To assess Quality Norms of Worsted Yarns being made by Indian Industry

V.C.Panse, A.K.Samanta, J.Behera, R.B.Chaudhari

Wool Research Association, Thane

Abstract

It is imperative now-a-days for the yarn manufacturer to produce consistent quality of yarn each time and every time to sustain in this globalization era. Indian worsted industry has potential to produce world compatible quality product by systematic optimization of raw martial selection, motivation for proper machine maintenance, and most importantly, sustenance of standard quality level, in pre-spinning processes. In the present scenario, all Indian worsted industries are having individual settings & standards, so it was difficult to judge quality parameters at national level. This research work was aimed for standardization of quality parameters at worsted industry level, so that quality can be judged and maintained prior to export. This work is expected to give a standard goal to be achieved by participating Indian worsted industry and help to assess their present status with respect to the quality level of final product.

Keywords: blend, norms, quality, statistics, worsted yarn

1. Introduction

Today, the emphasis of wool fibre and textile marketing has switched from quantity to quality. Product and process innovation has extended the appeal and applications of wool. The development of softer, light-weight fabrics based on finer yarns and fibres, innovative blends with other natural and man-made fibres, and new finishing techniques has improved the technical performance range and trans-seasonal appeal of wool textiles. New developments have extended the application of wool textiles to include a wider range of casual and sportswear items. In parallel, new efforts have been made to promote consumer awareness of wool and to position it as a quality item for formalwear and smart casual wear through new sub-brands of the Woolmark. However, there is an uphill struggle to achieve consumer recognition at par with cotton and branded man-made fibres, especially among younger consumers. Fashion is also changing every day, rather every moment, which has shifted focus from big lot size to very small (as low as 50 kg). This has built in pressure on processers to produce right at first time and right every time. Considering the above facts, the norms for worsted yarn are to be set for various end uses. The cotton industry is having some norms but worsted industry does not have. So, it is need of the hour to establish such norms for worsted yarn manufacturer.

Necessity for Norms

The mechanical processing stage in the wool pipeline commences with the clean scoured wool and ends with the yarn ready for the fabric manufacturing stage. Different Industries use different type of wool depending on their desired quality level in final product and processing system. The technical specification of objective measurements like yield, staple strength, micron, colour, staple length, etc. give guidelines for selection of appropriate wool, optimization of production efficiency, use of suitable processing condition and cost of the raw material. The main objectives of this mechanical processing stages are to disentangle the fibres, remove vegetable matter, mix (blend) the fibres, form a uniform coherent strand of fibres (sliver or slubbing) and then attenuate the fibre strand and impart cohesion to form a yarn of the desired linear density (count), quality and character. The quality of the yarn also depends on the quality of wool top which is the raw material of spinning. Quality of the top is usually defined by its fineness i.e. Average Diameter, hauteur (fibre length) and other parameters like neps, short fibre content, vegetable matter percentage etc. These parameters affect the physical properties of the yarn, spinning, winding, and weaving performance and ultimately the quality of the end product (Fabric). It is also to be appreciated that spinning performance and yarn performance in subsequent processing stage, are critical because both spinning and weaving cost, typically, are three to four times as much as all of top making cost. Yarn breaks are so expensive in terms of labour cost and loss of productivity. This implies the dire necessity of working out norms in all stages of processing of worsted yarn manufacturing.

Availability of Norms

International Status: The Pioneering work for establishing quality norms in worsted industries was initiated by IWS in 1993. The main object of this project was to

- Highlight the advantage of Australian wool.
- Develop an expert reference guide for the production of high quality 100% wool worsted weaving yarn.
- Predict performance of wool top or yarn from raw wool properties.
- Minimise faults rate by optimising machine settings and improve production efficiency.

- Select proper wool for a particular product.

After producing yarn in their own pilot plant and testing it, IWS has published their specification [1]. Although the specification set by the IWS is for 100% wool worsted yarn, it is not suitable for Indian worsted industries. In our country, wool- Polyester blends are more popular than 100% woolen product. So 'norms' should be based on blended product to fit with our requirement. IWS published their specification on some fixed count like 2/32, 2/36, 2/40, 2/48, 2/52, 2/64, 2/72, which are not so much popular for blended yarn produce in our country.

As the processing pipeline starts with the selection of raw wool so fixing the raw wool properties for a particular product is very essential.

AWTA Ltd has created a service available to mills called 'TOPMARK – Global Benchmarking for Top makers'. It helps to select the proper greasy wool for a particular quality top in a cost effective manner [2].

AWTA Ltd has collected the data from all participating mills to determine 'benchmarks' for all the major processing results. These benchmarks allow one mill to confidentially compare its performance against the average of all the other mills participating in this program. It is planned that regular reports will be provided to mills detailing their performance against key characteristics such as Hauteur, Romaine, Top & Noil Yield, and Core/Comb Fibre Diameter.

The USTER® *STATISTICS* are the only benchmarking tool available for blended worsted yarn that allows the user to compare his process results with worldwide levels in spinning performance. Although USTER® *STATISTICS* are mainly available for raw cotton, the carded and combed ring-spinning process, and the carded open-end-spinning process, they are restricted to benchmark levels only on 100% wool and 55-45 polyester/wool blended Product. USTER® *STATISTICS* is providing benchmark only for the single weaving yarn and do not provide any benchmark for Double yarn, Roving and Top Quality. Also, no other blend except 55 – 45 are covered in this tool [3].

National Status: In cotton spinning area lot of work has been done regarding quality norms of cotton yarn and their blends In India. Research Associations like ATIRA, BTRA, SITRA, and NITRA worked to set up the norms [4]. In August 2005, BTRA published "Quality and operational benchmarks for modern spinning mills". It enumerates in detail about the benchmark to be achieved regarding quality and operational performance of the modern spinning mills. But still no work has been carried out to set up the norms for Indian worsted industries [5]. Indian worsted sector though relatively small, has large export potential. To trap this potential it is essential to produce consistent quality of yarn being processed by every mill. Hitherto there were no real term 'Norms' at ground level for blended worsted yarn industry in wool sector to establish linkages with the attributes of the original raw wool or top from which it is made and to determine its probable contributing underlying characteristics that have direct bearing on the properties of final end product. It is rather an alarming situation, especially when yarn manufacture is becoming a vacating area in the traditional European countries and the trade is witnessing globalization. This is a challenging opportunity for Indian Woolen Industry to enter into the arena of export of quality worsted yarn in a big way.

2. Back Ground of the Project Work

The Ministry of Textiles sponsored an R & D project to WRA, entitled "To assess Quality Norms of Worsted Yarns being made by Indian Industry" for initiation as an exercise in this direction. The environmental condition of the tropical countries like, India is not suitable for wearing 100% woolen cloth. So blend of wool with other fibre becoming more popular. As synthetic fibres can be cut as per the requirement and easily processed with the existing worsted system so wool – polyester blended product are getting much more popularity. In this project effort has been taken to set up the norms both for 100% wool and wool-polyester blended yarn.

3. Objective

The broad objective of this research study was to

- Set an achievable minimum quality level for final yarn of a particular blend and count.
- Optimise the minimum quality level of pre-spinning stages like roving/ rubbing, finisher sliver, re-combed top and grey top which ultimately determine the quality of the final yarn.
- Set up Super norms and Benchmark level for continual improvement in product quality.
- Motivate the industries to compete in the global market.

4. Design of Experiment

Although there are total 18 worsted yarn manufacturing industries throughout India, but only 13 of them were selected for survey and study purpose on the basis of geographical location, age of industry, brand popularity and other parameters like their willingness to become industry partners for this project work. As there were lot of variations in blend and count spun throughout the industries in India, yarn count and blends were sorted out parameters based on the popularity for generalized scrutiny and project study. Only those count and blends were selected which are produced by maximum number of industries in India. Total five different blend ratio of wool-polyester including the 100% wool and six popular counts, ranging from 2/24 to 2/80 have been taken up for study.

Table 1 Selected blends and Counts

Blends (Polyester/Wool)	**Count (Nm)**
75/25	2/24, 2/48, 2/56, 2/60, 2/70, 2/80.
65/35	
55/45	
40/60	
All wool	

To make the uniformity in data and sample collection procedure throughout the 13 industries, a data collection sheet and questionnaire was prepared. This data sheet covered all the important stages, starting from the raw material up to the final ply yarn of worsted spinning system and important quality parameters usually checked by every good quality yarn manufacturer.

After extensive travel throughout the industries, total 23863 lots data and samples from different blend, count and stages were collected.

Table 2 Parameters considered in the Norms

Stage	Parameter
Grey wool top	Hauteur(mm), $C.V._H$%, Short fibre%<30mm
Grey polyester top	Hauteur(mm), $C.V._H$%, Short fibre%<30mm
Re-combed Top	Hauteur(mm), $C.V._H$%, Short fibre%<30mm U%, C.V.m%, Index of Irregularity
Finisher sliver	Wrapping C.V.%, U%, C.V.m% Index of Irregularity
Rubbing	Wrapping C.V.%, U%, C.V.m% Index of Irregularity
Single yarn	Count, Count C.V.%, U%, C.V.m%, Index of Irregularity, Thick(+50%)/ Km, Thin(-50%)/ Km, Neps(+200%)/ Km Hairiness Index, Breaking Strength, Breaking Elongation%.
Double yarn	Count, Count C.V.%, U%, C.V.m%, Index of Irregularity, Thick(+50%)/ Km, Thin(-50%)/ Km, Neps(+200%)/ Km Hairiness Index, Breaking Strength, Breaking Elongation%.

During the preparation of data bank, every care was taken to keep the confidentiality of the participating mill/organization. All the collected samples were tested in WRA lab under standard test methods and condition, to prepare the in-house data set. The different parameters which were tested in WRA Lab are given below.

Table 3 Testing of different parameters in WRA Lab

Testing Parameter			
A	**Diameter measurement**	M/C name	OFDA-100
		Principle	Image analysis
		Range	3 to 300 micron
		Standard used	IWTO-47
B	**Strength , elongation measurement**	M/c name	SHIMAZU , autograph- AG-X
		Type	CRE
		Gauge length	500 mm
		Jaw speed	500 mm/min
		Standard used	EN ISO-2062-1995
C	**Evenness and Imperfection Measurement**	M/c name	USTER ZELWEGER ,UT-4
		Type	Capacitive
		Speed	Yarn - 400 mts/min
		Testing time	2.5min
		Standard used	ASTM D 1425
D	**Length (Hauteur, Hauteur C.V., <30mm)**	M/c name	ALMETER 2OOO
		Type	Capacitive
		Standard used	IWTO-17

5. Data Analysis

After collection of various lots data from different industries, required number of data were selected from each variable based on the sample determination formula.

Determination of sample size

Determination of sample size is a common task for many organizational researchers. The first and most important step to set up the norms is selection of proper sample size. Inappropriate, inadequate, or excessive sample sizes continue to influence the quality and accuracy of research. A critical component of sample size formula is the estimation of variance in the primary variables of interest in the study. After estimating the standard deviation of the population, required sample size was calculated by using Cochran's sample size determination formula

$$No = \frac{t^2 x\, s^2}{d^2}$$

Where,
No = required sample size.

t = value for selected alpha level.
s = estimate of standard deviation in the population.
d = acceptable margin of error for mean being estimated.

All the collected data were tested for its significance with the tested results by using student's t test. Only those data which were not significantly differ from the tested results were considered for setting up the Norms, Super norms and Benchmark.

All the selected data were arranged on the basis of blend, count, stage and different quality parameters. Individual data set was statistically analyzed to determine its

i) Central tendency, i.e. mean, median and mode.
ii) Dispersion, i.e. S.D, C.V%, Quartile deviation, σ deviation etc. and
iii) Distributions of the data set.

Each frequency distribution curve was superimposed with normal probability curve to compare the distribution of one data set with the ideal normal distribution. From the statistical analysis results Norms, Super norms and Benchmark was selected.

6. Results and Discussions

As reported in the foregoing, certain popular blends in different count were selected for this study. On the basis of data analysis of various stages of processing such as grey wool /polyester top, re-combed top, finished sliver, rubbing, single and double yarn with various quality parameters were designated as parameters to be determined for norms, super norms and bench mark respectively. Accordingly, following are the counts and blends

Count 2/24 (Nm), 2/48 (Nm), 2/56 (Nm), 2/60 (Nm), 2/70 (Nm), 2/80 (Nm)
Blends 75/25 (P/W), 65/35 (P/W), 55/45 (P/W), 40/60(P/W), All wool

It was observed that every mill was following its own Norms. So quality of the final product set to different standard value, varied from mill to mill. As all the samples and previous test results were collected from different Lots (population), geographical location, machines and technology used, it was observed that normal probability distributions of the data sets deviated from the ideal normal distribution curve. Frequency distribution of the data set showed right skewed, left skewed or even cluster of frequencies lying at extreme left side or to the extreme right. Some of the plots showed bimodal or even multimodal peaks. This led to do a careful study of each graph first and then to select the norm value from central tendency i.e. mean, mode, median, or dispersion i.e. σ deviation, Quartile deviation (Q1, Q3). So it becomes very challenging task to extract the value of norm, super norm and benchmark by following a single thumb rule. Depending on the desired quality level in various stages of production for producing better quality yarn, super norm and bench mark were fixed. For example upper control limit(UCL) of 1σ was set as super norm and UCL of 2σ was considered as a benchmark for yarn strength, which indicate that 16% of the total sample results were following Super norms and 2.5% of the total sample results were following Benchmark. But in case of yarn U%, lower control limit (LCL) of 1σ was set as super norm and LCL of 2σ was considered as benchmark. In very few cases 2σ level used for super norm and 3σ level for bench mark.

It was observed that different quality parameters at different stages showed different trends in variation with the count and blend percentage.

6.1 Grey Top

It was observed that in case of grey wool top, quality parameters didn't show any trend with the increase of the micron value of the wool. The deviation of these parameters from the theoretical aspect might be, due to the unavailability of proper sample size at the time of analysis. In case of Polyester top, with the increase of the denier there is a tendency to increase in mean fibre length. Hauteur C.V% and fibre less than 30mm didn't show any trend. It was also observed that although there was no significant change in Mean fibre length between grey wool top and grey polyester top but Hauteur C.V% and less than 30mm is always less in case of polyester top. This might be due to having control over polyester fibre cut length.

6.2 Re-combed Top

It was observed in the analysed results of re-combed top that U%, CVm% and Index didn't change significantly with change in Count but it decreased with rise of wool content in the blend. As coarser fibres are generally used for coarse count yarn, fibre length (Hauteur) is inversely proportional to count due to the natural phenomenon of wool fibre of having higher length in coarser fibre. Hauteur CV%, Fibre length <30mm is directly proportional to count. When compared with different blends it was found that in 55/45 (P/W) blend, faults were maximum. It was also observed that Mean fibre length increased and Hauteur C.V% decreased in re-combed top in comparison with the grey top, due to the incorporation of one more combing process in the process line. This re-combing process removed most of the short fibres, neps and also helped in good orientation of the fibre in the sliver strand.

6.3 Finisher Sliver

In finisher sliver it was observed that wrapping CV%, U%, C.Vm% and Index of irregularity increased in finer count materials and it decreased with rise in percentage of wool component in the blend composition. In case of 100% wool, those quality parameters showed a higher value. It was also observed that U%, C.Vm% and Index of irregularity decreased in finisher sliver in comparison with the re-combed top. This could be due to the incorporation of more doubling and more parallelization of fibres in the processed sliver.

6.4 Rubbing

In rubbing strand wrapping C.V%, U%, C.Vm% and Index of Irregularity changed positively with Count and decreased with rise in percentage of wool component in blend, except in the case of 100% wool, where the said quality parameters showed a higher value. It was also observed that U%, C.Vm% and wrapping C.V% were increased in Roving/Rubbing in comparison with the Finisher sliver except, in the case of Index of Irregularity. Usually there is no further doubling in the process line but application of draft in the subsequent processing reduces the number of fibre in the fibre strand which, ultimately results in increased the unevenness % of the fibre strand. With the decrease in the number of fibres in the fibre strand, $C.V_{lim}$ % increases, resulting in decrease in the irregularity index value.

6.5 Single Yarn

In case of single yarn, finer the count higher was the count CV%. U%, thin place/KM, thick places/km, neps/Km and index of irregularity increased as count becomes finer, due to decrease in the strand diameter and number of fibres in the cross-section. Hairiness Index, Breaking Strength and Elongation % decreased with finer the count. Coarser fibres which usually are used in a coarser count yarn, have a higher bending rigidity and may be one of the main reasons for increase hairiness in the coarser count yarn.

Polyester top showed less variation in fibre length and less number of short fibres content than the wool top. It was also observed that thin and thick places were increased when blend component moves from polyester rich to wool rich. But breaking strength, breaking elongation% and Neps/Km were in decreasing order. Higher strength of polyester fibre compared to wool, increase the yarn strength but it also increases the probability of neps formation on yarn surface.

6.6 Double yarn

In double yarn, it was observed that norms for count C.V% was directly proportional to yarn count i.e. finer the yarn count more was the C.V%. U%, thin place/km, thick places/km, neps/km and index of irregularity increased as count becomes finer, whereas Hairiness Index, Breaking Strength and Elongation% decreased. Count C.V%, U%, C.V.m%, Thin/1Km, Thick/1km, , Index, Hairiness Index, increased when blend component moved from polyester rich blend to wool rich. On the other hand Neps/1km, Breaking Strength and Elongation % decreased. Comparing the results of single yarn and double yarn it was observed that U%, C.Vm%, Thick places and thin places drastically reduced in double yarn due to the plying of two yarns which, was very similar with the doubling operation. But hairiness of the yarn increased due to more abrasion of yarn surface, in subsequent processing. Set norms and benchmark were compared with available USTER 95% level and USTER 5% level for 100% wool single yarn and 55/45 P/W blended single yarn on international level. From the graphical comparison of these two standards, it was observed that although there was a nominal difference in quality level, it however, followed the same trend with respect to counts and blends.

7. Conclusion

Quality of the final yarn is solely dependent on quality of the pre-spinning stages like grey top, re-combed top, and finisher sliver, rubbing and single yarn. So in the study, standardization for quality parameters was made at these stages for producing better quality product each time and every time with less effort. Though, 100% wool and 55/45 poly/wool blended yarn are most popular in the Indian worsted industry, other blends like 65/35 poly/wool, 75/25 poly/wool and 40/60 poly/wool are also getting popularity day by day. There is also a lot of variability in yarn count spun from mill to mill and the trend is towards finer count. So, the present work included all these blends and some common counts ranging from 2/24Nm to 2/80 Nm. For each quality parameter, three quality levels are standardized, namely ‘Norm’, ‘Super norm’ and ‘Benchmark’, for continual improvement in the product quality. After achieving the norms at some level, mill should go for the Super norm level for producing better quality product and at the end; Benchmark will be the goal for producing best quality product. Finally this effort is presumed to ease the task of worsted yarn producer to achieve & maintain the optimum quality level in the pre-spinning stages to produce desirable quality of yarn. In addition production manager can also plan on how to effectively utilise of the available raw material and thereby saving money.

References

1. A Technical Specification of Australian Wool, International wool Secretariat, 1993
2. Australian Wool Testing Authority, (www.awta.com.au/en/Home/Our_Services/Topmark/)
3. Fibre to yarn statistics (www.uster.com)
4. Norms for cotton industry, ATIRA, BITRA, SITRA and NITRA
5. Quality and operational benchmarks for modern spinning mills, BITRA