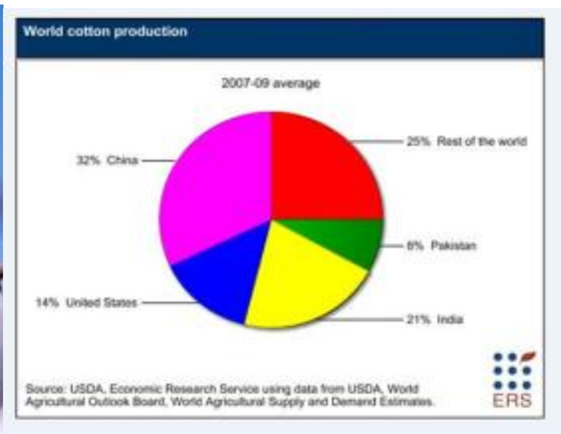
TRANSPORTATION OF COTTON CARGO

Cotton is the soft fibre that grows around the seeds of the cotton plant (*Gossypium* spp). Following pollination of the cotton flower a boll forms. The seeds grow and mature inside the boll capsules. When the seeds are matured the boll bursts open revealing the white cotton lint. If left on the plant under natural conditions, the cotton lint facilitates windborne dispersal of the cotton seeds.



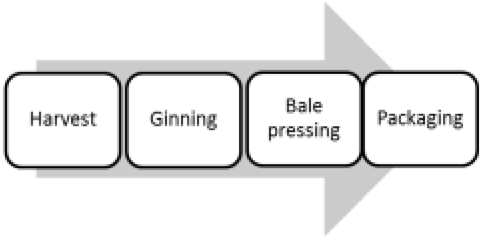
There are numerous cotton species, some of which have been cultivated for several thousand years. Currently, the most widely grown species are *Gossypium hirsutum*, *Gossypium barbadense*, *Gossypium arboreum* and *Gossypium herbaceum*. The most commercially important is *Gossypium hirsutum,* which accounts for about 80 to 90% of the raw cotton trade.

Raw cotton is one of the most important fibres used in the textile industry currently accounting for about 35% of world fibre use. This percentage has decreased over the last 40 years from almost 70% due to the competition from man-made fibres, such as polyester.

DID YOU KNOW?

- Since the 1980's, the top three exporters of cotton have been the US, West Africa and Uzbekistan, with the vast majority of their exports sent to Asia
- According to the United Nations Conference on Trade and Development (UNCTAD), cotton is produced in almost 90 countries
- The largest cotton producers - China, India and the US - account for 75% of total global production, with a total nominal value of $12 billion in 2006/2007
- The world production in 2012/2013 was over 25 million metric tons
- China is currently the largest producer, importer and consumer of cotton
- In addition to the larger more developed producers, exporters of cotton also include West Africa, India and several other smaller-scale producers
- The largest demand for raw cotton is in South East Asia, particularly Indonesia, Bangladesh and China
- Turkey is becoming an increasing important destination for raw cotton

COTTON PRODUCTION



Steps involved in raw cotton production

1. Harvest

Traditionally cotton is harvested by hand by picking the lint of the cotton plant. In many developing regions, including West Africa and India this method is still in use. Hand harvesting can be associated with poorer quality cotton as the facilities for storage and onward transport are underdeveloped. For example, in India harvested cotton is often left to dry on gunny sacks. Over-drying by the sun can cause yellowing and brittle fibres.

Cotton lint is accumulated and often stored in sacks. The use of polypropylene sacks is not recommended, as small pieces of polypropylene can contaminate the raw cotton. The cotton is then transported by a variety of means including; head load, tractor, horse and cart, overloaded trucks and rail. Therefore, there are many opportunities for contamination or damage to cotton during transport before processing and baling.

In many developing regions, cotton is harvested by hand

In contrast, the modern harvesting methods used by developed producers such as those found in the US allow for the rapid harvest and transport of large areas of cotton. The majority of cotton in the US is harvested by mechanical cotton strippers or cotton pickers.

The cotton picker removes the cotton lint from the boll without damaging the plant, while the cotton stripper strips the plant removing the lint and also some of the plant material such as unopened bolls. The stripper tends to be used in windy regions (Texas) where picker cotton varieties with easily removable lint are unsuitable.

In developed regions, cotton is mechanically harvested

2. Ginning

Following harvest the cotton is delivered to the ginning facility. During this process, the fibres are separated from the seeds of the cotton plant. This process also removes the dirt, stems and leaves mechanically, producing clean cotton lint ready for bailing. Cotton fibres with too high moisture content will not separate readily and can choke or break the machinery. Cotton that is too dry will cause stoppages by clinging to metal due to high levels of static electricity.

Managing the moisture content of the cotton passing through the gin is important as it facilitates the removal of foreign matter, and ensures that the cotton passing through the machinery is in the optimal condition for separation of the seed from the lint.

Cotton being delivered to the ginning facility for the removal of the fibres from the seeds of the plant

3. Bale Pressing

The bale press and strapping system are the last stages in the production of a raw cotton bale. This process involves spinning the raw cotton into compressed bales.

From the gin stand or cleaners the lint is transported by air to the baling machinery. In the past, there were numerous types of bale press producing many different densities of bale. Now, typically, only two types of bale are produced:

1. universal density (UD) bales
2. modified flat bales which can be subsequently recompressed to the UD

In the US, exported bales are now compressed to the UD that has a weight of 218kg. This complies with the ISO 8115 specifications:

L (mm)	W (mm)	H (mm)	Density (kg/m³)
1060	530	780 to 950	360 to 450
1400	530	700 to 900	

However, it is possible for bale density to vary between production areas and this can affect the storage and risk of damage to the bale. In much of West Africa, the ginning facilities are old and the equipment often obsolete. Cotton bale presses are generally old and in poor condition. The variability in and between bales is much greater than in developed cotton producers.

Bale pressing involves spinning the raw cotton into compressed bales

4. Packaging

Packaging is the final step in the processing of lint cotton. Typical bale packaging materials include steel bale ties, polyethylene or polypropylene plastic packaging. In some areas jute packaging is used to cover the exterior of the bale. In the US, virtually all bales are now packed with the bale ties inside the bale cover to prevent metal on metal sparks, which can be a problem during onward transport.

Compressed cotton is then packaged using materials such as bale ties and plastic bags

STANDARDS

Cotton quality is based on colour and fibre properties such as length, maturity and strength. Instrument testing has become increasingly important in the global cotton market as it provides a better indication of cotton quality.

At present, there are no universal quality standards. However, many Standard Organisations have issued standard methods for the determination of the various quality requirements:

- American Association of Textile Chemists and Colorists (AATCC)
- American National Standards Institute (ANSI)
- American Society of Agricultural and Biological Engineers (ASABE)
- ASTM International
- International Organization for Standardization (ISO)

In addition to the above organisations, many countries that produce and export cotton also have their own independent national methods and standards.

QUALITY TESTING

Recent technical developments have made automatic computer controlled testing machinery possible. The High Volume Instrument (HVI) system developed in the US includes instruments that detect a wide range of quality parameters at one time. The main driver behind the development of HVI Systems was the labour and time required for suitable representative sampling and analysis of cotton bales. The system allows a large volume of samples to be analysed rapidly and is more accurate than subjective hand classing.

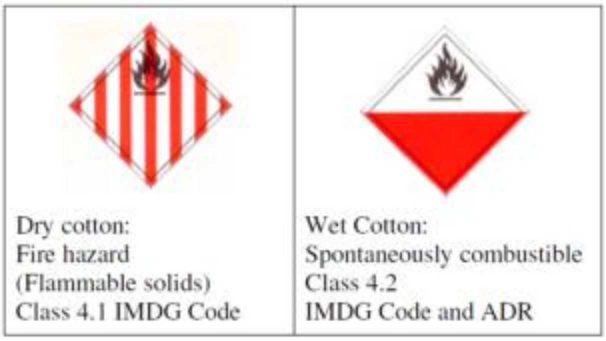
Unfortunately, despite the advantages and practicality of HVI Systems there are still large discrepancies in infrastructure development between cotton producers and the use of different methods and standards between developed and developing nations are likely to continue for some time. For example, in West Africa most cotton lint continues to be classified by visual and manual inspection, instrument classification is only performed on a sample basis (if at all).

CLASSIFICATION

The aim of the IMO (International Maritime Organisation) IMDG (International Maritime Dangerous Goods) Code is to facilitate the safe stowage and shipment of dangerous cargoes by providing information concerning the potential hazards associated with their carriage. The IMDG Code provides three UN Classifications relevant to the carriage of raw cotton and raw cotton by-products.

The IMDG Code classifies

- Fibre, vegetable, dry (COTTON, DRY) as Class 4.1 (Flammable solid)
- COTTON, WET as Class 4.2 (substances liable to spontaneous combustion)
- COTTON WASTE, OILY as Class 4.2 as well (substances liable to spontaneous combustion)



Cotton under the IMDG Code

In 1996, the NCCA petitioned the US Department of Transportation (DoT) for a change in the regulation of cotton carriage. It argued that cotton compressed to a UD (understood to have dimensions consistent with the ISO specifications and density of 360 to 450 kg/m^3) should not be regulated as a Class 4.1 flammable solids under IMO regulations for vessel shipment nor as a Class 9 hazardous substance under the US DoT regulations for domestic water-borne shipment.

Consequently, the IMDG Code incorporated Amendment 299 removing baled cotton with a density not less than 360 kg/m3 from Class 4.1 provided it was carried in cargo transport units (i.e. containers).

Further details of the IMDG regulations applicable to cotton are summarised in Table 1 below.

Table 1: Summary of International Maritime Dangerous Goods Code (IMDG)

UN No.	3360	1365	1364
Proper Shipping Name	Fibres, Vegetable, Dry	COTTON, WET	COTTON WASTE, OILY
Class	4.1	4.2	4.2
Packing Group	-	III	III
Special Provisions*	29, 117, 299	29	29
Packing Instructions	P003	P003	P003 LP02
Packing Provisions	PP19	PP19	PP19
IBC Instructions	-	IBC 08	IBC 08
IBC Provisions	-	B3 B6	B3 B6
Emergency Schedule	F-A, S-I	F-A, S-J	F-A, S-J
Stowage and Segregation	Category A	Category A	Category A, Separated from animal or vegetable oil
Properties and Observations	Ignite readily. Consignments of COTTON, DRY having a density not less than 360 kg/m^3 ((ISO Standard 8115(1986)) are not subject to the provisions of this Code when carried in closed cargo transport units.	Readily combustible, liable to ignite spontaneously according to moisture content.	Fibres of vegetable origin.

**Special Provisions*

29 – The packages, including bales, are exempt from labelling provided that they are marked with the appropriate class. Packages, with the exception of bales, shall also display the Proper Shipping Name and the UN number of the substance that they contain in accordance with 5.2.1. In any case, the packages, including bales, are exempt from class marking provided that they are loaded in a cargo transport unit and that they contain goods to which only one UN number has been assigned. The cargo transport units in which the packages, including bales, are loaded shall display any relevant labels, placards and marks in accordance with 5.3.

117 – Only regulated when transported by sea

299 – Consignments of Cotton, dry having a density not less than 360 kg/m3 according to ISO 8115:1986 are not subject to the provisions of this Code when transported in closed cargo transport units.

PROBLEMS ASSOCIATED WITH THE CARRIAGE OF COTTON

There are several types of damage and risk associated with the carriage of raw cotton:

Pre-loading damage

→ This typically occurs prior to shipment and includes exterior damage from rain, mud, sand, wet ground and insect damage

→ This can result in the degradation of cotton fibres, discolouration and mould damage to the surface of the bales

→ Weather damage of this nature is generally a result of poor storage or transport between production and export

→ Any exterior damage of this nature should be noted during a loading survey and if significant, the bales should be rejected. It is important that a discharge survey assesses bales for pre-loading damage in order to avoid claims against the vessel

→ In addition, damage occurring after discharge can be wrongly attributed to the vessel or shipper when it reaches the end user

Poor storage of cotton can result in damage prior to loading

FIRE

- Cotton is highly combustible. Fires are usually started by an external source of ignition such as machinery sparks, cigarettes, electrical or friction sparks. According to US research, UD bales exposed to an external source of ignition such as an open flame or cigarette do not result in a widespread fire but can cause some minor combustion damage to the bale surface. Fire as a result of external ignition is, therefore, deemed a low risk but under certain conditions remains a possibility

- A more likely source of fire in raw cotton is due to bursting bales. The steel ties holding the bales together cause friction sparks when coming into contact with metal present in the hold. The burst bale no longer has a limited supply of oxygen and will burn readily when loose

- There is anecdotal evidence of bales with smouldering cotton being packed in the centre of bales during the ginning and packaging process. This occurrence is known as a fire packed or hot bale. The smouldering is thought to continue for several days or weeks before the smoulder reaches the surface and a fire breaks out. However, there is little scientific support for the fire packed bale theory and internal fires are unlikely to manifest in exported UD bales. However, research indicates that bales with densities below 260kg/m^3 can support internal fires as the diffusion of oxygen supports internal smouldering

Fire damaged cotton bales

INTERNAL DAMP

- The effects of internal damp are generally only noticeable when the bale is cut open at the spinning facility

- Cotton is very hygroscopic, meaning it will lose or gain moisture to the atmosphere resulting in a loss or gain in weight. In some cases, cotton is shipped at higher moisture content so that it arrives at the correct weight

- Bales compressed with excessive or uneven moisture due to inadequate drying or excessive moisture restoration during ginning can exhibit signs of internal damp. These include fibre discolouration, accompanied by mould growth or mildew patches inside the bale

- The development of HVI Systems may assist with alleviating this problem as a more representative sample will allow a greater indication of the moisture content of the bale before shipping. In addition, CAT scans have been used more recently to assess the moisture content of bales and successfully detected bales with significant ranges in moisture content

WATER

- → Water damage differs from internal damp as it generally only affects the exterior of the bale
- → Wetting to the exterior by water ingress or rain will cause staining/ discolouration, rusting of the steel ties, mould growth and subsequent reduction in fibre quality
- → Generally wetting damage remains relatively close to the surface and can be alleviated by suitable drying. If however, the bale has been substantially wetted, the bale will need to be opened, dried and re-compressed
- → A significant increase in moisture content can cause wetted bales to burst as the force exerted on the bale ties increases. This can lead to an increased risk of fire as the steel bale ties create sparks and the cotton density is reduced
- → There is no universal bale moisture content. Generally bales are packed at 5 to 8% moisture content, however it is possible for bales at higher moisture content to be packed if the remoistening of the cotton during ginning is not effectively monitored. The NCCA provides advice that 7.5% should be considered a moisture content ceiling and states that bales with average moisture content above 7.5% may be at risk of damage if the moisture is not distributed evenly. Lloyds Survey Handbook states a maximum admissible moisture content of 8.5%. As an example of the differences between producers, the NCCA advises a ceiling moisture content of 7.5%, while the Indian Cotton Grading & Marking Rules are rather vague specifying that cotton "shall be dry and free from any trace of added moisture"
- → Wet cotton can undergo self-heating due to the growth of moulds within the bale. COTTON, WET is included in the IMDG classification UN 1365 as Class 4.2, a substance liable to spontaneous combustion. This does not appear to be supported scientifically. It is unlikely that wet cotton undergoing self-heating due to mould would ever reach temperatures that could spontaneously combust, as the combustion temperature of cotton is between 360 and 400°C. The maximum temperature possible due to mould growth would be around 40°C to 50°C. At this temperature the heating is self-limiting as any moulds would be killed at an increased temperature. Heating would not continue unless oily residues remained present in sufficient quantities to sustain chemical heating. The main limiting factor of any heating or combustion inside a cotton bale is oxygen. Once packed to the UD, oxygen diffusion into a cotton bale is restricted and continual self-heating would be unlikely

Wet discoloured bales

CONTAMINATION

- Contamination is a common problem and is usually caused by poor packaging and stowage
- During a voyage, contamination damage mainly occurs on the exterior of the bales and typically manifests as discolouration of the cotton by co-stowed cargoes or foreign material present inside the hold/ container
- In addition to discoloration, contamination can cause stickiness and depending on the contaminant, it can also become a fire risk
- Some contaminants can be incorporated during processing, the most common contaminants being rubber and plastic
- A particular problem with cotton exported from West Africa and India is polypropylene contamination. During harvest, the cotton is collected in polypropylene sacks before it is accumulated in sufficient quantity for onward transport to the gin. Small polypropylene fibres can contaminate the raw cotton and cause a problem during further processing as the plastic fibres prevent uniform dyeing of the cotton and can become incorporated into products

BURST BALES

- Burst bales usually occur due to poor quality bale production and packaging or damage to the bale ties from shifting during transport
- The bale can be unstable if not enough bale ties are used, the bale is uneven in density and if the moisture content increases significantly
- Burst bales also present a fire risk as the steel bale ties can cause sparks that ignite the cotton

LOSS PREVENTION

Cotton can be carried in containers or as general cargo. There are several important points that must be considered in order to successfully carry cotton and avoid damages.

PRE-LOADING SURVEYS

- It is important to perform an effective pre-loading survey of the container or hold and the cargo
- The US DoT provides some useful guidance on the packaging and stowage of raw cotton in the US Code of Federal Regulations

CARGO INSPECTION

- Cotton bales should be effectively covered with bagging/plastic on at least three-quarters of the surface, including both ends. The bales should be bound with at least six bale ties. Any bales observed to be poorly packaged or having damaged bindings should be rejected for carriage
- Any bales with evidence of oil or grease contamination should be rejected for carriage, similarly any bale that appears saturated with water or deemed wet should also be rejected
- The attending surveyor should note any examples of exterior damage, contamination or poor packaging
- Unfortunately, it is not possible to determine moisture content at loading, as even a bale that has a moisture content in excess of 20% will feel dry to the touch. The bales should be labelled according to the relevant requirements of the IMDG Code. If the cargo is to be exempted from the IMDG UN 1365 as COTTON, DRY it is important that the bale density and moisture content of the cotton are known before loading of the cargo transport unit

STOWAGE CONSIDERATIONS

- The container or hold must be thoroughly inspected before loading. It is important that all residues of previous cargoes, dirt or oil residues are removed before loading. In addition, recently painted or cleaned holds should not be loaded unless the holds have been suitably dried
- The hatch covers of the holds or door seals of containers should be inspected for water tightness and the relevant tests, such as a hose or ultrasound test performed. For general cargo, the holds or compartments to be loaded should be equipped with suitable CO_2 or sprinkler equipment which should be tested prior to loading to ensure it is in good working order
- The US DoT also require that ventilation hatches are fitted with spark screens and the bulkheads of holds or compartments adjacent to heated tanks, the engine room or boilers should be separated from the cotton by a wooden separation bulkhead

Moisture on container ceiling and walls due to inadequate ventilation

- COTTON, WET should not be co-stowed with COTTON, DRY. Furthermore, it is important to avoid co-stowing of cotton bales with cargoes that pose a risk of contamination or are themselves a fire risk. The main cargoes responsible for contamination damage of cotton bales include carbon black, coal, sugar and ores

- Cotton should not be stowed with hygroscopic cargoes with high moisture contents, in holds or compartments with cargoes containing vegetable or animal oils, or with cargoes that have a risk of leakage

- The bales should be stowed safely and securely ensuring that the risk of shifting is minimal and the risk of metal on metal sparks is avoided. The bales should be stowed in such a way that shifting does not damage the bale ties and cause bales to burst or come into contact with co-stowed cargoes

- It is important to avoid and prevent wetting, in addition to the checking of water tightness the use of dunnage would also assist with protecting the bales from wetting

- All three IMDG UN Classifications for cotton pose a fire risk. No sources of ignition should be present during loading; smoking is not permitted and the use of any open flame or equipment likely to produce a spark is prohibited

THE LAW

Cotton cargoes, given their propensity for being easily damaged, have featured in the law reports including being the cargo of the famous House of Lords decision of *Elder Dempster & Co. v. C. G. Dunn & Co. (1909) 15 Com. Cas. 49.*

FACTS

- Cargo had been tendered for loading which was to be marked, and these marks were within the exclusive knowledge and control of the Charterers. The Master had no real opportunity of checking this
- Numerous sets of Bills of Lading were issued, which the Master tried to check against the daily tally of the Charterers
- At the discharge port it turned out that some of the cargo had no such marks, and other cargo which was marked could not be reconciled with the Bills of Lading
- Under the law of the discharge Port, the statement of the marks on the Bills of Lading was conclusive evidence against the vessel, which was then subject to liability towards cargo receivers

RECOURSE AGAINST CHARTERERS

- The Owners succeeded in their indemnity claim against the Charterers
- During the course of the case through the High Court, the Court of Appeal and ultimately the House of Lords, different views were expressed as to whether the claim was an indemnity claim and/or a claim for damages for breach of contract
- The breach would be the Charterers tendering Bills of Lading for signature that did not conform to the Charterparty or actual condition of the cargoes
- The Court of Appeal expressed the further view that Charterers should not present Bills of Lading which will themselves impose an aggravated risk of liability to the Shipowner
- Furthermore, a Master who sees that he is being asked to sign Bills of Lading for goods which he knows are not on board is entitled to refuse to sign and issue such Bills. Even if he does not so refuse, the risk still stays with the Charterers who present these Bills

This vintage decision was cited with approval in the more modern decision of *Naviera Mogor S.A. v. Societe Metallirgique de Normandie ("The Nogar Marin") [1988] 1 Lloyd's Law Reports 412.*

FACTS

- In this case, however, the Master had erroneously signed off on clean Mate's Receipts for a cargo of steel that was rust damaged

NO RECOURSE AGAINST CHARTERERS

- → The Master should have, the Court of Appeal held, properly checked the Mate's Receipts before agreeing to sign them and to ensure the actual condition of the cargo was properly recorded
- → He should have refused to sign the clean Receipts
- → Failure to do so meant the Owner had to issue clean Bills of Lading and had no right of indemnity against the Charterers

HOW CAN THESE TWO DECISIONS BE RECONCILED?

1. The Bill of Lading and the Mate's Receipts are two different documents, with the Mate's Receipts being only a receipt of the goods shipped and a record of their weight, count, condition, etc. on loading;
2. If the Master has opportunity to check the cargo condition against the statement made in the Mate's Receipt then he must do so, and he must (and is legally entitled) to refuse to sign off on a document that is not accurate;
3. As Bills of Lading are not always seen by or issued by the Master, often this task being delegated to Charterer's Agents, the Owner will be protected with an indemnity should the Bills of Lading not accurately reflect the cargo laden (assuming that the Mate's Receipts were accurate, but not followed)

ADVICE TO MEMBERS

The advice to members is to ensure Ship's Officers and Crew pay close attention to the loading and carefully verify any cargo documented presented. In case of doubt, uncertainty or dispute, the Master should always feel free to contact the Club's local correspondent for assistance

HOT TIPS

Until production, transport and handling systems, become more suitable to handle the export demand and expected increased production, there is potential for further claims to arise with cotton exported from developing producers

1. **Appoint an experienced surveyor to monitor the loading process**

- → Members loading cotton cargoes in West Africa, India or other less developed cotton exporters are advised to appoint a reputable surveyor to monitor the loading, including a detailed recording of cargo appearance and stowage

2. Mitigate damage

- → Regardless of the production area, cotton can be damaged by a number of factors. In most cases substantial savings can be made with timely and efficient mitigation of damage
- → Despite the poor visual appearance of bales damaged by fire, wetting or contamination, it is often the case that the majority of the bale is still in sound condition and can still retain significant value if the damage is mitigated correctly
- → Generally, this is simple to remedy with the damage removed or cleaned and the bale packaging repaired or replaced

3. Mitigate fire damage

- → It is not advisable to break open a bale when fighting a fire. Once an external fire has been extinguished a charred outer coat remains on the bale, which has the useful effect of protecting the centre of the bale from further fire damage
- → If the bale has been significantly wetted to fight the fire, the bale will require reconditioning. This involves opening the bale and removing the damage from the sound cotton followed by re-baling
- → If the affected area of the bale is restricted to the surface or has not penetrated too deeply into the bale wetted bales can be unloaded and left to dry naturally. If wetting is significant the bale will require opening and drying before repackaging

4. Mitigate contamination

- → Areas of discolouration by contamination can, in most cases, be removed by brushing
- → Depending on the extent of damage it may be beneficial to segregate such damaged bales for picking and mending where the damaged cotton is removed and the packaging repaired
- → Exterior contamination or mould damage is generally less intensive and often does not require the bale to be opened
- → Once the damage has been removed the loss is determined by the quantity of damage. The loss can in some cases be reduced as, depending on the extent of damage, the pickings can retain a small salvage value

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