6 Tools, Equipment, Supplies and Materials

• Timber	• Wood planer
• Nails	• Groove cutter machine
• Coffee tray wire	• Paint
• Stainless steel wire	• Paint brush
• Wood glue	• Artist brush
• Carpenter's square	• Carpenter's brace drill
• Carpenter's saw	• Iron sheets (plain sheets)
• Pliers	• Wood screw.

1.2.4.7 References

Kiros, W., & Tsegay, T. (2017). Honey-bee productions practices and hive technology preferences in Jimma and Illubabor Zone of Oromiya Regional State, Ethiopia. Agriculture and Environment.

Monga, K., & Manocha, A. (2011). Adoption and constraints of beekeeping in District Panchkula (Haryana), India. Livestock Research for Rural Development.

Mujuni, A., Natukunda, K., & Kugonza, D. R. (2012). Factors affecting the adoption of beekeeping and associated technologies in Bushenyi District, Western Uganda. Livestock Research for Rural Development.

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1.2.5 Learning Outcome 5:
Constructing Observation Hive

1.2.5.1 Introduction to the Learning Outcome

This learning outcome outlines the competencies required to identify observation hive, identify and assemble materials for construction of observation hive, identifying components of observation hive and their measurements and assembling of components of observation hive.

1.2.5.2 Performance Standard

- Observation hive is identified as per the workplace procedures.
- Materials and equipment for construction are identified and assembled as per the requirements.
- The timber is seasoned as per work place procedures.
- The timber is planed to the recommended thickness.
- Components of the observation hive and their measurements are identified.
- The timber and glass are cut/ split to size as per the component standard specification.
- The lid material is cut as per standard specification.
- Bee entrances/holes are drilled on one end.
- Various components are assembled according to the work place procedures.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources required
• Identify observation bee hive	• Collaborative thinking: lead trainees to brainstorm in the identification of observation hive.	• Marker pens • Charts
• Assembly of materials and equipment for construction.	• Interactive lecture: facilitate a lecture on the assembly of materials and equipment. • Group discussion: prompt and cue trainees to assembly materials and equipment.	• Marker pens • Charts
• Seasoning of timber. - Methods of seasoning. - Methods of conversion. - Timber preservation.	• Demonstration: lead trainees to watch a video of procedure of timber seasoning. • Group discussion: prompt and cue trainees to classify different methods of seasoning. • Interactive lecture: facilitate a lecture on advantages and disadvantages of different methods of seasoning.	• Laptop • Projector • Marker pens • Charts

	• Interactive lecture: facilitate a lecture on the methods of timber conversion. • Group discussion: guide trainees' thinking to explain the reasons, types of preservatives and methods of preservation.	
• Planing of timber	• Explanation: give direct instruction: trainees to plane timber to size. • Demonstration: demonstrate the planing of timber to size. • Demonstration: demonstrate face side and face edge marks.	• Marker pens • Charts
• Identify components of observation hive and their measurements	• Group discussion: prompt and cue trainees to identify the components.	• Marker pens • Charts
• Cut/ split timber/ glass to size as per the component standard specification	• Demonstration: demonstrate the cutting of timber/glass to size.	• Marker pens • Charts
• Cut the lid material as per the standard specifications	• Demonstration: demonstrate on how to cut the lid material.	• Marker pens • Charts
• Drilling of bee entrances on one side.	• Explanation: give direct instruction on the drilling of bee entrances.	• Photos
• Assembly of various observation hive components.	• Demonstration: lead trainees to watch a video of assembly of components. • Explanation: give direct instructions on the assembly of observation hive.	• Laptop • Projector
Duration: 30 hours		

1.2.5.3 Information Sheet

Identification and assembling of materials and equipment for construction of the observation hive

Materials and equipment for constructing an observation hive are the same as those used for constructing the hives that have been discussed earlier in Chapter one (1) - Learning outcome two (2), but in addition, a clear glass is used to allow seeing the activities of the bees while in the observation hive.

Procedure for seasoning timber

Seasoning of timber is an important process in construction of observation hive. This is discussed in details in Chapter one (1) - Learning outcome two (2).

Procedure for planing timber to the recommended thickness

Planning of timber is discussed in depth in Chapter one (1) - Learning outcome two (2).

Components of the observation hive

An observation hive is a type of bee hive that allows the observer to see the inside of the colony without disturbing the bees. The colony is observed through the glass or acrylic panels, and monitor the growth and activity of the colony.

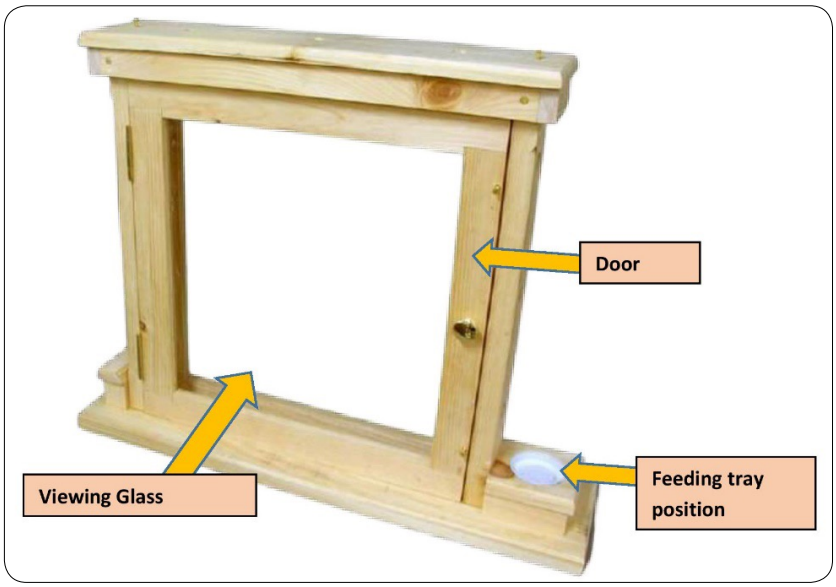


Figure 53: Observation hive

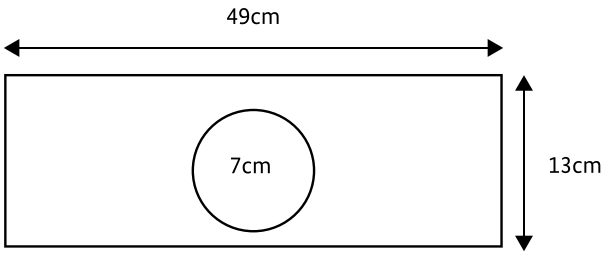
Construction and assembling of different observation hive components

To construct an observation hive, you will need the following materials, tools and equipment;

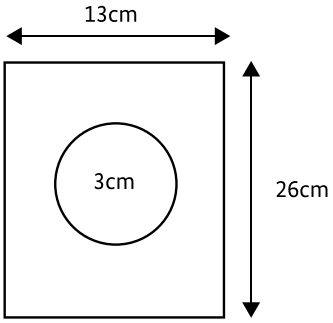
- A clear glass or acrylic box
- A bottom board
- Wooden frames with foundation
- A top cover
- A feeder
- Frames
- Screws and glue
- Wooden strip
- Glass clips

Steps:

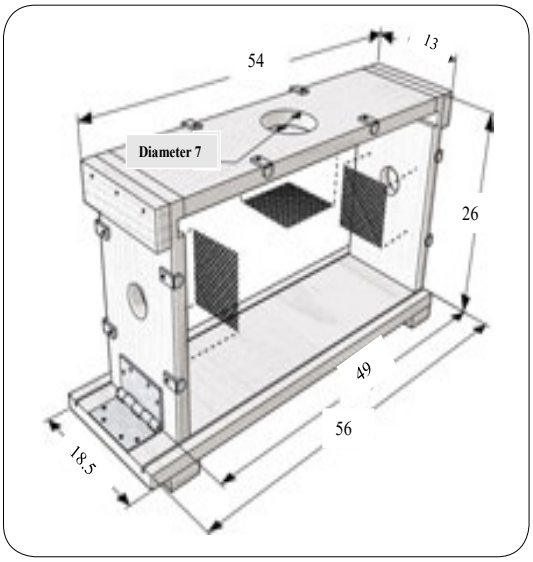
- Cut a well planed timber measuring 49cm x 13cm.
- In the middle of the timber make a hole of 7cm diameter. This will form the lid of the hive.



- Cut 2 pieces of timber measuring 13cm by 26cm.
- In the middle of the wood make two holes of 3cm each.
- This is the sides (width wise of the hive).
- On one piece of timber cover the whole with a hardware cloth.



- On top of the sideboards (length wise) affix a piece of timber of 13cm by 2cm.
- This will form the handles of the hive
- Cut a bottom board measuring 56cm by 18.5cm.
- Take one of the side board (without hardware clothing) and connect it with a bottom board using a door hinge at 7cm from left side of the bottom board and placed at the middle of the bottom board
- Affix the other side-board on the other side of bottom board at 0cm mark.
- Join the top lid on top of the structure. The lid should be joined on both sideboards to form a structure as shown below.



Source: Felix Freudzon

Figure 54: Observation hive design

- Cut two pieces of glass or acrylic sheets to size (26cm x 50cm). These will be the sides panels for the purpose of observation of the bee colony.
- Fix the cut pieces of glass on both sides of the hive using glass clippers.
- Cut the wooden strips to size (2.5 x 0.6 x 51cm). These will be used to reinforce the corners of the glass or acrylic panels. Use screws and glue to secure the corners of the structure.
- Place the frames inside the box (on frames' construction please refer on Langstroth hive construction). The frames should be centered and spaced evenly apart, with enough room for the bees to move between them.
- Fill the frames with foundation or leave them foundationless, as desired.
- On one side panel (without hardware clothing) install a feeder.

1.2.5.4 Learning Activities

1. Construct observation hive.
2. Use PPEs as per specification and as per the occupational health and safety standards during observation hive construction.
3. Assemble materials and equipment for construction of observation hive as per the requirements.
4. Construct and evaluate quality of observation hive as per standard specifications.
5. Store observation hive constructed as per the workplace procedures.
6. Manage and dispose waste from observation hive construction appropriately as per NEMA and workplace procedures.

1.2.5.5 Self-Assessment

1. What is an observation hive?
2. State the places where an observation hive can be used.
3. List the materials, tools and equipment required for construction of an observation hive.
4. Outline the steps of constructing an observation hive

Notes:

1.2.5.6 Tools, Equipment, Supplies and Materials

• Timber • Nails • Coffee tray wire • Stainless steel wire • Wood glue • Carpenter's square • Carpenter's saw • Pliers	• Wood planer • Groove cutter machine • Paint • Paint brush • Artist brush • Carpenter's brace drill • Iron sheets (plain sheets) • Wood screw.

1.2.5.7 References

Gebiso, T. (2015). Adoption of modern bee hive in Arsi zone of Oromia Region: Determinants and financial benefits. Agricultural Sciences.

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1.2.6 Learning Outcome 6:

Post-construction of Hives and Catcher Box

1.2.6.1 Introduction to the Learning Outcome

In this learning outcome you will learn competencies for post construction practices for bee hives and equipment. It involves procedures for baiting hives and catcher boxes, storage of hives and catcher box, and waste management and disposal practices at the apiary.

1.2.6.2 Performance Standard

- Hives and catcher boxes are baited as per workplace procedures.
- Hives, catcher box and observation hives are stored as per the workplace procedures.
- Waste is managed and disposed appropriately as per NEMA and workplace procedures.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources required
• Identify observation bee hive	• Collaborative thinking: lead trainees to brainstorm in the identification of observation hive.	• Marker pens • Charts
• Baiting of hive and catcher boxes. • Types of baits. • Procedure of baiting.	• Collaborative thinking: lead trainees to brainstorm in defining various related terms. • Group discussion: prompt and cue trainees to identify types of baits. • Interactive lecture: facilitate a lecture on the procedure of baiting	• Marker pens • Charts
• Waste management and disposal. • Methods of waste disposal. • NEMA requirement in waste disposal.	• Demonstration: lead trainees to watch a video on various methods of waste disposal. • Interactive lecture: facilitate a lecture on the NEMA requirements of waste disposal. • Survey: lead trainees on a field trip to a dumping site.	• Laptop • Projector • Marker pens • Charts
Duration: 15 hours		

1.2.6.3 Information Sheet

Definition of terms

- **Bait:** the material applied on Top Bars or Frames of the bee hives to attract bees.
- **Bait hive:** an empty hive that is set up to attract a swarm during the swarming season.
- **Baiting:** the process of attracting a swarm of bees to a trap using an attractant.
- **Beeswax:** the main structure of the comb made of secretions by worker bees.
- **Burr combs:** honeycombs build in other places of the hive other than the frames.
- **Catcher box:** a box, or container used to catch a swarm of bees to be transferred to the hive later.
- **Essential oils:** natural oil having the scent of the plant/source where it was extracted from lemongrass oil, lavender oil.
- **Observation hive:** a hive with most of its structure made of transparent material such as glass to allow one to view the progress of the bee colony.

Types of baits/ materials for baiting

Hives need to be baited to ensure that the bees occupy them, that is, attractants applied on them to attract bees. The following are some baits or baiting materials that can be used.

1. **Beeswax** - Bees will be attracted to the scent of bees' wax. It is the best bait to use because it retains most of its characteristics for a long time.
2. **Propolis** - Propolis also releases a scent similar to beeswax which attracts bees.
3. **Essential oils from some specific herbs** - Essential oils such as thyme, spearmint, lavender and lemon grass oil can be used as bait to attract bees. The scent of lemon grass is similar to pheromones produced by worker bees. Bees will be attracted to scent of lemon grass oil when rubbed on the inside of the bait hive. Lemongrass oil is also a good repellant for certain insects such as wasps that may attack bees.

Procedure/methods for baiting

1. **Determine the swarming season in your local area**

   Bees swarm for many reasons. The swarming season is mainly determined by availability of enough pollen and nectar to sustain a new colony.

2. **Prepare your bait hive**

   Identify bee hive to be used as bait hive or use catcher box instead. Also, ensure that the hive is properly cleaned and disinfected especially if you are using old frames.

3. **Prepare the bait material**

   For instance, if you are using beeswax then soften the beeswax by placing it in warm water or placing it in the sun or near a fire place.

4. **Apply the bait material**

   Rub the softened beeswax on the top bar and inside frames and entry point of the bait hive/catcher box. If your beeswax is completely melted, apply it by rubbing using a piece of cloth

5. **Position baited hive**

   Place the baited hive on a high place such as tree or rooftop along the swarming route. Use hanging wires to secure the bait hive in position. Protect the bait hive from ants and other insects. Positioning the hive in an area with blooming flowers increases the chances of the hive being occupied.

6. **Wait for bees to occupy the bait hive**

   As you wait for the bait hive to be occupied, monitor any activity around the hive. Check that no insects have occupied the bait hive. Not all baited hives will be colonized. The goal is to make your bait hive more attractive than the natural alternative to the scout bees.

7. **Transfer the bees to the main hive in the apiary**

   Immediately the bait hive is occupied, transfer the bees to the main hive. This is because bees begin to orient themselves on the position of the hive and it will be difficult to transfer them the longer they stay. Where the bait hive also doubles as the main hive, simply move it to the apiary location after it has been occupied. Although swarming bees are mostly calm, remember to put on bees' suit.

Storage of hives and bee equipment

Fabricated bee hives and equipment should be stored well before dispatching them to where they are intended. Storage facilities should be suitable for the fabricated equipment and tools.

The following items are to be considered for storage facilities:

- Flooring

  A reinforced concrete floor, incorporating suitable drains to remove excess curing water (if this method of curing is to be utilized). The floor should be designed to withstand the local loads applied when jacking and moving the size of vessel to be constructed.

- Building framework

  The building framework should ideally be designed to allow for the use of stacks or rails to support the constructed hives and accessories.

- Building heights

  The height of the eaves of the building should be sufficient for ease of working on the sizes of equipment constructed. This may vary from the ferro-cement workshop to the fitting out workshop if composite construction is envisaged. Also, free air ventilation in hot climates must be allowed for, while being able to nullify the effects of wind.

- Material storage

Suitable covered storage for materials should be allowed for, including the proper racking as well as following manufacturers' recommendations regarding storage and treatment of materials to be held in stock.

- Access

  Adequate access should be provided for receiving materials and for allowing free movement of personnel around the working areas (also for fire and safety precautions).

- Space for machinery and equipment

  Due consideration should be paid to providing adequate space for machinery and equipment required where a variety of different materials may be considered for use including perhaps timber, steel, metal sheets, nails, hand tools among others.

Management and disposal of waste

Waste refers to unwanted or unusable material that is produced through the activity of humans and can have different forms. Waste can be liquid, solid, or gas with each having its disposal method and way of managing the waste.

Waste management entails all the activities that are required to manage waste so as to reduce the dangerous effects of such waste on the environment and human health.

The key areas of consideration in waste management include;

- **Waste generation**: involves all the activities that leads to generation of materials that are no longer usable or are of no economic value. Different types of waste is generated during bee hive and equipment processes.
- **Onsite handling, storage and processing:** after waste generation, there are activities to facilitate easier collection of the waste, such as the use of dust bins and putting them at places where most waste is being generated.
- **Collection of waste:** similar form/type of waste should be collected in a common place such as in waste collection bins for ease of handling.
- **Waste transfer and transport:** waste transport means should be properly planned. Some form of wastes requires special types of equipment or vehicle to handle and transport them. During transport, all efforts should be made to avoid dropping waste in unwanted areas, covered vehicles are most preferred for use.

Methods waste disposal

Waste disposal is the final step in waste management and involves all the activities that are needed for systematic disposal.

Waste management can be arranged in order of preference as follows;

- Prevention of waste generation,
- Minimization of waste being generated
- Recycling and reuse of materials that otherwise would be considered as waste.
- Biological treatment of the waste.
- Incineration
- Landfill disposal.

1. **Waste prevention:** The ideal waste management alternative is to prevent waste generation in the first place. Hence, waste prevention is a basic goal of all the waste management strategies.
2. **Waste minimization:** If waste cannot be prevented from being generated waste minimization strategies can be implemented to reduce or minimize generation.
3. **Recycling and Reuse**: Recycling refers to recovery of useful materials such as glass, paper, plastics, wood and metals from the waste stream so they may be incorporated into the fabrication of new products.

   Recycling allows waste materials to be recovered and utilized as valuable resource materials. Recycling of wastes directly conserves natural resources, reduces energy consumption and emissions generated.
4. **Composting:** This is allowing microbial bacteria to work on the organic waste by turning it into part of soil composition. Example; Dead bees' residues, and wood chips can be put into the farm land/compost pit to act as compost manure.
5. **Burning /incineration:** This is subjecting waste material into high temperatures to change its state and become un-harmful to the environment. The high temperatures of 950-1100°C in a properly designed incinerator reduce the waste to sterile ash.

1.2.6.4 Learning Activities

1

Store constructed bee hives and accessories as per the workplace procedures.

2

Manage and dispose waste from constructed bee hives and accessories appropriately as per NEMA and workplace procedures.

1.2.6.5 Self-Assessment

1. Define the term baiting.
2. List three types of baits.
3. What are the seven steps in baiting?
4. Why is it important to reinforce concrete floors?
5. Adequate access should be provided for receiving materials and for allowing free movement of personnel around the working areas. Is this statement ☐ True or ☐ False?
6. Which are the long-recognized hierarchy of waste management in order of preference?

Notes:

1.2.6.6 Tools, Equipment, Supplies and Materials

- Stores
- PPEs
- Wheelbarrows

1.2.6.7 References

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Republic of Uganda (2012). The National Bee Keeping Training and Extension Manual: Farm Income Enhancement and Forest Conservation Project, Apiculture Promotion Sub Component. Ministry of Agriculture, Animal Industry and Fisheries, Kampala.

1.3 Suggested Responses to Self-Assessment Questions

1.3.1 Learning Outcome 1

Preparing to Construct Bee Hives

1. Which are the two categories of bee hives used in beekeeping?
   - **Traditional bee hives**
   - **Improved bee hives**

2. Which among the listed four is the odd one out?
   A. Log hive
   B. Pot hive
   C. **Tree hive**
   D. Basket hive

3. Which are the two main types of modern hives?
   - **Langstroth hive**
   - **Top bar hive**

4. Which are the three main components of a Kenya Top Bar Hive?
   - **The hive body**
   - **The Lid**
   - **The Top Bars**

5. What are advantages of a Langstroth hive?
   - **It has frames that makes combs very strong especially when being transported.**
   - **Honey is extracted using the centrifugal honey extractor without destroying the combs, giving bees less time to fill the cells with honey.**
   - **The hive has space where new honey super can be easily added to control swarming and increase honey production.**
   - **By using a queen excluder between the brood chamber and super chamber, honey is separated completely from the broods, which leads to high quality honey production.**

6. List the materials, tools and equipment required for construction of bee hives and what are their function?
   - **Plain galvanized sheet**
   - **Timber**
   - **Hammer**
   - **Tape measure**

7. What are the four characteristics of timber suitable for hive construction?
   - **The timber must be durable and able to last for several years without replacement.**
   - **The wood must be suitable for carpentry- it must not split too easily and must not be so hard that wood working equipment is damaged.**
   - **The wood should be as free from knots as possible.**
   - **The wood must be properly seasoned, otherwise shrinkage and warping of the hive will occur.**

1.1.2 Learning Outcome 2:

Construct Kenya Top Bar Hives

1. What are the dimensions of the top lid when constructing KTBH?

   92cm x 4.5cm and **52cm x 4.5cm** or simply **92cm x 52cm**

2. List the parts for the construction of hive body of KTBH
   - **Two sides length wise,**
   - **Two sides width wise (front and backside) bottom board.**

3. What is the width and length of a standard top bar for KTBH?

   3.2cm W, 48cm L

4. At which bar is a queen excluder placed in the hive? **7th bar**

5. Describe the procedure of constructing a queen excluder.
   i. **Groove one top bar in the middle (length-wise).**
   ii. **Cut 3 pieces of wood from a well-planed timber of 2cm thickness. The wood should have length of 24cm and the other 2 pieces measuring 26.5cm. Each piece should be of width 2cm.**
   iii. **Join the cut wood to the top bar as shown below to form a queen excluder frame.**
   iv. **Nail a piece of coffee tray wire in the groove.**
   v. **Ensure that the queen excluder fits well in the hive body. The excluder can be removable or fixed.**
   vi. **Fix the excluder after the 9th bar from the hive entrance.**

6. Define timber seasoning.
   - **This is the removal of water from timber before it is used for any engineering purpose.**

7. List any three (3) reasons for seasoning timber for hive construction.
   - **To prevent the onset of stain fungi decay.**
   - **To decrease the weight of timber, hence lowering the cost of transport.**
   - **To increase the resistance power of the timber.**
   - **To make timber suitable for gluing.**
   - **To reduce the tendency of timber to crack, shrink and warp.**

8. Name the two categories of timber seasoning?
   - **Natural seasoning**
   - **Artificial seasoning**

9. What are the five various methods of artificial seasoning?
   - **Boiling**
   - **Chemical seasoning**
   - **Electrical seasoning**
   - **Kiln seasoning**
   - **Water seasoning.**

10. What is conversion of timber?
    - **This is the process by which timber is cut and sawn into suitable sections.**

11. What are the three objectives of preserving timber?
    - **To increase the life of timber structures.**
    - **To make the timber structures durable.**
    - **To protect the timber structures from the attack of destroying agencies such as fungi, insects, etc.**

1.1.3 Learning Outcome 3:

Construct Langstroth Hives

1. What are the dimensions of the Langstroth hive cover?

   57cm length x 50cm x 4cm width

2. Which are the six components of a Langstroth Hive?
   - **The lid**
   - **The honey super chamber**
   - **The queen excluder**
   - **The brood chamber/box**
   - **The floor board.**

3. What is the measurement for an inner cover of a Langstroth hive?

   48.5cm by 48cm

4. The two procedures of planing timber into the right thickness are **surface planing** and **thicknessing**.

5. What do you understand by the term 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.

6. What is the procedure of constructing super?

   - **Measure and cut 2 pieces of measuring 42.5cm by 14cm wood from a well planed timber of 2cm thickness. Make a rebate of 2cm in depth and 1cm in length.**
   - **Measure and cut 2 pieces of measuring 50.5cm by 14cm wood from a well planed timber of 2cm thickness. Make a rebate of 2cm in depth and 1cm in length.**
   - **Combine the four pieces using screws/nails to make a super.**

7. How do you construct queen excluder?

   A coffee tray wire (or plastic mesh) is used to construct queen excluders. Using a metal shear, cut coffee tray wire to size 42cm x 50cm. Prepare a frame to fit the coffee tray wire on the edges. The frame dimensions are 2.5cm width and 0.2cm thickness

8. Which type of wire-material and what gauge is used in frame construction.

   Stainless wire 0.477mm

1.1.4 Learning Outcome 4:

Construct Catcher Box

1. What are the two types of catcher boxes used in beekeeping?

   - **Kenya Top Bar Hive catcher box.**
   - **Langstroth catcher box.**

2. What are the three uses of catcher boxes?

   - **For catching a swarm of bees from the wild.**
   - **For colony division.**
   - **For relocating a swarm of bees from unwanted place to a desired and safe place where they cannot cause harm either to domesticated animals or human beings.**

3. What are the main parts of a KTBH catcher box?
   - **Lid**
   - **Hive body**
   - **Top bars**

4. What are materials required in preparation of construction of KBH catcher's box lid
   - **Thin planks of wood**
   - **Roofing materials (galvanized iron sheet)**
   - **Paint**

5. What is the dimension of bottom board, front side (at the hive's entrance) and the long side of the KTBH catcher box?
   - **Bottom board: 22.5cm by 24cm**
   - **Front side: 48cm (long side) 24cm (short side) and 26.5cm height**
   - **Long side: 20.5cm by 28cm**

6. Which are the components of a Langstroth catcher box
   - **Lid**
   - **Hive body**
   - **Frames**
   - **Bottom board**

7. What is the dimension of a rebate in the construction of a hive's body?
   - **2cm in depth**
   - **1cm in length**

8. What is the dimension (Length, width and height) of a Langstroth's catcher box's body?
   - **48.5cm L,**
   - **21.6cm W,**
   - **17cm H**

1.1.5 Learning Outcome 5:

Construct Observation Hive

1. What is an observation hive?

   An observation hive is a type of bee hive that allows the observer to see the inside of the colony without disturbing the bees.

2. List the places where an observation hive can be used.
   - **In classroom**
   - **During field days**
   - **In a research station, etc.**

3. List the materials, tools and equipment required for construction of an observation hive.
   - **A clear glass or acrylic box**
   - **A bottom board**
   - **Wooden frames with foundation**
   - **A top cover**
   - **A feeder**
   - **Frames**
   - **Screws and glue**
   - **Wooden strip**
   - **Glass clips**

4. Outline the steps of constructing an observation hive
   - **Cut a well planed timber measuring 49cm x 13cm. In the middle of the timber make a hole of 7cm diameter. This will form the lid of the hive**
   - **Cut 2 pieces of timber measuring 13cm by 26cm. In the middle of the wood make two holes of 3cm each. This is the sides (width wise of the hive). On one piece of timber cover the whole with a hardware cloth.**
   - **On top of the sideboards (length wise) affix a piece of timber of 13cm by 2cm. this will form the handles of the hive**
   - **Cut a bottom board measuring 56cm by 18.5cm.**
   - **Take one of the side board (without hardware clothing) and connect it with a bottom board using a door hinge at 7cm from left side of the bottom board and placed at the middle of the bottom board**
   - **Affix the other side-board on the other side of bottom board at 0cm mark.**
   - **Join the top lid on top of the structure. The lid should be joined on both sideboards to form a structure as shown below**
   - **Cut two pieces of glass or acrylic sheets to size (26cm x 50cm). These will be the sides panels for the purpose of observation of the bee colony.**
   - **Fix the cut pieces of glass on both sides of the hive using glass clippers**
   - **Cut the wooden strips to size (2.5 x 0.6 x 51cm). These will be used to reinforce the corners of the glass or acrylic panels. Use screws and glue to secure the corners of the structure**
   - **Place the frames inside the box (on frames' construction please refer on Langstroth hive construction). The frames should be centered and spaced evenly apart, with enough room for the bees to move between them.**
   - **Fill the frames with foundation or leave them foundationless, as desired.**
   - **On one side panel (without hardware clothing) install a feeder.**

1.1.6 Learning Outcome 6:

Post-Construction of Hives and Catcher Box

1. Define the term baiting.

   Baiting is the process of attracting a swarm of bees to a trap using an attractant.

2. List three types of baits.
   - **Bees wax**
   - **Propolis**
   - **Essential oils from some herbs.**

3. What are the seven steps in baiting?
   - **Determine the swarming season in your local area.**
   - **Prepare your bait hive.**
   - **Prepare the bait material.**
   - **Apply the bait material.**
   - **Position your baited hive.**
   - **Wait for bees to occupy the bait hive.**
   - **Transfer the bees to the main hive in the apiary.**

4. Why is it important to reinforce concrete floors?

   To ensure removal of excess curing water.

5. Adequate access should be provided for receiving materials and for allowing free movement of personnel around the working areas. **True.**

6. Which are the long-recognized hierarchy of waste management in order of preference?
   - **Prevention**
   - **Minimization**
   - **Recycling and use**
   - **Biological treatment**
   - **Incineration**
   - **Landfill disposal.**

2 Bee Equipment Accessories Fabrication

Unit Code:

AG/CU/APIHE/CR/02/4/A

Related Unit of Competency in Occupational Standards:

Fabricate Bee Equipment Accessories

2.1 Introduction to the Unit of Learning

This unit specifies the competencies required to fabricate bee keeping accessories, which include smoker, hive tool, bee brush, and feeder box. It involves preparing to fabricate and fabricating bee equipment accessories.

2.2 Summary of Learning Outcomes

In this unit of learning, there are five learning outcomes as listed below:

1. Prepare to fabricate a bee smoker.
2. Fabricate the smoker.
3. Fabricate a hive tool.
4. Construct bee brush.
5. Conduct post-construction activities on bee equipment.

2.2.1 Learning Outcome 1: Preparing to Fabricate a Bee Smoker

2.2.1.1 Introduction to the Learning Outcome

This learning outcome outlines the competencies required to identify and assemble materials and equipment for fabricating a smoker, to identify components of a smoker, to wear PPE as per occupational and safety procedures.

2.2.1.2 Performance Standard

- Materials and equipment for fabricating a smoker are identified and assembled as per the work place procedures.
- The components of a smoker (nozzle, smoker barrel, spring) identified as per the work place procedures.
- Personal protective equipment is worn as per the occupational health and safety procedures.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources required
• Identify materials and equipment used in smoker fabrication	• Demonstration: facilitate the showing of pictures tool, materials and equipment. • Group discussion: prompt and cue trainees to classify materials, tools and equipment and describe their use.	• Laptop • Projector • Photos of tools
• Identify the components of a smoker	• Asking questions: lead a question-and-answer session on the components of a smoker.	• Charts
• Identify the PPEs to be used in smoker fabrication.	• Group discussion: guide trainees' thinking to identify PPEs and their use. • Asking questions: facilitate a question and-answer session about the use of PPEs.	• Photos of PPEs
Duration: 15 hours		

2.2.1.3 Information Sheet

The smoker is an essential tool for any beekeeper. It is used in bee keeping to calm honey bees through generating smoke from smoldering various fuels.

Identification and assembling of materials and equipment for fabricating a smoker

The smoker is a sturdy container resistant to high temperature and therefore materials used in fabricating it should be of good quality.

The materials and equipment for fabricating a smoker include the following; *Grid, Coupling ring, Handle, Hinge, Hook, Air conducting tube, Bellow support, Galvanized strip, Vinyl or leather, and Bellows holding screw.*

Materials and tools

		
Hinges	*Timber*	*Metal Shear /Scissors: Used to cut the metal sheet into required sizes*

		
Hammer and nails	*Flat metal bar*	*Metals sheet: The most preferred sheet is galvanized zinc and aluminum or stainless steel of prefarably of 26mm gauge. This is usually higly healt resistant*
		
File for sharpening	*Wood planer- for smoothening timber*	*Zips and elastic material*
		
Tape measure	*Cotton material*	*Drilling machine*
		
Pliers	*Goose net*	*Coffee wire*
		
Leather/Rexene gloves	*Sewing machine*	*Tailoring scissors*

Tinsnip

Components of a smoker

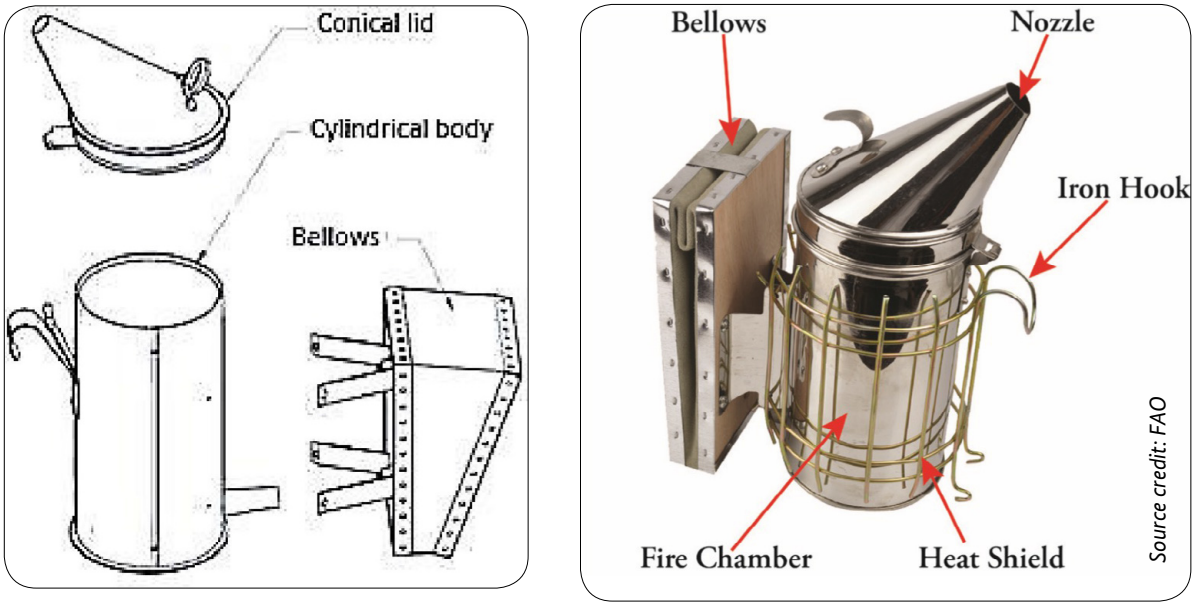

Figure 55: Components of a smoker

The components of a smoker include the following;

Conical lid: this allows the accumulation of the smoke flow through an outlet from its top and directs smoke where needed.

Combustion chamber (cylindrical body): this is a cylindrical can that holds smoldering fuel to generate the smoke. Inside the bottom of the chamber, ***a grill or grate*** provides air space under the fuel. It is the largest part of the smoker, where combustion is carried out to produce the smoke.

Bellow (leather, canvas, or rubber): is attached to the fire chamber's back. Squeezing the bellows pushes air into the fire chamber through ***air holes***. The fire is kept smoldering by moving air into the chamber, and smoke is forced out the nozzle.

Personal protective equipment in fabricating a bee smoker

Safety is important in any workshop to avoid any potential hazards that can cause injuries.

Wearing the right protective gear is one of the measures you can take to avoid exposing yourself to these hazards.

PPE (Personal Protective Equipment) specifically includes clothing worn or equipment used by workers that protects them against hazards in the workplace. It can include PPE like:

- Respiratory protective equipment (such as respirators or dust masks), which helps protect the respiratory system from harmful toxins and dust in the workshop.
- Hearing protection (such as earplugs or earmuffs) that will help to prevent hearing loss or impairment.
- Skin and hand protective equipment (including sunscreen, gloves and wristlets), which assists in preventing burns, cuts and electric shocks.
- General protective clothing, such as high-visibility vests, aprons, coveralls and well-fitting tops and pants.
- The right footwear (ideally non-slip, insulated with rubber and steel-capped footwear to prevent damaging impact on feet).
- Protective eyewear and headwear, including goggles, helmets and welding hoods.

Figure 56. Welding hood (left) and a helmet (right)

2.2.1.4 Learning Activities

1. Obtain and identify different parts of a smoker and how they operate.
2. Visit a workshop that constructs bee smokers and identify the type of PPEs in use in the workshop.
3. Identify any hazard that is likely to occur due to lack of any given PPE.

2.2.1.5 Self-Assessment

1. List any three materials used in fabricating a smoker.
2. The recommended gauge of the sheets used for fabricating the smoker is ....
3. Name the three main components of a smoker.
4. List any five parts of a smoker.
5. Name five (5) Personal Protective Equipment necessary during bee smoker fabrication.

Notes:

2.2.1.6 Tools, Equipment, Supplies and Materials

• Metal sheets • Timber • Nails • Spring, • Hammers • Cutter • Knife/ scissors	• Workbenches • Vices • Overalls • Goggle • Ear guards • Gloves

2.2.1.7 References

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Learning Outcome 2:

Fabricating the Smoker

2.2.2.1 Introduction to the Learning Outcome

This learning outcome outlines the competencies required make a nozzle, shape the barrel, make bellows, fix pump spring and leather material. It also involves how to assemble smoker components and fix handle, finish smoothening of sharp edges and evaluate quality of the smoker as per the standard specifications.

2.2.2.2 Performance Standard

- Measure, cut, shape and make the nozzle.
- Measure, cut and shape material into shape of the barrel.
- Close the bottom of the barrel and smoothen the edges.
- Measure and cut the material for the smoker pump (bellows).
- Fix the pump spring and leather/rexin material.
- Assemble the smoker components and fix the handle.
- Finish by smoothening all the sharp/rough edges.
- The quality of the smoker is evaluated as per the standard specifications.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources required
• Making of the nozzle: Measuring, cutting, shaping and joining.	• Demonstration: demonstrate the measuring, cutting, shaping and making the nozzle.	• Marker pens • Charts
• Making of the barrel: Measuring, cutting, shaping and joining.	• Explanation: give direct instructions trainees on how to measure, cut, shape and make the barrel.	• Laptop • Projector
• Closing of the bottom and smoothening the edges of barrel	• Explanation: give direct instruction trainees on how to close the bottom and smoothen edges.	• Marker pens • Charts
• Measure and cut the material for the smoker pump (bellows)	• Demonstration: demonstrate the measuring and cutting material for the smoker pump.	• Marker pens • Charts

• Fix the pump springand leather/ rexin material	• Explanation: give direct instructions trainees on how to fix pump spring and leather material.	• Marker pens • Charts
• Assemble the smoker components and fix the handle.	• Demonstration: lead trainees to watch a video of procedure of assembling the smoker components and fixing the handle.	• Laptop • Projector
• Finish by smoothening all the sharp/rough edges	• Explanation: give direct instructions trainees to finish off by smoothening sharp edges.	• Marker pens • Charts
• Evaluate the quality of the smoker as per the standard specifications	• Demonstration: lead trainees watch a video on how to check the quality of the smoker.	• Laptop • Projector
• **Duration:** 25 hours		

2.2.2.3 Information Sheet

The identification of materials and equipment for fabricating a smoker, identifying the components to fabricate and donning PPEs are necessary for before fabricating the bee smoker.

Assembling materials and equipment for fabricating a bee smoker

The materials and equipment for fabricating a bee smoker are assembled as indicated in Learning Outcome 1.

Measuring, cutting, shaping and making the nozzle

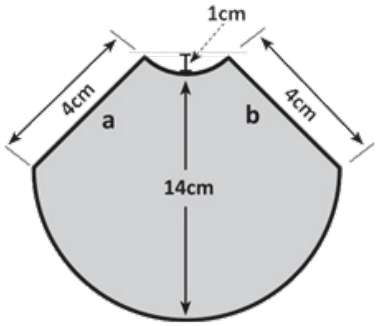
The nozzle comprises of the conical lid and the coupling ring. The required resources include;

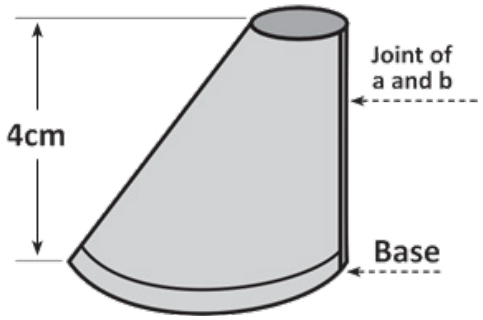
- plain sheet gauge 28
- Metal shears
- Pliers
- Tape measure
- Pencil
- Leather/rexin material
- Tin Rivets

Steps of conical lid construction

i. Measure, mark and cut the plain metal sheet according to the dimensions shown on the net below.

ii. Join sides a and b to make a cone with a hole as illustrated below;



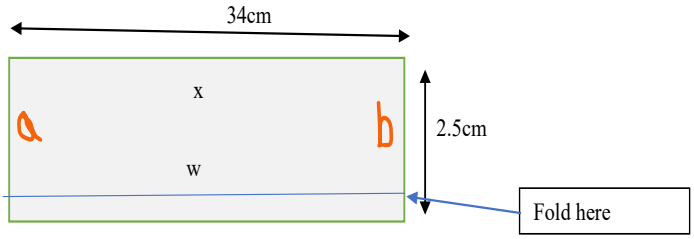


Fold out the base 2 mm at right-angle to the base of the cone.

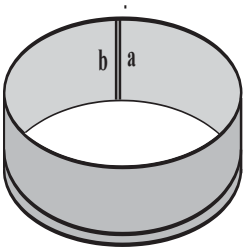
Steps of coupling ring construction

i. Cut plain sheet gauge 28 as per size below.

ii. Fold to remove the sharp edge at side W.



iii. Join side a and b and make it round as shown below;

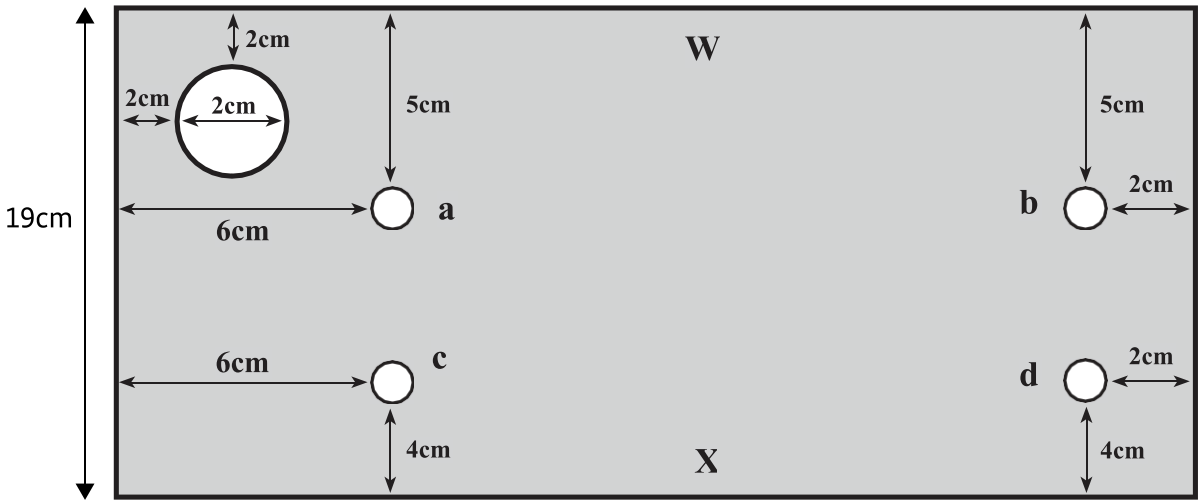


iv. Fold 0.3cm at right angle all round at X.

Joining conical lid to coupling ring

- Join the conical lid with the coupling ring at the base. Ensure the union is firmly joined together.

Measuring, cutting, shaping and making the barrel



i. Measure plain sheet gauge 28 and mark out 33cm by 19cm on the sheet.

ii. Using a metal shear cut out the plain sheet on the marked area.

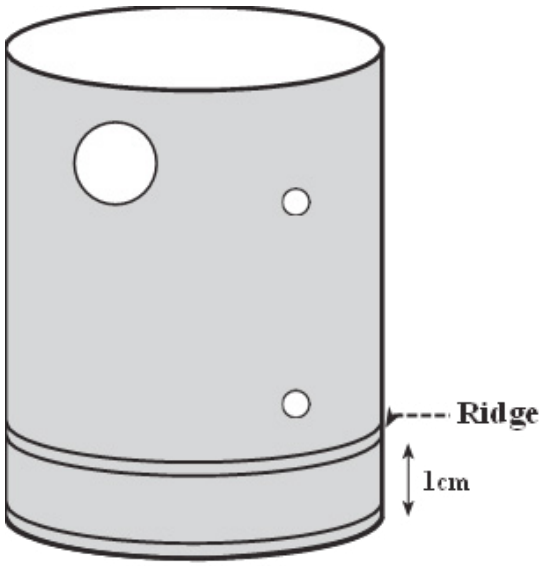
iii. On the cut piece make cut out holes of 2cm diameter using a riverter. The size of a rivert is used to indicate the hole size.

iv. Join the two sides along the width to form a cylinder of 10 cm diameter.

v. Fold 1mm to remove the sharp edge at the bottom.

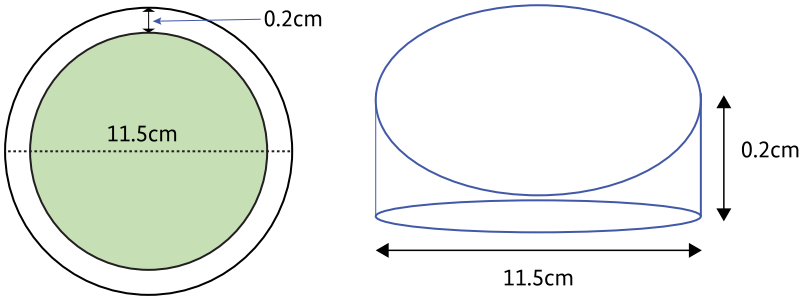
vi. Fold 1mm at right angle at side W near a big hole.

vii. Put a ridge 1 cm from the base.



Construction of the smoker's base/barrel bottom

- Cut a circular plain sheet (gauge 28) with a diameter of 11.5.
- Fold 0.2cm facing upward.
- Fix this to the bottom of the above cylindrical barrel.

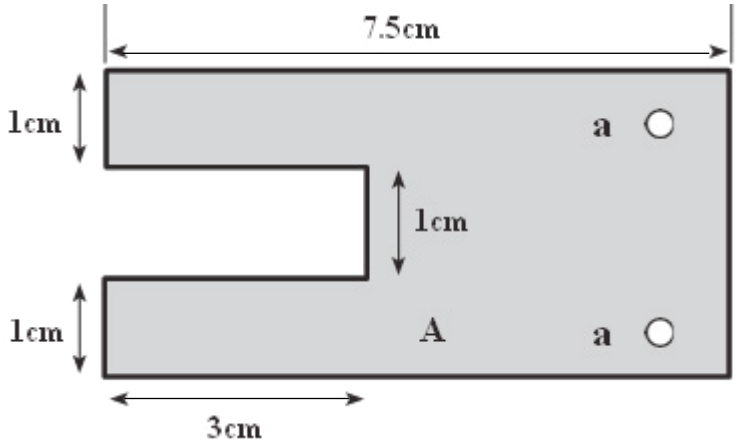


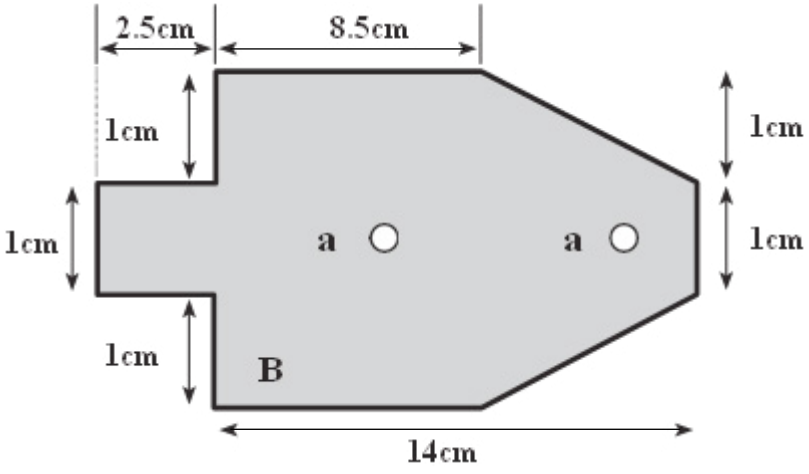
Construction of a hinge

Required resources: Plain sheet gauge 24, shears, rivet and pliers.

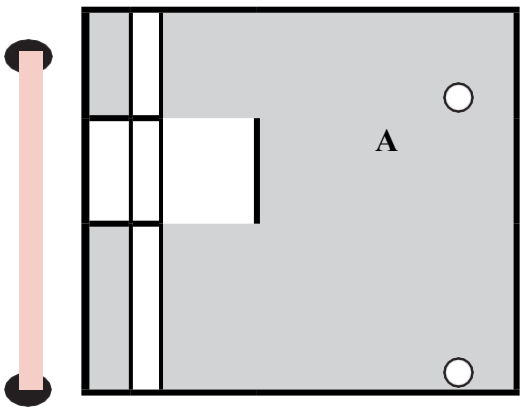
Steps:

- Assemble the required resources
- Cut out a plain sheet (gauge 24) as indicated in the figures below.
- Make the holes a and b as shown below.

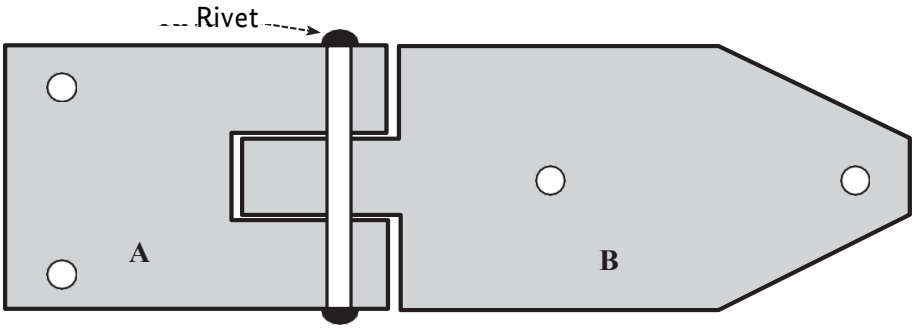




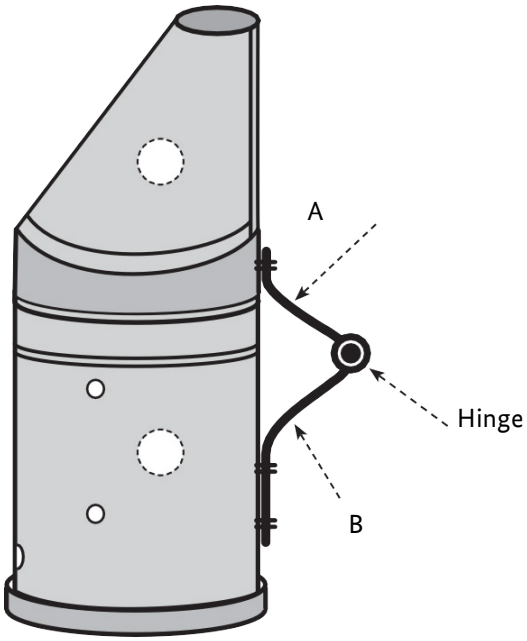
- Take the first cut plain sheet (diagram A) and fold the 2 tongues around a rivet.
- Put holes as the size of rivet.



- Fold the tongue of B around the rivet which was fixed in part A and form a hinge as below.

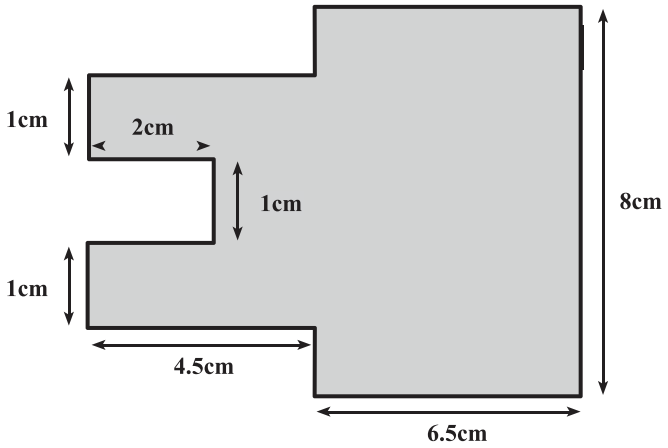


- Firmly fix the hinge on one side on the conical lid and the other side on the and cylindrical barrel.

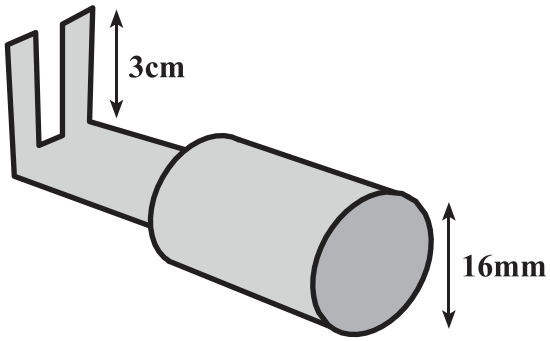


Measuring and cutting the material for the smoker air pump

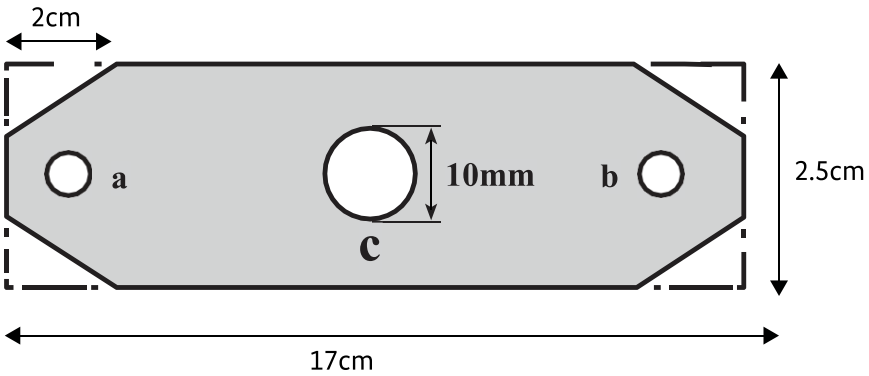
- Cut plain sheet gauge 28 as per the size indicated below;



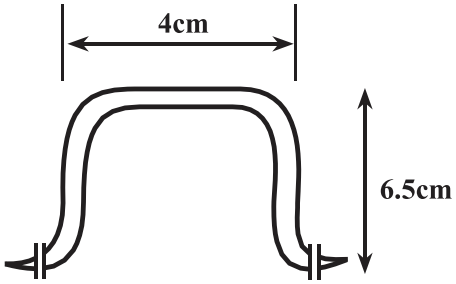
- Fold the biggest part on a round bar of 16mm diameter.
- Bend the 2 tongues at 3cm at a right angle.



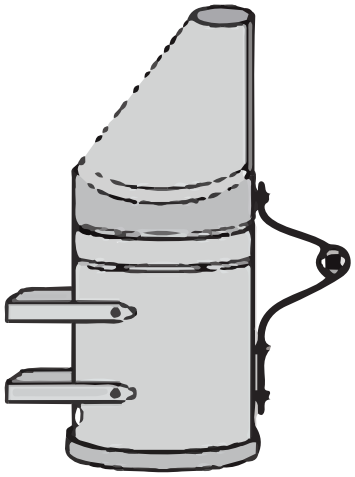
- Cut plain sheet gauge 24 as per size (2 pieces).
- Make 2 holes (a and b) to accommodate rivets and hole C to fit 10mm bolt17cm



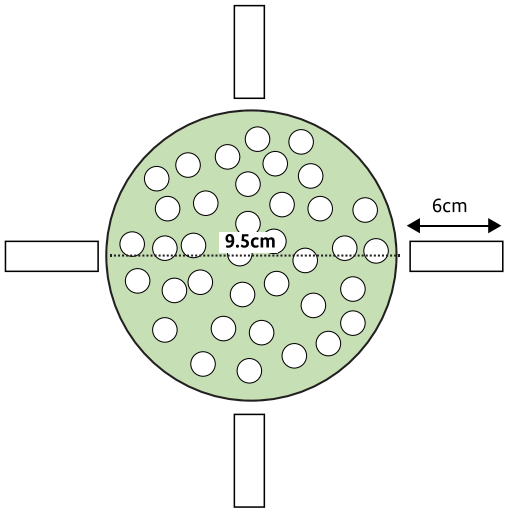
- Bend the above in small 'n' letter like.



- Fix the 2 pieces on part as shown in the figure below.

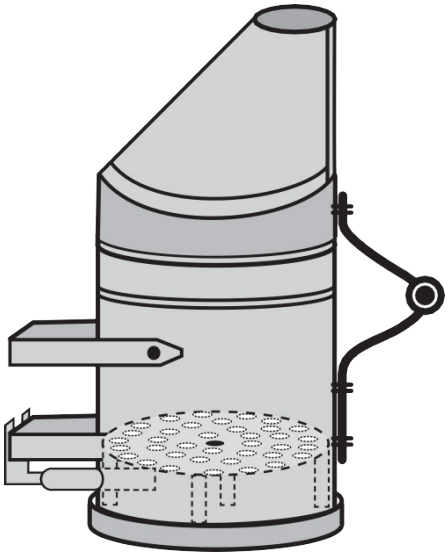


- Cut plain sheet of gauge 28 of diameter 9.5cm.
- Put about 40 air holes at random in the above piece of about 8mm diameter.
- Cut 4 pieces of plain sheet of 6cm length and evenly attach them to the circular holed sheet as shown below;



- Fold the 4 attached plain sheet at 90^0 angle to form a stool-like structure.

- Insert the above "stool-like" structure in an upright position into the cylindrical barrel as shown below;

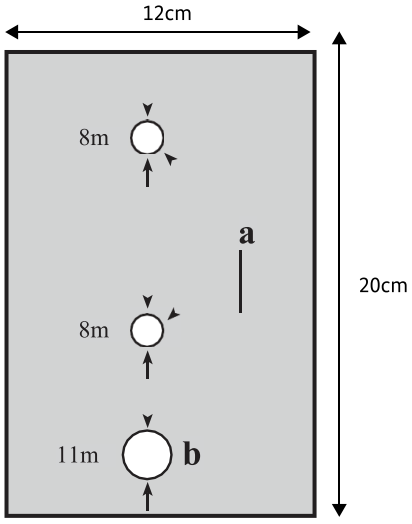


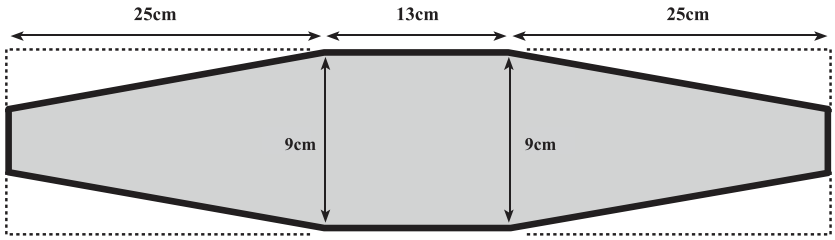
Fixing the pump spring and leather/rexin material

- Cut 2 pieces of wood measuring 12cm by 20cm. The wood should be well-planed to a thickness of 1cm.
- Drill 3 holes in the middle line.

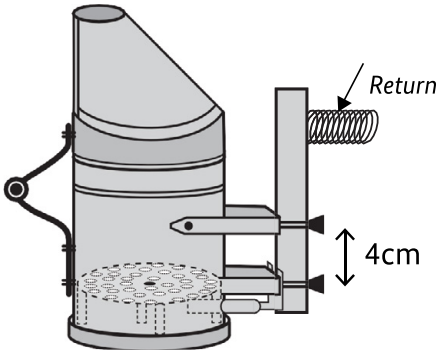
  (a) holes should should fit a 1cm bolt.

  (b) holes '**b**' should be directed to the air pipe No.10 as fixed in No.16.





- Fix the drilled piece with 1cm bolts.
- Fix a return spring at the upper part of wooden piece.



- Cut a rexin/leather as per size.
- Fix the rexin/leather around the wood starting from bottom with taxi nails.
- Fix the second wooden piece against the spring and nail the rexin/leather around it.
- Fix the lace around the two pieces of wood over the rexin/leather with chair pins at least 1cm apart to seal any air leakage.

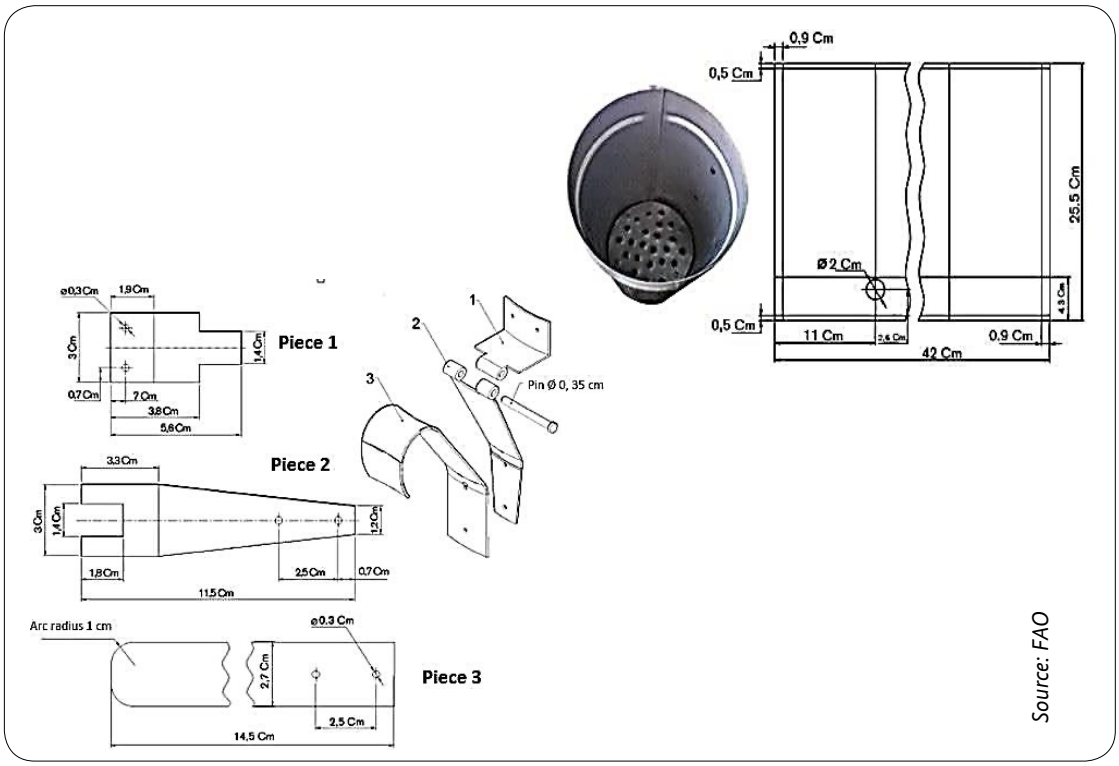


Figure 57. Hinges, hooks, measurements of the cylinder and combustion chamber of the barrel

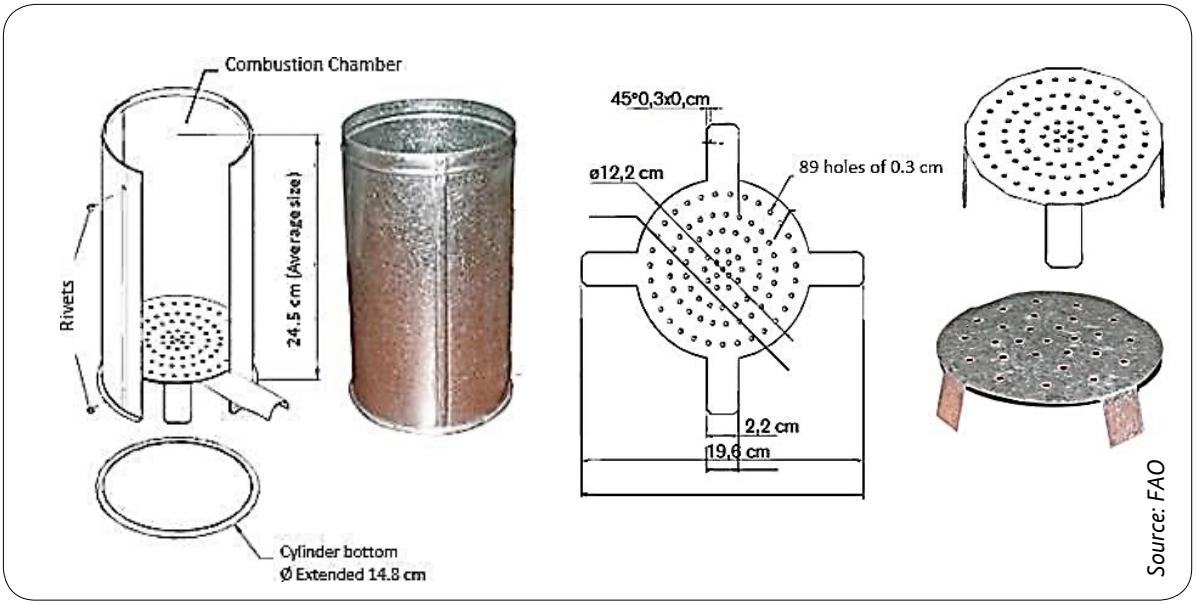


Figure 58: Fuel grid

Fixing the bottom of the barrel and smoothening the edges

The fuel grid must have as many holes as possible with a diameter of 0.3 cm to allow the passage of air to the combustion. The grid can be removable (allows easy cleaning of the smoker) or fixed (less handling is possible, and deterioration of the material is faster).

The air conducting tube guides the air from the bellows to the combustion chamber. It can be fixed to the combustion chamber with rivets or it can be welded. The fuel grid must have as many holes as possible with a diameter of 0.3 cm to allow the passage of air to the combustion. The grid can be removable (allows to clean the smoker better) or fixed (less handling is possible, and deterioration of the material is faster)

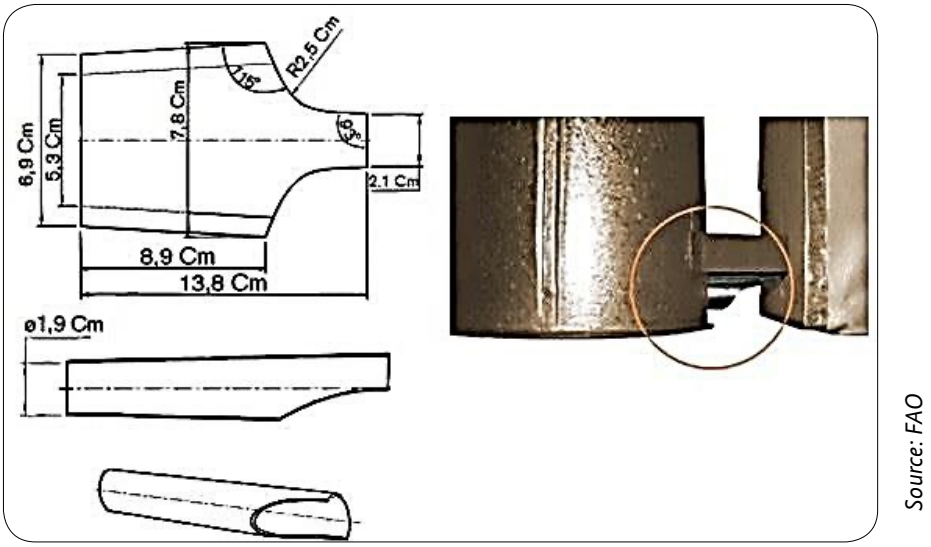
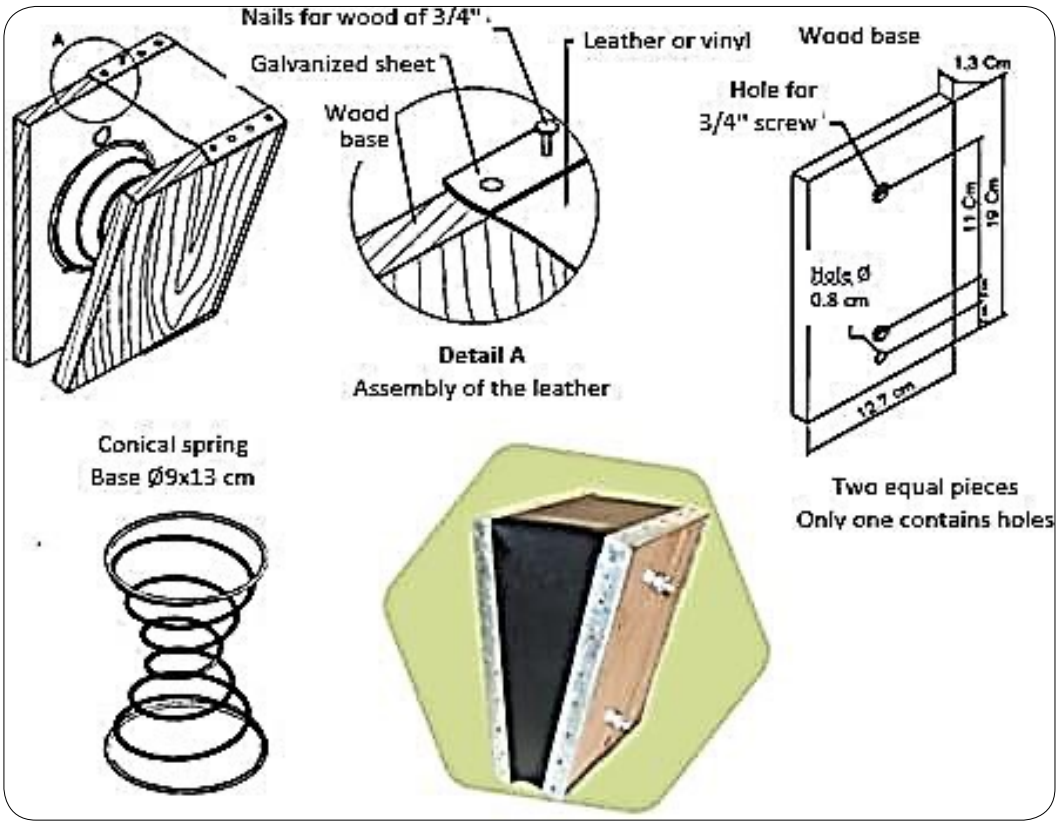


Figure 59. Air conducting tube

Bellows are constructed with:

- Two wooden bases of rectangular shape (12.7 cm x 19 cm x 1.3 cm);
- A conical spring of 9 cm of base (diameter) and 13 cm of height. (the spring can be the type used in furniture);
- Two strips of galvanic sheets to join and seal the bellows; and
- A piece of leather that provides mobility to the bellows.
- Two plates with the indicated measures are required for fixing the bellows and the combustion cylinder.
- The leather (or vinyl) must be one piece. If extensions are needed, they must be done in the lower part of the bellows, and they must be reinforced to avoid air leaks.



Source: FAO

Figure 60: Parts and measurements of the bellow

Smoothening all the sharp/rough edges

This is done using a file to ensure that there is no danger to the user when the smoker is being used.

Evaluation of the quality of the bee smoker

Once all the pieces have been assembled, it is recommended to check the smoker operation before using it to work in the hive.

Follow the link to watch on how to fabricate bee smoker with locally available materials:

https://youtu.be/T1iFr-clDh4

2.2.2.4 Learning Activities

Visit a workshop undertaking bee smoker construction and carry out the following tasks;

1. Measure, cut and shape smoker nozzle and bellows.
2. Fix the pump springs and leather material.
3. Assemble the smoker components and fix the handle.
4. Evaluate the quality of smoker as per standard specifications.

2.2.2.5 Self-Assessment

1. How do you differentiate smokers?
2. Name two materials used for fabricating smoker body and lid.
3. The nozzle of a smoker comprises of the conical lid and the coupling ring. ☐ True or ☐ False?
4. Fill in the blank spaces. A smoker nozzle can be ..... or ..... with heat to achieve its complete bending and assembly.
5. Name the components of a combustion chamber?
6. The cylinder may not be close by overlapping of its two ends and not fixed using rivets for the escape flame or smoke. ☐ True or ☐ False?
7. What is the procedure of constructing conical lid?

Notes:

2.2.2.6 Tools, Equipment, Supplies and Materials

• Metal sheet • Hammer • Overall • Goggles • Helmet • Cutter • Knife or scissors • Workbenches • Vices	• Protective gloves • Plywood • A piece of leather • Nails • Screws • Hinges • Screw drivers • Pliers

2.2.2.7 References

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Adgaba, N., Al-Ghamdi, A., Shenkute, A. G., Ismaiel, S., Al-Kahtani, S., Tadess, Y., Ansari,

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2.2.3 Learning Outcome 3:
Fabricating a Hive Tool

2.2.3.1 Introduction to the Learning Outcome

This learning outcome outlines the competencies required to assemble materials and equipment for making hive tool; to measure and cut material into size, to curve one end according to the specification, sharpen both ends and smoothen and paint according to workplace procedures

2.2.3.2 Performance Standard

- Materials and equipment for making the hive tool are assembled as per the requirements.
- Measure and cut the material to size.
- Curve one end according to the specification.
- Sharpen both ends.
- Smoothen and paint according to the work place procedures.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources required
• Identify types of hive tools.	• Asking questions: lead a question-and-answer session in identifying types of hive tools.	• Marker pens • Charts
• Assembly of materials and equipment for making hive tool.	• Explanation: give direct instructions to trainees to assemble materials and equipment.	• Marker pens • Charts
• Measure and cut the material to size	• Explanation: direct instructions to trainees to measure and cut materials to size.	• Marker pens • Charts
• Curve one end according to the specification.	• Demonstration: demonstrate curving of end of the tool.	• Marker pens • Charts
• Sharpen both ends.	• Demonstration: demonstrate sharpening of the tool.	• Marker pens • Charts
• Smoothen and paint according to the work place procedures.	• Explanation: direct instructions to trainees to smoothen the hive tool.	• Marker pens • Charts
Duration: 20 hours		

2.2.3.3 Information Sheet

A hive tool is an essential implement to the beekeeper. It is used for separating hive components to facilitate the inspection of the bee hive. This tool is used for various purposes including: prying the bee hive lid off, removal of bur comb, separation of supers or boxes, removing debris off the floorboard, loosening some hive components such as frames, and scraping out stings. Honeybees collect fluids secreted by plants (such as sup), mix it with beeswax and saliva, creating propolis (also called bee glue).

A simple design of the hive tool consists of hardened steel that has a hook on one end and a small blunt blade on the other end.

Types of hive tools

There are various types of hive tools around today. Making the best choice among them can be a challenging for beginners in beekeeping. The following are some of the available types;

a) Mann Lake HD584 steel hive tool

Figure 61: Mann Lake HD584 steel hive tool

Made of thin, rust and abrasion resistant stainless-steel material. This hive tool does a good job when it comes to separating supers and hive bodies.

It has a hooked end for lifting frames and a flat surface for wax and propolis removal and comes with a nail removal feature.

Its dimensions are 23.5 x 4x 3 cm (9.25 x 1.57 x 1.18 inches). It weighs barely 30g which is ideally light enough to carry around when working on the bee hives.

It is also longer lasting and that means you will use it for a long time.

b) Amrka J-type stainless steel hive tool

- This stainless-steel tool with its signature silver red color does an excellent job when it comes to separating supers and hive components. It is sturdy and will never bend even when subjected to hardy propolis and wax.
- It is silver and red in color for maximum visibility.
- It has a hanging hole for keeping it when not in use.
- It weighs only 30grams and therefore it is so easy to carry around when working on the hives.

- Designed for various purposes; prying frames, separating wax and propolis, as well as separating hive boxes.

Figure 62: Amrka J-type stainless steel hive tool

c) Ream Top Bee Hive scraper & frame lifter

Figure 63: Ream Top Bee Hive scraper & frame lifter

Source: Desertcart Antigua and Barbuda

- It is made of stainless-steel material.
- Bright in color for best visibility in case it drops accidentally.
- Multi use hive tool: pry bar, nail puller, wax or propolis scraper, frame cleaner, queen excluder, and others.
- Fitted with a wooden handle for a firm grip.
- It has a J hook that has gripping teeth. On its other side is a sharp edge.
- Product dimensions are 25.4x0.25x6.6 cm and weighs 272.2 grams.

d) Weichuan Beekeeping hive scraper tool

- Product dimensions are 27.9x5.6x1.8cm and 113.4g.
- Made of stainless-steel material hence sturdy and longer lasting.
- Has a hooked and flat end. Hooked end is used for lifting frames and flat end for removal of excess wax or propolis.
- It has a wooden handle.

- Multipurpose tool: nail puller, queen excluder, hammer, hive scraper, frame lifter, and many others.

Figure 64: Weichuan Beekeeping hive scraper tool

Assembling materials and equipment for making the hive tool

Materials, tools and equipment for construction of hive tool:

The following are the tools, equipment and materials necessary for the construction of hive tools

- A metal bar made of materials such as stainless steel
- Hack saw
- Grinder
- File
- Drill
- Hammer
- Source of fire
- Pliers

Steps of fabricating a hive tool include;

Measuring and cutting the material to size

1. Cut the metal: Cut the metal to the desired size for the tool. The size of the hive tool varies depending on the type of hive tool. A hacksaw or a grinder is used to cut the metal. The most common type of hive tool in Kenya is Mann Lake HD584 steel hive tool. To fabricate this hive tool cut a metal measuring 23.5cm length x 4cm width x 3cm thick as indicated in the figure below;

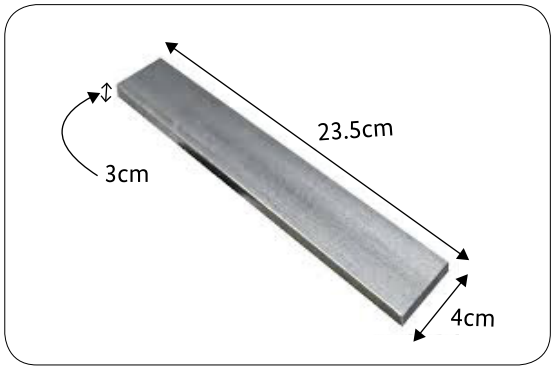

Figure 65: Dimensions of a hive tool

Curving one end and Sharpening of both ends

2. Shape the metal: a typical hive tool has a flat, straight blade on one end and a curved, hooked blade on the other end.
    i. Using a hammer, hit one side of the metal bar against a metal block so as to flattened the side.
    ii. Sharpen and shape the flattened side using a file or grinder.
    iii. Curve the other side of the hive tool using a claw bar or any other equipment to bend the metal bar.
3. Drill holes: If desired, drill holes into the curved side of the metal for hanging the tool

Smoothening and painting

4. Smooth edges: Use a file or grinder to smooth any rough edges or sharp points on the tool.
5. Heat treatment: Depending on the type of metal you are using, you may want to heat treat the tool to improve its durability and hardness. This step may involve heating the metal to a high temperature and then cooling it quickly.
6. Paint the tool: Hive tool is painted halfway from the side that is curved. The flattened side should not be painted as it comes into contact with the honey. Painting prevents rust and wear of the tool. Bright colours such as red or yellow are used for ease of identifying the tool

Evaluation of the quality of the fabricated hive tool

Test the tool to ensure of its functionality and quality. Hive tool should be resistant to rusting to prevent honey contamination. Ensure that the tool is well smoothened to avoid any cuts or harm that may be caused by the tool while in use.

Note:
It's important to note that fabrication of a beekeeping tool can be a safety-sensitive task that requires proper safety equipment and techniques. It is advisable to seek guidance from experienced beekeepers and/or professional metal workers if you are not experienced in metalworking.

2.2.3.4 Learning Activities

1

Visit an outlet selling bee hive tools and identify the different types of hive tools.

2.2.3.5 Self-Assessment

1. What do you understand by a hive tool?
2. List any three uses of a hive tool.
3. The hooked end of a hive tool is used for lifting frames. ☐ True or ☐ False?
4. How do you use a hive tool?
5. Why is a hive tool smoothened?
6. What is the procedure of fabricating a hive tool?

Notes:

2.2.3.6 Tools, Equipment, Supplies and Materials

• Metal sheet	• Cutter
• Hammer	• Workbenches
• Overall	• Vices
• Goggles	• Protective gloves
• Helmet	• Pliers

2.2.3.7 References

Abebe, W., Ranjan, S. K., & Puskur, R. (2011). Determinants of box hive promotion and financial benefits in selected district of Ethiopia. International Journal of Agricultural Science, Research and Technology.

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2.2.4 Learning Outcome 4: Constructing Bee Brush

2.2.4.1 Introduction to the Learning Outcome

This learning outcome outlines the competencies required to identify and assemble materials and equipment for making bee brush, to cut sisal fiber into the recommended length, to cut timber handle and design it as per workplace procedures. It also involves how to trim sisal fibers as per workplace procedures.

2.2.4.2 Performance Standard

- Materials and equipment for making a bee brush are identified and assembled as per the workplace procedures.
- Sisal fibers are cut into the recommended length as per workplace procedures.
- Timber handle is cut and designed as per the specifications.
- Sisal fibers are fixed onto the handle as per the workplace procedures.
- Sisal fibers are trimmed as per the workplace procedures.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources required
• Identification and assembly of materials and equipment for making bee brush.	• Asking questions: lead a question-and-answer session in identifying and assembling of materials and equipment.	• Marker pens • Charts
• Cutting of sisal fibres into the recommended length as per workplace procedures	• Demonstration: demonstrate the cutting of fibres.	• Marker pens • Charts
• Cutting and designing of timber handle as per the specifications	• Explanation: give direct instruction on the designing and cutting of the handle.	• Marker pens • Charts
• Fixing the sisal fibres onto the handle as per the workplace procedures.	• Demonstration: lead trainees to watch a video on fixing the fibres.	• Laptop • Projector

• Trimming of Sisal fibres as per the workplace procedures.	• Explanation: give direct instructions trainees to trim the sisal fibres.	• Marker pens • Charts
Duration: 20 hours		

2.2.4.3 Information Sheet

Definition of terms

A bee brush is a tool used for brushing off the bees from the comb by a beekeeper when manipulating bee colonies.

The bee brush is used to gently remove bees from comb or other surfaces without squishing or damaging them. It is made with long, soft, non-ridged bristles or sisal fibres mounted on a 35 cm long wooden handle. When the soft brush is used for removing bees from the surface of the delicate comb, equipment or from the protective clothing of a beekeeper, it is harmless and does not irritate the bees.

Identification and assembling of materials and equipment for making a bee brush

Materials needed:

- Soft bristles (e.g., horse hair or foam or bird feathers)
- Hot glue or wood glue
- Scissors
- Paint or finish for protection (optional)
- Hand rip saw
- Pliers
- Well-seasoned Wooden dowel/rod or timber
- Sandpaper
- Paint or finish for protection (optional)
- Ruler or measuring tape
- Saw or cutting tool.

Procedure for cutting of timber/bee brush handle

Step 1: Cut and shape the dowel:

- Cut the wooden dowel or rod to the desired length using a saw or cutting tool.
- A common length for a bee brush handle is around 20 to 40 cm.
- Shape the dowel as per your preference.
- The recommended type of timber to be used is pine or cedar as they can withstand different weather conditions and handling and therefore will make the handle to be durable.

Step 2: Sand the handle:

- Use sandpaper to smooth any rough edges or surfaces on the handle.
- This will make it more comfortable to hold and prevent any splinters.

Step 3: Make holes by drilling one side of the wood dowel.

- Depending on the size of a bee brush that you want to make a one can determine the length of the dowel in which holes will be drilled.
- A 40cm dowel, the bristles can be attached to approximately 24cm.

Step 4: Paint or Finish (Optional):

- If desired, paint or finish the handle for protection and a more polished appearance.
- Allow the paint or finish to dry completely before using the handle.

Cutting, fixing and trimming bristles on the handle

i. Cut the bristles: Cut the bristles to the desired length, making sure they are long enough to reach the bottom of the comb. The bristles can be cut to a length of 6.5cm. Scissors can be used for this purpose.

ii. Attach the bristles to the handle: Using hot glue or wood glue, attach the bristles to the drilled end of the wooden handle. Make sure the bristles are evenly spaced and securely attached to the handle. The bristles should be pressed in the holes to fit perfectly.

iii. Trim the bristles: Trim the bristles if necessary, making sure they are of even length and shape.

Note:
The length and thickness of the bristles will depend on personal preference and the type of bees you are working with. Soft, gentle bristles are recommended to avoid injuring the bees.

Evaluation of the quality of the bee brush

Testing the bee brush after it has been made is very important to ensure that it will perform the intended work. The bee brush should be gentle to the bees and should be able to swipe off the bees during colony manipulation.

2.2.4.4 Learning Activities

1

Visit a bee equipment making facility and participate in the making of bee brush. Alternatively, acquire sisal and timber and simulate the process of making a bee brush.

2.2.4.5 Self-Assessment

1. Which three materials can be used while making a bee brush?
2. What are the steps in making a bee brush handle?
3. What are the qualities of a good bristle for making bee brush?

Notes:

2.2.4.6 Tools, Equipment, Supplies and Materials

• Sisal fibre/non-ridged bristles/horse tail • Nails • Timber • Tape measure • Drill	• Hammer • Pliers • Planes • Scissors • Hand/rip saw

2.2.4.7 References

Abebe, W., Ranjan, S. K., & Puskur, R. (2011). Determinants of box hive promotion and financial benefits in selected district of Ethiopia. International Journal of Agricultural Science, Research and Technology.

Adgaba, N., Al-Ghamdi, A., Shenkute, A. G., Ismaiel, S., Al-Kahtani, S., Tadess, Y., Ansari, J., Abebe, W., & Abdulaziz, Q. A. (2014). Socio-economic analysis of beekeeping and determinants of box hive technology adoption in the kingdom of Saudi Arabia. The Journal of Animal & Plant Sciences.

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2.2.5 Learning Outcome 5:
Post-construction Activities and Bee Equipment

2.2.5.1 Introduction to the Learning Outcome

This learning outcome outlines the competencies required to store hives and equipment and to manage and dispose waste appropriately as per NEMA and workplace procedures.

2.2.5.2 Performance Standard

- Hives and equipment are stored as per the workplace procedures.
- Waste is managed and disposed appropriately as per NEMA and workplace procedures.

Suggested Training Delivery

Training Activities	Training Delivery Methods and Description	Resources required
• Storing hives and equipment as per the workplace procedures	• Facilitate a lecture on storage of hives and catcher boxes.	• Marker pens • Charts
• Waste management and disposal. • Methods of waste disposal. • NEMA requirements in waste disposal.	• Lead trainees to watch a video on various methods of waste disposal. • Facilitate a lecture on the NEMA requirements of waste disposal. • Field trip: lead trainees to a dumping site.	• Laptop • Projector • Marker pens • Charts
Duration: 15 hours		

2.2.5.3 Information Sheet

Once construction of the hives and fabrication of equipment is complete, it is in order to store them appropriately and also manage and dispose generated.

Storage of fabricated bee hives and bee equipment

Fabricated bee hives and equipment should be stored well before dispatching them to where they are intended. Storage facility should be suitable for the fabricated equipment and tools.

The following items are to be considered for storage facilities:

• Flooring

A reinforced concrete floor, incorporating suitable drains to remove excess curing water (if this method of curing is to be utilized). The floor should be designed to withstand the local loads applied when jacking and moving the size of vessel to be constructed.

• Building framework

The building framework should ideally be designed to allow for the use of stacks or rails to support the constructed hives and accessories.

• Building heights

The height of the eaves of the building should be sufficient for ease of working on the sizes of equipment constructed. This may vary from the ferro-cement workshop to the fitting out workshop if composite construction is envisaged. Also, free air ventilation in hot climates must be allowed for, while being able to nullify the effects of wind.

• Material storage

Suitable covered storage for materials should be allowed for, including the proper racking as well as following manufacturers' recommendations regarding storage and treatment of materials to be held in stock.

• Access

Adequate access should be provided for receiving materials and for allowing free movement of personnel around the working areas (also for fire and safety precautions).

• Space for machinery and equipment

Due consideration should be paid to providing adequate space for machinery and equipment required where a variety of different materials may be considered for use including perhaps timber, steel, metal sheets, nails, hand tools among others.

Management and disposal of waste

Waste management entails all the activities that are required to manage waste so as to reduce the dangerous effects of such waste on the environment and human health as discussed in Chapter one (1) - Learning outcome six (6) of this guide.

2.2.5.4 Learning Activities

Visit a busy workshop and carry out the following tasks;

1. Observe the storage area of the bee hives and equipment.
2. Assist in storage of the hive and equipment.
3. Observe the existing waste disposal methods.

2.2.5.5 Self-Assessment

1. What are the advantages of storage facility?
2. List any five considerations for bee hive and bee equipment storage.
3. The building framework should ideally be designed to allow for the use of hanging tie rods to support the timber's reinforcement both prior to and during curing. ☐ True or ☐ False?
4. Industrial waste is not a key factor when assessing the sustainability of a manufacturing process or company. ☐ True or ☐ False?

Notes:

2.2.5.6 Tools, Equipment, Supplies and Materials

• Incinerators • Wheelbarrows • Overall	• Gloves • Face shields • Gumboots.

2.2.5.7 References

Adgaba, N., Al-Ghamdi, A., Shenkute, A. G., Ismaiel, S., Al-Kahtani, S., Tadess, Y., Ansari, J., Abebe, W., & Abdulaziz, Q. A. (2014). Socio-economic analysis of beekeeping and determinants of box hive technology adoption in the kingdom of Saudi Arabia. The Journal of Animal & Plant Sciences.

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2.3 Suggested Responses to Self-Assessment Questions

2.3.1 Learning Outcome 1:

Prepare to Fabricate a Bee Smoker

1. List any three materials used in fabricating a smoker.

   Galvanized sheet and stainless-steel sheet.

2. The recommended gauge of the sheets used for fabricating the smoker is **26mm gauge.**

3. Name the three main components of a smoker.
   - **Conical lid,**
   - **Cylindrical body, and**
   - **Bellows.**

4. List any five parts of a smoker.
   - **Combustion chamber**
   - **Grid**
   - **Coupling ring**
   - **Conical lid**
   - **Handle**
   - **Hinge**
   - **Hook**
   - **Air conducting tube**
   - **Bellow support**
   - **Galvanized strip**
   - **Vinyl/leather**
   - **Bellows holding screw.**

5. Name five (5) Personal Protective Equipment necessary during bee smoker fabrication.
   - **Earmuffs/plugs**
   - **Helmet/welding hoods**
   - **Gloves**
   - **Coveralls**
   - **Gumboots.**

2.3.2 Learning Outcome 2:

Fabricate a Bee Smoker

1. How do you differentiate smokers?

   By sizes, shapes and materials used in fabrication.

2. Name two materials used for fabricating smoker body and lid.
   - **Galvanized zinc sheet**
   - **Stainless steel sheet.**

3. The nozzle of a smoker comprises of the conical lid and the coupling ring. **True**

4. Fill in the blank spaces. A smoker nozzle can be **moulded** or **welded** with heat to achieve its complete bending and assembly.

5. Name the components of a combustion chamber?
   - **The base**
   - **Grid**
   - **Cylinder**
   - **Air conditioning tubes**

6. The cylinder may not be close by overlapping of its two ends and not fixed using rivets for the escape flame or smoke. **False.**

7. What is the procedure of constructing conical lid?
   - **Obtain a plain sheet of gauge 28 and measure and mark and cut an area measuring 10cm by 2cm.**
   - **On the cut metal sheet make two holes (a and b) using a riverter.**
   - **Cut off the corners.**
   - **Join size a and b to make a cone with a hole.**
   - **Fold out the base 2 mm at right-angle to the base of the cone.**

2.3.3 Learning Outcome 3:

Fabricate a Hive Tool

1. What do you understand by a hive tool?

   This is an implement used by a beekeeper for separating hive components to facilitate the inspection of the bee hive.

2. List any three uses of a hive tool.
   - **Prying the bee hive lid off.**
   - **Removal of bur comb.**
   - **Separation of supers/boxes.**
   - **Removal of debris of the floor board.**
   - **Loosening the hive components (frames).**

3. The hooked end of a hive tool is used for lifting frames. **True**

4. How do you use a hive tool?

   Using;
   - **Nail puller**
   - **Hammer**
   - **Hive scraper**
   - **Frame lifter**

5. Why is a hive tool smoothened?

   To avoid cuts or harm that may be caused by the tool while in use.

6. **Wh**at is the procedure of fabricating a hive tool?
   - **Gather the materials, tools and equipment.**
   - **Cut the metal: Cut the metal to the desired size for the tool. The size of the hive tool varies depending on the type of hive tool. A hacksaw or a grinder is used to cut the metal. The most common type of hive tool in Kenya is Mann Lake HD584 steel hive tool. To fabricate this hive tool cut a metal measuring 23.5cm length x 4cm width x 3thick.**
   - **Shape the metal: a typical hive tool has a flat, straight blade on one end and a curved, hooked blade on the other end.**
   - **Drill holes: If desired, drill holes into the curved side of the metal for hanging the tool.**
   - **Smooth edges: Use a file or grinder to smooth any rough edges or sharp points on the tool.**
   - **Heat treatment: Depending on the type of metal you are using, you may want to heat treat the tool to improve its durability and hardness. This step may involve heating the metal to a high temperature and then cooling it quickly.**
   - **Paint the tool: Hive tool is painted halfway from the side that is curved. The flattened side should not be painted as it comes into contact with the honey. Painting prevents rust and wear of the tool. Bright colours such as red or yellow are used for ease of identifying the tool.**
   - **Evaluation of the fabricated hive tool: test the tool to ensure of its functionality and quality. Hive tool should be resistant to rusting to prevent honey contamination. Ensure that the tool is well smoothened to avoid any cuts or harm that may be caused by the tool while in use.**

2.3.4 Learning Outcome 4:

Construct Bee Brush

1. Which three materials can be used while making a bee brush?
   - **Timber**
   - **Nails**
   - **Fibre/bristles**
   - **Pliers**
   - **Hammer**
   - **Glue**

2. What are the steps in making a bee brush handle?

- **Cut and shape the dowel: Cut the wooden dowel or rod to the desired length using a saw or cutting tool. A common length for a bee brush handle is around 20 to 40 cm. Shape the dowel as per your preference.**
- **Sand the handle: Use sandpaper to smooth any rough edges or surfaces on the handle. This will make it more comfortable to hold and prevent any splinters.**
- **Make holes by drilling one side of the wood dowel. Depending on the size of a bee brush that you want to make a one can determine the length of the dowel in which holes will be drilled. A 40cm dowel, the bristles can be attached to approximately 24cm.**
- **Paint or finish (Optional): If desired, paint or finish the handle for protection and a more polished appearance. Allow the paint or finish to dry completely before using the handle.**

3. What are the qualities of a good bristle for making bee brush?

   Should be soft and gentle.

2.3.5 Learning Outcome 5:

Conduct Post-construction Activities on Bee Equipment

1. What are the advantages of storage facility?
   - **They free up space.**
   - **They keep the items in a systematic manner.**
   - **They help in saving time when items are organised.**
   - **Saves money - cheaper when you have one than renting.**
   - **Makes the items secure and safe.**

2. List any five considerations for bee hive and bee equipment storage.
   - **Flooring**
   - **Building framework**
   - **Building heights**
   - **Building cladding**
   - **Access**
   - **Material storage**

3. The building framework should ideally be designed to allow for the use of hanging tie rods to support the timber's reinforcement both prior to and during curing. **True.**

4. Industrial waste is not a key factor when assessing the sustainability of a manufacturing process or company. **False.**

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