Beekeeping Basics

by
Jon Zawislak
University of Arkansas System
Division of Agriculture
Cooperative Extension Service

Part 2:
Introduction to the Bee Hive

Modern techniques of keeping honey bees in tidy, stacked rectangular boxes is relatively new in our long association with the honey bee. There have been many types of bee hives used throughout history, and there are a number of styles still in use today. You may be familiar with images of the straw baskets called **skeps** that were once widely used. But today most places in the U.S. require beekeepers to employ some type of **moveable comb hive**. These hives allow us to remove a single comb at a time, so we can inspect it for signs of disease, evaluate the productivity of the queen, and assess the space in the hive for brood and honey storage.

And we can do all of this without destroying the nest structure and the hard work of the honey bees. We can rearrange a bee hive to expand its capacity, or to consolidate it to a smaller volume, or encourage the bees to focus their work in different areas of the hive. We can also open the hive to inspect the bees and their home with a minimum of disturbance that was not always possible when using bee gums or skeps.

No matter where honey bees make their homes, they always do so by building vertical beeswax honey combs, which hang down from the roof of a cavity or sheltered location, and they expand their nest by building additional combs parallel to each other.

The architecture of these combs is both elegant and efficient. Repeating hexagonal cells ensure there is no wasted space. And the beeswax, which the worker bees themselves secrete, makes for a very strong, lightweight and versatile structure. Combs are generally centered approximately 1 ½ inches apart and are separated by a small amount of space that we call **the bee space**. This bee space varies from about 1/4" to 3/8" and is just enough room for a couple of honey bees to work, back to back, on opposite combs without getting in each other's way.

And it was the discovery of this universal bee space that has become the basis for our modern moveable comb hives. When people began to understand how to design hives to utilize the bee space it ushered in a revolution that allowed beekeeping to go from a small scale occupation to a very large industry.

Inside of the hive, the honey bees use every available space very efficiently. In any space larger than a bee space, they will attempt to build wax honeycombs, which they use to store food (honey and pollen) or to raise more offspring, which we call the **brood** or **larvae**.

Any space inside the hive that is smaller than a bee space – that is, smaller than about ¼ inch – the bees cannot utilize it, and they seal it off. They do so with a resinous substance called **propolis**,

which they collect primarily from trees. The bees utilize this propolis like caulking, and will seal up small spaces, cracks and crevices in the hive, and any gaps between stacked boxes.

Propolis is actually quite amazing on its own. It has been shown to be naturally antiseptic – effective at killing bacteria, viruses and fungi. Trees produce this material to help protect new growth, and the bees bring it home and effectively use it as part of their colony's social immune system.

In the wild, when bees move into a hollow tree for instance, they seal the inside of the cavity with a **propolis envelope**. They start at the top, reinforcing and strengthening what might be rotting wood, and giving the first honey combs a secure place to hang. This envelope extends down, inside the cavity, and helps to sterilize, protect and waterproof the structure of the nest. They may seal off extra exits to help them keep their nest safe. Also, when the bees enter their home after returning from foraging flights, they walk across this sterilizing layer and they clean their feet. In our modern hive, bees still tend to coat every surface with a very thin layer of propolis, both to help disinfect and to keep things from moving around, and to eliminate places where pests can enter the hive and hide inside.

During the 19th century, several people have been credited with developing hives that incorporated the bee space in their design and function:

In 1789, the French beekeeper **François Huber** designed his "leaf hive" which opened like a book, and allowed beekeepers to inspect individual combs.

In 1814, Ukrainian beekeeper **Petro Prokopovych**, invented one of the very first beehives that used frames. His hive opened from the side, which is a style still favored in some parts of eastern Europe. He is credited with inventing commercial beekeeping in Ukraine.

In 1835, Polish beekeeper named **Johann Dzierzon** is said to have correctly identified the bee space, and devised the first practical movable-comb beehive, a top-bar design, which improved on previous types.

It was the American beekeeper Lorenzo Langstroth who, in 1851, designed a top opening hive that incorporated wooden frames, and utilized the bee space to arrange all the movable parts. He recognized that when he incorporated a space between 1/4 and 3/8 inches between all the wooden pieces, the bees did not tightly seal the lid with propolis, or seal the frames to the insides of the hives. His subsequent book ***A Practical Treatise on the Hive and Honey-Bee*** could be said to have launched the era of modern beekeeping.

The **Langstroth Hive**, which still bears his name, or some similar version of this design, has since become the worldwide standard for practical beekeeping and commercial honey production. Langstroth hives are not perfect. They can be cumbersome when large, and involve heavy lifting sometimes to manipulate, but they are modular, and very adaptable and portable, and they lend themselves to commercial beekeeping and honey production very well. They represent a pretty good compromise between the practical needs of the honey bees and the beekeepers.

While other hive styles are used, The Langstroth hive, "Langs" as they are sometimes called, are still probably the most popular type in use, and are easy to come by. In addition, most beekeepers you meet will have experience with these, and most general beekeeping books are written, and the majority of tools are produced, with this type of hive in mind.

The Langstroth hives use a series of wooden frames to encourage the bees to produce straight, flat honey combs, which are easy to remove, to inspect, and to harvest honey. The internal dimensions of the hives should all be very precise, to fit the frames and to maintain the essential bee space between all the wooden parts. When assembled correctly, there should be about a 3/8 inch gap between adjacent combs, between the frames and the hive walls, as well as between tiers of frames in vertically stacked boxes, and between the frames and the lid.

The dimensions of the Langstroth hive have been essentially standardized over the years by the industry. And these hive components are now widely available from many manufacturers. Although some very slight differences sometimes occur between makers, most Langstroth equipment should fit together fairly well.

Let's take a tour of a standard bee hive arrangement and discuss the function of each component, and the structure as a whole…

First, some quick vocabulary terms. Beekeeping involves a lot of new words and it's easy to get lost in the technical jargon. But learning these new terms and keeping them straight will allow you to better understand what you read and hear, and better communicate with other beekeepers when you have questions.

Although many people use these terms interchangeably, a **bee hive** is a structure. This is the house that the bees live inside of. A stack of man-made boxes or a hollow tree could be called a hive. A **hive body** is one of the individual boxes that make up a bee hive. They may be different sizes, and are used for different purposes, but they all usually contain a series of wooden frames for the bees to build honey combs. A **bee colony** refers to the group of bees themselves that live inside a hive. A bee colony is usually all one related family, highly organized to produce more bees and to store food for times when there are no flowers available.

There are several standard sizes of hive bodies. The traditional **deep frame** was the industry standard for more than a century, and is still one of the most commonly used sizes, especially in commercial beekeeping operations. Because they are the most common, most **nucleus hives** you find for sale include deep frames. Consider this if you plan to raise bees to sell in **nucs**. Deep frames provide a large area for a brood nest. But when they are full of honey, these boxes can become very heavy.

For that reason, many beekeepers have switched to **medium** boxes for honey production. These are the same dimensions around, but a few inches shorter, and boxes full of honey will be considerably lighter, but you will need more of them to produce the same volume of honey. The consideration of weight can be very important when you are working your bee hives alone.

Suppliers also offer **shallow** hive bodies, which are even shorter, and therefore even lighter when full of honey. These are often used to produce **comb honey**, because it's easier to get bees to produce a nice uniform, fully capped section of comb in smaller areas than in much larger ones.

Traditionally, Langstroth bee hives hold 10 frames across. Nowadays, some beekeepers are choosing to keep bees in **8-frame equipment**. These hives come in all the same sizes, except that they are narrower, and comparatively slightly lighter than the 10-frame hives.

Some beekeepers also choose to put only **9 frames in a 10 frame box**. By spacing out the combs just a bit, the bees will draw out the honey combs a little thicker. This can make is easier to harvest

honey later, because the combs are so thick. But only do this in the honey supers, not in the brood boxes. You want to give your queen as much room as possible to produce brood.

What variety of hive bodies you choose for your beekeeping is a personal choice. Many people use a combination of deeps for the brood chambers, to ensure a large area for the queen to lay, and medium sized boxes for honey supers, because the weight is more manageable. Other beekeepers use all medium equipment for both brood and honey, for the convenience of having only one size of box and frames to keep track of.

In a natural hive that they make themselves, honey bees will tend to store honey in the top of the hive, and rear their brood down below. So no matter what style of boxes your bee hive may be composed of, your bees will make themselves at home, and they will utilize the space as they see fit.

Let's look at a modern Langstroth hive, from the ground up.

Most beekeepers will be advised to place their bee hives on a **hive stand**. This is simply any structure that keeps the bee hive up off the ground. The ground can hold a lot of moisture, which will promote wood rot. And your hives will also be prone to termite damage if they are in direct contact with the soil. So a hive stand prolongs the useful life of your wooden hives.

You should not build bee hives out of treated lumber, which typically contains an insecticide. But you can build a hive stand to support your bee hives from treated wood, because the bees will not typically not be in direct contact with it very much. You can also build one using a resilient wood like cedar or cypress, but it's still recommended that you keep the hives up off the ground. There are a number of commercially available hive stands on the market made from metal, plastic or wood. But a couple of concrete blocks also makes good stand. They are durable, inexpensive, and easy to find, and easy to move if you need to.

These provide a fairly good height for a lot of people, or you may find it too low. Having your hive up off the ground makes it easier to work with your honey bees. You don't want a hive stand that is too tall, or it can become difficult to add and remove heavy honey supers, or even just to inspect. You will need to find something that is comfortable for you, and works for you at your height, and provides a nice solid, level place your bee hives. Having your hives up off the ground also keep helps to keep grass or weeds from growing up in front of the entrance. A hive stand may be built to hold just one hive, or several at a time. They need to be sturdy. And remember that it may need to be able to hold several hundred pounds per hive if you have a really good season!

Commercial beekeepers often put their hives on wooden pallets, to make it easier to load and unload them on trucks with a forklift, and move them from farm to farm. But if you are not planning to move your hives, pallets are generally not the best choice for your hives, since the wood used for pallets will not last long on the ground outside, and can be more prone to termite infestations.

At the bottom of the hive is the **bottom board**. This is just the floor of the bee hive. It was traditionally just a solid board with short rails around 3 sides, typically these rails are 3/8 or 3/4 inches high. The open side is the entrance to the hive, which we call the **flight entrance**. A short "front porch" area here is called the **landing board**. It may be flat, or it may angle down. Depending on the design of your hive, you might consider elevating the back of your hive slightly, so any rain that falls will drain away from the hive, and not into it.

Some bottom boards have screen floors. These can improve ventilation, and are also used for pest control. One of the worst enemies of your honey bees are parasites called **varroa mites**. These mites occasionally fall off of bees, and will pass through the screen, and be unable to climb back up into the hive. It doesn't get rid of all the mites, by any means, but they do seem to help some. These types of bottom boards can also be fitted with a shallow tray underneath, which can be used to combat another hive pest, the **small hive beetle**. The pesky little beetles are a small invasive species that has made it here form Africa, and can cause a lot of damage in our hives. Placing these trays under our hives, filled with mineral oil or soapy water, can help to eliminate some of these pests. We will discuss pests, pathogens, and diseases in detail in an upcoming lesson.

At the front of our hive we might use a **reversible entrance reducer**. This simple device is just a strip of wood, with various sized notches cut into it. We can use it to close up the bee hive completely, or to restrict the entrance to a very small opening, so that a weak colony (one with a small population) can better control access to the inside of the hive. We can turn it to provide a larger opening as the population increases, or we can remove it altogether.

Above the bottom board we begin to add our **hive bodies**. A hive body is just a wooden box that makes up a part of the bee hive structure.

In the wild, honey bees typically organize their nest with surplus honey stored near the top of the cavity, and raise their brood down below it. As beekeepers, we should try to arrange our hives to mimic this natural organization.

The lowest box, or hive body, on our hive is called a **brood chamber**. This is where our queen bee is usually found, laying eggs, and where the bee larvae, called **brood** will grow and develop.

The queen bee is a larger than the workers. When you see her, the difference is obvious, but often she may be difficult to spot because there can be anywhere from 20,000-60,000 bees in a hive, all moving around, and possibly covering the queen. It's helpful to mark our queen bees with a small dot of paint. This makes her obvious, and also lets us know if she has been naturally replaced by the colony.

The queen bee's main job is reproduction. She is the only bee capable of producing fertilized eggs that become new worker bees, which ensure the continued survival of the colony.

When the queen lays an egg, she sticks it to the back of the cell. After about 3 days, it hatches to become a bee larva. Young workers, called **nurse bees** immediately begin to feed the larvae with a nutritious jelly-like substance that they secrete from special glands. This jelly is rich in proteins, amino acids, carbohydrates, vitamins, and other nutrients – everything a growing bee needs. The nurse bees, will continue to provision each brood cell with jelly for about three days, after which they will change the growing larva's diet to a mixture of pollen and nectar we call **bee bread**. On about the 6th day of development, the workers "cap" the brood cell with a wax lid, and the larva will spin a cocoon inside and pupate. They go through complete metamorphosis – just like a caterpillar turning into a butterfly! These will grow their legs and wings, eyes and antennae, and other parts they need. About 21 days after the queen bee lays the egg, a mature adult worker bee will chew her way out of her cell and emerge to begin her life as part of the colony.

The area where the queen is laying eggs is called the **brood nest**. Around the brood nest, the workers store the bee bread so it is convenient for them to feed it to the developing larvae. It's

common to find a little bit of honey across the tops of the brood frames as well, to provide a little food for the worker bees.

That all happens here in the brood chamber. A new colony may start out with just one hive body. As the colony grows, we can expand the space they have, to give them more room for food and for brood.

A standard deep brood frame has about 80 cells across, in about 42 rows. If fully drawn out, that gives the bees 3,360 cells on each side of a single frame, and in a 10-frame deep hive body, there could be well over 67,000 cells for the queen bee to lay eggs and the bees to store food.

Estimates vary, but a healthy queen bee is said to be able to lay well over 1000 – or even as many as 1500 or more eggs per day. Even at that rate, a queen will need just over 30,000 cells for brood – about half the number of cells available in a deep hive body. The rest of the space will be used for storing food – both pollen and honey – which will be convenient to the nurse bees caring for the brood and for their queen. And the queen honey bee requires a lot of food to maintain such a high rate of egg production.

Above the brood chambers, we place boxes we call **honey supers**. They get their name because they are in the "superior" positon, the Latin word meaning "above." In the spring, when flowers start to bloom in abundance, beekeepers will begin to "super" their bee hives in anticipation of a good honey crop. In Arkansas, this period, called the **honey flow** or **nectar flow** usually begins around the middle of April, but can vary by a few weeks (earlier or later), depending on your specific latitude and the weather we have from year to year. Talk to experienced beekeepers in your own area to get a reliable estimate of when the honey flow in your own part of the country usually begins.

These honey supers are where the bees store surplus honey. Depending on your location, time of year, and the floral resources available, beekeepers add additional supers as the bees fill them, and their hive requires increased space. Supers are removed when it's time to harvest the honey. The hive is consolidated to a smaller size as we get closer to winter, with just room for the brood nest and enough honey to last them through the cold months. Next spring we can begin adding supers again.

Sometimes the queen may wander up into the honey supers and begin laying eggs. We don't want this to happen, because we don't bee brood mixed in with out honey. To prevent this, some beekeepers employ a device called a **queen excluder**. The queen excluder is placed above the brood chambers, and the honey super is placed on top. The spacing in the queen excluder allows a worker bee to pass through, and deposit honey in the combs above, but restricts (or excludes) the larger queen, who doesn't fit. Many beekeepers don't like queen excluders, and some call them "honey excluders" because they feel that these screens discourage the workers from squeezing through to deposit honey above, and will be more inclined to deposit it in cells below, which can crowd the brood nest with honey. There may be some merit to this idea, but during a strong honey flow, the bees will usually be busy enough that they will still move through it. There are several kinds of queen excluders. They may be plastic or metal, but they all work the same. One of the best queen excluder you can have is a full super! Once the bees have filled a super with nectar (it doesn't even have to be fully ripened honey), then you can usually remove your queen excluder. Your queen bee knows that her workers normally start to fill honey cells at the top of the hive and work down. If she wanders up, looking for empty cells, and encounters combs full of honey, she will

usually go back down below, because she will be thinking like a bee, and assume that there is honey all the way to the top of the hive. If you have a full super, and still plenty of time left in the honey flow season, you can remove your queen excluder and add an empty super on top, so your bees have easy access to it, and your queen will probably never find it.

Above the supers a Langstroth hive has two lids. There is an **inner cover** and an **outer cover**. The outer cover, or **telescoping cover** is there to keep the weather out. Some are made from wood, and clad with metal, and last a very long time. You can also find lids made from plastic or polystyrene foam. Don't set your hot smoker on top of one of these while you are working in the hive next to it! As heavy as they are, it's possible for a hard wind to get under the edge of these and flip them right off, potentially exposing your bees to a cold winter storm. So if your hives are out in the open, or sit on an exposed hilltop, place a brick or heavy stone on top of the hive to keep the lid down tight.

The **inner cover** provide an insulating airspace, and helps prevent condensation from forming and dripping directly down onto the bees in the winter. It also makes removing your telescoping lid a lot easier. Remember that the bees will try to seal up cracks and crevices. They will often seal the lid on tightly with propolis! If they glue your heavy outer cover on, it can be very difficult to pry it up sometimes. But with an inner cover in place, the outer lid will come right off, then you can use your hive tool to pry up the inner cover. Notice that many inner covers have a right and wrong way to go on your hive. If the lid is flipped over, it may leave to much space – more that the **bee space** – which encourages the bees to build lots of **burr comb** between the tops of the frames and underside of the lid. Also, if you flip over your inner cover, you will soon have propolis on both sides, and it may become stuck to the inside of your outer cover, as well as being glued down to the top of your hive!

Where can you get bee hives? There are a number of reputable beekeeping suppliers that will ship your equipment directly to you. They all have websites and most will still send you a paper catalog if you prefer. Wooden bee hives are bulky, and can be quite heavy, so take advantage of special deals to help you save on shipping for your initial purchases. There may also be a local supplier near your home. If you're not sure, visit with the friendly people at your local beekeeping club for suggestions on where to make purchases.

You can purchase bee hives pre-assembled, with frames and foundation already installed. You can also start with a **knock-down kit** that contains pre-cut/pre-drilled lumber. These usually have a moderate price and are easy to assemble. Do make sure you put them together with the handholds on the outside. They are a lot easier to carry that way!

If you have the time and tools and skills to do your own woodworking, you can build most of the essential beekeeping equipment yourself. Just be sure to start with a good set of plans and measure all of your components very precisely. Over the years, your beekeeping equipment will tend to get mixed up, so it's very important that all of your boxes and frames are made to the same industry-standard sizes so it all fits together flawlessly. There are a number of books and websites with excellent blueprints available. Your local County Extension office or other beekeepers may also be able to provide you a set of good plans.

You can build your own **frames**, but they require a lot of very precise cuts, and can be very time consuming. If you need a lot of frames, it might be more cost effective to buy them in bulk and just assemble them yourself.

Hive bodies need to have good strong, tight corners to keep out the weather and to prevent unwanted pests from sneaking in. These boxes will be outside for years, and the wood may try to swell, warp and twist. You should use high quality carpenter's glue at every joint before you nail the boxes together. Strong finger joints, glued and nailed in both directions will remain solid for many years. If you are building your own hives from scratch, consider rabbet joints, which can be strong, and reduces the amount of end grain exposed to moisture. Simply tacking together some planks will usually not last long, as the wood will likely begin to pull apart at these corners.

Paint every hive to protect your investment! Thoroughly painting over the end grain will help to keep the wood in good shape. A coat of primer will help the paint stick to the wood. And you can use either latex paints or oil-based exterior paints. Paint all the exterior surfaces, but don't paint the inside of the hives. Remember that your bees will coat the inside with a thin layer of propolis, which will protect the wood and help protect the bees. You can often find bargain prices on high-quality brands of paints at your local hardware store or home-improvement center. Look for a shelf of paint cans that were mixed for customers who did not like the results. They will often be set aside and marked down for half-price. If you don't care what color your bee hives are, remember that your honey bees don't really care either. They live in trees and all kinds of places!

If you are feeling particularly artistic, you can certainly use your hives as a canvas for self-expression, but over the years, your equipment will likely get mixed and matched as you need it, and many apiaries wind up with quite an assortment of colors.

Winter can be a great time to check your inventory, when some of your hive bodies may be empty, you can repair and repaint them, so they are ready to go for the new spring season, and you can trade out fresh boxes with older ones that might need a little bit more work.

The **frames** hold the honey combs in place, and make it possible to remove, inspect, rearrange, and replace them without destroying them. Our ability to easily manipulate individual combs was part of the revolution in beekeeping that the Langstroth type of hive design made possible and practical.

You can buy frames assembled or do it yourself. It's not difficult, but it can be repetitive if you have a lot of them to do at once. But if you assemble them properly and take of your equipment, your frames will last you for many years, so it's worth it to take your time and do it right. There are different types of frame styles, meant to hold different types of foundations. The main difference is the design of the top bar and bottom bar. Plastic foundation usually snaps into grooves in the top bottom and bottom bars, while beeswax foundation usually hangs down from the top, where is secured by a thin strip of wood called a wedge, and the bottom bar may be split all the way through.

Modern bee hive frames are **self-spacing** to maintain the appropriate bee space. The end bars are wider than the top bar. When they are pushed together tightly, they should provide an ideal space for the bees to build their honeycombs and leave the proper bee space in between each pair.

If we are careless in how we place the frames, and leave a wide gap, the bees often respond by drawing combs perpendicular to the foundation, or parallel to it, but only attached to the wooden top bar. Or they may draw unevenly, with some parts thicker than others, while matching the contour on the adjacent frame. They still leave a bee space between the combs, but now these two combs really only fit next to each other. If you ever move them around, the bee space will be incorrect, and this may cause the combs to get crushed, or they may build more poor comb next to these.

Encouraging your bees to draw good combs is a very important first-year task for new beekeepers, as the quality of these new combs can affect comb-building for many seasons to come.

Even if you plan to use **9 frames in a 10-frame honey super**, you'll get the best results if you place all 10 frames in the super while bees are drawing the comb. Later, once they are drawn, you can remove one, and space the remaining 9 frame evenly within the box. There are tools available to help you with this, but if you give a box a shake, they generally shift into place, as long as the frames or frames rests aren't thick with propolis.

Assemble frames with glue first, then nails. Using a good at every joint will make the frames last much longer! Put in either 1 or 2 nails, vertically, in every corner. You can hammer them in, or if you have pneumatic nail gun, it will be make the job go much faster. You can use nails or staples, but be sure to drive them in straight. It's very easy to shoot them out the side if you aren't careful. These nails will hold frames together, but another very important step is to add an anchor nail through the side bar, and into the top bar. After some time, when the bees have stuck their frames together with propolis, you may need to use your hive tool to lever the frames out with some considerable effort. These other nails are all put in vertically, and will eventually be pulled loose. This horizontal "anchor nail" through the side will take a lot of stress, and make your frames last much longer. If you have bought your frames pre-assembled, check and see if they have this nail. If not, it's definitely worth the effort to add one before you place these frames in your hives!

Sometimes the end bars are beveled on one side. This is because of propolis! Recall that the bees tend to seal any small gaps with propolis, and when there is a small space between frames, they will glue them together. Some colonies use a lot of propolis, and this can make removing frames difficult. Because this beveled edge doesn't leave much area for contact between the frames, the bees place relatively little propolis here, and that seal is easier to break. Some manufactures have begun cutting corners, by not cutting these corners, so this step may not apply to you. But if your end bars are beveled, take care when assembling your frames, and position the end correctly. Don't face them all the same direction, because you will often turn frames around. Face each pair in opposite directions on every frame, and be sure to do so identically for all your frames. It's a small step, but it can make your job as a beekeeper a little bit easier.

Traditionally the wooden frames were **wired** to provide extra support and strength to the wax honeycombs – especially during the extracting process. The end bars of the frames are pre-drilled with holes for the wires. Brass eyelets are often inserted to keep the wires from cutting into the wood. These eyelets and spools of galvanized wire are both available from most bee supply companies. Some beekeepers also use monofilament fishing line instead of wire. Secure the wire on a small nail, and run it continuously in 4 rows, then pulling it **tightly**, securing it to another small nail. Some beekeepers use only two strands, especially on medium or shallow frames, and other wire it in an "X" shape. Try to pull these wires as tight as you can. If they are too loose, the foundation may sag, which results in poorly drawn combs. A tool called a wire crimper can help take out some of the slack.

After the frames are assembled, it's time to install **foundation**. The foundation serves a blueprint for the bees' efforts, and provides them with a starting point to begin build their combs. The foundation becomes the center of the finished honeycomb, and when it is utilized properly, helps the bees build nice straight combs that are much easier for the beekeepers to manage without damage. Beeswax foundation is simply a sheet of beeswax that has been pressed with a perfect

honeycomb pattern on each side. The foundation is placed in the center of each frame, and the bees will recognize that this is beeswax, and will add more, drawing out the honeycomb pattern, making perfect hexagonal cells, about half an inch deep, on both sides of the frame. Once the combs are drawn out, the reinforcing wires become buried in the center, and resulting in a much stronger comb.

The bees often draw out cells on more than one frame at a time, leaving the appropriate **bee space** between the combs. As long as the foundation is flat and even, the surface of the resulting comb is very even, and the frames with drawn combs can be removed and replaced without damaging the combs or harming the bees. However, if the foundation is warped, sagging, bent or broken, it can result in very poorly drawn combs. These may be very deep on one side, but so shallow on the other side that they are of no use to the bees.

Crimped wire beeswax foundation has thin, zig-zagged strands of wire running vertically though it. Combined with the horizontal wires we install in the frames, the resulting drawn combs are well-reinforced. This type of foundation is made to go into **wedge-top frames**. There will be a small strip of wood on the underside of the frame's top bar that pops right off with your hive tool. You may need to shave off tiny bits of wood that's left behind.

Place the sheet of beeswax foundation across the horizontal wires that we added, and replace the wooden wedge, securing it with a couple of short tacks or small brads. It's often easier to put a couple of small nails into the strip before you hammer it into place. This strip of wood will hold the foundation in place until the bees draw the combs out, securing it all around the frame. The final step is to **embed** these added wires into the beeswax. Support the foundation from below, with a short board, and use a tool called a **spur embedder** to push the wires into the foundation. This keeps the foundation in place, and helps the bees to build right around it.

You might notice that the queen doesn't like to lay eggs in the cells right above these wires at first, leaving noticeable lines of empty brood cells, but don't worry: the workers will soon cover the wires in the bottoms of the cells and the queen will eventually use them all.

Wiring a lot of frames can be time consuming, so some beekeepers don't cross-wire the frames. Instead, they insert **support pins** into the holes in the sides of the frames, which grip the sheet of foundation on its edges. The bees draw the comb around them. This method can work if the bees draw it out right away, but if the foundation sits for a long time in a warm environment, such as a shed or barn, or even in a warm hive, it may begin to sag in the middle, before the bees draw it out, and can produce uneven results.

Many beekeepers choose **plastic foundation** for their frames. These are flat sheets of plastic, molded with the same hexagonal cell pattern that gives the bees a uniform place to begin drawing comb. They may be sold as plain, unwaxed plastic, or with a with a beeswax coating. Unless there is a strong nectar flow happening, honey bees may be reluctant to draw combs directly on a plastic surface; or they may start at the top, but are reluctant to finish out the whole frame. Painting this foundation with a thin layer of melted beeswax covers up this unnatural surface and mask its odors. Spraying new foundation with a simple 1-to-1 sugar syrup just prior to placing into the hive, also encourages bees to lick the sugar up, which spreads their own "footprint" pheromones across the foundation, and gives them some extra carbohydrates that they'll need to secrete beeswax. This helps them to more readily accept the plastic foundation.

Plastic foundation is typically used in frames that have grooves cut into the top and bottom bars. Gently flex the plastic foundation and pop it into these grooves, which should hold it securely. You may notice that some plastic foundation has a perforated line diagonally across the corners. This is so you can easily snap off the bottoms corners before you install it in the frames. This allows the bees to maintain a "communication hole" that allows them easy access the other side of the frame. In the wild, bees build the honey combs with a natural U-shape, with a rounded bottom. They often chew a hold in the corners of beeswax foundation to give themselves this access. Some types of plastic foundation may come with these holes already formed.

Without foundation in place, using frames is essentially useless. Your bees will build combs in the empty space in the box, separated by a bee space, but you will not be able to slide the frames out without destroying the combs. If you leave an empty box (with no frames at all) on a hive long enough, the bees will also build comb from the underside of the lid, preserving the bee space between them, but it cannot be easily inspected or harvested by the beekeeper.

If we accidently leave a frame or two out of a hive when we close it up, the bees will readily respond by building new comb to fill that space. These combs should be removed, and the frames replaced as soon as they are found. If the new comb is filled with nectar, it can left outside for a day and the bees will lick it clean.

If you plan to harvest comb honey, sections of sealed honey combs right out of the hive, you obviously can't use plastic or wired foundation. For this you can purchase wireless beeswax foundation. It may be called **cut comb** or **thin surplus** foundation in your supply catalogs. This is usually meant to be used in wedge-top frames, which will hold it until the bees draw it out. Because it is extra thin, it is easy to bend or break, so be careful handling it – especially if it's cold. There are also a number of kits available for producing uniform sections of comb honey for sale. Some people like to include a small section of sealed honey comb in a jar of liquid honey – this is known as "chunk" honey.

Beekeepers can encourage bees to build straight combs without installing any foundation, by utilizing a **comb guide**. In the wild, when honey bees move into a cavity such as a hollow tree, they seem inclined to follow some natural ridge when they begin building their first comb. Additional combs are then built parallel to the first, with the **bee space** left between. Once combs have been started, the bees continue to build them straight down, eventually to the bottom of the available cavity. If combs are built crooked, they would bend or break once they are filled with heavy honey. Beekeepers can provide empty frames with **comb guides** to encourage the bees to begin building in a straight line, and rely on the bees to continue the combs straight down. For **foundationless beekeeping**, the top bar of the frame could be crafted with a bevel, like a "V" with a ridge that points down. Rubbing this edge with beeswax will encourage the bees to begin working along this edge. If you are using standard frames, you can insert a flat piece of wood, such a tongue depressor or popsicle stick into this groove. You may need to add a bit of melted wax to secure it. Rub this down with additional beeswax to encourage the bees to notice it. You can also take standard sheet of beeswax or plastic foundation, and cut it into short strips, about an inch or two tall. Secure these strips in the top of the frame to encourage the bees to begin building. Again, if you use a strip of plastic foundation for this, coat it with beeswax to get the bees to accept it more readily.

For best results, add foundationless frames into the hive between two frames that already contain flat, even, perfectly-drawn combs. This encourages your bees to draw another comb in between,

starting along the comb guide you provided, and out to both sides, and leaving a nice even bee space that matches the existing comb surface on each side.

So… what kind of foundation is best? What style of frame? What size of hive bodies should you use? These are all matters of opinion. And you are certain to find that beekeepers are very opinionated about their equipment choices and management styles. There are pros and cons to every choice and every combination of equipment. If this is all new information to you, then take the time to visit with experienced beekeepers at your local club or association and ask them to share their insights and experiences about the equipment that they use in their operations, before you invest a lot in your new purchases.

Beekeepers in the U.S. use mainly type Lansgstroth Hives. The commercial honey industry relies heavily on these standardized sizes of hive bodies and frames, so the majority of honey processing equipment and tools are geared for these types of hives. But there are many **other types of bee hives** that you can use. While some may not be as suitable for large scale production, they can be perfectly suited for backyard or hobbyist beekeeping.

Top Bar Hives are gaining popularity in the U.S. These hive provide a cavity for the honey bees, with strips of wood used for the top of the hive, as the name implies. Honey bees build their combs, without foundation, hanging down from each of these "top bars" which can be lifted out and inspected individually. Archaeological evidence suggests that the concept has been used in ancient Greece as far back as the 3rd century B.C., but for some reason had not been widely adopted. Since the 1970's their design has been adapted and refined, and their use has been encouraged in developing countries, as a transition between traditional log-hives and modern moveable frame hives. This low-tech method of beekeeping allowed for continual non-destructive harvesting of honey, without heavy lifting or the need for specialized equipment. And construction of these hives can be adapted to local resources without a big investment in specialized tools or milled lumber that may be difficult or expensive for some people to acquire.

The most common types are **Tanzanian Top Bar Hives** – with straight sides – or **Kenyan Top Bar Hives** – with angled sides. Because a honey bee's comb is naturally rounded on the bottom, bees seem to consider these slopes sides as part of the floor, and tend to avoid attaching the combs to the sides or bottom of the hive, making each comb easier to remove.

The hive itself is essentially a horizontal box, with uniform strips of wood laid across the top. Each of these **top bars** should have a **comb guide**, rubbed with beeswax. The bars may be cut with a V-shaped bevel on the underside, or have a strip of thin wood fitted into a groove. Short starter strips of foundation could also be used, or a small piece of comb can be pressed onto the comb guide to encourage more comb building. A **follower board** is cut to fit precisely inside the hive. This is used to control the volume of the hive available to the bees. As they build combs, and the bees need to expand their nest, the beekeeper simply moves the follower board over, adding more empty top bars for the bees to build onto. When these empty top bars are positioned between two flat, well-drawn combs, the bees should draw another new comb in between, precisely matching the contours of the combs, and leaving a bee space in between. Poorly drawn, crooked combs, and any that are build spanning more than one top bar should be removed immediately to correct the bees' efforts. Otherwise, they continue to build additional combs crosswise to the top bars. Because these combs are only attached to the bars on one edge, they are necessarily fragile, and care should be taken to remove and handle them gently. Combs full of honey can be very heavy – weighing 5 or

more pounds – and the beeswax will be fairly soft when warm from being in the hive with the bees. Always carefully hold the top bars so combs are vertical, or they may break off if tilted at an angle.

To harvest honey from a top bar hive, simply remove a comb once all the cells have been fully sealed by the bees, and cut it from the top bar. It can be served just as the bees produced it, as comb honey, or crushed and strained to separate the honey from the beeswax. Compared to a Langstroth hive, this style of beekeeping tends to produce less surplus honey per hive, but provides the beekeeper with more beeswax to harvest, which has countless uses. And a single hive can still supply plenty of honey for one household, as well as providing adequate pollination for gardens and small orchards.

You can find some very expensive and elegantly designed top bar hives offered for sale today. But this style of beekeeping was intended to be very economical, with do-it-yourself simplicity of design. Many books and internet resources can provide you with an array of different blueprints and plans for building your own top bar hives. The only critical dimension for these hives is the width of the top bar. It should be 1 3/8 inches wide or 1 1/2 inches wide. This give room for a honey comb to be centered on each bar, with half of a bee space on each side. Tthe other half of the bee space is on the adjacent bar. You can find great variation and debate over the merits of the suggested length, width and depth of these hives, as well as the angles of the tilted sides and the orientation and size of the entrance and other details. Some beekeepers will construct these hives so that the top bars are 19 inches long – the same length as Langstroth frames – so that they have the flexibility to transition the honey bees from one type of hive to another in the future.

A **Warré hive** combines elements of a top bar bee hive and a vertically stacked modular bee hive. It's named for its inventor, the French monk Abbé Émile Warré. He loved bees and fresh honey, but considered beekeeping methods using the hives of his day, such as skeps, to be too destructive to the bees, or the Langstroth hives, too cumbersome and expensive for many people. For many years he studied the way honey bees nested in natural tree cavities, and eventually developed a design he called **The People's Hive** in the early 1950s. His goal was to mimic the way bees organized their own natural nests, with a focus on simplicity and ease of management for a beekeeper, while being economical to build.

Warré's design consists of multiple stacked boxes, each with top bars. These bars should be crafted with a comb guide underneath. And each top bar is just wide enough for a single comb, and may be set into a notch to keep them precisely spaced so that a proper "bee space" remains in between each, allowing the bees to travel up and down between boxes.

A swarm can be introduced into one or two boxes. As the bees draw out their own combs, they will begin to organize their nest as they please. This usually means they will store honey toward the top, with brood reared below. Once the nest is established, additional empty boxes with top bars are added at the **bottom** of the stack. The honey bees will continue to grow their nest downward, building more combs. As the upper boxes fill with honey, the queen tends to migrate down, onto the new comb, to lay eggs. When the upper box is completely filled with capped honey, it can be removed. Each comb is cut from the bars, which are replaced, and the now-empty box is moved to the bottom position. Another box of honey can be harvested as soon as it is ripened and capped. Experience will teach the beekeeper how much honey to leave on the hive for a typical winter in any given climate. Honey harvested in this manner can be served as comb honey, but it better when combs are crushed and strained. By the time these boxes have been rotated from bottom to top and

harvested, the combs have had multiple generations of brood reared in each cell, and will tend to become dark in color, reinforced with propolis, and likely have pupal cocoons imbedded in the walls of cells. It's better to separate the honey from the combs, and clean the beeswax for other uses.

Horizontal Hives have been used traditionally in Russia and Europe. They are sometimes also called **Layens hives** after French botanist and beekeeper Georges de Layens who popularized this style of hive in the 19th century. It consists of a single large hive body, often with 12 to 30 frames, and up to twice as tall as a standard Langstroth deep frame. The hive has thick walls, so it provides increased winter insulation. Because the entire hive is contained in a single large box, there is rarely anything heavier to lift than the lid or a single frame. The frames for these hives may be foundationless or fitted with starter strips, with self-spacing top bars that often touch to prevent bees from moving upward between them. These large frames give the queen room to expand her brood area without limits. The bees still place honey above the brood nest, but also to both sides. The honey on the sides can be removed later for harvest, while the honey above the brood area is consumed by bees during the winter. Depending on their size, frames can be extracted if they have been wired for strength, or the honey can be harvested as sections of sealed comb. Numerous construction plans, ideas, and specific management tips for this type of hive can be easily found online.

There are many other types of bee hives in use, and many different beekeeping techniques, just as there are many types of beekeepers. It's likely that some of these hive styles may not be as common as Langstroth hives in a particular area, so beginners may not be able to find local mentors with much experience in the use of some hives or techniques. However, there is a growing body of resources, including books and websites, and online forums where users can ask questions, share their knowledge and learn from each other. Honey bees are highly adaptable, and can make themselves at home in just about any suitable cavity. Bee hives are mainly for the convenience of beekeepers. None of them are perfect for everyone. Don't be overly dogmatic about a particular hive style. Be a pragmatic beekeeper and choose a type of hive that will work for you and meet your beekeeping goals.

In our next lesson we'll look at some of the other important tools and beekeeping equipment, and how and why we use them.