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Sustainable Cotton Production
in Pakistan's Cotton Ginning SMEs

SPRING

Better Ginning Practices (BGPs) Manual

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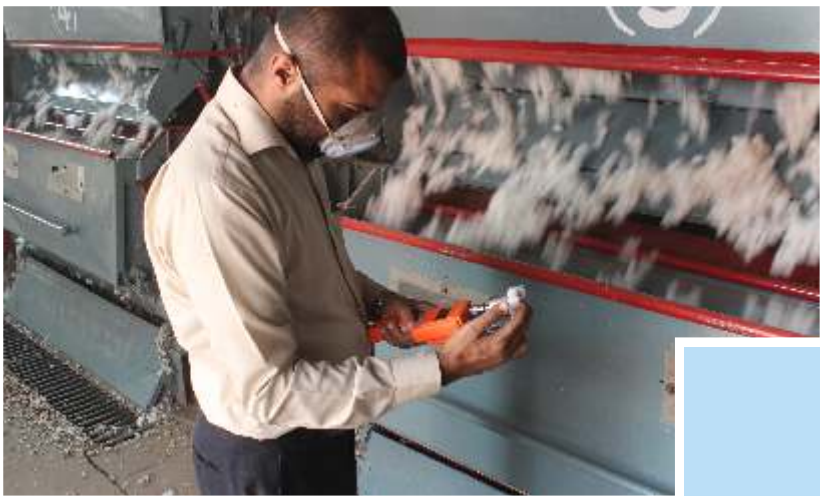

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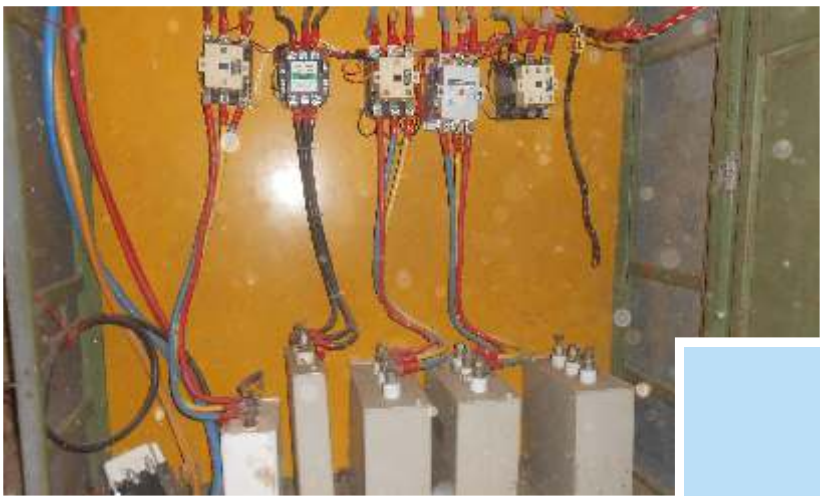

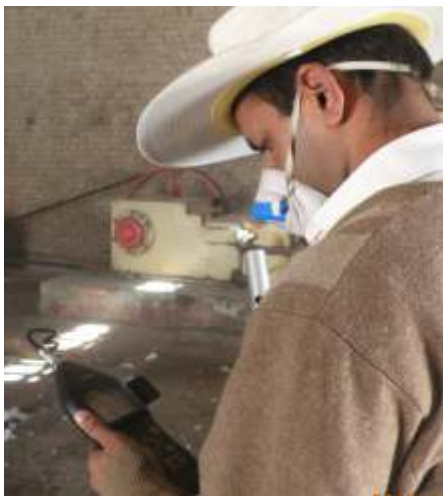

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ABBREVIATIONS & ACRONYMS

ACGIH	The American Conference of Government Industrial Hygienists
APTMA	All Pakistan Textile Mills Association
BGPs	Better Ginning Practices
CO	Carbon monoxide
CO_2	Carbon dioxide
CPI	Cleaner Production Institute
CV	Calorific Value
dB	Decibel
EHS	Environment Health and Safety
GOT	Ginning Out Turn
KCA	Karachi Cotton Association
Kg/m^3	Kilogram per cubic metre
KJ/Kg	Kilo Joule per Kilogram
kVAr	KiloVolt - Ampere Reactive
kW	Kilo Watt
kWh	Kilo Watt Hour
MDI	Maximum Demand Indicator
Mg/m^3	Milligram per cubic metre
NIOSH	National Institute for Occupational Safety and Health
Nox	Oxides of Nitrogen
O&M	Operation and Maintenance
OHS	Occupational Health and Safety
PCGA	Pakistan Cotton Ginners Association
PM	Particulate Matter
PPE	Personal Protective Equipment
PSI	Pound per square inch
REL	Recommended Exposure Limit
Rpm	Revolution per minute
SCP	Sustainable Consumption and Production
SFI	Short Fibre Index
SMEDA	Small and Medium Enterprise Development Authority
SMEs	Small and Medium Enterprises
Sox	Oxides of Sulfur
SPM	Suspended Particulate Matter
SPRING	Sustainable Cotton Production in Pakistan's Cotton Ginning SMEs
TLV	Threshold Limit Value
TPM	Total Particulate Matter
VOC	Volatile Organic Compounds
WWF-Pakistan	World Wide Fund for Nature-Pakistan

INTRODUCTION

General

1

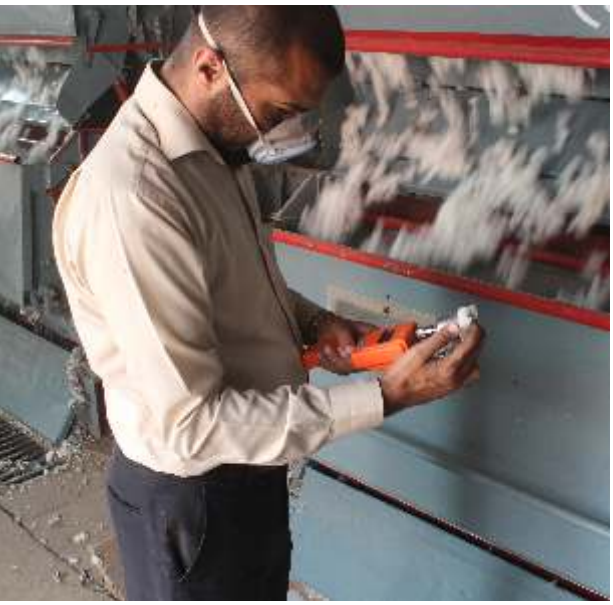
1.1 INTRODUCTION

This manual has been prepared under the project Sustainable Cotton Production in Pakistan's Cotton Ginning SMEs, abbreviated as SPRING, which is a four-year capacity building project under SWITCH-ASIA (2011-2015).

SWITCH-ASIA, the new regional environmental programme, in line with the European Commission (EC) Regional Paper for Assistance to Asia (2007-2013), aims to promote the adoption of Sustainable Consumption and Production (SCP) among small and medium sized enterprises (SMEs) and consumer groups in Asia.

The SPRING project is funded by the European Union and being executed by World Wide Fund for Nature-Pakistan (WWF-Pakistan) with Cleaner Production Institute (CPI) as consultant. The project is directed to the Pakistani Cotton Ginning SMEs with the overall objective that "By 2040, sustainable production and consumption in the cotton market worldwide predominates as best practices, resulting in increased environmental sustainability and poverty reduction".

The purpose of this manual is to help SMEs implement better ginning practices (BGPs) in order to improve their energy and resource efficiency, product quality, occupational health and safety (OHS) conditions and waste management.



1.2 THE SCOPE OF THE MANUAL

The BGPs recommended in this manual, are based on the following:

- Integrated audits of 45 ginning units, in the three major ginning clusters of Bahawalpur, Rahim Yar Khan and Sukkur regions, carried out under the project
- Implementation experience of BGPs in 30 ginning units, in the three major ginning clusters of Bahawalpur, Rahim Yar Khan and Sukkur regions, selected under the project for implementation
- BGPs, adopted by other countries, and reported in international literature

The recommended practices have been identified based on their applicability and relevance under local conditions.

Implementation of any specific BGP will lead to one or more of the following benefits:

- Improvement in the product quality
- Resource conservation
- Improvement in OHS conditions

Resource conservation, in most cases, results in direct economic benefits for the industry. Improvement OHS conditions, in general, results in enhanced efficiency and performance of staff, and reduction in potential accidents.

1.3 THE FORMAT OF THE MANUAL

Chapter 2 (Cotton Ginning Sector of Pakistan) and chapter 3 (Cotton Ginning Process) provide the necessary background information.

Recommended BGPs, categorized under different subjects, are presented in the following chapters:

- Chapter 4: Better Practices: Processes, Operations and Product Quality
- Chapter 5: Better Practices: Process Energy Conservation
- Chapter 6: Better Practices: Housekeeping and Maintenance
- Chapter 7: Better Practices: Decent Work
- Chapter 8: Better Practices: Occupational Health and Safety

COTTON GINING SECTOR OF PAKISTAN

2 Cotton Ginning Sector of Pakistan

2.1 GENERAL

Agriculture plays a pivotal role in the economy of Pakistan. Cotton is the main cash crop of the country and is often referred to as white gold. Pakistan is the fourth largest producer of cotton after China, the USA and India.

The cotton ginning process converts seed cotton, an agricultural product, into cottonseed and bales of lint, by separation of seed from the lint and removal of undesirable elements like stones, dust, trash, grass, leaves, sticks, bark, hulls, seed coat fragments, motes (green immature cotton bolls), neps and short fibre content.

Table 2.1 presents data on agricultural cotton production (in terms of lint) of Pakistan, for the last 10 years.

Table 2.1
Cotton (Lint) Production of Pakistan

Year	Cultivated Area	Cotton (Lint) Yield	Cotton (Lint) Production
	(hectares)	(kg/ha)	(170-kg bales)
2001-02	3,115,800	579	10,314,256
2002-03	2,793,600	622	96,87,401
2003-04	2,989,300	572	96,94,526
2004-05	3,192,600	760	14,347,032
2005-06	3,103,000	714	12,394,789
2006-07	3,074,900	711	12,410,620
2007-08	3,054,300	649	11,352,925
2008-09	2,819,900	713	11,349,029
2009-10	3,105,700	707	12,693,268
2010-11	2,689,100	725	11,698,166
2011-12	2,835,000	815	11,036,018
2012-13	2,879,000	769	10,768,909
2013-14	3,000,000	780	12,249,949
2014-15	3,128,350	-	12,245,705 3rd-Dec-2014
14-Year Average	**2984325**	**-**	**-**

Source: Government of Pakistan, Pakistan Statistical Year Book: 2012

2.2 PAKISTAN COTTON GINNERS ASSOCIATION (PCGA)

The Pakistan Cotton Ginners Association (PCGA) is a representative body, which takes care of the common interests of ginners and takes up their problems with different government departments to resolve them. It was established in 1958 and is recognized and licensed as an A-class association, by the Federal Government of Pakistan.

The head office of the association is in Multan, with a zonal office in Karachi. Additionally, there are five circle offices, located in Karachi, Multan, Bahawalpur, Vehari and Chechawatni. A PCGA House, located in Multan, holds the main secretariat of the association. The association is run by a chairman along with five vice chairmen, one each from the five circle offices.

2.3 PAKISTAN GINNING SECTOR PROFILE

Table 2.2 presents the geographical distribution, with respect to zones, provinces and districts, of the operational cotton ginning units in Pakistan, in 2014. This data has been provided by PCGA, collected in conjunction with the All Pakistan Textile Mills Association (APTMA) and the Karachi Cotton Association (KCA).

According to PCGA, as shown in table 2.2, a total of 1,139 ginning factories were in operation in 2014; however, there are about 300 additional ginning units, located in Punjab and Sindh provinces, which are not registered and operate in the informal sector. This implies that the total number of ginning units in Pakistan is more than 1,200, of which possibly not all are operational in a season. It is estimated that on average the numbers of operational units, in a year, range from 900 to 1,000 which were involved, in recent years, in producing cotton (lint), ranging from 10 to 14 million bales per annum, with an average of about 12 million bales per annum, as shown in table 2.1.

Cotton ginning units do not operate throughout the year. Their operations are seasonal, with the operating period ranging from six to nine months, starting from as early as July and finishing as late as March. Data on operational durations of the local industries, based on audits conducted under the project, is as follows:

Days of production per season	30-120-240
Hours of production per season	720-1720-4140
Working hours per day in peak season	22-24
Working hours per day at start & end of season	8-14-24

Table 2.2

Operational Cotton Ginning Units in Pakistan (2013)

ZONE, PROVINCE & DISTRICT	OPERATIONAL UNITS	
	NUMBERS	%AGE
North Zone (Punjab Province)	877	77
Multan	54	4.74
Lodhran	42	3.69
Khanewal	75	6.58
Muzaffargarh	54	4.74
Dera Ghazi Khan	51	4.48
Rajanpur	50	4.39
Layya	20	1.76
Vehari	92	8.07
Sahiwal	42	3.69
Pakpattan	16	1.40
Okara	4	0.35
Qasur	3	0.26
Toba Tek Singh	23	2.02
Faisalabad	10	0.88
Jhang	12	1.05
Mianwali	27	2.37
Bhakkar	13	1.14
Sargodha	4	0.35
Rahim Yar Khan	107	9.39
Bahawalpur	104	9.13
Bahawalnagar	74	6.49
South Zone (Sindh Province)	262	23
Hyderabad	18	1.58
Mirpur Khas	20	1.76
Sangarh	95	8.34
Nawabshah	27	2.37
Naushero Feroze	16	1.40
Khairpur	17	1.49
Ghotki	25	2.19
Sukkur	21	1.84
Dadu	5	0.44
Jamshoro	8	0.70
Badeen	4	0.35
Balochistan	6	0.52
TOTAL FOR PAKISTAN	**1,139**	**100**

Source: PCGA: Consolidated Statement of Cotton Arrivals in Factories of Pakistan as on 01-12-2014

Table 2.3 presents production data (latest season), of the local industries, based on audits conducted under the project.

Table 2.3
Audited Ginning Units: Production Data (Latest Season)

Max. Lint Production Capacity (bales/d)	200 – 290 – 625
Max. Lint Production Capacity (bales/season)	4,000 – 33,000 – 84,000
Actual Lint Production (bales/season) – Latest Season	3,700 – 21,000 – 56,000
Weight of Lint Bale (kg)	145 – 160 – 174

Collation and assimilation of the data, presented in tables 2.1, 2.2 and 2.3, clearly reflect that total installed capacity of the ginning sector of Pakistan is greater than the quantity of cotton produced in the country. Consequently, most units operate at a capacity which is substantially lower than their installed capacity.

Local data also indicates that the range of the seasonal production capacities, of small-to-large ginning units, is far more than the range of their daily production capacities, owing primarily to a large variation in the numbers of operational days per season, utilized by different units.

2.4 SEED COTTON AND LINT QUALITY

Table 2.4 presents data on mass balance of seed cotton (latest season), of the local industries, based on audits conducted under the project.

Table 2.4
Audited Ginning Units: Seed Cotton Mass Balance (Latest Season)

Mass Balance (% of Seed Cotton) – Latest Season Data	
Lint - Ginning Out Turn (GOT)	35.0 – 37.0 – 39.3
Cotton Seed	53.0 – 58.0 – 62.0
Waste + Invisible Loss	1.4 – 5.0 – 10.5

Data on proportions of lint, cotton seed, waste and invisible losses, as a percentage of seed cotton, for the audited units, presented in table 2.4, reflect a large variation, which can be attributed to the following factors:

- Variation in the quality of the seed cotton received from the field
- Variation of the difference in the moisture contents of the seed cotton and lint bales
- Variation in the efficacy and effectiveness of the ginning process

Table 2.5 presents data on comparative quality characteristics of seed cotton and lint, as reported by the local industries, audited under the project.

2.5 COTTON STANDARDS

Table 2.5
Audited Ginning Units: Comparative Quality of Local Seed Cotton and Lint

Parameter	Seed Cotton	Lint
Moisture Content (%)		
Reported	5 – 10 – 18	5 – 9 – 11
Field Measured	7 – 16 – 20	5.5 – 9 – 11.5
Trash Content (%) – Reported		5.0 – 6.4 – 7.2
Cotton Fibre Quality – Reported		
Staple Length (in)	1.06 – 1.20 – 1.61	1.02 – 1.08 – 1.15
Uniformity Ratio (%)	81.5 – 84.9 – 87.7	80.0 – 82.4 – 84.0
SFI (Short Fibre Index)	2.5 – 6.6 – 11.1	5.6 – 10.0 – 15.6
Micronaire – Fineness (µgm/inch)	4.4 – 4.9 – 5.7	3.7 – 4.6 – 5.3

Among the various factors affecting cotton quality, ginning is one of the main factors. The cotton ginning industry in Pakistan operates at a considerably low-level of efficiency and machinery used is sub-grade and old thus rendering it obsolete. There is no standardization of ginning machinery.

The principal function of cotton ginning (cotton processing facility) is to separate lint from seed and produce the highest total monetary returns for the resulting lint, seed, etc., under the marketing conditions that prevail. These marketing quality standards more often reward cleaner (contamination free) cotton with a certain traditional appearance of the lint. A ginner must have two objectives;

- To produce lint of satisfactory quality for the grower's classing and market system, and
- To gin the cotton with a minimum reduction in the fibre spinning quality so that the cotton meets the demands of its ultimate users; the spinner and the consumer. Cotton gins are responsible for converting a raw agricultural product, seed cotton into marketable commodities such as bale of lint, cotton seed, motes, compost, etc. ginning units are a focal point of the cotton community. Thus, quality preservation during ginning requires the proper sequence of machinery to produce marketable fibre.

International competition has placed a premium on doing things properly not only in the cotton sector but also in the high technology textile sector. Today, the textile sector is advancing at a very rapid speed and its management is calling upon manufacturing processes to control cost, reduce wastage and improving quality levels. To achieve these, the spinner requires clean and standardized lint, which fulfills their specifications and where standards are the essential ingredients ensuring the quality of all raw materials, product system, and services. The cotton standardization system is devised on scientific basis with a view to upgrade Pakistani cotton and the resulting yarn thereby raising its status and value in the highly competitive world market. Such an arrangement is of vital importance when viewed in the

Lint Cotton Grade Super

context of cotton's contribution to the national economy and future gains in cotton production, which will only be possible through greater qualitative improvements. This has direct impact and immediate bearings on the entire chain of value addition. This provides a boost to the national economy.

All over the world cotton trade takes place on the basis of grade, staple length and other fibre properties. As such PCSI recommendations on proper picking and better ginning practices, (Dandari Khilari and Drying) seed cotton grading and lint cotton classification along with the quality based marketing system on the basis of grade staple length and other fibre properties subject to premium / discount may be incorporated in the better cotton initiative.

PCSI proposal: The implementation of a cotton standardization system for the production of high quality standardized clean and homogeneous cotton is imperative. PSCI will offer the services and expertise of its cotton classers for SMEs ginning factories to implement such a system.

The high quality, standardized, clean and homogenous cotton bales produced under the collaborated supervision of the Better Cotton Initiative (BCI) and PSCI will be marked on BCI tags with quality parameters. This will shift the present marketing system to a quality based marketing system which is imperative for the production of high quality standardized, clean and homogeneous cotton. Therefore it will provides substantial foreign exchange earnings for the national economy.

It is fervently assessed that the end users wants decent social compliance and the same coupled with marketing, better quality and better price will together with the efforts of BCI and PSCI pave the way for BCI to make the business case for standardization and explore and make successful inroads to other global market retailers with endorsed quality label thereby expanding its business stature.

6. The minor corrections and suggestions are as under;
   Section 4.11 Fiber Quality may be termed as Lint Quality:
   Lint Quality from the spinning point of view means Grade, Staple Length and other fiber properties.
   Section 4.11.11 efforts should be made to gin the cotton at 6 to 7% moisture cotton (Source Best Ginning Methods ICAC) and (USDA – ARS). Internationally acceptable moisture percentage in pressed bale is 8.5%.

7. Seed cotton grading: Section 4.3.2 recommendation and storage: The seed cotton grading is the basic in the segregation of seed cotton quality which is missing and the same may be incorporated.

Seed Cotton Super

Seed Cotton Grade 1

Seed Cotton Grade 2

Seed Cotton Grade 3

Seed Cotton Grade 4

Seed Cotton Grade 5

Lint Cotton Super

Lint Cotton Grade 1

Lint Cotton Grade 2

Lint Cotton Grade 3

Lint Cotton Grade 4

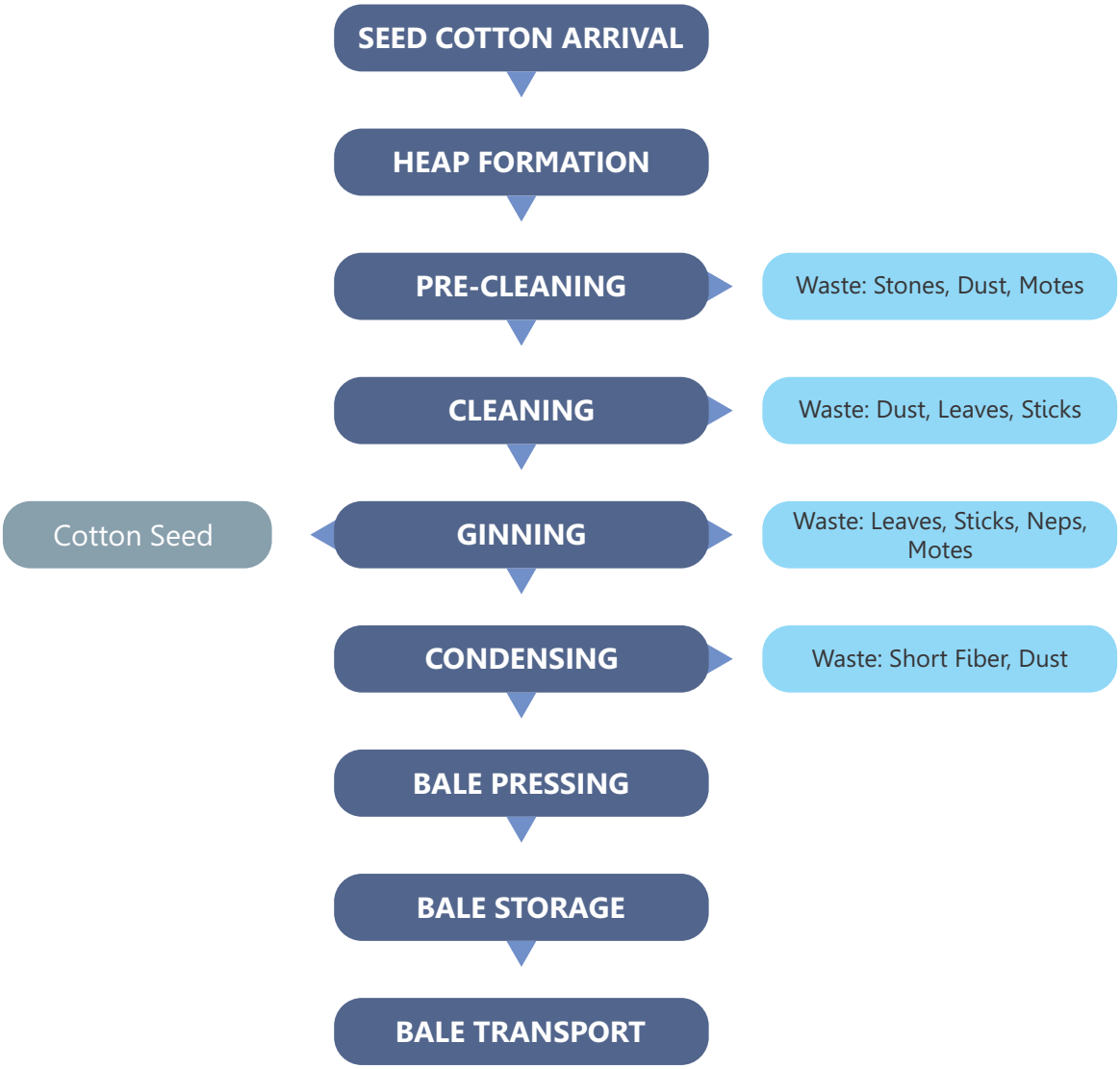
Lint Cotton Grade 5

COTTON GINNING PROCESS

3 Cotton Ginning Process

This chapter provides a brief description of the cotton ginning process, employed in the ginning units of Pakistan. Figure 3.1 presents a flow diagram of the typical cotton ginning process.

Figure 3.1
Typical Cotton Ginning Process



Seed Cotton Heaps

3.1 SEED COTTON ARRIVAL

Seed cotton, collected from different areas, is transported by suppliers to the ginning units, through various transportation means, including animal carts, trucks and trolleys.

Once received at the factory gate, seed cotton is weighed on a factory-owned weighbridge and then stored in the seed cotton storage yard. Most weighbridges employed for this purpose are digital.

A few progressive units maintain in-house laboratories, to measure ginning-out-turn (GOT), moisture content and trash content of the seed cotton received. In most cases, the quality of the seed cotton lots is established by on-site qualitative assessments and the field in-charges or cotton selectors, on the basis of their experience.

3.2 HEAP FORMATION

In the seed cotton storage yard, batches received from different sources are mixed with each other to make a cotton heap, by the field in-charge or cotton selector, based upon his experience. Usually heaps are formed, keeping in view the daily production capacity of the ginning unit.

The use of manual labour is common for making and mixing cotton heaps. Some of the units, however, use tractors and/or mobile conveyors for this purpose.

The quality parameters, considered for making a heap, are colour, trash content and moisture content.

3.3 PRE-CLEANING

Pre-cleaning (first-stage cleaning) is usually done in two stages. The first stage is separator, where the seed cotton is separated from dust and any other impurity. The second stage is opener and beater, where seed cotton lumps are opened up into single cotton balls and beaten to open them further and make them fluffy. Some ginning factories have also installed a third stage of cleaning called stick machine which separates the sticks (cotton plant stems) from the seed cotton.

There are two common alternate systems in practice of feeding seed cotton from the cotton heap to the separator. One is the pneumatic conveying system in which a suction fan sucks the seed cotton from cotton heap and transports it through a pipe to deliver it to the separator. A stone catcher is also installed in the suction line which separates heavy particles like stones, brick pieces and motes from the feed supply.

The second alternate system employed for cotton feeding uses a conveyor belts. Generally, two-stage conveyor belts are installed in series with a fan installed between them, which work as a heavy particle separator. The air currents, generated by the fan, throw cotton balls onto the second stage conveyor belt, while heavy particles are dropped in a trash container, placed right below.

Separator

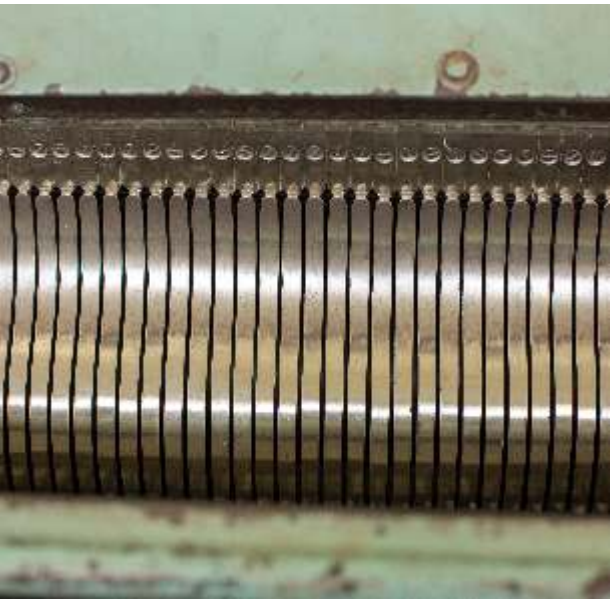
Main Beater

3.4 CLEANING

At this stage, the pre-cleaned cotton is cleaned again and beaten-up in a beater. A beater consists of four to six rollers with spikes on its outer surface. When cotton passes over these rollers, its fibres are opened up and dust and other impurities are removed. These impurities are carried away by a suction fan, generally called chooser fan, to the dust room.

The cotton is transported to this beater either by a belt conveyor or by pneumatically.

Ginning Section



Ginning Ribs

Ginning Saws & Ribs

3.5 GINNING

Ginning is the core process, carried out in a gin stand. In Pakistan, generally, saw-type gin stands are installed, commonly known as saw gin machines. A unit of ginning machines comprises of five to six saw gin machines, installed in parallel; however, some ginning factories have two to three such units.

An overhead feed worm is provided to transport seed cotton from the beater (in the previous process stage) and distributed to the feeding buckets of the saw gin machines. A saw gin machine usually consists of a couple of feed rollers, a set of beater rollers, a saw roller and a hull roller. A saw roller is the most important component of the saw gin machine. It is of specific length, with a specific number of circular saws, a specific diametre and number of peripheral teeth, mounted on a shaft, driven by an electric motor. Some ginning factories have also installed feeder-extractor-cleaner (FEC) machines, before the beater rollers of saw gin machines, for advanced cleaning.

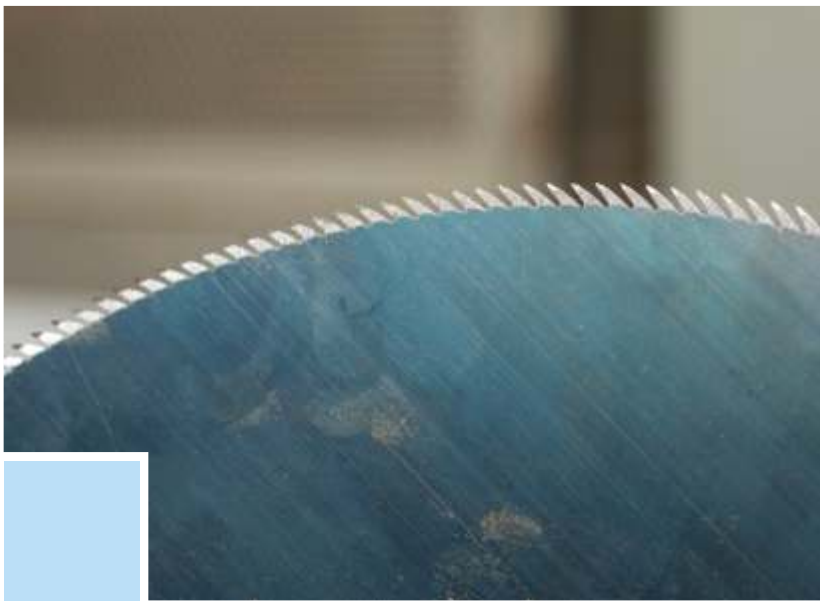
The saw gin machine pulls away lint and separates it from the seed cotton and other unwanted materials such as leaves, neps and motes. One or two delivery fans, along with a network of ducts, are installed to transport lint from the saw gin machine to an overhead condenser. The delivery air is injected on the edge of the saw roller, through a nozzle, which carries lint along with it. The cotton seed, separated from lint, is collected for further processing.

Table 3.1 presents data on certain key specifications of the saw gin machines, employed by the local industries, audited under the project.

Table 3.1
Audited Ginning Units: Saw Gin Machine Specifiations

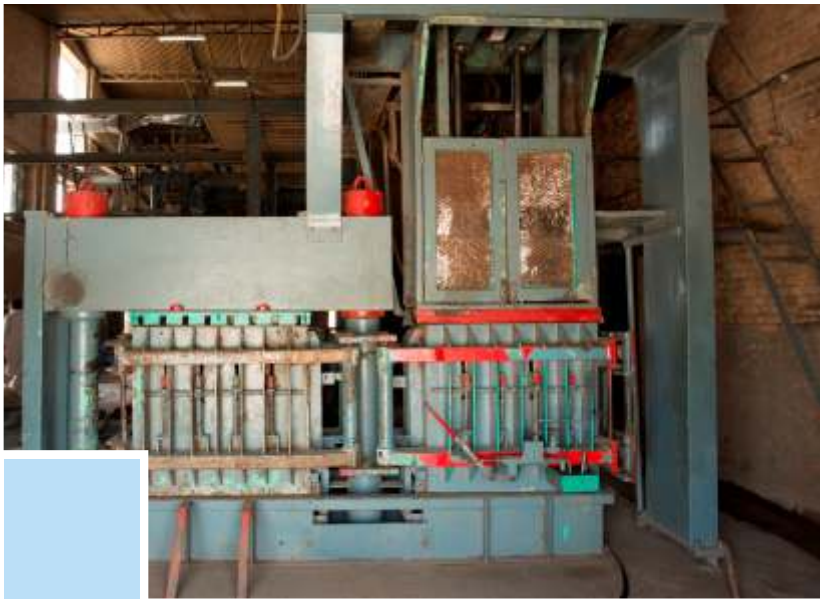
Ginning Rate (bales/h/gin stand)	1.4 - 1.9 - 2.8
Length of Saw Rollers(in)	
Range	63 – 72 – 102
Common Range	71 – 72
Number of Sawsper Gin Stand	
Range	90 – 100 – 120
Common Range	90 – 105
OriginalDiametre of the Saw (in)	
Common	12.0
Rare	11.5
Numbers of Teethper Saw	260 – 282 – 288
Type of Saws	
Local Make	50%
Imported/Brand	50%
Ribs Spacing (mm)	1.6 – 2.5 – 3.0

Space Block



Ginning Saw

Condenser



Bale Press

3.6 CONDENSING

From the saw gin machine, lint is fed to a condenser. A condenser is a roller shaped filter, with galvanized iron (GI) wire mesh on its periphery, which rotates at a regulated speed. The lint, while passing through the condenser, is converted into a thick flat sheet, called bat. During this process, any dust remaining in the lint, is also vented to the dust room.

The bat, formed at the outlet of the condenser, is transferred to the bale press section, through a slide, under gravity. Usually, the slide is equipped with water sprinklers, which add moisture to the lint bat.

3.7 BALE PRESSING

The lint bat is converted into lint bales, by means of two machines, placed in sequence, called tramper and press. The tramper consists, mainly, of one box and mechanical plunger. In the tramper lint is filled and pressed by repeated strokes of a plunger. After passing through the tramper lint is pressed, to a pre-set pressure, by means of a hydraulic press, driven by oil-based hydraulic pumps. After the lint is pressed, steel wires are tied around the bale. Finally the bales are weighed and sent to the bale storage yard.

Table 3.2 presents data on lint bales and bale pressing, as reported by local industries, audited under the project.

Table 3.2
Audited Ginning Units: Data on Lint Bales and Bales Pressing

Moisture Contents (Reported) of the Lint after Water Spray (%)	4.5 – 9.2 – 15.0
Applied Hydraulic Pressure (PSI)	2,500 – 3,000 – 4,500
Length of Bale Ties Used per Bale (in)	88 – 97 – 100
Lint Bale Weight (kg)	145 – 160 – 174
Lint Bale Volume (ft^3)	12.0 – 15.6 – 18.4
Lint Bale Density (kg/ft^3)	8.5 – 10.2 – 13.1

3.8 BALE STORAGE

Bales are stored in a storage yard, which is mostly open air; though some of the ginning factories have bale sheds, for indoor storage.

Commonly, bales are placed on a set of four bricks, laid on the yard floor.

Bale Storage

3.9 BALE TRANSPORT

Bales are transported from the ginning units to the textile mills in heavy transport vehicles such as trucks and trailers. A collection of 100 bales is usually termed a lot. The loading and unloading of material is usually done manually.

BETTER PRACTICES
Processes, Operations and Product Quality

Better Practices Processes, Operations and Product Quality

4

This chapter presents better ginning practices, under local conditions, in respect of production processes, operations and equipment, with particular reference to the potential improvements in the quality and value of the product (lint).

4.1 GENERAL

The initial quality and characteristics of the cotton fibre depend primarily on its genetics, climatic conditions during growth and cultivation practices. Within these parameters the fibre is of the highest quality when the bolls are mature and freshly opened and the weathering effects have not taken place.

It must be appreciated that the ginning process cannot as such enhance the inherent quality of fibre; it can however be conducted in such a way to preserve, with minimum damage, the initial fibre quality, and, by doing so, can improve its market value. The objective and due role of the ginner, therefore, is to produce lint of satisfactory quality, keeping in view the quality of the seed cotton received and the requirements of the downstream users, principally the textile spinning units.

Production of lint of satisfactory quality, from a given seed cotton, entails the following key considerations:

a) Undesirable content like dust, trash, seed coat fragments, neps and short fibre, in the lint bales, must be less than the permissible limit and its moisture content must be within the acceptable range.

b) Measures must be adopted to minimize the effects of weathering on the fibre quality characteristics like colour and strength, particularly during storage of seed cotton. Under certain conditions, excessive weathering can have a far greater impact on fibre quality than the most rigorous of the ginning processes.

c) Whereas, on one hand, the ginning process reduces undesirable content like trash, seed coat fragments, neps and short fibre, in the lint; on the other hand, it adversely affects the fibre quality characteristics like staple length, uniformity ratio and micronaire. Therefore, while choosing the degree and extent of the ginning cleaning, a balance and trade-off needs to be maintained between the fibre trash content and fibre quality.

4.2 SEED COTTON RECEIPT AND QUALITY ASSESSMENT

4.2.1 Existing Conditions

Seed Cotton Arrival

Calibration of Weighbridges

The in-house digital weighbridges, employed for the purpose of weighing the seed cotton received, are generally calibrated, once at the start of season, usually by comparison with the nearby commercial scales and weighbridges. Some ginning units are reported to employ local testing and calibration laboratories and have their weighbridges calibrated once at the start of season, ensuring this calibration by comparison with nearby commercial scales and weighbridges during the season.

Seed Cotton Weighing

Seed Cotton Quality Assessment:

The quality assessment of seed cotton arrivals in the ginning unit is mainly performed by the field in-charges or cotton selectors, who usually rely on personal experience and the look and feel of the material. These experts measure the Sangli content in a specific sample of seed cotton collected from the arrived batches by weight measurement and manual separation. Their expert-opinion is usually considered enough about the parameters including colour (Rd), moisture content, immature cotton content and ginning-out-turn (GOT). In specific cases, especially when GOT percentage is claimed to be higher than normal by the supplier, a locally developed GOT machine is used for verification. Only a few progressive units are reported to maintain in-house laboratories to measure GOT, moisture content and trash content of the seed cotton received.

Trash & Contamination in Seed Cotton

Lint Quality Assessment:

Presently, no local ginning unit maintains an in-house lint quality assessment laboratory. Testing of lint is usually performed through quality control laboratories available with buyers, mainly textile spinning units. Sometimes the ginning units avail the services of institutional laboratories including the Pakistan Cotton Standard Institute Laboratory or other commercially available laboratories for quality assessment of their product (lint).

Lint Quality Assessment (Manual)

4.2.2 Recommendations

Establishing Proper Functioning Laboratory

It is suggested that ginning units should have in-house laboratories to carry out quality control and assurance functions and partly provide assistance to top management for environmental and energy management. A properly equipped and operated laboratory should carry out the following functions:

a) Perform in-house process quality control and assurance functions for the ginning process starting from arrived seed cotton up to cotton bale formation. The parameters including Sangli content, moisture content, colour (Rd) and micronaire should be tested as part of quality control and assurance functions of the ginning process on a regular basis. Use cotton cloth to unload seed cotton to avoid the addition of any silk or polyester. Deploy trained workers at unloaded seed cotton to segregate organic and inorganic matters. Provide head cover to workers to avoid hair fall in the seed cotton.

b) Perform environmental monitoring of the ginning unit to support the environmental management function of top management. The parameters including noise level (dB), total particulate matter (mg/Nm3) and light intensity (LUX) should be monitored as part of the environmental monitoring function of the ginning unit on a regular basis.

c) Perform energy monitoring of the ginning unit to support the energy management function of top management. Specific data including power factor (PF), amperes (A), voltage (V), electricity consumption (kWh/d) should be monitored as part of the energy monitoring function of the ginning unit on a regular basis.

4.3 SEED COTTON STORAGE AND HEAP FORMATION

4.3.1 Existing Conditions

All local ginning units have a substantial area designated for the storage of seed cotton. These storage yards are open to the atmosphere and are made of brick soling. For heap formation a square shaped platform is usually constructed 14 inches above ground level with tapered sides. These platforms are made near the seed cotton feeding to pre-cleaning section of the ginning process. The tapered formation of the brick soling of these platforms helps to drain out rainwater. The wear and tear of the installed brick soling deteriorates the overall condition of the storage yard as well as platforms with the passage of time. Moreover, its low quality workmanship sometimes results in improper slopes which hold rainwater instead of draining it out.

All seed cotton arrivals are unloaded in the storage yard as per the instruction of field in-charges or cotton selectors. These are mixed with to make a sizable seed cotton heap upon the instruction of the field in-charge or cotton selector, based upon his experience. The quality parameters considered for making a heap are colour, trash content and moisture content. Usually heaps are made, keeping in view the daily production capacity of the ginning unit.

All seed cotton purchased is stored in the open storage yard, which is exposed to weather conditions. Seed cotton heaps are usually covered with tarpaulin to protect them from all types of weather conditions

Heap Formation

4.3.2 Recommendations

Storage

When seed cotton is consolidated for storage it should be in a covered storage area such as a shed, storage house, trailer or on ground covered with high-quality tarpaulin.

The seed cotton platforms should be constructed with careful workmanship, keeping in view the slope required to drain out rain water. The surface of these platforms should be evenly cemented and the tapered sides should be monitored regularly and immediately repaired even during the production season.

Heaps of seed cotton should be managed grade-wise and according to their proper size to preserve quality. Gaps between heaps are necessary for the flow of air and for safety measures to protect from any fire. If possible a good distance of 20ft should be maintained between the heaps.

Quality Assessment during Storage

It is recommended that moisture content (%) of the seed cotton is regularly monitored and decisions about the storage length taken accordingly. Moisture content (%) of the seed cotton is one of the critical parameters of the ginning process. At high moisture levels, bacteria lection causes temperature increases within 48 hours that result in discolouration. Some colour degradation (spotting) occurs in seed cotton stored at a moisture level above 11%. High moisture content causes yellowness to increase sharply at levels above 13-14%, especially when the storage period exceeds 45 days. For long storage periods, the moisture level should be below 12%.
Temperature should be checked daily in several locations in a stored mass for the first five to seven days, typically about 1.5 metres (5 feet) apart. After that, probing can be done every three to four days or as the temperature dictates. The temperature probe should reach at least 0.8 metres (2.5 feet) into the seed cotton.

Seed Cotton Heap

4.4 SEED COTTON FEEDING TO PRE-CLEANING SECTION

4.4.1 Existing Conditions

There are two common systems in practice to feed seed cotton from the cotton heap to the pre-cleaner. One is a pneumatic conveying system and the second is via a conveyor belt system.

Oversized suction fans and leakages in the suction lines are common problems in the pneumatic conveying system. A drop in the suction pressure due to cracks in the out-of-operation lines is also an issue in the day to day operations of a ginning unit. Stone catchers installed in the pneumatic conveying system are mostly inefficient due to improper design and lack of maintenance during the production season. An oversized suction fan not only increases electricity consumption in the ginning process but also damages the screens and meshes when it carries the materials like stones, brick pieces and metallic scraps along with seed cotton due to higher suction pressure and elevated air velocities. However, pneumatic conveying systems are efficient in separating dust and reducing moisture content from the seed cotton.

The conveyor belt system is mostly installed in two stages. This system is considered as efficient in terms of energy consumption. The limitation associated with this system is the fixed seed cotton feeding point. However, some of the ginning units have overcome this issue by transferring seed cotton to the specific feeding point on daily basis and mixing the heap with the help of tractors.

Few of the ginning units have both the conveying systems installed to compensate each other. The choice of operation lies with the field in-charges or cotton selectors. Such arrangement also helps ginning units to maintain their production schedule in case of maintenance issue in any one of the conveying systems.

Seed Cotton transportation through conveyor belt

Seed Cotton feeding through suction pipe

4.4.2 Recommendations

Both seed cotton conveying systems are good if properly designed and maintained regularly. However, the belt conveying system is recommended because it consumes less electrical energy thus reducing the energy consumption of the ginning process.

To install a pneumatic conveying system, selection of the suction fan and appropriate suction line/pipe is critical. A suction fan which generates an air flow velocity of 3,500 to 5,000 ft/min in a suction line size of 11 to 15 inch diametre should be considered the basis for the design of a pneumatic conveying system for the conveyance of seed cotton. Moreover, it should be kept in mind that 15 to 20 ft3 of free air is required by fans for the conveyance of the cotton material. Furthermore, the selection of stone catchers with respect to the suction line size is also important. The preventive maintenance of the pneumatic conveying system keeps it up to date and reduces the chances of loss of energy and overall production time. Such maintenance should involve daily checkups of suction lines along bends and joints, daily checkups of the physical condition of suction fans and routine monitoring of the motor installed with it. These checkups should follow immediate maintenance in case of any problem.

4.5 PRE-CLEANING AND CLEANING

4.5.1 Existing Conditions

The pre-cleaning stage of seed cotton usually involves a separator followed by a first stage opener and beater. The cleaning stage of seed cotton includes a beater and cleaner. The ginning operation continuously requires the separator operation; however the use of the first stage opener and beater or the second stage beater and cleaner is the choice of field in-charges or cotton selectors and the ginning expert. The quality of seed cotton in the heap formation depicts the use of single stage cleaning and beating and/or double stage cleaning and beating.

The beater and cleaner are usually equipped with four to six spike rollers in a horizontal or inclined arrangement. The width of rollers, diametre, size and arrangement of spikes varies with respect to the local equipment manufacturer. The speed of rollers is adjusted with respect to the daily production capacity of the ginning unit. Most ginning units operate the pre-cleaning and cleaning machine roller at a speed ranging from 400 to 600 rpm.

Common problems associated with the pre-cleaning and cleaning equipment operations is their inefficient use and irregular maintenance. Improper use of the available contact area of the spike rollers usually reduces the overall efficiency of these machines. Similarly the damaging of spikes and mesh/screen due to the inefficient operation of stone catchers at the back end in suction lines also reduces overall effectiveness.

Pre-cleaning Section

4.5.2 Recommendations

The pre-cleaning and cleaning stage is important in the ginning process. The efficiency and effectiveness of this process stage is achieved through the effective use of an available contact area. It is recommended that a feed bucket equipped with a feed roller should be installed before the beater and cleaner. This will regulate the seed cotton fed to these machines and will result in their efficient use.

The efficiency of seed cotton cleaning machines depends on many factors, including machine design; cotton moisture level; processing rate; adjustments, speed, and the condition of the machine; the amount and nature of trash in the cotton; distribution of cotton across the machine; and the cotton variety. It is recommended that the cleaning machines is adjusted with SMEDA approved standard gauges and the speed of rollers is optimized keeping in view the physical condition of the machine, recommendations from machine manufacturers and the quality of seed cotton supplied for cleaning. The standard speed of cleaning machine rollers is 400 to 600 rpm.

Preventive maintenance is also necessary to maintain efficiency of these machines. It is also very important that this stage of the process remain free of material other than seed cotton. This is achieved by the efficient operation of stone catchers in the pneumatic conveying system and supply of effective air currents in between the two stages of the conveyor belt system.

The length of spikes should range between 1.5 to 2.00 inches and the space between a pair of spikes should be 6.34 mm. The mesh/screen should have holes of 6 to 8 mm. During maintenance broken and bended spikes should be replaced with new uniform spikes. The wear and tear of mesh should be monitored and replaced with new one immediately.

Moreover, while selecting a new beater or modifying the existing one keep in mind that inclined beaters with grid bars/rods have higher cleaning efficiency than horizontal beaters, due to the gravity effect.

4.6 SEED COTTON FEEDING TO GINNING SECTION

4.6.1 Existing Conditions

Seed cotton, once it has passed through the beating and cleaning stage of the production process, is dropped in an overhead screw worm which distributes it to the feeding buckets of saw gin machines. The feed is distributed to saw gin machines one by one, starting from the one closest to the cleaning stage. When feeding buckets of all saw gin machines are filled, the seed cotton is dropped at the far end of the ginning machines on the ground, which is collected manually or through a designated suction line and again fed to the first stage or second stage cleaning system. This feeding arrangement in the cleaning system not only increases the specific energy consumption of the ginning process but also becomes the cause of product quality loss due to over processing of seed cotton in the beater and cleaner. Some ginning units have installed a recirculation system to manage the overflow of seed cotton feed. The system is equipped with a conveyor belt which collects the overflow seed cotton from the far end of the screw worm and transfers it back to the screw worm.

The workmanship of the screw worm and the hopper, in which the worm operates, plays a critical role in the efficient operation of the seed cotton feeding system. Poor workmanship of the hopper and misalignment of the screw worm usually causes a blockage of seed cotton during the production process. Moreover, lack of instruments causes the unnecessary operation of the overflow conveyor; leading to increased energy consumption of the ginning process.

Seed Cotton feeding to gin stand

4.6.2 Recommendations

A well aligned screw worm and quality workmanship of the hopper increases the overall efficiency of the seed cotton feeding system by reducing the time loss due to blockage during day to day operations. It is recommended that a recirculation system should be installed, which is equipped with a material sensor (to turn the recirculation conveyor belt on/off) to manage the overflow of seed cotton feed to saw gin machines. This system prevents over-processing of seed cotton, maintains product quality whatsoever and keeps energy consumption of the ginning process within limits.

4.7 GINNING

4.7.1 Existing Conditions

The gin stand removes (pulls) fibre from the seed and is considered the heart of a ginning unit. The production capacity of a gin stand depends on the recommendation from the equipment manufacturer, mechanical adjustments and the physical condition. Most of gin stands report production capacity in the range of 1.5 to 3 bales/hr.

The production capacity of a gin stand is directly proportional to the speed of the feed roller installed at the top of the gin stand and the speed of the saw roller. This speed adjustment is the decision of the ginning expert and is primarily dependent upon the daily production planning and secondly on the quality of seed cotton feed into the gin stands. A higher speed of these rollers means a higher production rate. A higher speed of saw roller increases the ginning rate (bales/hr/gin stand) negatively influencing the product (lint) quality. The decrease in staple length, increase in short fibre content and increase in trash content is the result of a higher ginning rate. The speed of gin saw rollers in ginning units are in the range of 700 to 900 rpm. Moreover, the mechanical adjustments in the gin stand including rib spacing, rib width, spacer width, spike clearance and saw projection are manually done by the mechanical fitter with his experience rather than using standard gauges. These adjustments play an important role in the overall efficiency of the gin stand. Improper mechanical adjustments result in incomplete fibre separation from the seed, seed damage and other fibre quality problems as discussed earlier. Fibre quality testing is not in practice in ginning units. Moreover, mechanical stress on belts, pulleys and rollers under high ginning rate conditions and improper mechanical adjustments trigger maintenance issues during the production season resulting in mechanical downtime of gin stands. Such mechanical downtime is estimated to cost a ginning unit in the range of 1,400 to 4,000 bales per season.

Apart from mechanical controls like feed on/off and speed high/low, there are no other instruments related to fiber quality such as seed cotton moisture sensor available with the local gin stands. Moisture content in the range of 6 to 7.5% is considered optimum for seed cotton; however this parameter is commonly not monitored by the industry.

The saw roller in the gin stand is equipped with saws which rotate in between the fixed ribs. Generally 100 saws of 12 inch diameter are installed on a standard 6 foot wide saw roller shaft. The construction material of the saw and the formation of teeth on it are critical for effective ginning. Some ginning units use imported steel saws with 282 teeth per saw while others use local saws with 264 to 286 teeth per saw.

The teeth on saws wear out and loose their shape while in use with the passage of time. Manual filing of worn out saws is common practice in ginning units. The filed saws are used again in gin stands. Saws also decrease in diameter while in use with the passage of time. The lifting of a saw roller shaft in order to compensate for the decrease in diametre of saws is common practice in ginning units. In units audited under the project, the frequency of sharpening of saws ranges between 1,000 – 5,000 bales, with a median value of about 3,000 bales. In some units audited under the project, complete replacement of saws is carried out at the start of each season.

Mechanical adjustments during the production season are made without any standard gauges i.e. with match sticks, pieces of wood and sometimes with coins. The ginning ribs and spacers used in the gin stand are mostly inconsistent. Moreover, the back of the ginning rib at the ginning point have been welded, which is not suitable.

Ginning Hall

4.7.2 Recommendations

The capacity of the system and the quality and potential spinning performance of the lint depend on the operating condition and adjustment of the gin stand. Gin stands must be properly adjusted, kept in good condition, and operated at or below design capacity. For the adjustment of gin stands, it is recommended that SMEDA approved standard gauges be used. If gin stands are overloaded, the quality of the cotton may be reduced. Short fibre content increases as the ginning rate increases above the manufacturer's recommendations. Short fibre also increases as saw speed increases. An increase in the ginning rate also increases yarn imperfections and seed damage, especially when seeds are dry. A high ginning rate and low seed moisture cause seed damage ranging from two to eight per cent in gin stands. Thus, it is paramount to maintain the gin stand in good mechanical condition, to gin at the recommended moisture levels, and not exceed the capacity of the gin stand or other components of the system. The speed of the gin saws rollers should be kept between 500 to 750 rpm, which is the most appropriate rate given the required production rate and fibre quality as discussed above. Management should adjust the speed of the ginning saw roller keeping in view both the parameters. Fibre quality monitoring is highly recommended.

It is important to note that the quality of ginned lint is directly related to the quality of the cotton before ginning. High quality grades will result from cotton that is from clean fields harvested by hand. Lower grades will result from cotton that is from grassy, weedy fields in which poor defoliation or harvesting practices are used.

Monitoring of moisture content just before the seed cotton is dropped on to the saw roller is important and recommended. The moisture content in the range of 6 to 7.5 per cent is considered optimum for ginning and it is recommended that the seed cotton should be ginned below a moisture level of nine per cent. To monitor the level, sample collection from each gin stand, measuring moisture with a moisture meter and keeping a record of this parameter on regular basis is important and recommended. Variation in the moisture content should be controlled from the seed cotton heap in the storage yard. It is important to note that adding moisture before fibre/seed separation and lint cleaning will help maintain fibre length and reduce fibre breakage in the gin stand and lint cleaners. For example, if moisture is restored to the seed cotton to raise the fibre moisture from four

per cent upto six per cent, staple length will increase by 0.08 mm (1/32 inch) and short fibre content will decrease by two per cent.

Saws should also be installed with a standard spacing of 1 mm on both sides. For this purpose it is recommended that SMEDA approved standard gauges are used and that saws with imported steel sheets of 282 teeth per saw and standard hook type teeth shape are used.

Existing saws should be replaced with new ones when the diametre of the existing saw falls to 4 mm. It is not recommended that saws are filed or reused. Saw teeth and their curvature are very important in ginning, with filing or sharpening this curvature will lead to damage.

Standardized ribs of high quality last should be used for four seasons without any repair or re-fixing. The ginning rib should be 14 mm in the ginning point and should be measured with SMEDA approved rib gauges. The gap between two ribs should be 2.5 mm and should be checked with the rib gap gauge. Good quality ribs and spacers have no need of marking/numbering therefore they are easy to fix and save time in fitting.

Standardized spacers should also be used as it is then easy and quick to fix ribs and saws. Standardized spacers help properly align saws between ribs and damage to saws and ribs is reduced including less chances of fire due to friction. Standard spacers have a width of 15.58 mm and should be measured with SMEDA approved spacer gauges.
Balancing and alignment of the saw shaft is recommended each time a saw or spacer is changed. With use of standardized spacers and saws, balancing them once a season is enough.

Nozzles remove lint from the saw and also work as flow-through-air lint cleaner up to extent point. Therefore a properly designed air flow nozzle and properly designed air blast fan are necessary for the capacity of the gin stand and quality of lint.

A curved saw with a higher teeth angle is better for fibre quality and production. The height of teeth should be considered a major factor while installing the saw; however the influence of height on fibre quality is not significant. The projection of the saw from the ginning rib should ranging from 45 to 50 mm and from huller rib from 9 to 10 mm and adjustments should be made using SMEDA approved saw projection gauges. A good quality ginning saw is very important as it enables the saw to detach fibre from seed instead of cutting or damaging it. A good quality saw decrease the short fibre index (SFI) by two per cent and preserves the length by 1-1.5mm with a minimum 0.135 % (50 gm/mound) increase in GOT through proper cleaning of cotton seed.

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4.8 CONDENSATION AND MOISTURE RESTORATION

4.8.1 Existing Conditions

The condenser is a roller shaped filtre which rotates at a regulated speed. The bat (a thick flat sheet of lint), formed at the outlet of condenser, is transferred to the bale press through a lint slide under gravity. Usually, the lint slide is equipped with water sprinklers, which add moisture to the lint bat.

The size and speed of the condenser drum varies in ginning units and the size of the condenser drum ranges from six to 10 feet in diametre while the speed ranges between 12 to 30 rpm.

There is no standard approach to regulate the water sprinkler, installed on the slide just before the bale press, except the hit and trial method to maintain moisture content at a minimum level of nine per cent in the bale. A moisture metre is used to monitor the moisture content of lint bales.

Condensation & Moisture Restoration

4.8.2 Recommendations

The speed of the condenser drum should be adjusted to the capacity of the gin so that a smooth, solid bat is formed. If the drum runs too fast, breaks will occur in the bat; if too slow, the bat will be thick, causing high static pressure loss and possible chocking in the system.

A peripheral speed of 6 to 15 rpm is recommended for a condenser drum with a diatmetre from 3 to 8 feet. The gin saw rollers rate should also be taken into consideration while adjusting the condenser drum rate.

Adding moisture to lint that has already been ginned, however, will not increase fibre length. Other benefits from moisture restoration include reducing static electricity level of the cotton, reducing the volume of cotton required to achieve a given bale size and reducing the force required to press the bale. The resilient force exerted on the restraining bale ties is also lower for cotton with more moisture.

4.9 BALE PRESSING

4.9.1 Existing Conditions

The lint cotton bat is dropped into a bale pressing machine after it has passed through the condenser and moisture level has been adjusted. The bale press machine consists of two integrated parts i.e. tramper and press. Most ginning units have a manual control mechanism to feed the machine which is done by an employee placed above the tramper platform. His only duty is to drop the lint bat towards the tramper plunger with the help of a bamboo stick. A few progressive ginning units have a roller slider installed, which automatically pushes the bat under the tramper.

A major problem with the bale press machine is the synchronization of the bale pressing rate with the incoming lint rate from the condenser. Most of the time the incoming lint rate is greater than the bale pressing rate, which results in blockage of the lint bat on the slide. To overcome this issue, press operators increase the stroke rate of the tramper plunger.

The press of the bale press machine is equipped with a motor and hydraulic pump (oil based) that generates pressure up to desired level so that bales can be pressed and packed. Most ginning units have no indication of applied pressure. Instead the press machine operators take notice of ampere load of the motor, through an ampere metre, to decide when the task is complete.

Tramper chain breakage, tramper jamming, oil leakages in hydraulic lines, and inappropriate pressure distribution through the sides of the bale are common problems that occur in the day to day operations of the ginning unit. Some ginning units also face breakage of the bale tie when bales exit the press of the bale press machine.

The following data shows some data on the lint bales and bale pressing in audited ginning units.

The press machine operator usually has the additional duty of documenting a daily press report, a summary of the day's production and operation of the plant. It is reviewed by the top management in order to resolve daily operational issues recorded. The daily press report is generated in all ginning units; however the extent of information required and skill of personnel writing the report varies. Often times this report is not produced due to the lack of personnel. Incomplete information, wrong information and tailored information are common issues with daily press reports.

Audited Ginning Units: Data on Lint Bales and Bales Pressing

Moisture Contents (Reported) of the Lint after Water Spray (%)	4.5 – 9.2 – 15.0
Applied Hydraulic Pressure (PSI)	2,500 – 3,000 – 4,500
Lint Bale Density (kg/ft3)	145 – 160 – 174
Lint Bale Weight (kg)	8.5 – 10.2 – 13.1

Bale Press

4.9.2 Recommendations

It is recommended that the ginning rate from the gin stands, speed of condenser drum and pressing rate of the bale press machine should be to optimally synchronized. This requires careful calculations to adjust the feed roller and saw roller speed (rpm) at the gin stand, speed of condenser drum (rpm), speed of tramper (strokes/minute) and hydraulic press timing (minutes/bale).

The tramper speed should be adjusted to 10 strokes per minute and synchronized with the ginning rate, which is between 10 to 15 bales per hour. A lint feeder (paddle kicker or pusher type) should also be installed to support the tramper operation. "The lint feeder and tramper should have a capacity greater than the gin plant capacity to be able to accommodate the extra lint accumulated in the lint slide during turning of the press boxes. If the tramper gets behind while processing the cotton, the tramper should be able to catch up with the lint flow from the condenser well before the press box is filled. This will allow the bale weight control system to produce uniform bale weights. Varying bale weights not only have a very detrimental effect on the energy consumption of the press and on the bale tie forces but also cause serious problems at the textile mills (Jones 1980)."

A pressure gauge of suitable range i.e. 2,500 to 4,500 psi, should be clearly installed downstream from the pipeline of the operating valve and visible to the press operator. Installation of the gauge should be carried out carefully by an experienced workman to avoid accidents during high pressure operating conditions.

Preventive maintenance of the bale pres machine should be carried out, anticipating previous mechanical problems including tramper chain breakage, tramper jamming, oil leakages in hydraulic lines, and inappropriate pressure distribution through the sides.

It is suggested that good quality steel wire of minimum 10 gauge should be used as bale tie. A sufficient number of ties should be used to maintain suitable external dimensions and to minimize bulges between the ties. It is also suggested that tie connections should be positioned near the top or bottom of the crown of the bale. The tie force is considerably less at that point, and the connection is protected as it tends to recess inside the fibre.

The daily press report is a very important document, which must be recorded with great responsibility. It is recommended that daily production and operational information is recorded daily by following a standard procedure. Moreover, the personnel responsible for recording the information must be trained by the top management to do so. The following are recommendations for the daily press report:

- The press report should be written on a prescribed printed format.
- The report should only be developed by a trained employee. The author of the report must sign the report before submission to top management to ensure responsibility and authenticity.
- The report must be documented with the consultation of a ginning expert, electrical and mechanical supervisor.
- The report must contain details about the daily production of bales.
- The report must include precise information about out-of-operation timing of the ginning plant.
- The report must contain details of daily operational problems including cause and effect information.
- The press report data must be converted into soft copies on computer to generate weekly, monthly and/or seasonal performance evaluation reports.
- The press report information must be recorded for at least three years.

4.10 BALE STORAGE

4.10.1 Existing Conditions

Once lint cotton is pressed into bale formation and tied, it is weighed and marked with a unique code number and name of the ginning unit. This marking is mostly done with a stencil and black ink. Some ginning units use stickers instead of ink.

It is common practice in ginning units to store lint bales in open areas. The bales are usually placed on a set of four bricks laid on the yard floor and a stack of 100 bales is termed a lot. A few ginning units have covered storage halls.

Most of the time lots are not protected from the sun, rain or wind. Some ginning units provide protection by covering lots with tarpaulin.

The lint bales are sold to buyers as soon as possible and are manually loaded and unloaded from delivery trucks.

Bale Storage

4.10.2 Recommendations

It is recommended that stickers with the specific information of ginning units be used as well as a bale tracking number rather ink markings to avoid any discoloration of lint cotton.

Lint bales should be fully covered (including where they are opened for sampling), and all covering material should be clean, in sound condition, and of sufficient strength to adequately protect the lint cotton.

For outside storage, bale covering must include ultraviolet inhibitors commensurate with the anticipated storage period. The level of bale storage area should be elevated to avoid any rainwater accumulation.

4.10.3 STAFF TRAINING ON PROCESSES AND OPERATIONS

The following are recommendations for staff trainings on the ginning process and its operations. Such trainings are beneficial to run an efficient production process.

- Develop specific job descriptions for each employee, and ensure that it is available in the appropriate language.
- Train ginning personnel in basic mechanics and use of hand and power tools properly. Provide additional training annually.
- Train personnel in basic ginning machinery operations and minor repairs such as how to replace belts, install bearings, etc. Provide refresher training annually.
- Train management and ginning personnel in capabilities, functions and safe use of each machine and associated equipment as well as the entire ginning system.
- Train senior ginning personnel in visual fibre quality assessment and causes of change in its appearance.

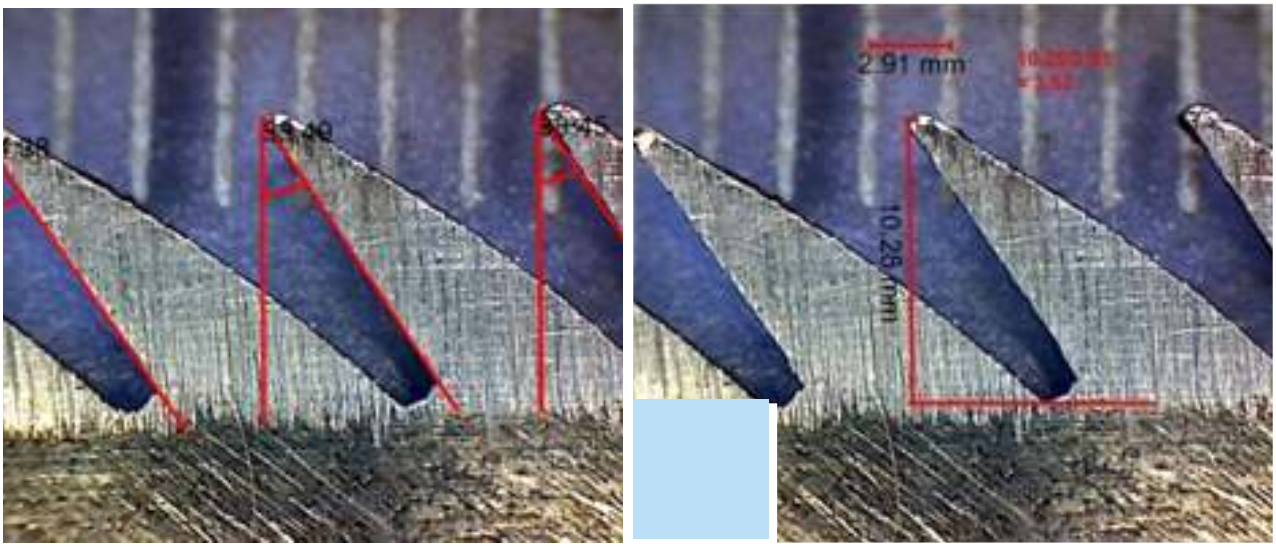
4.11 Fibre Quality

4.11.1 Saw Type

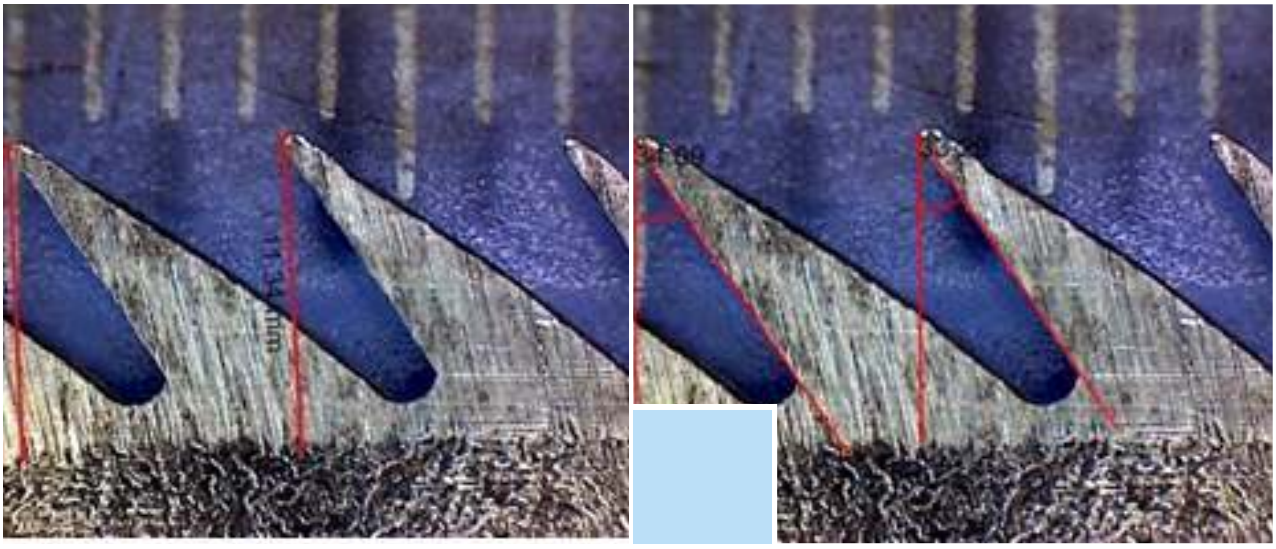
There are about 5 to 6 types of different saw used currently in the Pakistani market:

1. KKK saws
2. M/S Abdul Karim saws
3. M/S Brothers Industries saws
4. M/S Sardar Industries saws
5. Chinese made saws

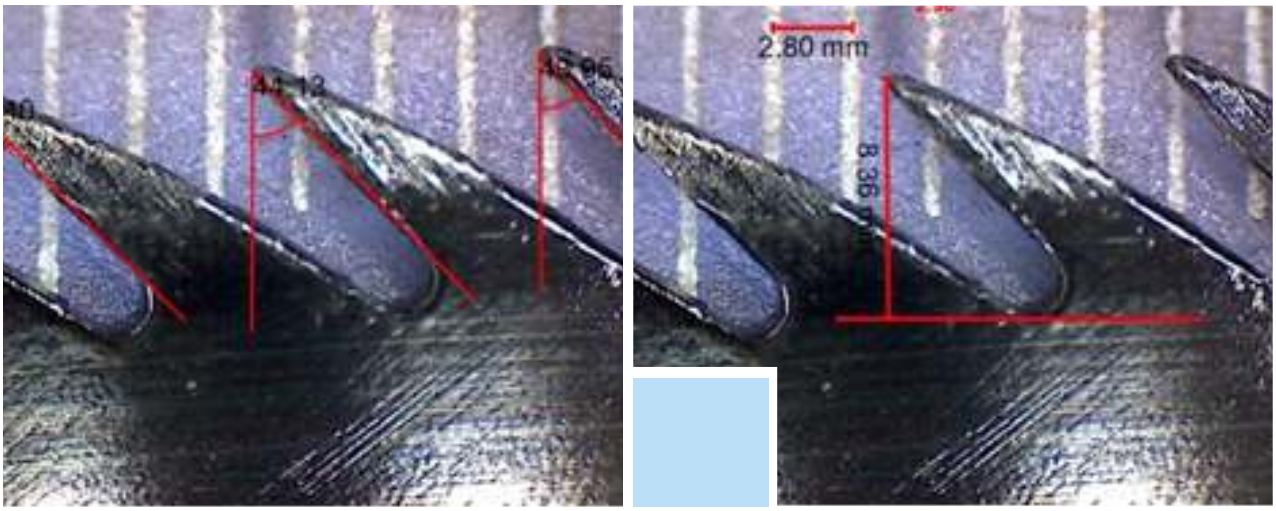
The importance of the saw shape and sharpness in not well known in the ginning sector. The primary importance is given to the saw price and quality aspects are mostly neglected.



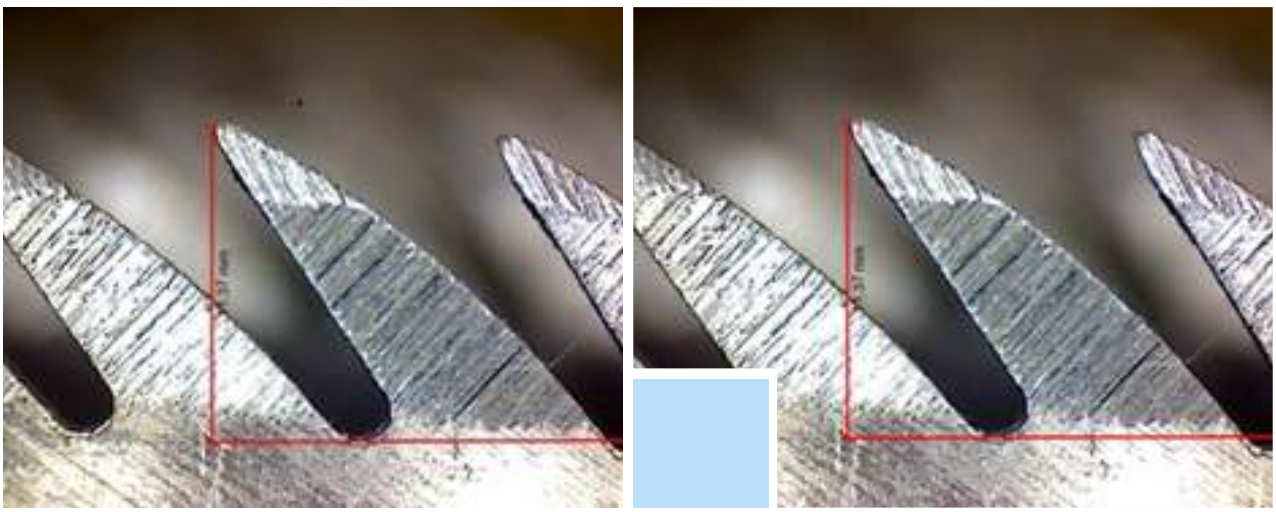
4.11.1 Ginning Saws_AbdulKarim Industries



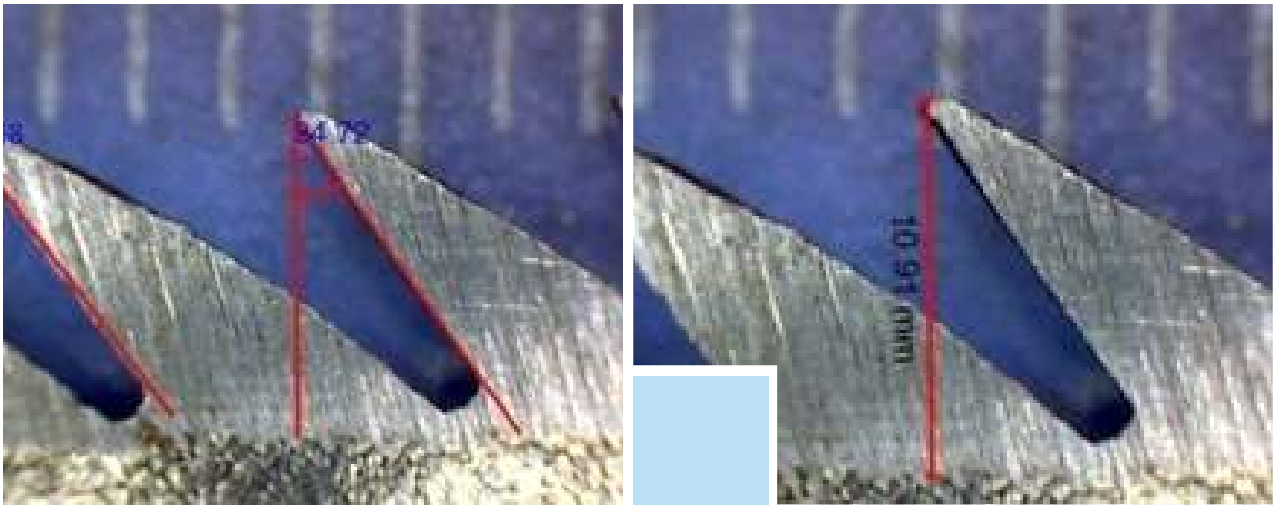
Ginning Saws_Brothers Industries



Ginning Saws_China



Ginning Saws_KKK Industries



Ginning Saws_Sardar Industries

4.11.2 Experimental Results

The force required to break fibres is 1.8 times higher than the force required to detach fibres from seed. Hence the tooth angle, its hardness and sharpness play a combined role in preserving the fibre quality during ginning. Experimental work carried out in this project shows that the average increase in percentage of short fibre contents at all ginning speed are 3.93, 4.90, 6.00, 4.93 and 4.57 for KKK, AK, Brothers, Sardar and Chinese saws respectively.

4.11.3 Recommendations

The choice of saws should be made focusing on the quality of material used, and their effect on lint quality. The results of present research work can be utilized in this respect. Better quality saws can compensate for high prices by increasing the lint percentage, i.e. by cleaning the seed more efficiently.

4.11.4 Saw Grinding

Existing Conditions

Worn out saws are normally grinded to increase their sharpness. Grinding is also very common in Pakistan's ginning industries, which is performed manually. Unfortunately, there are no standards for grinding and machine grinding is not available. Hence, worn out and badly grinded saws significantly influence the ginning process and, in turn, the ultimate fibre quality

Saw Grinding

4.11.5 Recommendations

Normally it is difficult to grind saws properly, thus it is advisable to replace saws after a specific number of bales are produced. Moreover, in case replacement cannot be done the grinding intervals for specific saws should be known and grinding should be performed accordingly to maintain sharpness of the teeth. This can be achieved with the help of image analysis as presented in this work.

4.11.6 Saw Speed

Currently, the ginning saw speed in factories in Pakistan ranges from 625 to 800 rpm. The concept of saw speed in the ginning sector corresponds to an increase or decrease in production of the machine. No attention is given to the ginning speed on fibre quality.

Revolution per minute (rpm) Calculation

4.11.7 Recommendations

As mentioned in literature, a speed of 700 rpm is recommended for 12 inch saws, which are commonly used in Pakistan. As the reduction in the ginning speed also leads to a reduction in the production of machinery, a speed of 750 rpm is recommended which results in good fibre length distributions, as well as trash removal and de-dusting.

4.11.8 Feed Rate

Existing Condition

Normally, the feed rate in ginning factories is not considered as factor that influences performance or fibre quality. Factories employ the same feed rate for all kinds of cottons. However, the feed rate can be increased when greater production is required. Further, most ginning factories in the Punjab region have pneumatic feeding which is done manually at the cotton heap, thus feeding is not homogeneous.

4.11.9 Recommendations

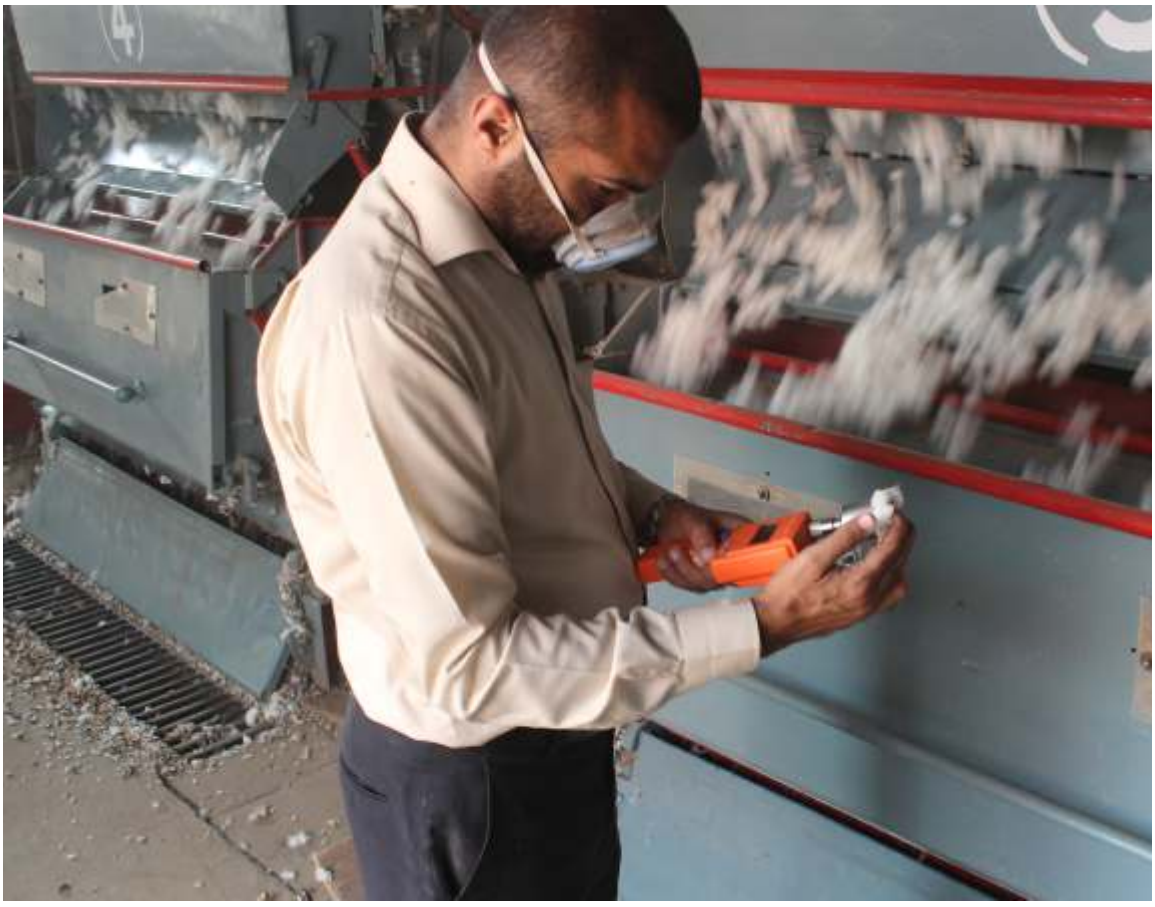
Results clearly indicate that an increase in the saw point's action/ gram fibre can increase fibre damage by increasing the short fibre content of cotton lint. On the other hand, it also improves the cleaning efficiency. The saw point action/gram fibre can be optimized from 2,500 to 3,500, where the ginning process can be carried out satisfactorily and without any loss of fibre quality. The reduced intensity of the ginning action can be easily compensated by using good quality sharp saws.

4.11.10 Moisture

Existing Condition

Moisture plays an important role in cotton ginning, it is also a neglected characteristic in view of fibre quality and ginning efficiency. However, moisture is as an important factor when considering bale weight. Cotton heaps are placed under the sky and normally no drying equipment is available. Therefore, the moisture in the seed cotton depends heavily on atmospheric conditions. Even cotton that has been ginned at different times of the day and night may have different moisture levels. Hence constant and homogeneous quality cannot be achieved.

Moreover, seed cotton coming into the ginning factory contains as much as 18 to 20 per cent moisture, which makes it very difficult to reduce moisture levels with drying equipment.



Moisture measurement of Seed Cotton

4.11.11 Recommendations

The global optimal moisture level recommended is seven to eight per cent. Below five per cent can cause serious damage to fibre and above 10 can reduce the ginning capacity and increase the trash percentage. However, in current ginning factory conditions it is difficult to maintain desired moisture levels in the absence of seed cotton driers. Moreover, it is easily understandable that different cotton regions have different atmospheric conditions; therefore, changes in moisture in different factories will be different. Hence, it is recommended that ginners should know the change in the moisture content from heap to ginning point at different times during the day and night as well as different months. Moreover, it is recommended that efforts should be made to gin cotton at a moisture level of around nine per cent as a slightly higher moisture level can provide safeguards against fibre damage due to non-optimized settings and vigorous ginning action.

Better Practices
Process Energy Conservation

Better Practices Process Energy Conservation

5

Energy is utilized in the form of electricity and fuel. Almost all ginning machinery is run by electricity, which is extensively used at each process level. Generally the unit electricity consumption for an efficient ginning mill is about 0.07 kWh per kg of lint. Ginning mills, with relatively high electricity consumption, have very old and inefficient machinery. Improperly maintained machines also produce less output with long running hours as compared to well maintained machines, which have better production rates. Fuel is used in those ginning mills which have standby electricity generation arrangements from generators during electricity shut downs from the grid.

5.1 ENVIRONMENTAL IMPACTS OF ENERGY CONSUMPTION

Inefficient use of energy and natural resources, apart from the economic loss and increase in per unit cost of production, result in the following large-scale environmental problems:

a) Higher emissions of air pollutants such as oxides of sulfur (SOX), oxides of nitrogen (NOX), carbon monoxide (CO), volatile organic compounds (VOC) and particulate matter (PM), consequent to higher rates of fuel burning.

b) Higher emissions of carbon dioxide (CO2), which is a greenhouse gas and its increased concentrations in the atmosphere are responsible for the global warming phenomenon.

c) Depletion of non-renewable natural resources.

5.2 MONITORING OF ELECTRICITY CONSUMPTION

5.2.1 Existing Condition

Unit electricity consumption in the local ginning mills varies from 0.07 – 0.16 kWh/kg of lint with a median value of 0.11. The percentage increase in the unit consumption figure is about 45 to 129 per cent and shows huge potential of electricity savings. On the basis of average production of the mill in a particular season, this saving in electricity bills can be in the range of Rs. 2 to 4 million, depending upon how efficiently or inefficiently the mill is operated.

Mointoring of electricity consumption

Open electric wiring in ginning hall

5.2.2 Recommendations

The unit consumption of electricity can be reduced by taking different energy efficiency measures. However, the first step towards these measures is monitoring followed by its management and control.

It is recommended that production management should start making daily production reports which describe daily production of all commodities, machine operations and their stoppage detail with reasons. Daily recording of kWh and its comparison with production should also be part of this report. On the basis of these daily production reports, management can produce consolidated monthly and seasonal reports. These reports will indicate how efficiently or inefficiently the process is. In case of deviation from the routine unit consumption trend, particularly on the higher side, reasons can be explored and rectified timely.

Some ginning mills are adjoined to oil mills and their electricity supply is through one metre only. These mills allocate an energy consumption portion to the ginning and oil mill on the basis of estimation, which is not an appropriate way to monitor electricity consumption. It is recommended that for such mills separate sub-energy meters are installed to record and monitor electricity consumption separately.

For those ginning mills which have standby sources of electricity such as generators, kWh and hour meters should be installed in generators and consumption of fuel should be recorded as well as operational hours and corresponding daily electricity generation evaluated.

Electric Panel

Measuring electrical efficiency

5.3 VOLTAGE IMBALANCE

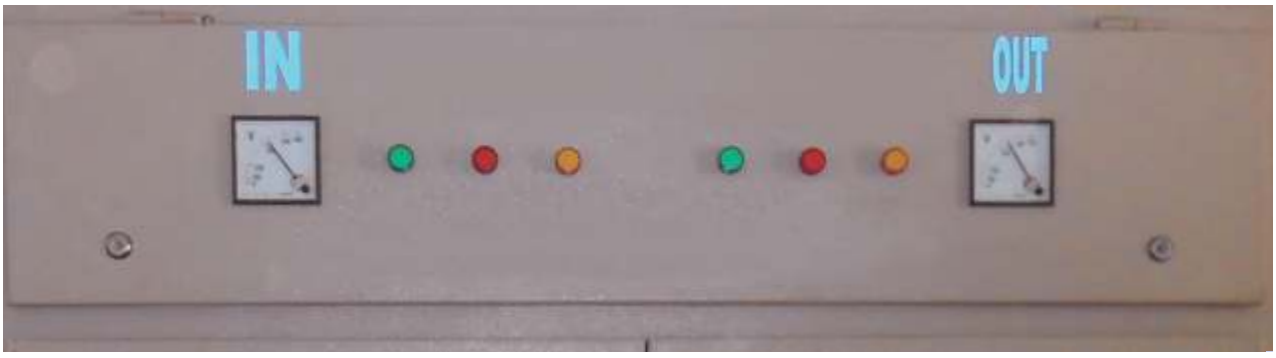
5.3.1 Existing Condition

Voltage imbalance is in the range of 0.1 to 2.5 per cent whereas it should be within one per cent. In 60 per cent of cases machines operate at about more than one percent of the voltage imbalance which results in de-rating of motors (efficiency is decreased) and a current imbalance which results in heating up of motors.

Voltage Measurement

5.3.2 Recommendations

It is recommended that the load distribution should be regularly checked to avoid voltage imbalance and other related issues. All loose connecting points of motors should be checked and tightened appropriately, followed by checking the single phase load distribution and balancing the load accordingly.



Voltage Stabilizer

5.4 CAPACITY OF ELECTRIC MOTORS

5.4.1 Existing Condition

All ginning machines are equipped with electric motors of varying capacities. Ginning machines which are equipped with larger sized electric motors include saw gin stands, bale press and suction and delivery fans.

Saw Gin Stands

Generally, each saw gin is operated independently with a single motor. However, a number of mills have one motor of a relatively larger size coupled with two saw gin stands. These saw gin stands are generally equipped with electric motors of capacities in the range of 18 to 45 kW with the median value of 25. The most common range is 22 to 30 kW. A high capacity motor of 45 kW is coupled with two saw gin stands with the consideration of energy saving. The loading of motors attached with saw gins is in the range of 24 to 119 per cent. Approximately 40 per cent of cases have saw gin motors operating at more than 50 per cent load. This situation shows that oversized motors are attached with saw gin stands which result in energy losses.

When two saw gins are coupled with a single large motor, it creates two problems i.e. in case one machine must be stopped due to some fault a single machine operates with a large sized motor. This motor then operates under load condition and results in energy losses.

Bale Press

Bale presses are generally equipped with electric motors of capacities in the range of 22 to 55 kW with a median value of 30. The most common range is 30 to 37 kW. The loading of motors attached with bale presses is in the range of 30 to 180 per cent. In about 10 per cent of cases bale press motors operate at a load of more than 50 per cent. This situation shows that oversized motors are attached with bale presses which result in energy losses.

Electrical Motors

Suction and Delivery Fans

Suction and delivery fans are generally equipped with electric motors of capacities in the range of 18 to 75 kW with a median value of 50. The most common range is 37 to 55 kW. The loading of motors attached with these suction and delivery fans is in the range of 44 to 110 per cent. In about 10 per cent of cases fan motors operate at a load of more than 50 per cent. This shows that oversized motors are attached with fans which result in energy losses.

A summary of motors capacities and loadings in audited units is given in table 5.1.

Delivery Fan

5.4.2 Recommendations

Use of Motor of Appropriate Size

Saw gins can be operated with electric motors of 18, 22 and 25 kW capacity. Management should frequently monitor loading of these motors and if their loads are less than 50 per cent then they should be replaced with smaller motors to avoid under load condition which results in substantial energy loses.

It is recommended that bale presses equipped with large size motors i.e. above 37 kW should be replaced with motors of appropriate size to avoid motors operating under capacity which results in substantial energy loses. Fans equipped with motors of large size i.e. above 55 kW should be replaced with motors of smaller size as well.

Coupling of Single Gin Stand with Single Motor

It is recommended that a single gin stand operate with a single motor of appropriate size.

5.5 Rewound Motors

Table 5.1
Summary of Motor Capacities and Loadings

Individual Motors Capacity (kW): Saw Gins	
Range	18 – 25 – 45
Most Common Range	22 – 30
Individual Motors Capacity (kW): Bale Press	
Range	22 – 30 – 55
Most Common Range	30 – 37
Motors Rated Outputs (kW): Suction & Delivery Fans	
Range	18 – 50 – 75
Most Common Range	37 – 55
Motor Loadings (%): Saw Gins	24 – 119
Percentage Cases with Motor Loadings < 50%	40
Percentage Cases with Motor Loadings < 60%	60
Motor Loadings (%): Bale Press	30 – 180
Percentage Cases with Motor Loadings < 50%	10
Motor Loadings (%): Suction & Delivery Fans	44 – 110
Percentage Cases with Motor Loadings < 50%	10
Percentage Cases with Motor Loadings < 60%	25

5.5.1 Existing Condition

Ginning mills do not keep proper record of rewound motors and the amount of copper used for these motors is not recorded, which is a direct way to evaluate the frequency of rewinding in the industry and expenses associated with it. A rewound motor consumes more power than high efficiency motors of the same rating due to increased iron losses. Also, each rewinding decreases motor efficiency from two to five per cent, which results in a reduction in the power factor. This negatively impacts the overall efficiency of the motor.

Motor Rewinding

5.5.2 Recommendations

It is recommended that a record of motor rewinding should be kept along with details on quantity of copper used and cost involved. This information will help in deciding when to replace the motor. If a motor has been rewound two to three times or the rewinding cost is approximately 40 percent of the cost of a new motor, it is better to replace it.

It is also suggested that a motor replacement plan be made for each year. An old rewound motor with longest running hours over the year should take top priority for replacement.

5.6 POWER FACTOR CONTROL

5.6.1 Existing Condition

Generally switching of capacitors is manual. This manual switching results in under/over compensation of kVArm which causes inefficiencies in the system.

Electric Power demand & supply Assessment

5.6.2 Recommendations

Mode of switching of capacitors should be automatic, which compensates the kVAr requirement of load variation automatically and improves system efficiencies. Also, the ginning unit should install an automatic power factor controller to correct the power factor according to the load variation in motors.

Power factor division with capacitor

5.7 LOAD MANAGEMENT

5.7.1 Existing Condition

All ginning mills use electricity supplied from the grid to fulfill the power demands of the mill. Electric metres records peak electric load every 30 minutes and this peak value for the month i.e. Maximum Demand Indicator (MDI) is recorded in the monthly bill and charged accordingly at the rate of Rs. 375/kW. Thus, the electricity bill increases due to an increase in MDI of the month.

From MDI data collected from different mills, it is evident that this value differs each month and does not remain constant. This trend shows that the electric load is not managed from an with MDI perspective. The higher the MDI value (peak value in any 30 minutes of the month), the greater the electricity bill. Also, the load factor of mills varies every month, which is defined as the ratio of the average kilowatt load over a billing period to the peak demand.

$$\text{Load factor} = \frac{\text{Total Kwh in the month}}{\text{No of days/month x hourse per day x MDI}}$$

A high load factor (usually close to unity) indicates that less opportunity exists for improvement because the load is already relatively constant. In case the load factor is far from unity there is substantial potential to manage MDI and reduce electricity bills.

An ideal MDI in the month will be at load factor of unity which means power consumption remains constant in the whole month i.e. there is no abrupt peak power consumption during any 30 minutes of the production cycle. An abrupt peak power consumption generally occurs when all machines are operated at once. This peak load is recorded and the electric bill charged on the

basis of this peak load (MDI).

For an efficient system, theoretically, the load factor should be 1.0. If the load factor varies significantly from billing period to billing period without an explanation, mill operation requires careful review. Also if load factor is less than 0.8, there is potential to reduce maximum demand.

Load Management

5.7.2 Recommendations

It is suggested that management should plan machine operations in such a way that the maximum demand should not increase beyond a certain set value. Machines should be started one by one, particularly heavy machines. Also, during peaks a generator which starts automatically can be used for a short while to adjust the peak, in case it is available. Another option is to install an automatic demand controller. This controller will automatically control the peak demand by shutting off those machines or appliances which will not disturb the production for a short period of time.

Management should analyze the MDI value in its monthly bill and calculate the load factor by using the above formula and evaluate whether the production load is being managed efficiently or not. In case the load factor comes out to be less than 0.8 strict control over load management is required.

The ginning mills located next to oil mills which have one collective electricity supply should not be started simultaneously to control MDI. In case, if it is possible, management can also operate mills during different times of the day i.e. the oil mill can be operated at night and ginning mill during the day.

BETTER PRACTICES
HOUSEKEEPING AND MAINTERANCE

Better Practices Housekeeping and Maintenance

6

These recommendations focus on improving working practices, good housekeeping and proper maintenance of the process infrastructure and are mostly simple in nature. Implementation of these recommendations requires improvement in the management system and investment requirements are mostly nominal with an indirect rate of return. This chapter lays down only general and routine maintenance requirements for equipment in the mill and its housekeeping.

6.1 WORKERS SENSITIZATION

6.1.1 Existing Condition

Ginning mill workers are neither sensitized nor trained on housekeeping and preventive and routine maintenance aspects of a ginning mill.

6.1.2 Recommendations

Management should focus on training, awareness raising and sensitization of the workers regarding housekeeping and preventive and routine maintenance aspects of mills. The maintenance in-charge should be encouraged and supported to formulate and implement preventive, routine and daily maintenance plans and inspection checklists. All maintenance requisites such as tools, oil and grease, spare parts etc. should be readily available in the mill to be used as and whenever required.

6.2 HOUSEKEEING

6.2.1 Existing Condition

The following are key housekeeping issues in ginning mills:

- Floors and machines remain dirty and covered with fluff.
- Safety guards are not placed around rotating, moving and sharp edged machine parts, which can cause injuries and major accidents.
- Fire extinguishers are not well maintained, improperly mounted on the wall and not accessible in most cases.
- No cable trays are used. Cables are mostly hanging on the wall or laid on the ground without any safety.
- Electricity panels are not installed properly for an efficient electrical distribution system, rather breakers are fixed on walls.
- Breakers are not properly fixed in panels.
- Panels are not earthed.
- Electric motors are generally dusty.

- Suction and delivery fans are dusty.
- There are leakages in suction and delivery ducts, which increase energy losses.
- Walkways are not clear, which can pose safety threats to workers and also result in production inefficiencies.
- Ladders used in different production areas are not appropriate and can pose safety risks for workers.
- Tools and parts are scattered in electrical and mechanical workshops.
- Lights are covered with dust due to the environment which results in reduced luminosity.

Poor Housekeeping

Poor Housekeeping

Poor Housekeeping

Poor Housekeeping

Poor Housekeeping

6.2.2 Recommendations

The following are recommendations for better housekeeping in ginning mills:

- Perform daily cleaning of machines and floors.
- All rotating, moving and sharp edged machine parts should be appropriately covered with safety guards. This includes conveyors, pulleys, moving cylinders, moving saws, fans, beaters and belts. Safety guards restrict free or unintentional access of workers to these parts and prevent injuries, major accidents and loss of life.
- All fire extinguishers should be checked to ensure they are full at the start of the season. They should be properly mounted in appropriate places for easy access.
- Appropriate sized cable trays should be installed or trenches should be made. Cables should be properly placed inside the trays and trenches to avoid fire and other hazards.
- Electric panels of appropriate size and design should be installed for a safe and efficient electrical distribution system.
- Breakers in electricity panels should be properly fixed.
- Electric panels should also be properly earthed.
- Electric motors and suction and delivery fans should be frequently cleaned to avoid overheating and burning.
- Suction and delivery ducts should be cleaned and well maintained.
- Walkways should be clear of any obstruction.
- Safe ladders should be used to avoid accidents in the production area.
- A 5S housekeeping procedure should be applied in electrical and mechanical workshops, as discussed in section 6.7.
- Light fixtures should be frequently cleaned to ensure proper luminosity in work spaces.

Good Housekeeping

Good Housekeeping

Good Housekeeping

Good Housekeeping

Good Housekeeping

Good Housekeeping

6.3 MAINTENANCE

6.3.1 Existing Condition

The following are key maintenance issues:

- There is no documented maintenance schedule for machines.
- There is no daily/routine maintenance checklist. There are no daily/routine checkups of machines.
- Instead of preventive maintenance, breakdown maintenance is carried out, which results in the loss of production hours.
- Workers are not trained on preventive maintenance and are used to breakdown maintenance activities.
- Terminal boxes are not installed in motors.
- Monitoring and maintenance tools are not available or used in mills.
- Meshes installed in suction fans, and delivery ducts are not cleaned regularly.
- Machines, motors, pulleys and other mechanical equipment are not properly aligned due to which frequent maintenance issues arise.

Poor maintenance of machinery

Poor maintenance of machinery

Poor maintenance of machinery

6.3.2 Recommendations

The following are recommendations for maintenance of machinery in mills:

- Belts and pulleys system should be inspected regularly for their alignment and tightness. Belt slips and misaligned pulleys hamper power transmission through the system. This results in production time increase and energy consumption increase due to time of production. Due to unavailability of proper sized pulleys, different sizes of pulleys are often used, resulting in poor performance. Belts and pulleys of proper sizes should be used when respective replacements are required.
- Terminal boxes should be installed properly in motors to avoid fire hazards and other accidents
- Proper tools required for in-house maintenance activities should be provided to the maintenance staff. They should include standard gauges for adjustment of ginning machines such as rib gap gauge, brush clearance gauge, channel saw grid bar clearance gauge, rib width gauge, saw projection gauge, spike clearance gauge etc. For the measurement of motor parameters, energy analyzers should be used. Motor parameters such as current, voltage, kW, power factor etc. should be monitored regularly and recorded to frequently evaluate motor performance.
- Meshes installed in suction fans, and delivery ducts should be cleaned regularly.
- Equipment should be properly aligned.


Good machinery maintenance

6.4 MAINTENANCE PROGRAMME

It is suggested that the operation staff should develop and formulate a detailed maintenance programme, at the start of each season, which should be implemented during the season. The maintenance programme should be adapted to past experiences and must include off-season repair, in-season preventive maintenance, and documentation. Prime time should be programmed (typically one hour per day) for routine maintenance to include clean up of facilities and machines and a checklist should be used for routine maintenance. Formal reviews should be conducted annually.

6.5 MAINTENANCE RECORDS

A suitable way to regulate the information on maintenance activities is the use of maintenance records, in which ginning staff describes their routine activities. The maintenance records should contain information on the nature of maintenance activities, dates, time spent and the quantities of supplies (oil, grease, bolts, nuts, paint etc.) and spare parts that were used for the execution of the job. Such records can be used to trace the cause of equipment failures and provide information to update maintenance schedules. Furthermore, these records are the basis for stock control.

6.6 STOCK CONTROL

Maintenance staff should always be provided with a sufficient stock of spare parts and supplies. The stock level of such parts should be established according to past experiences of the maintenance staff and keeping in view their respective order and delivery times.

6.7 5SGOOD HOUSEKEEPING TECHNIQUE

To achieve good housekeeping, the 5S Good Housekeeping Technique should be implemented. 5S is a Japanese system to reduce waste and optimize productivity by maintaining an orderly workplace and using visual cues to achieve consistent operational results. The concept of good housekeeping is based on the following five pillars.

1. Sort (Clearing up): Remove all items from the workplace that are not needed for current use. This step distinguishes between necessary and unnecessary items and eliminates the unnecessary items. It also provides more workspace and should be evaluated as a percentage of space saved per activity.
2. Set in Order (Orderliness): Arrange and label required items so that these are easy to use and easy to find. To keep things in order in the workplace there must be an efficient layout design. Orderliness in fact eliminates searches, when set in order items are named and properly stored away. This step provides a considerable decrease in equipment downtime.
3. Shine (Cleanliness): Eliminating trash, filth and foreign material for a cleaner workplace. This includes sweeping floors, whipping off machinery and making sure that everything in the factory stays clean. For effective cleanliness, inspection is important and every cleanliness activity must end with an inspection.
4. Standardize: Defines an ideal state of housekeeping. When the first three steps are performed, a standard is developed and can then be followed actively. Standardization is an objective for all the above steps and identifies training needs. It creates rules for checking and measuring. It also leads to regular auditing.
5. Sustain (Discipline): The right things as a matter of course i.e. again and again. In other words the correct procedure should be properly maintained. This involves developing norms and their continuous monitoring.

6.8 SOLID WASTE MANAGEMENT

6.8.1 Existing Condition

There is variety of waste in mills such as cotton waste and metallic parts scrap, which is not segregated properly and workers do not know about waste management (proper collection, storage and transportation).

The calorific value of the waste of ginning mills, which includes neps, motes and short fibers, is about 9,796 KJ/Kg with six per cent moisture and 37 per cent ash content. This waste has a heating value more than that of bagasse (7,368 KJ/Kg) and corn cob (8,300 KJ/Kg) and is is approximately one to two per cent of the seed cotton received by mills. Total waste from ginning mills in Pakistan is close to 115,000 ton per season. This waste is currently being burnt in local brick mills in an informal way.

6.8.2 Recommendations

A solid waste management system should be implemented in mills. All waste should be properly segregated and stored and management should keep a record of its sale. The scattering and mixing of different types of waste should be discouraged and one personal from the management staff should be responsible for waste collection, storage, sale and its record.

It is recommended to use the above mentioned waste as fuel for other industries in Pakistan in an organized way. Pakistani industries are currently shifting to biomass fuel due to the shortage of fossil fuel in the country and availability of biomass is an issue. This fuel will be a good addition to them.

On the other hand cotton gin waste is also used as growing media for mushrooms. The cultivation of mushrooms is an economically beneficial trend in the modern world and in Pakistan there is an opportunity to utilize it efficiently as the country is facing nutritional problems like other developing countries. The following are some efficient uses of cotton gin waste, which are being promoted by the SPRING project.

Mushroom Cultivation using Cotton Gin Waste as growing media

Cotton gin waste is generally composed of piece of leaves, bracts, sticks, broken seeds, moats and lint, bur and soil particles. Waste management is a big issue faced by the cotton ginning sector globally. In Pakistan disposal of large quantities of this waste is alarming and can cause serious environmental issues. The SPRING project team is trying to find environment friendly uses of cotton gin waste, one of which is the cultivation of oyster mushrooms.

Not only growing oyster mushrooms using cotton gin waste is helpful in reducing the environmental impact, but also it provides food to the masses. Moreover mushroom cultivation can provide an additional income for cotton growers that will improve their livelihood. Oyster mushrooms are a good source of essential mineral salts required by the human body. It is also rich in vitamin C and B complex and protein contents. It is suitable for people with hyper-tension, obesity and diabetes as it has low sodium, potassium ratio, starch, fat and calorific values.

The SPRING project conducted a mushroom cultivation training for the women of cotton growing families with the collaboration of the Department of Horticulture, University of Agriculture, Faisalabad. A training manual is published with all relevant information to grow oyster mushrooms along with recipes for its use. A concerned researcher from the University of Agriculture, Faisalabad provided on spot technical support to prepare mushrooms using the fertilizer and mushroom cultivation in five demonstration sites. This will create awareness among cotton grower to use the waste in an efficient and environment friendly way.

Cotton ginners also have a business opportunity to utilize their cotton gin waste in more profitable way by exporting it to other mushroom growing countries. Some ginners are already doing so but there is still room for growth. By doing so, not only will ginners can earn foreign exchange, but a local market of local mushroom growers will also be available.

Mushroom Cultivation

Use of Cotton Gin Waste in Making Cardboard

The SPRING team coordinated with the commercial sector to find possibilities for efficient ways to use cotton gin waste. Crushed waste was used in sundry cardboard making and the process was completed with the coordination of local cardboard makers in Multan.

Usually sundry cardboard is made of 100% recycled cardboard without complicated colouring or waxing requirements. It is thicker and less likely to tear or break and used for packing of bigger items for mailing or shipping. Sundry cardboard is used as is regardless of colour. Recycling of sundried cardboard is easier as it can be pressed into bundles and transported to a manufacturer directly where it is then shredded and mixed with water to make pulp for new cardboard products.

The SPRING project team conducted a trial to use cotton gin trash for sundried cardboard making, as it is cheaper than recycled cardboard, i.e. cotton gin waste is 33 per cent cheaper than recycled cardboard. For the trial 60 per cent recycled cardboard and 40 per cent crushed cotton gin waste was used. Results showed that the resulting cardboard gained more weight than traditional cardboard. Also, it was cheaper than traditional cardboard as it gained good strength due to the presence of fibrous material in cotton gin waste. However, its color was darker than traditional cardboard.

Therefore, cotton gin waste can be used for sundried cardboard making. Crushing of the waste is very important otherwise there will be large pieces of cotton bolls or sticks which will create problem during mixing and damage the sieve of the cardboard making machine. Crushing of the waste should be in such a form that it can easily be mixed with recycled cardboard pulp.

With the collaboration of the Art and Design Department, Islamia University Bahawalpur, different daily use items and decoration pieces were designed and prepared using this cotton gin waste cardboard.

Household Gasifier Stove; Clean Energy from Cotton Gin Waste

Household Gasifier Stove; Clean Energy from Cotton Gin Waste Cotton Gin waste having a heating value of 9,796 KJ/Kg that is more than bagasse (7,368 KJ/Kg) and corn cob (8,300 KJ/Kg) presented itself as a viable option for household fuel. Using this waste material in conventional household stoves was not possible as an efficient fuel source, due to its rapid burning, emission of excessive smoke and particulate matter causing indoor pollution leading to respiratory diseases.

Keeping in view all these issues, a collaborative research study was conducted with department of Chemical Engineering, University of Engineering and Technology Lahore, with an idea to design a household gasifier by controlling the amount of air used in burning cotton gin waste. After several attempts for an efficient & cost effective design, a prototype was developed that works on the basic principle of gasification converting the biomass to a synthesis gas. This household gasifier stove using cotton gin waste as fuel, is a low-cost yet clean source of energy for household use. It is hoped that wider use of this simple & user friendly gasifier has the potential of not only fulfilling the domestic fuel requirements of rural communities but also reducing the tendency of rural community to cut trees for domestic use. SPRING Project team demonstrated the use of this stove among rural communities especially living around ginning SMEs for it wider dissemination and adoption.

Fuel Pellets

A bulk quantity of cotton gin waste is produced during the ginning season which can be used to make fuel pellets and has properties that are comparable to pellets made from traditional sources such as wood chips. In addition, fuel pellets can be utilized in a number of items. Manufacturing of pellets involves placing gin waste under high pressure and forcing it through a dye, a process known as extrusion. Globally fuel pellets consumption has risen significantly over the last few years.

Ginners can efficiently utilize their gin waste economically. In this way ginners can earn more income than simply the direct selling of cotton gin waste.

Better Practices Decent Work

7

Decent Work is a term coined by the International Labour Organization (ILO) Director General Juan Somavia in 1999. Decent Work is the promotion of opportunities for women and men to obtain productive work in freedom, equity, security and human dignity. It has four strategic objectives; the promotion of rights at work, employment, social protection and social dialogue. In brief, the ILO considers Decent Work as the heart of social progress. Access to Decent Work and productive employment is essential as a sustainable way out of poverty and to meet the Millennium Development Goals.

7.1 WORK AND WAGES

7.1.1 ILO Conventions

- C131 - Minimum Wage Fixing Convention No. 131, 1970
- C095 - Protection of Wages Convention No. 95, 1949
- C117 - Social Policy (Basic Aims and Standards) Convention No. 117, 1962
- C001 - Hours of Work (Industry) Convention No. 1, 1919

7.1.2 Minimum Wage

A minimum wage must cover the living expenses of an employee and his/her family members. Moreover, it must relate to the general level of wages earned and the living standard of other social groups.

7.1.3 Regular Wage and Wage Protection

Wages must be paid regularly at intervals which are daily, weekly, biweekly or monthly as per agreement or set in law.

7.1.4 Overtime Compensation

Working overtime should be avoided. Whenever it is unavoidable extra compensation should be given, the minimum being the basic hourly wage plus all additional benefits which a worker is entitled to.

7.1.5 Existing Conditions

It was observed during the Decent Work scoping study that the average working hours of workers in the ginning sector were higher than those specified under law and international labour standards. Ginning enterprises used to make workers work 12 hours per day and often did not give an overtime wage. However, wages in the ginning sector are fair and are somewhat better than most other sectors of the economy in the targeted areas where these enterprises are operating.

7.1.6 Recommendations

Wages are the total remuneration payable to an employed person on the fulfillment of his or her contract of employment. The employer is responsible for the payment of all wages required to be paid to persons employed by him or her. The persons responsible for payment of wages must fix wage periods not exceeding one month.

The cotton ginning industry should ensure recommendations mentioned as under the Factories Act, 1934 as a worker who has completed his or her 18th year of age can be permitted to work in any establishment but not more than nine hours a day and 48 hours a week. Moreover, no young person under the age of 18 can be permitted to work more than seven hours a day and 42 hours a week.

As per section 4 of the Factories Act, cotton ginning is a seasonal industry where an adult worker should not work for more than fifty hours in any week and no more than ten hours in any day. However, if such an adult worker in a factory is engaged in work and for technical reasons he/she must work in continuous throughout the day, that adult worker should work no more than fifty-six hours in any week.

The periods and hours of work for all classes of workers in each shift must be notified and posted in a prominent place in the principal language in the industrial or commercial establishment. The law further states that no worker should work continuously for more than six hours, unless he or she has had an interval for rest or meals of at least one hour

7.2 ANNUAL LEAVE AND PUBLIC HOLIDAYS

7.2.1 ILO Conventions

- C132 - Holidays with Pay Convention - Revised No. 132, 1970
- C014 - Weekly Rest (Industry) Convention No. 14, 1921
- C047 - Forty-Hour Week Convention No. 47, 1935
- C106 - Weekly Rest (Commerce and Offices) Convention No. 106, 1957

7.2.2 Paid Leave

An employee is entitled to at least 14 consecutive paid leave annually. National and festival holidays are not included. Collective agreements must provide at least one day of annual leave on full remuneration for every 25 days on which the employee worked or was entitled to be paid.

7.2.3 Pay on Public holidays

Workers should be entitled to paid holidays during national and officially recognized public holidays

7.2.4 Weekly Rest Day

Workers should enjoy a rest period of at least 24 consecutive hours in every a week.

7.2.5 Compensatory Holidays

If a worker has to work on a national/festival holiday or a weekly rest day, he or she should be given one day additional compensatory holiday with full pay and a substitute holiday should be awarded.

7.2.6 Existing Conditions

Managers of cotton ginning enterprises were asked about weekly rest days. Though most of the enterprises observe a weekly holiday many do not have a weekly rest day during the peak period. The Decent Work scoping study was undertaken in the peak ginning season, which reflects the patterns of work during this season.

7.2.7 Recommendations

The Weekly Rest (Industry) Convention No. 14, 1921, regulates worker's right to weekly rest in detail for those employed in factories. This convention provides that workers must, in principle, enjoy in every period of seven days a period of rest comprising at least 24 consecutive hours. The Holidays with Pay Convention (Revised) No. 132, 1970 establishes the right of every person to whom it applies to an annual paid leave of at least three working weeks for one year of service.
As per the Factories Act, 1934, every worker who has completed one year of continuous service in a factory should be allowed to avail 14 consecutive paid holidays for the subsequent period. If the worker fails to take all of the holidays in one year then holidays allotted to him should be added in the next year.

7.3 EMPLOYMENT SECURITY

7.3.1 ILO Conventions

- C158 - Termination of Employment Convention No. 158, 1982

7.3.2 Written Employment Particulars

A contract of employment can be oral or written, however workers should be provided with a written statement of employment at the start of their work.

7.3.3 Fixed Term Contracts for Permanent Tasks

Workers must not be hired for permanent tasks as it leads to precarious employment.

7.3.4 Probation Period

A reasonable probation period must be provided to a worker to learn new skills. A newly hired employee may be fired during a probation period without any negative consequences.

7.3.5 Notice Requirement

A reasonable notice period, depending on the length of service of an employee, may be required before an employer may sever the employment relationship.

7.3.6 Severance Pay

Employers may be required to pay a severance allowance on termination of employment due to redundancy or any other reason, except lack of capacity or misconduct.

7.3.7 Existing Conditions

During the survey regarding workers most men and women responded that they had no written contracts specifying terms and conditions of employment. Although nearly all cotton ginning enterprises visited during the survey were registered as factories under the Factories Act 1934, records of working hours, leaves, holidays, overtime, bonus and financial and other benefits for which workers were entitled were not maintained in written formats as required under law. Some discrepancies were found in employment as workers were introduced to the workplace by relatives or acquaintances and the recruitment and selection procedure was mostly lacking. Moreover, some complaints in the Sindh region were also recorded about workers sharing their wages as a commission with a middle man for helping get a job.

7.3.8 Recommendations

The Industrial and Commercial Employment (Standing Orders) Ordinance was enacted in 1968 to address the relationship between employer and employee and the contract of employment. In the case of workers in cotton ginning engaged by contractors, their labour contracts are generally unwritten which should be enforced through courts on the basis of oral evidence or past practice. Every employer in an industrial or commercial establishment is required to issue a formal appointment letter at the time of employment of each worker. The obligatory contents of each labour contract, if written, are confined to the main terms and conditions of employment, namely nature and tenure of appointment, pay allowances and other fringe benefits admissible, terms and conditions of appointment. All terminations of service in any form must be documented in writing stating the reasons for such an act.

7.4 MATERNITY AT WORK

7.4.1 ILO Conventions

- C103 - Maternity Protection Convention (Revised) No. 103, 1952
- C183 - Maternity Protection Convention No. 183, 2000

7.4.2 Free Medical Care

During pregnancy and maternity leave, a female worker should be entitled to medical and midwife care, without any additional cost.

7.4.3 No Harmful Work

During pregnancy and while breastfeeding, a female worker should be exempt from work that might bring harm to her or her baby.

7.4.4 Maternity Leave

Women workers should be given maternity leave as per the country's labour laws.

7.4.5 Income

During maternity leave, a worker's income should not be stopped and proceedings should be in accordance with the country's labour standards.

7.4.6 Protection from Dismissals

During pregnancy and maternity leave, a female worker should be protected from dismissal or any other discriminatory treatment.

7.4.7 Right to Return to Same Position

Workers have the right to return to the same or an equivalent position after availing maternity leave.

7.4.8 Breast Feeding Breaks

After childbirth and once a female worker has rejoined her organization, she must be allowed paid nursing breaks to breastfeed her child.

7.4.9 Existing Conditions

Social security benefits were available to only a select number of workers of permanent nature. The lack of social security cards deny the workers of maternity benefits.

7.4.10 Recommendations

Article 37 of the Constitution makes reference to maternity benefits for women in employment. The Maternity Benefit Ordinance, 1958 stipulates that upon the completion of four months of employment or qualifying period, a worker may have up to six weeks prenatal and postnatal leave during which she should be paid a salary drawn on the basis of her last pay. Cotton ginning enterprises should follow the recommendations as per labour law.

7.5 FAIR TREATMENT AT WORK

7.5.1 ILO Conventions

- C111 - Discrimination (Employment and Occupation) Convention No. 111, 1958
- C100 - Equal Remuneration Convention No. 100, 1951

7.5.2 Equal Pay

In the workplaces equal pay for men and women for work of equal value is required, regardless of marital status. Pay inequality based on race, colour, sex, religion, political opinion, national extraction/place of birth or social origin is also forbidden. A transparent remuneration system and the clear matching of pay and position should be in place and to help prevent wage discrimination.

7.5.3 Sexual Harassment

There are no specific ILO conventions regarding sexual harassment. However, sexual intimidation/harassment is gender discrimination.

7.5.4 Non-Discrimination

The employer cannot discriminate against any worker in any aspect of employment (appointment, promotion, training and transfer) on the basis of union membership or participation in union activities, filing of a complaint against an employer, race, colour, sex, marital status, family responsibilities, pregnancy, religion, political opinion, national extraction or social origin, temporary absence due to illness, age, trade union membership, disability/HIV-AIDS, or absence from work during maternity leave.

7.5.5 Right to work

People have the right to work and there can be no occupational segregation on the basis of gender.

7.5.6 Existing Conditions

Many female workers in the ginning sector complained of harassment by male coworkers and supervisors. They complained of staring, catcalls and leering by their colleagues. The lack of privacy, inadequate toilets etc exacerbated this problem. The fact that many young girls are employed in the sector makes them even more prone to harassment and abuse. The ginning industry is better than many sectors of the economy as it provides a very useful source of livelihood for women near their homes and cash payment method leads to their empowerment. Women face problems like acceptability of technical jobs by families and the community. The average earnings of female workers were lower than their male counterparts and they also earned less than the official minimum wage for unskilled workers. The main reason for lower earnings seem to be that they are mostly employed in non-skilled and less arduous tasks like cleaning, while males work in relatively hard jobs like loading and unloading and jobs requiring more skills like operation and maintenance of the saw gin and other machinery.

7.5.7 Recommendations

Article 38 of the Constitution imparts the State's obligations aimed at achieving equality in the form of securing the wellbeing of the people, irrespective of sex, caste, creed or race, by raising their standard of living, by preventing the concentration of wealth and means of production and distribution in the hands of a few to the detriment of general interest and by ensuring equitable adjustment of rights between employers and employees. The cotton ginning sector should implement all these measures to ensure a safe workplace as per labour laws.

7.6 CHILDREN AT WORK

7.6.1 ILO Conventions

- Ø C138 - Minimum Age Convention No. 138, 1973
- Ø C182 - Worst Forms of Child Labour Convention No. 182, 1999

7.6.2 Children under 15

In the workplace, children may not be forced to perform work that can harm their health and hamper their physical and mental development. All children should be able to attend school. Once this is safeguarded, there is no objection against children performing light jobs between the ages of 12 and 14.The general minimum age is 15 years, however developing countries may set this at 14 years. The minimum age for hazardous work, work that is likely to jeopardize the health, safety or morals of young persons, is 18 years. It can also be set at a lower level of 16 years under certain circumstances.

7.6.3 Hazardous Work and Children

Children should not be employed in work that is likely to harm their health, safety or morals and is considered one of the worst forms of child labour. The minimum age for such hazardous work is 18 years.

7.6.4 Existing Conditions

During the scoping study of Decent Work in ginning SMEs, a very small proportion of the workforce observed in the ginning sector consisted of children (below 14 years) as well as young or adolescent workers (15-18 years of age). Employment of children is prohibited in Factories but it was observed that many processes in the ginning sector were not prohibited from employing adolescent workers. The working hours of adolescent workers were more than the legal hours mentioned in the Factories Act. These workers need special protection and supervision as they take risks and can be intimidated, coerced or harassed by coworkers and supervisors.

7.6.5 Recommendations

Article 11(3) of Pakistan's Constitution expressly prohibits the employment of children below the age of 14 years in any factory. The Factories Act, 1934 allows for the employment of children between the ages of 14 and 18 years, provided that each adolescent obtains a certificate of fitness from a certifying surgeon. The Act further restricts the employment of a child in a factory to five hours in a day. The hours of work of a child should thus be arranged in such a way that they are not spread over more than seven-and-a-half hours in any day. In addition, no child or adolescent is allowed to work in a factory between 7 p.m. and 6 a.m. Factories should display and correctly maintain in every factory a notice of Periods for Work for Children, indicating clearly the periods within which children may be required to work. The manager of every factory in which children are employed is compelled to maintain a Register of Child Workers identifying the name and age of each child worker in the factory, the nature of his or her work, the group, if any, in which he or she is included, where his or her group works on shifts, the relay to which he or she is allotted, the number of his or her certificate of fitness granted under section 52, and any such other particulars as may be prescribed.

7.7 COERCION OF INTIMIDATION

7.7.1 ILO Conventions

- Ø C029 - Forced Labour Convention No. 29, 1930
- Ø C105 - Abolition of Forced Labour Convention No. 105, 1957

7.7.2 Forced Labour

Forced labour is the work one has to perform under threat of punishment: forfeit of wages, dismissal, harassment or violence, or even corporal punishment. Forced labour means violation of human rights.

7.7.3 Prohibition on Forced and Compulsory Labour

Except for certain exceptions, forced or compulsory labour (exacted under the threat of punishment and for which a worker may not be willing) is prohibited.

7.7.4 Freedom to Change Jobs

Employers have to allow worker to look for work elsewhere. If a worker does so, he should not be threatened with lower wages or dismissal. (In the reverse cases, international law considers this as forced labour).

7.7.5 Existing Conditions

The respondents were asked a number of questions about the potential coercive measures which might have been taken by employers. Almost all workers stated that they were satisfied with their work and did not feel intimidated in any way. When managers were questioned, most of them stated that workers demand advance payments, which are provided to them. But these advances cannot be construed as bonded debt as they are usually up to two to three advance salaries. Some women workers in private in-depth interviews mentioned harassment by employers and their managers. One particular incident involved a woman from a minority in Bahawalpur district.

Employers were also asked about coercion or other kinds of restrictions on freedom of movement or employment. They did not confirm any such practice. However, they said that normally they recruit workers on the personal reference or recommendation of existing workers or their acquaintances. No document like ID cards or cash deposit is required for employment. Thus, they ensure that any advances, if due, are recovered through the social pressures of family or friends of workers.

Workers were also asked about any threats they faced during their work. A vast majority of them (95%) stated that they did not face any threats. Only four workers mentioned the threat of termination of employment, non-payment of wages, overtime or eviction from residence (in case it was provided by the employer).

7.7.6 Recommendations

Article 11 of the Constitution prohibits all forms of slavery, forced labour and child labour and the ginning sector should therefore take measures to ensure the eradication of such forced labour.

7.8 SOCIAL SECURITY

7.8.1 ILO Conventions

- C102 - Social Security (Minimum Standards) Convention No. 102, 1952
- C121 - Employment Injury Benefits Convention No. 121, 1964 [Schedule I amended in 1980]
- C128 - Invalidity, Old Age and Survivors' Benefits Convention No. 128, 1967
- C130 - Medical Care and Sickness Benefits Convention No. 130, 1969
- C168 - Employment Promotion and Protection against Unemployment Convention No. 168, 1988

7.8.2 Pension Rights

In normal circumstances, the age of retirement may not be set higher than 60 years. If retirement age is fixed above 60 years, it should give due regard to the working ability of elderly persons and demographic, economic and social criteria, which shall be demonstrated statistically. Pension can be set as a percentage of the minimum wage or a percentage of the earned wage.

7.8.3 Dependent's Benefit

When a worker has died, the spouse and children are entitled to a benefit, expressed as a percentage of the minimum wage, or a percentage of the earned wage.

7.8.4 Unemployment Benefit

For a limited period of time, an unemployed worker has a right to unemployment benefits set as a percentage of minimum wage or percentage of the earned wage

7.8.5 Medical Care

Employees and their family members should have access to the necessary minimal medical care at an affordable cost.

7.8.6 Invalidity Benefit

Invalidity benefit should be provided when a protected person is unable to engage in gainful employment, before standard retirement age, due to a non-occupational chronic condition resulting in disease, injury or disability.

7.8.7 Existing Conditions

Although all ginning factories were registered as factories with the Labour Department, obligations such as observing the relevant laws on wages, working hours, leaves and holidays, health and safety were not being met. Interestingly, all factories were visited by the relevant inspectors, but the efficacy of their inspection was not evident. It seems that they were also not rendering their duties in the true spirit of the law. The application of social security laws was highly selective, only a few highly skilled workers who are employed on yearly basis were covered and provided social security and old age benefits pension cards.

7.8.8 Recommendations

Workers and employers need to be educated about the benefits of coverage of social security and old age benefits schemes. This will ensure stability of the workforce for the employer and social protection and financial support for workers when it is most needed.

7.9 TRADE UNION RIGHTS

7.9.1 ILO Conventions

- C087 - Freedom of Association and Protection of the Right to Organize Convention No. 87, 1948
- C098 - Right to Organize and Collective Bargaining Convention No. 98, 1949

7.9.2 Trade Union at Work and Collective Bargaining

Trade unions are entitled to negotiate with employers on term of employment without hindrance. The freedom of a trade union to negotiate with employers to try and conclude collective agreements is protected. (The ILO has a special procedure for handling complaints from unions about violation of this principle).

7.9.3 Freedom to Join and Form a Union

Freedom of association means freedom to join a trade union. This is part of fundamental human rights. Employees may not be put at a disadvantage when they are active in a trade union outside working hours.

7.9.4 Right to Strike

Workers have the right to strike in order to defend their social and economic interests. The right to strike is incidental and corollary to the right to organize and unionize provided in ILO convention 87.

7.9.5 Existing Conditions

Finning enterprises visited during the study did not have workers union as workers don't have any concept of such unions.

7.9.6 Recommendations

Employers and workers should be encouraged to provide a mechanism for discussion on areas of mutual concern including conditions of work and employment. A trade union provides such a forum. There are deep suspicions among employers about trade unions because of the poor image unions have in the country. In any case employers need to understand the importance of social dialogue as a way to improve productivity, morale and economic viability of a business. They should:

- Allow union representatives to access workers in the workplace.
- Enable workers to form and join unions of their choice, and should not force them to join a particular union.
- Allow workers to meet freely without management present.
- Do not interfere with, manipulate or control any unions present in the workplace.
- During collective bargaining, do not limit the issues that can be negotiated.

7.10 HEALTH AND SAFETY AT WORK

7.10.1 ILO Conventions

- C155 - Occupational Safety and Health Convention No. 155, 1981
- C081 - Labour Inspection Convention No. 81, 1947

7.10.2 Employer Cares

The employer, in all fairness, should make sure that the work process is safe.

7.10.3 Free Protection

The employer should provide protective clothing and other necessary safety precautions for free.

7.10.4 Training

The worker and his / her colleagues should receive training in all work related safety and health aspects and should know of emergency exits.

7.10.5 Labour Inspection System

In order to ensure workplace safety and health, a central, independent and efficient labour inspection system should be present.

Better Practices
Occupational Saftey and Health

Better Practices Occupational Safety and Health

8

This chapter illustrates one of the better practices recommended for the local ginning industry which is occupational safety and health (OSH). This term is defined as the science of anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could impair the health and well being of workers, taking into account the possible impact on the surrounding communities and the general environment.

There are significant variations in OSH performance between countries, economic sectors and size of enterprise. In some countries the incidence of workplace fatalities varies and there appears to be a significant difference between developed and developing countries i.e. a factory worker in Pakistan is eight times more likely to die at work than a factory worker in France. OSH performance varies significantly between economic sectors within countries. Statistical data shows that, worldwide, the highest rates of occupational deaths occur in agriculture, forestry, mining and construction. Generally, small enterprises have poor safety record than large ones. It seems that the rate of fatal and serious injuries in small workplaces (up to 50 employees) is twice that in large workplaces (more than 200 employees).

SAFETY AND HEALTH HAZARDS

The cotton ginning industry, like other processing industries, has many hazards. Gin injuries are highest for the hand, followed by backbone, eye, foot, arm, shoulder, leg, and trunk and head injuries. Total economic costs for injuries and health disorders include direct costs (medical and other compensation) and indirect costs (time lost from work, downtime, loss in earning power, higher insurance costs for worker's compensation, loss of productivity and many other loss factors). Direct costs are easier to determine and less expensive than indirect costs. Other health disorders and their remedies in ginning enterprises are listed and explained below in detail.

8.1 OCCUPATIONAL AIR QUALITY

8.1.1 Introduction

The quality of air inside offices and other workplaces is important not only for the comfort of workers but also for their health. Poor indoor air quality (IAQ) results in symptoms like headaches, fatigue and irritation of the eyes, nose, throat and lungs. The main risk associated with worker's health is cotton dust in indoor air quality within the work premises of a ginning enterprise.

The National Institute for Occupational Safety and Health (NIOSH) defines the cotton dust as dust generated into the atmosphere as a result of cotton handling and processing of cotton fibres, combined with any naturally occurring materials such as stems, leaves, bracts, and inorganic matter, which may have accumulated on the cotton fibres during the growing or harvesting periods. This dust may contain soil particles, bacteria, fungi, pesticides and other contaminants, and potentially all those materials, which may have accumulated on the cotton, during its transportation, processing and storage. Cotton dust is classified in under table 7.1.

Table 7.1 Classification of Cotton Dust

Type	Size of the particle (mm)
Trash	Above 500
Dust	50-500
Micro dust	15-50
Breathable dust	Below 15

Micro dust comprises of 50 to 80 per cent of fibre fragments, leaf and husk fragments, 10 to 25 per cent sand and earth and 10 to 25 per cent water-soluble materials. The high proportion of fiber fragments indicates that a large part of micro dust arises in the course of processing. Nearly 40 per cent of micro dust is free between fibres and flocks, 20 to 30 per cent is loosely bound, and the remaining 20 to 30 per cent is bound to the fibre.

8.1.2 Types of Dust:

1. **Inhalable Dust:** Dust that is hazardous when deposited anywhere in the respiratory tract including the mouth and nose.
2. **Thoracic Dust:** Those materials that are hazardous when deposited anywhere within the lung, airways and gas exchange region.
3. **Repairable Dust:** Fraction of dust which reaches the alveolar region of the lungs.

8.1.3 Impacts of Cotton Dust on Worker's Health

Workers exposed to a cotton dust laden environment generally become patients of byssinosis, popularly called brown lung. This is a respiratory disease characterized by shortness of breath, chest tightness, and reduction in the pulmonary function due to exposure to raw cotton dust. Prolonged exposure makes patients more sick and can cause pulmonary diseases. A group of lung diseases known as chronic obstructive pulmonary diseases are major causes of illness and disability among workers. The most common types of chronic obstructive pulmonary disease are:

1. **Chronic bronchitis:** Characterized by a cough and sputum lasting for three or more months of the year and recurring year after year.
2. **Asthma:** An allergic type of response that causes airways to swell and become narrow. There is increased mucous causing a wheezy, and a whistling sound to breathing.
3. **Emphysema:** This is the damage of the delicate walls between tiny air sacks in the lungs. As the walls are destroyed, the air sacks enlarge and the lungs have less ability to supply oxygen to the bloodstream.

   Usually both chronic bronchitis and asthma improve when a person is removed from the cause of irritation but in emphysema, there is no way to repair the destroyed air sacs. Smoking is the leading cause of chronic obstructive pulmonary disease (COPD) and of lung cancer. Cigarette smokers also have increased risk of cough, colds and respiratory symptoms.

Dust Sampling

Mechanical Breakdown

Cotton dust in ginning continuously enters the rotating ginning machinery and leads not only to their excessive wear and tear but also can be a factor for internal heating of different parts of the equipment. Thus, it can result in continuous mechanical break downs over time.

8.1.4 Existing Conditions

The National Institute for Occupational Safety and Health (NIOSH) recommends that exposure to cotton dust should be reduced to the lowest feasible concentration to reduce the severity o byssinosis. The recommended exposure limit (REL) should be less than 0.20 milligrams per cubic meter (mg/m3).

Field measurements of total particulate matter (TPM) were randomly carried out at a number of points spread over the production area of the local ginning enterprises audited under the project. These values on aggregate basis vary in an overall range of 1 to 212 mg/m^3 and in a more common range of 4 to 119 mg/m^3. Obviously, these values vary tremendously and are enormously high when compared with an acceptable upper limit of 0.20 mg/m3. This implies that the occupational atmosphere in almost all local units is extremely unhealthy for workers as far as cotton dust is concerned.

Use of proper dust masks is almost nonexistent. Some workers make use of disposable masks which are not meant to filter dust. Others use their turbans or handkerchiefs for dust prevention in areas with very high concentration of cotton dust. Turbans with lose ends are always susceptible to accidents through possible entanglement in moving machinery parts.

8.1.5 Recommendations

Control of Occupational Air Quality: To substantially reduce particulate matter (PM) in the occupational atmosphere, bring it within or at least close to the desirable limits, requires planning, design, installation and operation of a comprehensive system, possibly, comprising of the following two key components:

a) Local or spot PM collection and transport system, limited to the major emission points of the production equipment, comprising collection/capture hoods, transmission ducts and exhaust air fans or blowers.

b) General area ventilation system, comprising exhaust air fans, of adequate capacity, installed alon s.

Personal Protection Measures: In case concentrations of PM in the occupational atmosphere cannot be brought within desirable limits the following personal protection measures should be adopted, in order to ensure the protection of workers' health:

a) Areas, where particulate matter concentrations are measured or otherwise expected to be higher than 0.2 mg/m3, should be marked as High PM Area.

b) Employees, working in designated High PM Areas, should be provided with appropriate dust masks and their continuous and regular use during working hours should be ensured and enforced by management.

c) Employees should be fully aware, by means of training sessions and by installing appropriate signboards, in Urdu and Sindhi languages, at conspicuous locations, on the health hazards of cotton dust and the necessary precautionary measures, in this regard.

d) The pulmonary health of all employees (permanent, contractual or seasonal) must be medically examined annually. This information must be stored as baseline information for all permanent employees. For contractual and/or seasonal employees, this baseline information should be used as a reference for their re-employment.

8.2 OCCUPATIONAL NOISE EXPOSURE

Noise level measurement

8.2.1 Potential Impacts of Noise Pollution

Noise is considered an interference and imposition on comfort, health and quality of life. Noise may have both physiological as well as psychological effects on human beings.

Physiological effects include dizziness, nausea, unusual blood pressure variations, physical fatigue, hearing impairment and, in acute cases, permanent hearing loss. The psychological effects may comprise reduced mental capability and irritation. Chronic exposure of workers to higher noise levels also impairs their efficiency and skill.

8.2.2 Existing Conditions

The guidelines, for the Threshold Limit Values (TLV) of noise levels versus the allowable exposure duration of a person per day, as laid down by the American Conference of Governmental Industrial Hygienists (ACGIH), are presented in table 7.1.

Table 7.1

ACGIH: TLV of Noise Levels versus Allowable Exposure Duration per Day

Exposure Duration per Day (Hours)	Noise Threshold Limit Values(dB-A)
16	80
8	85
4	90
2	95
1	100
1/2	105
1/4	110
1/8	115

For a normal eight hour working day, a safe noise exposure limit established by the ACGIH is 85 dB-A.

Ginning mill operations involve a number of heavy machines, equipped with moving and rotating parts, which result in elevated noise levels at the work place.

Noise levels were measured at a number of points spread appropriately over productions areas of the local industries audited under the project. These values, on aggregate basis, disregarding their respective points of measurement, vary in an overall range of 65 to 117 dB-A and in a more

common range of 80 to 110 dB-A. Large variations in noise levels are observed from unit to unit and from location to location, within a single unit. It is found, however, that in close vicinity of the main machinery, these levels are mostly above 85 dB-A. A qualitative comparison of this data, with the control values given in table 7.1 clearly reflects that most employees working in production areas, for most of the time, are exposed to unacceptably high noise levels.

The use of proper ear protection gear was not observed anywhere. Workers and management do not consider noise to be a health hazard or nuisance and therefore, no provisions are made in this regard. Rather, floor workers appear to be comfortably accustomed to very high noise levels.

8.2.3 Recommendations

Reduction in Noise Levels: The following engineering solutions may be adopted in general working areas:

a) Control of noise at source by providing enclosures, absorbent materials or silencers in machines, where feasible.

b) Regular maintenance of machines, specifically for the purpose of noise reduction, including replacement and repair of noisy, worn out and loose parts and proper lubrication and oiling of the moving parts, such as motors, gears, pulleys and bearings.

c) Provision of enclosed and noise proof rooms, where operators working with machines generating higher noise levels can rest for short periods.

Personal Protection Measures: In areas, where noise levels cannot be brought within the desirable limits for any reason the following personal protection measures should be adopted, in order to ensure the protection of workers' health:

a) Areas, where noise levels are measured or otherwise expected to be higher than 85 dB-A, should be marked as High Noise Area.

b) Employees, working in the designated High Noise Areas, should be provided with appropriate ear protection gears like ear plugs and ear muffs and their continuous and regular use, during working hours, should be ensured and enforced by management.

c) Job rotation of workers, who are exposed to higher noise levels, is also possible to reduce their exposure time. A worker continuously exposed to higher noise levels should be allowed to work in rotation, from higher noise areas to calmer areas, to minimize the effect of noise on the individual.

d) Employees should be fully aware, by means of training sessions, on the health hazards of noise pollution and necessary precautionary measures in this regard.

e) All employees (permanent, contractual or seasonal) should be medically examined annually by means of audio metric testing. This information must be stored as baseline information for all permanent employees. For contractual and/or seasonal employees, this baseline information should be used as a reference for their re-employment.

8.3 ILLUMINATION

Low Lux level in ginning hall

8.3.1 Existing Conditions

Field measurements of illumination levels (LUX) were carried out during different times of the day and night at a number of points spaced appropriately over the productions areas of local industries audited under the project. The data collected reflects a large variation.

It was observed that in production areas illumination levels vary from place to place and during the day and night. In many places, these levels were found to be appropriate, during the daytime due to sunlight, but were low during the night. In others, the levels were determined to be low during day and/or night.

In general, the illumination systems for the local ginning units are not professionally designed under proper engineering design practices, rather, capacities and locations of lighting fixtures have been provided based on guesswork.

In many cases, light fixtures provided were found to deliver lower illumination, either owing to the absence of appropriate reflectors or because of lack of cleaning, resulting in loss of lighting.

8.3.2 Recommendations

a) Existing illumination systems in ginning units including types, numbers, capacities and locations (vertical and horizontal) of light fixtures should be examined and reassessed, with reference to desirable illumination levels in different places in production areas, on the basis of professional engineering design practices. In accordance with these recommendations the illumination system should be re-installed, albeit making use of existing light fixtures, where appropriate.

b) Energy efficient light fixtures like energy savers and tube lights should be employed. Use of incandescent light fixtures should be avoided.

c) All light fixtures should be equipped with proper reflectors to enhance their illumination capacity.

d) Regular cleaning of light fixtures should be performed to avoid reductions in illumination capacity.

8.4 PHYSICAL SAFETY

Open Belts Without Protective machine gaurds

8.4.1 Safety Guards in Machinery

In most cases no safety guards, covers or grills are provided for the protection of workers around moving and rotating parts, sharp edges, including fans and belt-pulley systems of different machines.

It is recommended that properly customized and fabricated safety guards and/or grills should be provided as protection cover on all exposed moving and rotating parts and sharp edges of different machines.

Dangerous ladder used for working up on the plateform

8.4.2 Safety of Accessibility

The following are recommendations for the safety of workers to access machines for the purposes of operation or maintenance:

a) In general, it should be ensured that rotating or moving components of machines cannot be accessed by workers while the machine is operating.

b) The electric supply to rotating machinery should be switched off, before any maintenance.

c) In many cases, gaps between machines are insufficient for maintenance staff to carry out their activities while machines are in operation. In such cases, it should be ensured that the machines are stopped, while the staff is moving in such gaps.

d) There should be no slippery floor surfaces in the production areas particularly in the vicinity of machines.

e) Full body safety suits (overalls) should be provided to all workers involved in the operation and handling of machines with moving and rotating parts.

8.4.3 Protection from Falls

The following are recommendations for the safety of workers against falls:

Existing Conditions

It was observed in many places that overhead operation platforms and access ladders are without proper safety railings. In some places, no ladder was available for access to overhead platforms and workers employed unsafe practices for access. Similarly, most access ladders were found to be quite steep, without guard cages.

Recommendations

a) All working areas and platforms, raised by six feet or more, from their surrounding levels, should be provided with safety railings along their periphery and with proper access ladders, also equipped with safety railings.

b) All safety railings should be of proper strength, duly anchored with the platforms and at least four feet in height.

c) Ladders should preferably not have an angle-to-horizontal of more than 600. Where steeper ladders are to be provided for any reason, they should be furnished with appropriate guard cages for protection against falls.

d) For overhead operations where safety railings are not available, safety harnesses must be used by workers. In such cases, activities performed should be administered by at least two workers, in order to provide support in case of any accident.

8.5 FIRE FIGHTING SYSTEM

Fire Extinguishers Placed outside ginning Hall

8.5.1 General

In most cases no safety guards, covers or grills are provided for the protection of workers around moving and rotating parts, sharp edges, including fans and belt-pulley systems of different machines.

It is recommended that properly customized and fabricated safety guards and/or grills should be provided as protection cover on all exposed moving and rotating parts and sharp edges of different machines.Cotton, whether in the form of seed cotton or lint, is a highly combustible material, rendering the cotton ginning industry a high fire risk.

Fire, in general, is grouped into four classes, according to the type of material burning. The following two fire classes are applicable to the cotton ginning industry:

a) **Class A Fire**

Characteristics: Those fires in which ordinary combustibles such as wood, cotton, cloth, and paper are burning.

Fire Extinguishing Mechanism: Class A fire extinguishers are usually

water-based. Water provides a heat absorbing (cooling) effect on the burning material to extinguish the fire.

b) **Class C Fire**

Characteristics: Those fires which involve live electrical equipment.

Fire Extinguishing Mechanism: The extinguishing agent for this class of fire should be electrically non-conductive. Both carbon dioxide and dry chemicals can be used in electrical fires. An advantage of carbon dioxide is that it leaves no residue after the fire is extinguished. When electrical equipment is not energized, extinguishers for Class A fires may be used.z

Fire Extinguishers in Poor Condition

8.5.2 Existing Conditions

In local ginning units a large variation was observed, with respect to available fire fighting facilities, ranging from provision of only water and sand buckets to water-based systems with fire hydrants. The extent of these facilities also varies a lot from unit to unit, in terms of coverage of the seed cotton storage yard, production areas and bale storage yards. In most units, fire fighting facilities are grossly inadequate, keeping in view the level of fire risk and danger.

In certain cases, it was found that ready access to available fire extinguishing fixtures is obstructed by storage of different materials in front of them

8.5.3 Recommendation

a) A typical ginning unit should provide more than one type of parallel fire fighting systems.

b) In ginning unit should provided a properly designed comprehensive water-based fire fighting system, comprising of a ground-level water storage tank, water pumps (one duty and one standby), a water piping network, appropriately located external fire hydrants with an attached hose for the seed cotton and bales storage yards and properly placed hose reel cabinets, in production areas. A standby electric power supply should be available for the water pumps. The system provided may be of a low-flow basis, with the provision two simultaneously operating water streams.

c) In addition to the above mentioned water-based system, the following fire fighting fixtures should also be provided:

- Water and sand buckets, on stands in appropriate places
- An adequate number of wall mounted portable fire extinguishers (CO_2 based), installed in appropriate locations within the production area only, keeping in view the placement of machinery and electric installations

d) In all circumstances, easy accessibility to all fire extinguisher fixtures should be ensured, without any hindrance or obstruction.

e) Employees should be fully trained in fire control and fighting, by means of the systems provided for this purpose.

8.6 MEDICAL EMERGENCY RESPONSE PROCEDURE

8.6.1 Existing Conditions

a) In most of the units, there is no documented procedure, for medical emergency response; but, in case of emergency, the patient worker is sent to the nearby hospital.

b) In most of the industries, first aid boxes are maintained, generally by the respective administration departments.

8.6.2 Recommendations

a) At least one first aid box, furnished with standard provisions and medicines, should be provided in the ginning unit and there should be a provision for checking and maintaining its inventory on a regular basis, so that necessary medicines are not missing at the time of a medical emergency.

b) A selected numbers of employees should be trained in first aid and attending to medical emergencies.

8.7 PERSONAL PROTECTIVE EQUIPMENT (PPE)

8.7.1 General

Personal protective equipment (PPE) is required to protect workers against different types of occupational hazards. The main PPE, proposed for ginning workers, are dust masks, ear protection gears and full body safety suit (overalls).

8.7.2 Provision of PPE

It is recommended that arrangements are made for full coverage of employees with PPE. A PPE inventory should be maintained and used equipment should be replaced at suitable intervals.

8.7.3 Use of PPE

Cultural norms are sometimes blamed for the low usage of PPE among the workforce in factories. In addition to this, workers complain about the inconvenience, in terms of comfort and efficiency, when using personal protection measures. In these circumstances, it is recommended to introduce a system based on rewards and penalties to ensure full use of OHS measures. Genuine problems in the inconvenience PPE use should, of course, be addressed too. In this regard, it is seen that maximum impact is observed from a demonstration effect, whereby top management themselves take OHS measures.

Management should conduct employee trainings and awareness sessions on the use and utility of the OHS equipment including personnel protective equipment (PPE).

8.8 EMERGENCY PLANNING

8.8.1 Existing Conditions

In the local ginning units, there is generally neither awareness nor provision for any emergency planning or management

8.8.2 Recommendations

Emergency Sirens:

Emergency sirens, located at various appropriate points throughout the factory, should be installed.

Emergency Exit:

Well defined emergency exits should be provided in all enclosed areas and passages to emergency exits should be kept clear and without any obstruction.

Assembly Area:

Assembly areas should be specifically designated, for assembling in all events of emergencies.

Emergency Schematic Plan:

An emergency schematic plan should be prepared and displayed in prominent locations in the factory, indicating the following:

- Locations of emergency sirens
- Locations and routes to emergency exits
- Locations and routes to designated assembling areas

8.9 SAFETY INSTRUCTIONS

Signboards are an effective way of communicating hazard and safety messages and instructions, both to the staff and visitors.

Important safety signboards, containing instructions and precautions, related to occupational hazards, personal hygiene, personal safety, material handling, machinery operation and emergency management, should be installed in appropriate places.

8.10 RECOMMENDED INSTITUTIONAL MEASURES

The following institutional measures are recommended to improve the environmental and occupational health and safety conditions in ginning mills.

8.10.1 Defining and Setting Objective and Policies

Top management should define and set short-term and long-term objectives and policies, on all the environment, health and safety (EHS) issues. Compliance with legislation and commitment to continual improvement should be the objectives covered by an EHS policy statement. The goals and objectives should be as specific and quantified as possible.

Management should establish an EHS department, which should be responsible for the planning, coordination, implementation and monitoring of measures, identified in the light of the objectives and policies, set by management.

8.10.2 Areas of Responsibilities of an EHS Department

The following should be the main areas of activities of an EHS Department:

- Air quality and noise monitoring
- Air and noise pollution control
- Management of solid waste
- Firefighting
- Monitoring and control of occupational health and safety

8.10.3 Functions of EHS Department

An EHS department should carry out the following functions in all areas of its responsibilities:

a) Define roles, responsibilities and tasks of other departments and staff, in the operation of an EHS management system.

b) Develop operational control procedures and manuals, for operation and maintenance of related equipment and works.

c) Carry out training for personnel for the following purposes:
Create and promote general concern and awareness on EHS issues.
Training in control, operation and maintenance of EHS equipment

d) Coordination with the concerned government agencies as well as any local community services, on EHS issues.

e) Document and maintain all pertinent records and data.

f) Implement projects related to the EHS.

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Liaqat Ali Khan
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