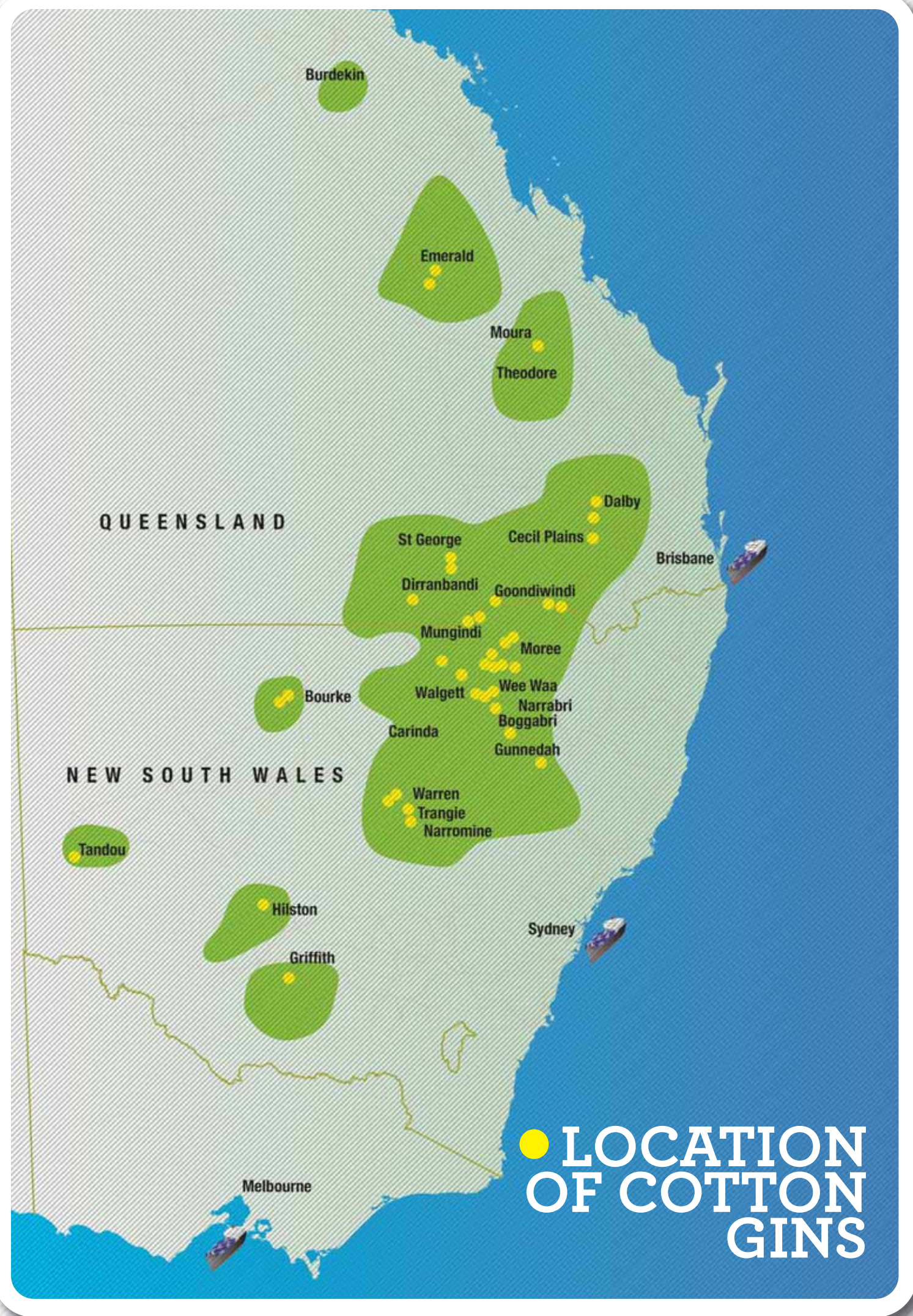


CHAPTER 7

Processing: from Gin to Fabric



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Cotton gins like this one are mostly located in cotton regions to cut transport costs

GINNING

Cotton gins are factories that complete the first stage of processing cotton – separating the lint from the seed. Gin is short for en-“gin”. In Australia gins are located in cotton areas to avoid costly transport.

Before the gin was invented, the lint and seed were separated by hand. It took one person a whole day to separate only half a kilo of the lint from the cottonseed. Modern gins can separate and bale about 230,000 kilograms of cotton in one day.

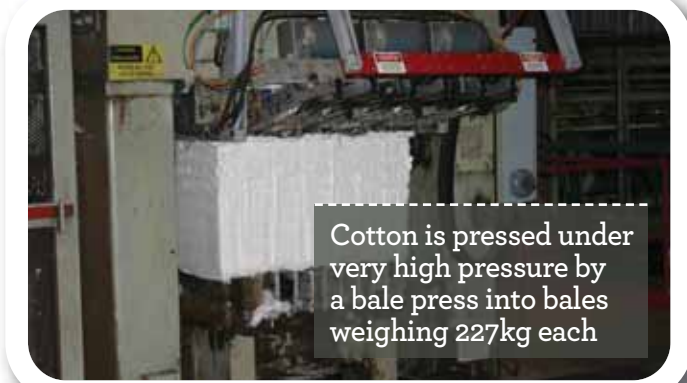
THE GINNING PROCESS

The seed cotton arrives at the gin in round bales or modules.

The first step in the ginning process is where the cotton is vacuumed into tubes that carry it to a dryer. Cotton must be ginned with a moisture level of 5%. The cotton is dried out if it is too wet or water is added if it is too dry to ensure the correct moisture level. Next, the cotton goes through several stages of cleaning equipment to remove leaf trash, sticks, dirt and other foreign matter.

After cleaning, the cotton is then ready for separation in the gin stand. The gin stand removes the seed from the lint. In Australia, most cotton is ginned with saw gins where fast moving circular saws grip the fibres and pull them through narrow slots.

The raw fibre, now called lint, has any remaining trash removed and makes its way through another series of pipes to a press where it is squashed into bales under very high pressure. Each bale weighs 227kg. Samples are taken from each bale for classing and the bales are wrapped in stretchy white cotton fabric to protect the lint. They are now ready for transport to one of the ports for shipping into overseas markets.



Cotton is pressed under very high pressure by a bale press into bales weighing 227kg each



Gin is short for en-“gin”



Cotton being fed into the gin
photo by Andrew Patton

PRODUCTS FROM GINNING

WHEN THE SEED COTTON IS PROCESSED IN THE GIN, THREE PRODUCTS RESULT — COTTONSEED, LINT AND TRASH.

SEED

THE SEEDS MAKE UP ABOUT 55% OF THE SEED COTTON WEIGHT THAT COMES FROM THE FARMS. THEY ARE VERY VALUABLE AND ARE USED FOR A VARIETY OF PRODUCTS SUCH AS OIL, PLASTICS, STOCK FEED, COSMETICS AND MARGARINE. THEY MIGHT ALSO BE USED AS SEEDS FOR THE NEXT COTTON CROP.



Fuzzy Seed

LINT

LINT MAKES UP APPROXIMATELY 35% OF THE SEED COTTON WEIGHT. ONCE THE LINT HAS BEEN SEPARATED IT IS COMPACTED INTO BALES FOR EASY TRANSPORTING. THE COTTON BALES ARE THEN MOSTLY TRANSPORTED DIRECTLY TO AUSTRALIAN PORTS FOR EXPORT TO OTHER COUNTRIES TO FURTHER PROCESS (SPIN) THE COTTON.



Bales of Lint

Cotton Lint
photo by Pete Johnson

TRASH

THE REMAINING 10% OF THE SEED COTTON IS CLASSED AS WASTE PRODUCT OR TRASH. COTTON FIBRE WASTE CAN BE USED IN ETHANOL MANUFACTURING OR IN PRODUCTS THAT CLEAN UP OIL SPILLS. IT CAN ALSO BE USED AS A FERTILISER.



Cotton Trash

PROCESSING COTTONSEED

Cottonseed is separated from the lint during the ginning process. Before the seed can be crushed for oil extraction or used for planting future crops, it must be delinted. This means removing any excess lint still attached to the seed. These final short fibres (linters) are used to make many industrial and domestic products.

After the linters are removed, the hull (the hard shell covering the seed) is removed. Inside the hull is the kernel – the really valuable part of the seed. To produce oil, the kernels are flattened using rollers and then cooked at very high temperatures.

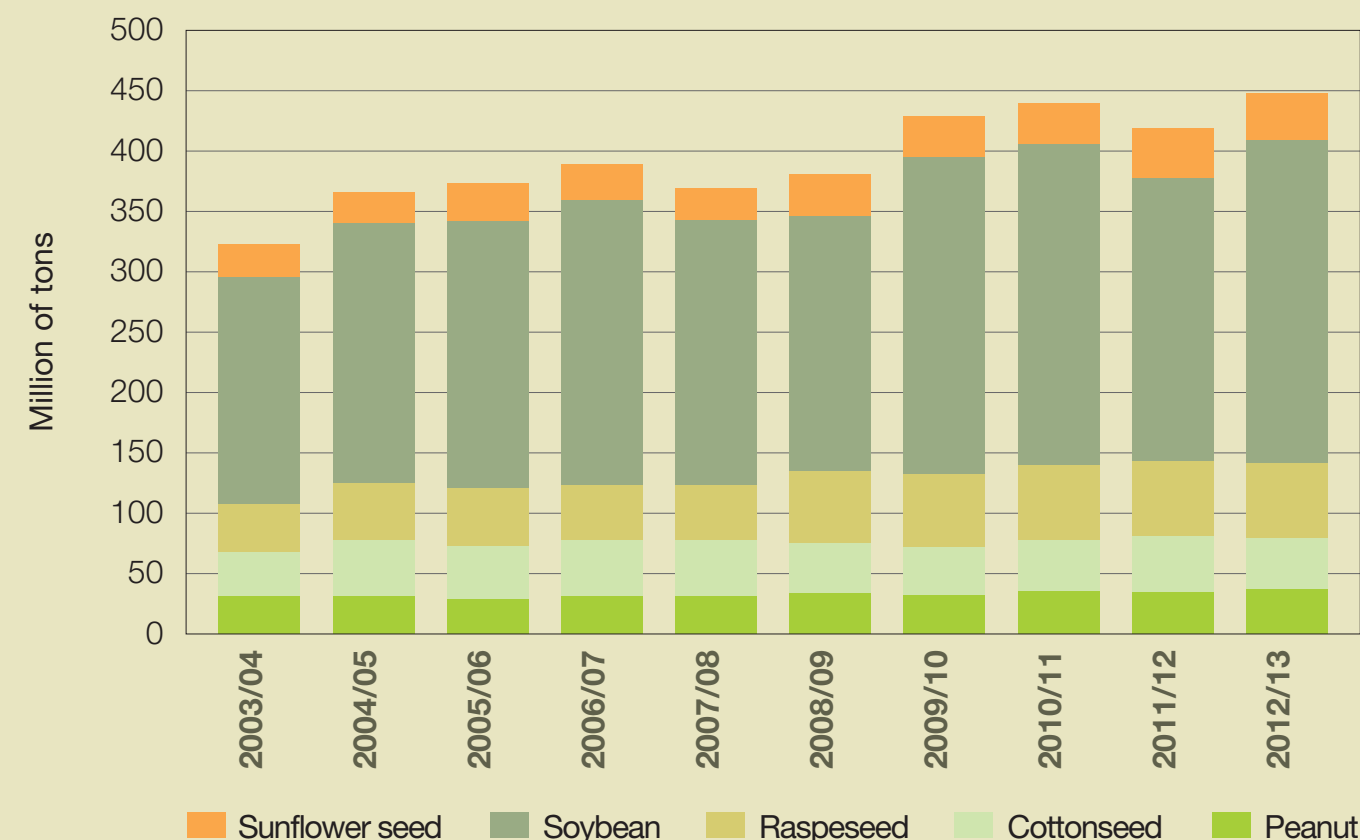
The kernels are squeezed and crushed and the oil flows out. This oil is then processed and refined further, turning it into a light yellow, tasteless, odourless oil. Cottonseed oil is used in the manufacture of products such as vegetable oil, margarine, soap and cosmetics.

The excess hulls and leftover kernels can be used to feed animals such as pigs, cattle and poultry.

COTTONSEED VERSUS OTHER OILSEEDS

World Oilseeds Production

source: USDA



CLASSING

AFTER THE COTTON IS GINNED, A SAMPLE IS TAKEN FROM EACH BALE AND SENT AWAY TO CLASSING ROOMS TO HAVE IT GRADED FOR ITS QUALITY. THE COTTON FIBRE IS SORTED INTO DIFFERENT QUALITY-BASED GRADES (OR CLASSES). THE HIGHER THE CLASS, THE BETTER THE QUALITY OF THE COTTON FIBRE, AND THE HIGHER THE PRICE THAT WILL BE PAID.



TRADITIONAL CLASSING METHOD

The more traditional method of testing cotton quality involves using specially trained 'classers' who manually examine the cotton fibres. This testing involves the classer taking a sample from each bale of cotton and assessing it by:

- Colour (bright or dull, white or grey)
- Trash content (the amount of stalk, leaf or dirt)
- Character (whether the sample has a smooth or lumpy appearance)
- Staple (length of fibre)
- Strength of the fibres

Manual classers still largely determine the leaf, extraneous matter and preparation grades of cotton.

MODERN CLASSING METHOD - HVI TESTING

High Volume Instrument (HVI) testing is a machine-based method that can quickly and accurately check the quality and exact value of cotton fibres. The technique originated in the USA and Australian companies have also contributed to the world's knowledge about HVI testing.

An HVI test print-out includes information relating to the following areas:

- Colour grade (relating to any visible impurities and the degree of whiteness)
- Length (the price of cotton is roughly proportional to staple length. Australian crops typically produce 28mm (1.15 inch) staple if irrigated, but shorter from a dryland crop).
- Micronaire (the fineness of the cotton that affects how quickly it can be spun)
- Trash and dust (the number of trash and dust particles that are in the cotton)
- Strength (if the cotton is stronger it can be used in smaller quantities)
- Length (fibre length)

At the end of the classing process each 227kg bale of cotton carries a classing description. This grade will decide whether the cotton is sold for a higher or lower price, known as premium or discount.



HVI Classing machinery can accurately test for a number of cotton quality parameters



SHIPPING THE COTTON TO MARKET

Once the cotton is ginned and pressed into bales it is loaded on to trucks and trains and sent to port for shipping, mostly to overseas markets. Over 99% of Australia's cotton is sent overseas, with only a very small spinning industry left in Australia – it's almost non-existent.



Australia is the fourth largest exporter of cotton in the world



Cotton is warehoused before it is shipped

The main ports for Australian cotton are in Brisbane and Sydney. The cotton bales are warehoused, and once they're sold and ready to be shipped are loaded into large shipping containers.

The main customers for Australian cotton are spinning mills located in south east Asia – China is Australia's largest buyer of cotton.

SPINNING TO PRODUCE YARN



Nan Yang Textile Mills

Historically, cotton was spun by hand using spinning wheels – this practice is no longer used to produce commercial quantities of cotton yarns, but the method is still practiced as an artisan craft by some.

Cotton arrives at a spinning mill in bales. Most often these mills process a range of different types of fibres including cotton and man-made fibres including polyester and nylon.

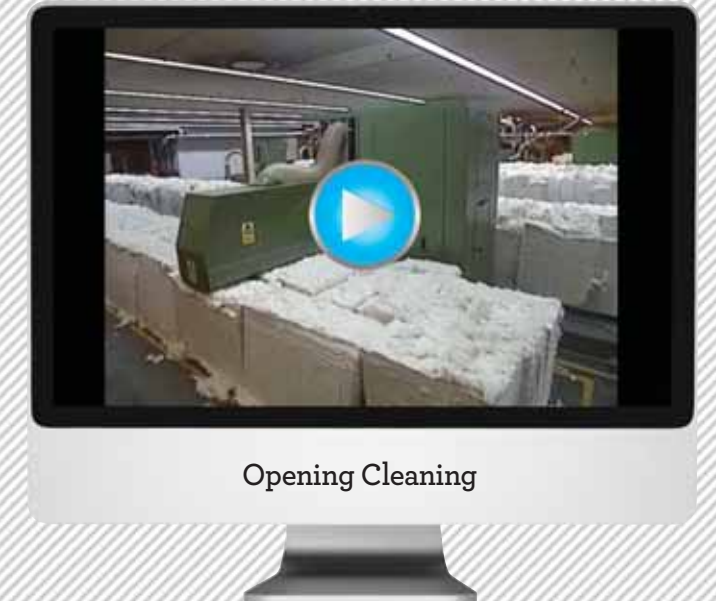
At the textile mill, the cotton is put through a number of processes, depending on the setup in the spinning mill and the desired quality of the yarn to be produced.



Cotton Carding Machine

1 OPENING, BLENDING AND CLEANING

The bales are laid down in a row (called a laydown), opened and blended through a range of machines. This ensures a consistent blend of fibres. The blended fibre is then put through more machines to loosen the fibre tufts and to remove leaf, sticks, boll parts, bark and seed fragments.



Opening Cleaning

2 CARDING

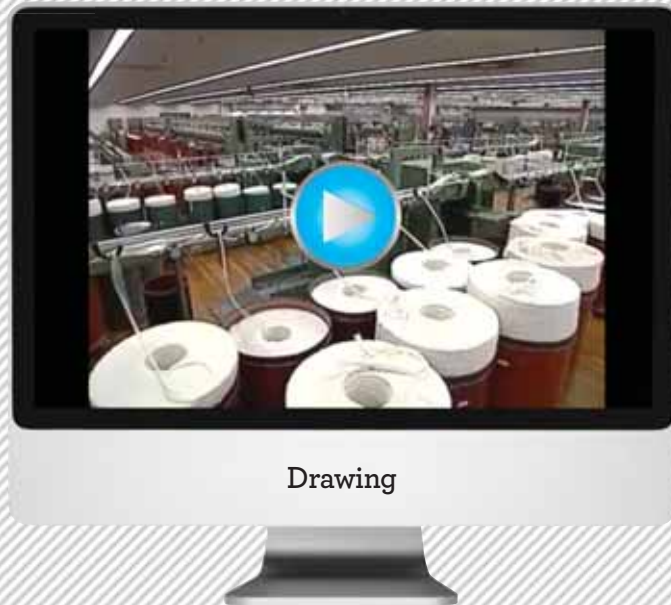
Next, the fibre is fed into a carding machine which is often referred to as "the heart of the spinning mill." The carding machine individualises, aligns and further cleans the fibres before pulling them into a single, continuous, loose rope called sliver.



Cotton Carding

3 DRAWING

Drawing is the process where the fibres are blended, straightened and the number of fibres reduced to achieve a desired density. It also improves the evenness of the sliver.



Drawing

4 COMBING

This process removes any final waste from the cotton and makes it finer, stronger, smoother and more uniform compared to carded yarns. Combed yarns are also more expensive than carded yarns because there's an extra processing step and there's more waste.

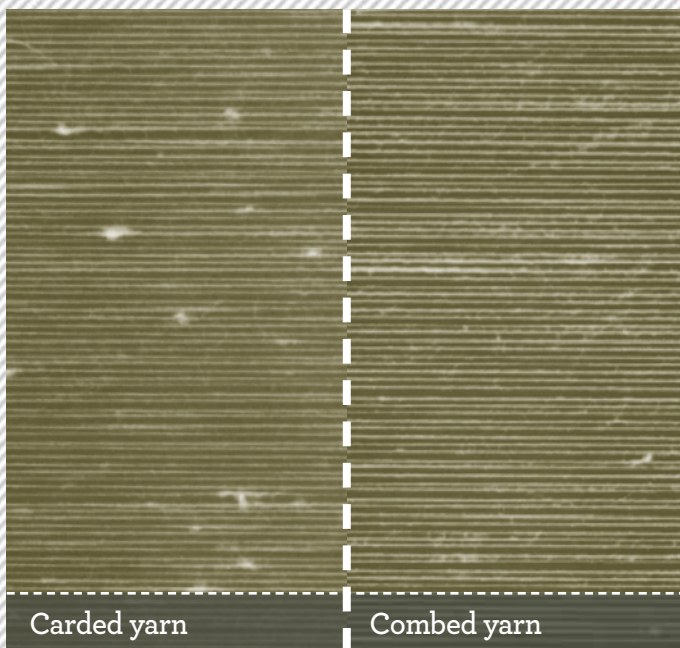


Photo courtesy of CSIRO and FIBREpak

Carded yarn

Combed yarn

5 ROVING

In preparation for ring spinning, the sliver is condensed into a finer strand known as a roving, before it can be spun into yarn. The roving frame draws out the sliver to a thickness of a few millimetres and inserts a small amount of twist to keep the fibres together. This is then wound on to a bobbin in readiness for spinning yarn.

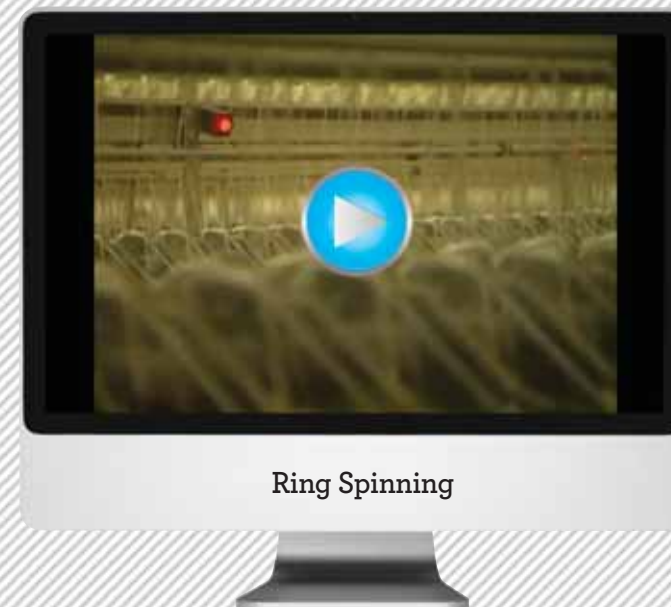
6 SPINNING

There are three main spinning systems used commercially to produce cotton:

RING SPINNING

Ring spinning was perfected as a process by the end of the 19th Century. There are currently 213 million ring spindles installed worldwide that account for about 60% of all short-staple yarn production.

Ring spinning draws out the roving and inserts a twist into the fibres by a rotating spindle and winding the yarn onto a bobbin simultaneously. It's a comparatively expensive process due to slower production speeds and additional processes.



Ring Spinning

AT THE TEXTILE MILL, THE COTTON IS PUT THROUGH A NUMBER OF PROCESSES, DEPENDING ON THE SETUP IN THE SPINNING MILL AND THE DESIRED QUALITY OF THE YARN TO BE PRODUCED.

ROTOR SPINNING

(also known as open-end spinning)

This was introduced in the mid-1960s. Today, there are over 9 million rotors installed world-wide which account for about 30% of short-staple yarn production.

Sliver is fed into the machine and combed and individualised by the opening roller. The fibres are then deposited into the rotor where air current and centrifugal force deposits them along the groove of the rotor where they are evenly distributed. The fibres are twisted together by the spinning action of the rotor, and the yarn is continuously drawn from the centre of the rotor. The resultant yarn is cleared of any defects and wound onto packages.



Rotor Spinning

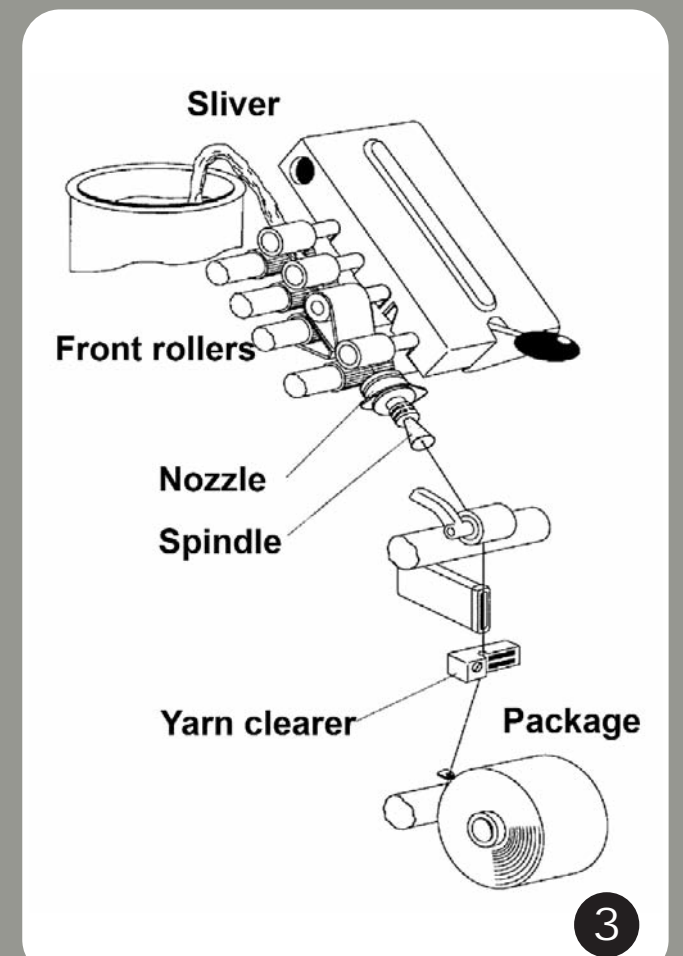
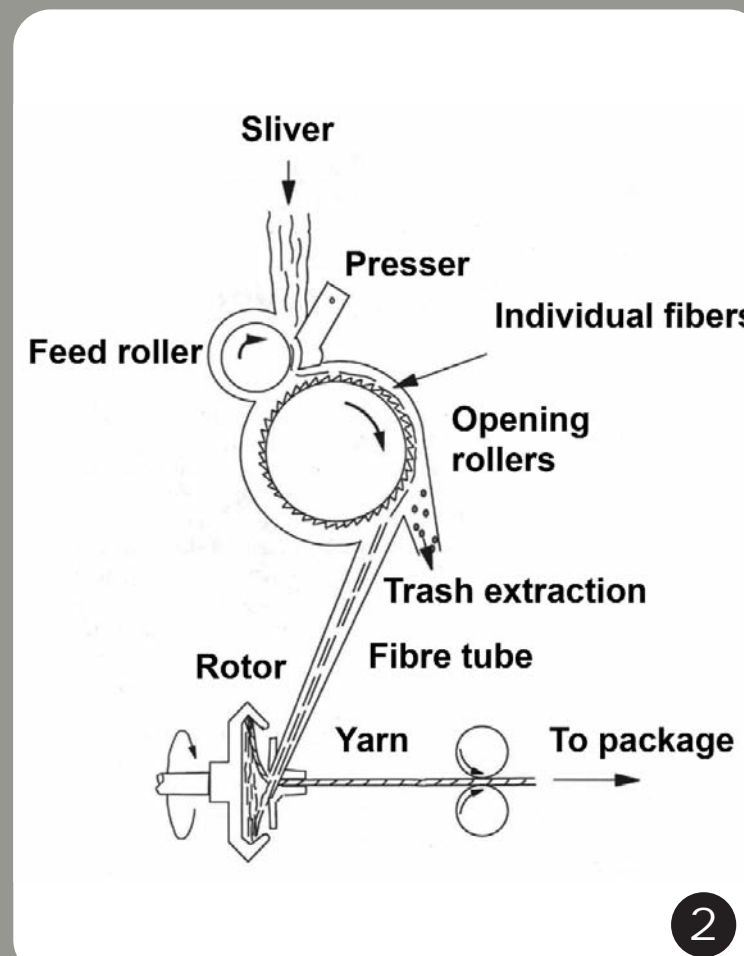
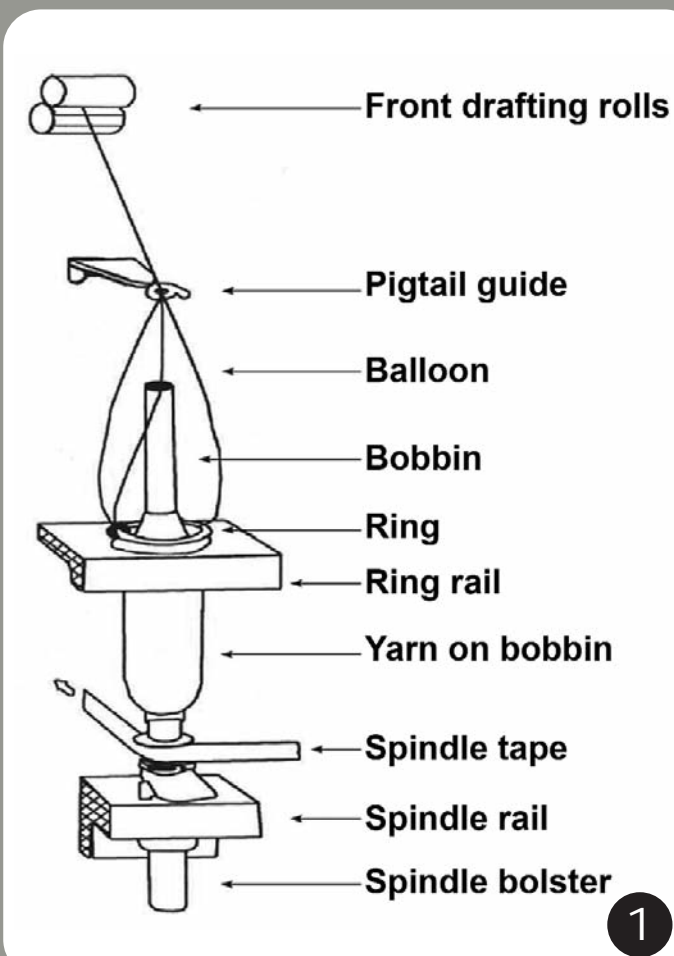
AIR-JET SPINNING

This was developed in the 1960s but was not commercially successful until the 1980s. There are currently about 500,000 airjet spinners installed world-wide.

Sliver is fed into the machine and is further drawn out to the final count and twist is inserted by means of a rotating vortex of high pressured air. The resultant yarn is cleared of any defects and wound onto packages ready for use in fabric formation.

(These spinning processes are summarised from the FIBREpak, a guide to improving Australian Cotton Fibre Quality)

Figure 1, 2 and 3 – courtesy of short Staple Manufacturing, McCreight, Feil, Bosterbaugh and Backe and FIBREpak



MANUFACTURING FABRICS

AFTER THE COTTON LINT HAS BEEN SPUN INTO YARN IT IS THEN WOVEN OR KNITTED INTO FABRIC.

Woven Fabrics

Weaving is the oldest method of making yarn into fabric. While modern methods are more complex and much faster, the basic principle of interlacing yarns remains unchanged.

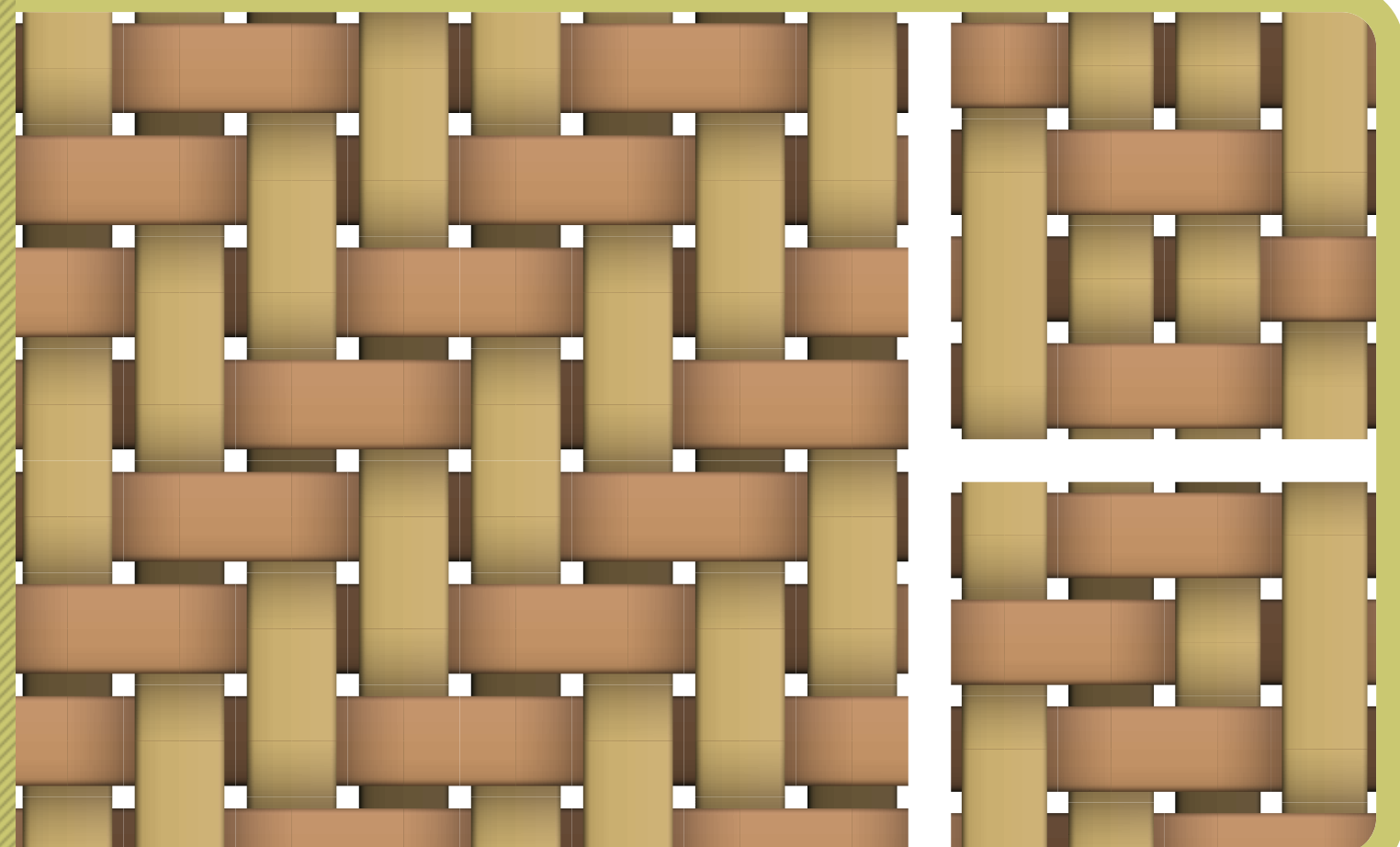
Weaving is done on a machine called a loom. Before the weaving can start, the loom needs to be set up with warp yarn. Warp yarn runs up and down the loom. Weft yarn is then woven (or sewn) over and under the warps from side to side. A torpedo-like implement at very high speeds does the weaving and can produce an almost endless variety of fabrics. Some of these machines carry the yarns

across the loom at rates in excess of 2,000 meters per minute! The resulting fabric is particularly strong.

There are three basic weaves with numerous variations, and cotton can be used in all of them. The plain weave, in which the filling is alternately passed over one warp yarn and under the next, is used for gingham, percales, chambray, batistes and many other fabrics.

The twill weave, in which the yarns are interlaced to form diagonal ridges across the fabric, is used for sturdy fabrics like denim, gabardine, herringbone and ticking.

The satin weave, the least common of the three, produces a smooth fabric with high sheen. Used for cotton sateen, it is produced with fewer yarn interlacings and with either the warp or filling yarns dominating the "face" of the cloth.



MOST FABRICS ARE FINISHED TO MAKE THEM LOOK AND FEEL MORE ATTRACTIVE. THIS IS THE FINAL STEP IN THE MANUFACTURING PROCESS.



Cotton is woven into long reams of fabric



Weaving

KNITTED FABRICS

Knitting fabric from cotton yarn is a simpler process than weaving. Knitting involves forming loops with one or more single continuous yarns and joining each loop to its neighbours to form a fabric that's stretchy, like t-shirt material.

Lengthwise rows of loops, comparable to the warp yarn in woven goods, are called wales. Crosswise rows, comparable to filling yarns, are known as courses.

Most cotton is knit on circular machines which have needles fixed to the rim of a rotating cylinder. As the cylinder turns, the needles work their way from stitch to stitch producing a tubular fabric.

Depending on the width of fabric desired, a modern knitting machine might use over 2,500 needles. The number of needles varies according to the type of machine used and the fabrics produced.

The flat knitting machine is another basic type. Designed with a flat bed, it has dozens of needles arranged in a straight line and produces a knit fabric that is flat, similar to woven fabric. A flat knitting machine makes over one million stitches a minute, and can be set to drop or add stitches automatically in order to narrow or widen the fabric at certain points to conform to specific shapes. Knitting machines can be programmed to produce a wide variety of fabrics and shapes.

FABRIC FINISHING

Most fabrics are finished to make them look and feel more attractive. This is the final step in the manufacturing process.

Cotton fabrics, as they come from the loom in their rough, unfinished stages, are known as greige goods. Most undergo various finishing processes to meet specific end-use requirements.

Some mills, in addition to spinning and weaving, also dye or print their fabrics and finish them. Others sell greige goods to converters who have the cloth finished in independent plants.

Cotton finishing processes are numerous and complex, reflecting today's tremendous range and combination of colours, textures and special qualities. In its simplest form, finishing includes cleaning and preparing the cloth, dyeing or printing it and then treating it to enhance performance characteristics.

There are literally hundreds of ways to finish off cotton fabrics to change its look and feel. More than one finish can be applied to a single cotton fabric and there are more innovations introduced all the time.

Some examples of cotton finishes include:

SCOURING	this process removes microdust
BLEACHING	this produces an off-white colour
GASSING	this produces a smooth finish to the fabric
STENTERING	this prevents the shrinkage and wrinkling of knitted or woven fabrics
SANFORISING	this prevents the shrinkage of woven fabrics
CALENDERING	fabric is given a final press to produce different effects
DYEING	colour can be added to the yarn or the fabric. Fabric can also be printed to apply colours and patterns
PERMANENT PRESS	this finish prevents the need for frequent ironing
WATER REPELLENCY	this finish ensures water is repelled not absorbed
FIRE RETARDANT	finishes such as cotton proban

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GENERAL STEPS IN MANUFACTURING COTTON TEXTILE GOODS



FIBREpak: A guide to improving Australian Cotton Fibre Quality



Fact Sheet: Processing, Exporting and Marketing Australian Cotton

CASE STUDY: THE STORY OF DENIM



A BRIEF HISTORY OF DENIM

Denim was first made in the 16th Century at a place called Nimes in France. The name 'denim' comes from the French words 'serge de Nimes' (fabric of Nimes). Indian sailors were wearing a similar fabric at about the same time. It is also said that Columbus was using denim sails when he first discovered America.

For a few hundred years denim was mainly used as durable work clothing. Around the 1940s denim started to be used in different clothing forms such as wet weather gear and sports clothes. It was not until the 1970s that denim started to become fashionable, particularly with American youth.



The making of Denim at Cone Mills
for Self Edge Jeans

JEANS

During the Gold Rush of the 1850s in the USA, a man called Levi Strauss, unsuccessful at finding his own gold, became rich by making denim pants for more successful miners. This is where the name Levi comes from.

Jeans however, were around a long time before Levi Strauss made his denim pants on the American Gold Fields. Jeans, like denim itself, go back to the 16th Century (about 400 years or so) when Italian sailors at the Port of Genoa wore denim trousers with a particular cut. The word 'jeans' comes from 'Genes', the French word for Genoa. Indian fishermen and sailors were wearing similar trousers called dungarees. Jeans were called "waist overalls" or "oweverall" before 1960 when Levi Strauss changed it to its popular name of "jeans".

The original jeans were a natural pale stone colour and not indigo (blue). Eventually the leaves of the Indigo fera plant were used to dye the fabric a deep blue.

While styles have changed dramatically jeans have shown remarkable resilience and over the years has become an expression of popular culture. In the 1960s flares, painted, stone-washed and marbled jeans were the rage. By the 1980s, stretch jeans, skin-tight jeans and later designer jeans were fashionable. In the 90s ripped and aged jeans were commanding a premium. Today styles and prices vary with one company in Japan charging around \$2000 per pair!

Jeans have, over the years had to compete with trousers made with other fibres including lycra, teflon, nylon and corduroy with cargo pants providing the greatest challenge of recent times. However, despite this the dominance of denim has persisted for more than half a century and today 62% of all consumers say they love jeans.

Both jeans and denim continue to evolve as textile technologists develop new finishes and treatments. One such example is STORM DENIM™, a product that is a water-repellent while not inhibiting cotton's natural ability to breathe.

Cool denim facts

- One bale of cotton can make 266 pairs of denim jeans
- There exists 0.27 pairs of jeans for every man, woman and child on earth
- One denim manufacturer says it takes 17 minutes to make a pair of jeans
- Jeans could be found in some form in the middle ages

ONE BALE OF COTTON

CAN MAKE 266 PAIRS OF DENIM JEANS



The making of weSC Denim Jeans – cutting, sewing, stitching and manual treatment



Momatoro Jeans Japan



Case Study: Storm Denim Technology, new ways with denim