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Study of the Effects of Number of Sliver Doubling in Draw Frame Sliver, Roving and Carded Yarn Quality

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Abstract: *Number of sliver doubling in the draw frame machine has a huge impact on quality of draw frame sliver, roving and carded yarn quality characteristics - the tensile strength, elongation, evenness, and imperfection index of yarn. The main objective of this study was to examine the effects of numbers of sliver doubling in draw frame machine performed in 4.508KTex card sliver, which was used to produce 40 Ne carded yarn. The analytical finding shows that doubling only improves variability to some extent and increasing the number of sliver doubling in the draw frame machine does not always improve the carded yarn quality. The optimum level of sliver doubling which imparts high quality parameters in the carded yarn is six.*
Key words: *Doubling, Imperfection, Evenness, Tensile strength, Elongation.*

I. INTRODUCTION

Ring spinning is one of the most commonly used spun yarn manufacturing technologies for producing high strength carded and combed cotton yarns in the widest range of linear densities [1-2]. Various processes involved in the spinning of carded, spun yarn include opening, cleaning, mixing and blending cotton in the blow room, sliver formation, dust removal, parallelization and cleaning in carding, sliver doubling, parallelization, drafting, dust removing, auto-leveling and draw frame sliver formation in drawing, drafting and roving formation on the simplex and yarn formation on the ring frame [3-9]. Draw frame is a very critical spinning machinery and has a high influence on quality, especially on evenness of yarn. The process of draw frame starts when carded slivers are fed into the Draw-Frame. Then they are stretched/straightened and made into a single sliver. Also, sliver doubling can be done at this stage. If the draw frame is not set properly, it will also result in a fall in yarn strength and yarn elongation at break. The faults in the sliver that come out of draw frame cannot be corrected and will pass into the yarn[10]. Doubling involves placing several slivers in parallel, usually 5-12, and roller drafting. This is a process of equalizing. Several products are fed in together in a sliver drafting arrangement where the thick places generally tend to distribute and compensate each other[11]. In principle, every doubling is a transverse doubling because the feeds are united side-by-side and the combination using a draft equal to the number of juxtaposed slivers. Doubling serves two purposes. It enables the reduction of sliver irregularity and improves the blend or mix of the fibers [12]. Greater demands of quality of spinning process are directly associated with the development of the spinning industry and process parameters. For instance, the quality of the yarn is adversely influenced by the processing speeds [13], machine optimization [13], use of raw material quality and blending ratio [14], material handling [15], drying condition [16-18], numbers of sliver doubling [19-20] and types of drafting [21-22]. Irregularities increase by drafting and decrease by doubling. Doubling is considered to be the simplest and most suitable method to even out the drawing slivers. Doubling serves three purposes: reducing sliver irregularity, improving the blend or mix of the fibers, and improving fiber alignment. However, this method is not a very precise one. Unevenness or irregularity of the drawing sliver should be controlled as it influences the final yarn evenness and subsequently fabric appearance [23]. The major improvement in sliver evenness is achieved by controlling the short, medium and long term variations in the draw frame which continuously measure the thickness of slivers and changing the draft ratio automatically in response to the measured thickness [24-25]. Keeping in view that doubling has been never sufficient to average out all the irregularities in the incoming slivers, a lot of pressure has been put on the precise auto-leveling and draft settings. Recently, the influence of CV_m of card sliver [26-29] and card delivery speed [30], draw frame bottom roller setting [31], on ring yarn quality and different numbers of doubling on breaker and finisher draw frame sliver, on yarn quality like evenness [32], thin and thick place of yarn, Neps of yarn, IPI and hairiness of yarn have also been investigated [13]. The significance of draw frame in the spinning process can be realized from different factors which are increasing the speed draw frames and the development of medium and short term auto-leveling and online monitoring systems [30]. The drawing process has a strong influence on yarn quality because quality can no longer be improved after the draw frame [33]. It is evident from the literature review that the previous work does not reveal the impact of numbers of doubling on both quality of draw frame sliver, roving and yarn in comparison with international standards. The main aim of this research is to investigate and optimize the numbers of sliver doubling in the draw frame process for obtaining better yarn quality in the manufacturing process of carded yarn.

II. MATERIALS AND METHOD

Material

The present work is divided into three sections which include the basis of experimental structure, i.e. the first section which is manufacture of 4.508 K Tex card sliver which has a cotton raw material property feed in the blow room as shown in Table1. After manufacturing card sliver, feeding of different numbers of card sliver doubling i.e. five, six and seven alternatively on draw frame machinery was performed by using similar machine settings as shown in Table 2.

Table 1. Quality characteristics of raw cotton in the blow room

SCI	Mst	Mic	Mat	UHML(mm)	UI	SF	Str (g/Tex)	Elg (%)	RD	+b	TrCnt
123	9.8	4.39	0.88	26.32	78.8	12	35.1	5	79.1	8.3	28

Table 2. RS-BD45 drawing frame machine setting

Draft arrangement	4 Up, 3 Down(4/3)
Top roller coat	Synthetic Rubber
Scan roller clearance 0% deviation	4.633 mm
Break Draft	1.40
Total draft	5-7
Type of auto-leveler	Automatic (RQM)
Delivery speed	510m/min
Can capacity	3500m

The second section is corresponding to the manufacturing of different samples of 1.1Ne rovings by using FT16-130 Rieter roving machine which has three up, three down drafting arrangements with average speed of 978 RPM and the manufacturing of different 40Ne carded yarn with 1080 twists per meter by using G35 Rieter ring frame which has three up, three down drafting arrangements with average spindle speed of 11591 RPM, spinning out speed of 6476 RPM, delivery speed of 10.7 m/min, total draft of 38.5 and travel speed of 25.1m/s with different numbers of doublings that are used alternatively in the draw frame sliver.

Methods of experiment and analysis

The third section is the measures and investigation of the quality characteristics of 20 samples of draw frame sliver, rovings and carded yarn, which are conditioned for 24 hours with an atmospheric condition of the RH% of 65%+/-2 and temperature of 20^0c+/-2.

After conditioning was performed, the draw frame sliver, the roving and the carded yarn samples were examined for quality characteristics by using fast count analyses for testing of mass count variation, Uster evenness tester for testing of CV%, evenness (U%), imperfection, thin and thick place and Neps and also the Statimat ME+ Tenssiorapid used for investigating the yarn tensile strength, tenacity and elongation percentage of carded yarn. Finally, the result data were compared to SITRA 2010 standards and analyzed using SPSS software.

III. RESULT AND DISCUSSION

The actual quality characteristics of the draw frame sliver, roving is examined and the mean count irregularity (CV%) and evenness (U%), draw frame sliver and roving produced by changing the numbers of doubling alternatively are presented in Table 3.

Table 3. Quality properties of 1.1Ne draw frame sliver and 1.1Ne roving

Material	No. of sliver doublings	Quality property	Obs.	Mean	Std.	Dev. Min	Max
Draw frame sliver	5	CV%	20	3.273	0.303664	3	4
		U%	20	3.5765	0.627479	2.46	4.28
	6	CV%	20	3.7185	0.363308	3.29	4.84
		U%	20	2.771	0.308202	2.26	3.71
	7	CV%	20	4.2335	0.851156	2.5	5.4
		U%	20	3.3165	0.412327	2.55	4.32
Flyframe roving	5	CV%	20	7.2515	0.433156	6.45	8.15
		U%	20	5.168	0.332876	4.08	5.56
	6	CV%	20	6.5735	0.398923	6.03	7.43
		U%	20	5.0675	0.30873	4.62	5.58
	7	CV%	20	8.372	0.765696	6.95	9.36
		U%	20	5.9955	0.515471	5.27	6.98

The mean value of the actual yarn evenness, yarn imperfection, yarn strength and yarn elongation of the produced yarns are presented in Table 4.

Table 4. Quality property of 40Ne yarn

No. of sliver doublings	Quality property of yarn	Obs.	Mean	Std. Dev.	Min	Max
5	B.F(CN)	20	155.3475	17.52252	124	185
	Elongation %age	20	3.993	.2911339	3.25	4.56
	Tenacity (CN/Tex)	20	11.886	.7008596	11.2	13.58
	CV%	20	24.2995	2.556254	20.19	29.65
	U%	20	19.2549	2.622759	14.58	27.66
	Thin 50%	20	155.9465	58.23437	36.58	267
	Thick 50%	20	243.35	91.20265	125	420
	Nep 200+	20	178.4	59.00	99	278

No. of sliver Doublings	Quality property of yarn	Obs.	Mean	Std. Dev.	Min	Max
6	B.F(CN)	20	194.105	9.19402	172.9	209.6
	Elongation% age	20	4.75	.2015727	4.37	5.07
	Tenacity (CN/Tex)	20	13.27	.7010968	11.8	14.92
	CV%	20	17.3305	2.543124	14.25	24
	U%	20	16.103	2.932299	11.96	22.91
	Thin50%	20	82.666	51.43695	19.6	220
	Thick 50%	20	210.9	80.35638	125	420
	Nep 200+	20	195.303	73.38961	60.6	299
7	B.F(CN)	20	182.077	11.46112	163.25	204.66
	Elongation% age	20	4.18	.2581513	3.66	4.72
	Tenacity (CN/Tex)	20	12.246	.7443642	10.78	14.56
	CV%	20	20.0815	2.798179	15.14	25.29
	U%	20	17.8255	3.188883	12.35	29.25
	Thin50%	20	55.163	28.99902	18	149
	Thick 50%	20	387.9	53.72728	310	485
	Nep 200+	20	236.7	53.64317	127	345

A. Effects of numbers of doubling on the draw frame sliver, roving and carded yarn quality

In this section, the actual quality characteristics of the draw frame sliver, the roving and 40Ne carded yarn quality characteristics ware measured by different textile quality measurement laboratories described above. The results are shown in the figures that follow.

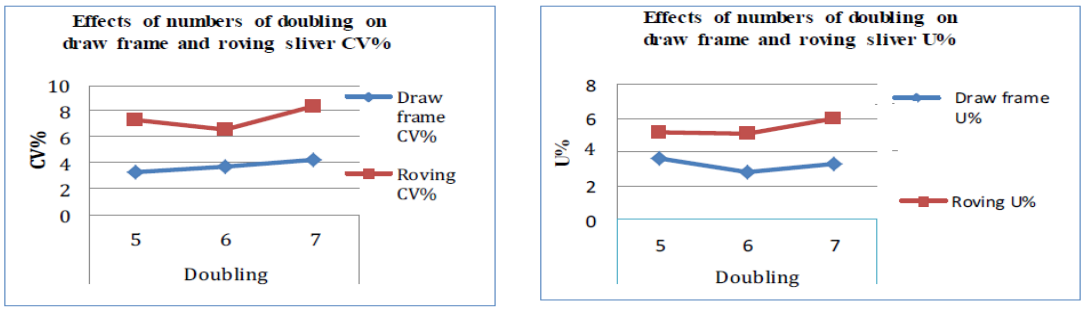

Figure 1. Effects of numbers of doubling on draw frame sliver and roving quality

Figure 1 reveals that CV% and U% of draw frame sliver show a decreasing trend when the number of doubling increases from 5 to 6, but 6 to 7 is an increase, The main reason for this increasing trend is when the number of doublings were increased, the feed material weight increased, but delivery material weight is needed to remain the same. So the irregularity increased.

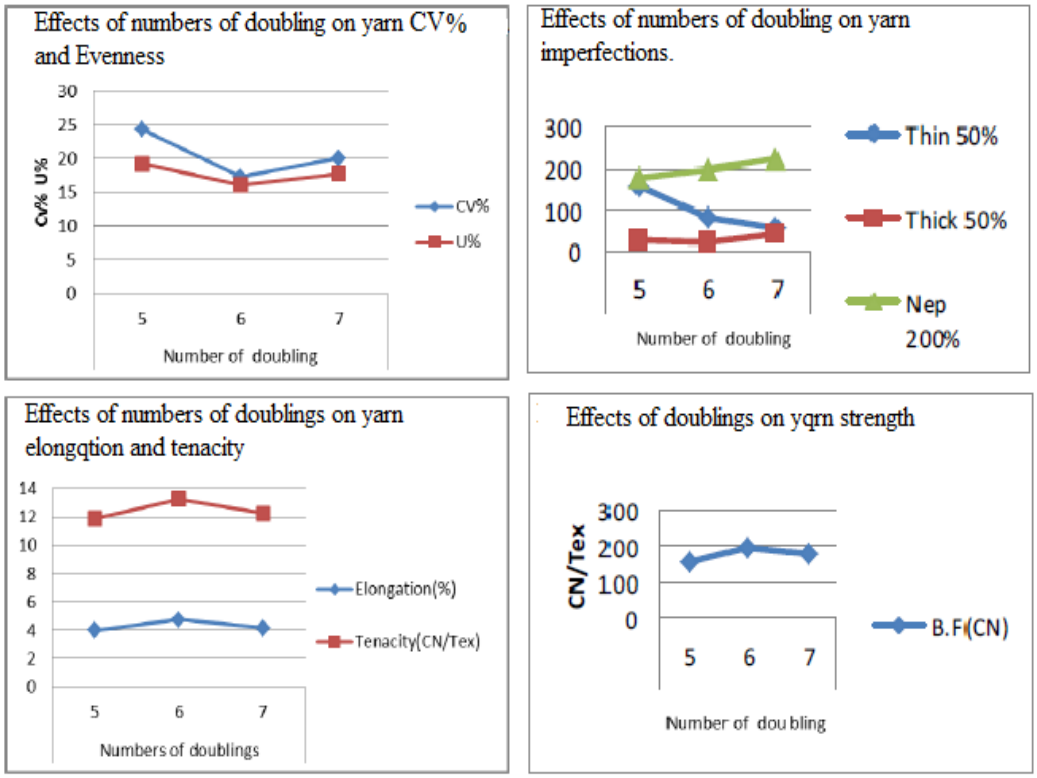

Figure 2. Effects of number of doubling on 40Ne carded yarn quality

Figure 2 shows that the yarn, which is produced from six numbers of doublings, has significantly higher tensile strength, tenacity and elongation. For yarn evenness and imperfections, it is observed that there is considerable decreasing trend which yarns produce from five to six numbers of doublings and an increasing trend from six to seven doublings. However, the total numbers of NEP 200+ indicate an increasing trend with an increasing number of draw frame sliver doubling from five to seven. This is because when the numbers of draw frame sliver doubling increase, the amounts of Nep found in each delivered specific sliver increases and the result shows the cumulative effects; these indicate that the yarn is many times more irregular than that of the draw frame sliver which it was made.

B. Comparison of Draw frames sliver, roving and yarn quality with SITRA standard

After the investigation of the quality characteristics and the effects of numbers of doubling on the quality of each draw frame sliver, roving and 40Ne carded yarn quality, a comparison is made with SITRA 2010 standards and the results are shown in Figure 3.

Table 5. Quality characteristics of sliver, roving and yarns of SITRA standards

Process	Quality variables	SITRA Standard
Draw Frame	Sliver CV%	2 0
	Sliver U%	2.5
Fly Frame	Roving CV%	3.5
	Roving U%	3 .5
Ring frame 40Ne carded cotton yarn	Elongation %	6.5
	Tenacity	20.5
	CV%	15
	U%	12
	Thin 50%	10
	Thick 100%	200.
	Nep200%	400

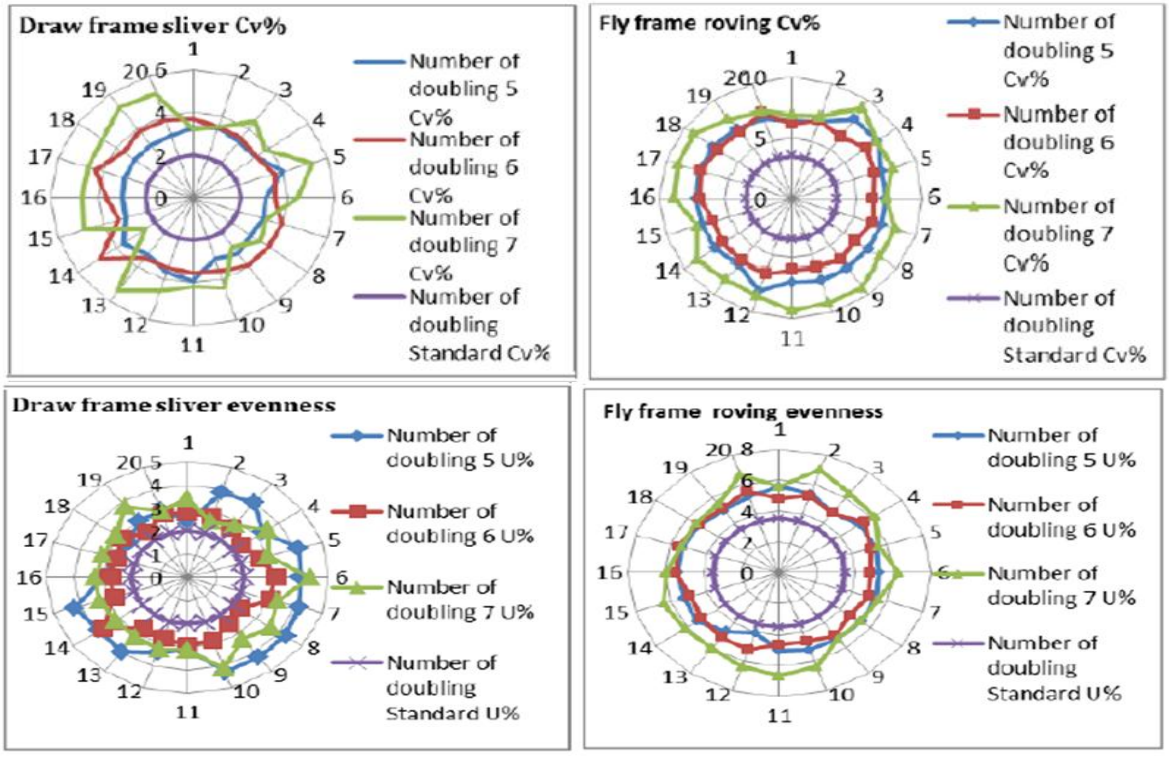

Figure 3. Comparison of draw frame sliver and roving CV% and evenness (U%) from SITRA standard

Figure 3 shows the comparison between properties of draw frame slivers and roving (CV% and U %) produced from different numbers of doubling with SITRA standard. The analysis of the results indicates that the value of the quality characteristics of the sliver and roving, which produce from six numbers of doubling, has the nearest value of the standard. The CV% and U% of the draw frame sliver and roving of flyframe is laid on 75% of the SITRA standard.

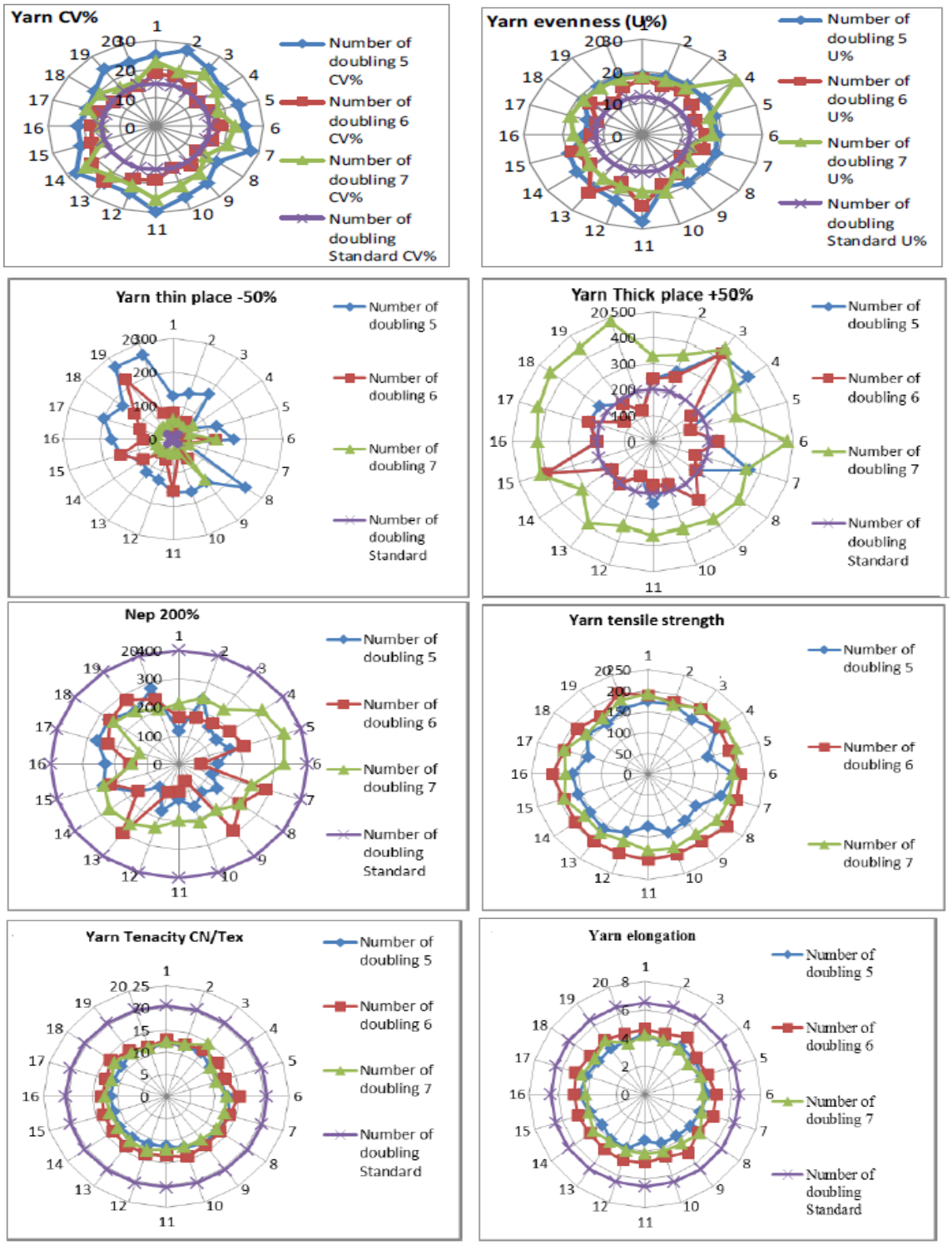

Figure 4. Comparison of yarn strength, elongation, and Tenacity from SITRA standard

Figure 4 shows a comparison between properties of draw frame slivers, rovings and carded yarn (tensile strength, elongation, tenacity, thick and thin place, CV%, U%, Nep 200+) produced from different numbers of doubling with SITRA standard. The analysis of the results indicates that the value of the quality characteristics of the yarn, which produce from six numbers of doubling of draw frame sliver, has also the nearest value of the standard.

IV. CONCLUSION

This study concludes that the draw frame sliver quality, the roving quality and the yarn quality characteristics have an impact on the numbers of sliver doubling in draw frame. The values of quality characteristics of the yarn i.e. CV%, Evenness (U%), Strength, Tenacity, elongation, thin and thick place which produce from six numbers of doubling obtains better results than the yarn which produce from five and seven numbers of doublings. However, the Nep 200+ increases when the numbers of sliver doubling increase. So, the optimum level of sliver doubling which imparts high quality parameter in the carded yarn is six numbers of doubling and the quality characterstics of the sliver, roving and yarns fulfil 75% of the SITRA standard.

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