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LONGITUDINAL AND CROSS-SECTION FIBER MIGRATION BEHAVIOUR OF POLYESTER/COTTON YARNS

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Abstract

The present study was conducted to determine the impact of polyester/cotton technique and ratio on the yarn structure and quality properties of yarns. The quality characters depend upon the ratio of polyester and cotton in the blend and also on the blending techniques, i.e., intimate blending, polyester can position in draw-frame blending to yarn spinning. The quality characters such as single yarn strength, yarn elongation, fabric appearance and dyeing properties were directly proportional to the ratio of polyester with cotton in the blend. Intimate blending or blow-room produced better quality yarn as compared to draw-frame blending.

INTRODUCTION

Blending of PE/CT fibers has the prime importance due to its multiple end uses and economical productivity and increasing demand. In comparison with 100% cotton, cotton/ polyester blends have higher breaking and abrasion strength, crease resistance, are more comfortable to wear, and display better easy-care properties. These advantages also permit an increased variety of products to be made, and yield a stronger marketing advantage. The best way of blending staple fibers is on blow-room process, because that gives accurate and homogenous fiber to fiber blending. Many spinning mills prefer blending through draw-frame; the reason was that gives longitudinal blending. Anandjiwal and Goswami (1999) reported that the blending of dissimilar fibers leads to their non-uniform distribution throughout the yarn cross-section, which in turn leads to preferential migration depending on both fiber properties and mechanism of certain spinning processes. The present study was conducted in order to find out the impact of Polyester/cotton blending techniques and fiber migration on the quality characteristics of yarns. Nawaz et al. (1999) reported that there is a gradual decline in yarn strength as the share of polyester fibers decreases in the blend. Shahid et al. (2001) reveals that the quality characters such as single yarn strength, yarn elongation and rupture per kilometer of yarn were directly proportional to the ratio of polyester with cotton in the blend. However, draw frame blending produced better quality yarn as compared to blow room blending, lap former blending and simplex blending. Danuta Cyniak et al. (2006) reported that Low-vacuum Scanning Electron Microscopy (LV SEM) turned out to be useful in determining polyester fiber distribution in fiber cross-sections of classical rotor- and ring-spun yarns. The yarn cross-section images enable an estimation of the content's quality, as well as the type of distribution of the polyester fibers and cotton in the particular yarn samples. The yarn cross-section images obtained proved the differentiated content of polyester fibers and cotton. The distribution of the particular components of the blends can be accepted as random for all the cases analyzed.

MATERIALS AND METHODS

The present study on the comparison of different blending techniques of cotton and polyester at different stages during fiber to second passage, up to yarn spinning was carried out at Al-Ola Tex for spinning and weaving- 6th of October, and in the Spinning Research Dept. Cotton Research Institute-Giza, Egypt. Lint cotton samples were tested with average values of fiber properties by HVI as fiber length 32.8 mm, fiber length uniformity index 86.5%, fiber strength 43.00 g/tex., micronaire reading 4.3. While polyester fiber having the quality characteristics as fiber length 38mm, fiber denier 1.4, black color semidull, elongation % 16.30, fiber strength 53.00 g/tex and crimp per inch 13.60 was used in this study.

The blending and spinning processes of Ne 30/1 yarn was carried out in an industrial cotton spinning. After being blended by two techniques –automatically in blow-room by weight before carding "intimate blending by Trützschler blow-room and preparation line" and in pure component card sliver state called drawframe blending carried out at Trützschler HSR 1000, and passed through the drawing frames, black polyester can position was also changed from last two cans to first two cans in first draw frame passage, while six cotton cans were used to produce 75% cotton and 25% polyester. In second passage seven can of blended cotton/polyester were blended with one 100% cotton can to produce 78.2% cotton / 21.8 % polyester as shown in Figures 1 and 2. All fibers were tested to characterize the physical properties, fiber length, tenacity, dinar and elongation. Also, the physical properties of all yarns were evaluated following the standard method of ASTM with UT5 device and Tensorapid. The data were statistically analyzed at a 95% confidence level and compared with Uster Statistics professional level 2019.

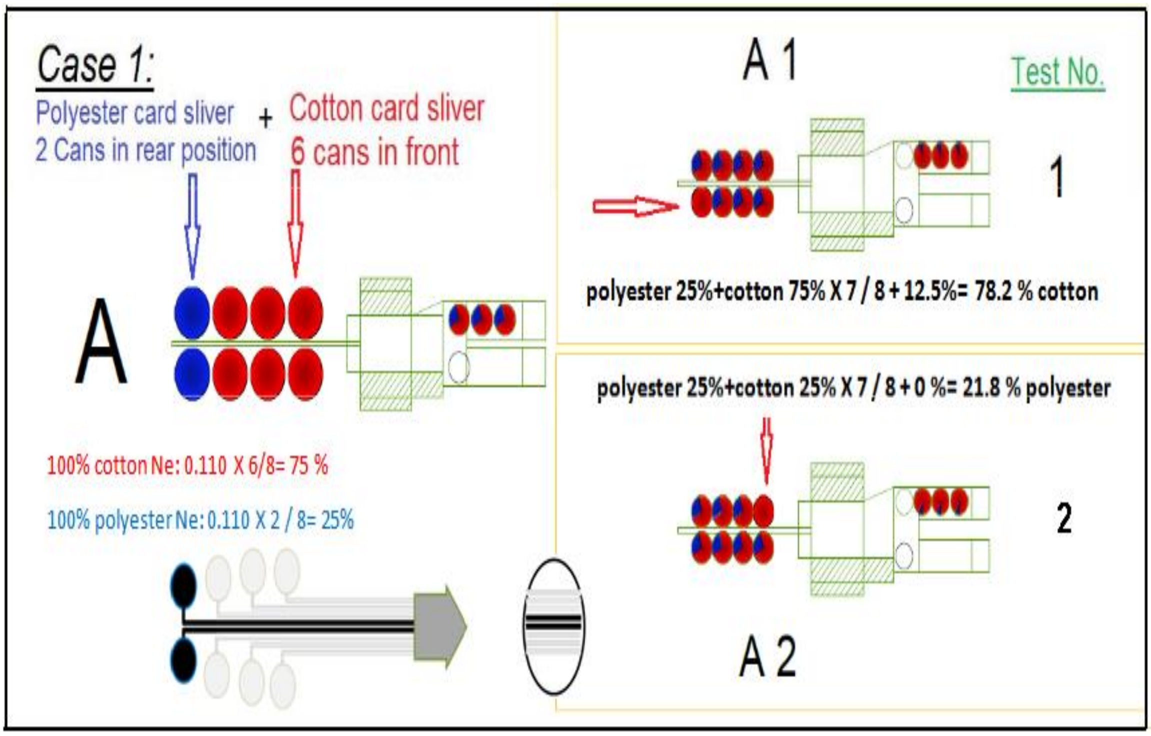

Figure 1. Case 1, blending cotton/polyester in 1 & 2 passage

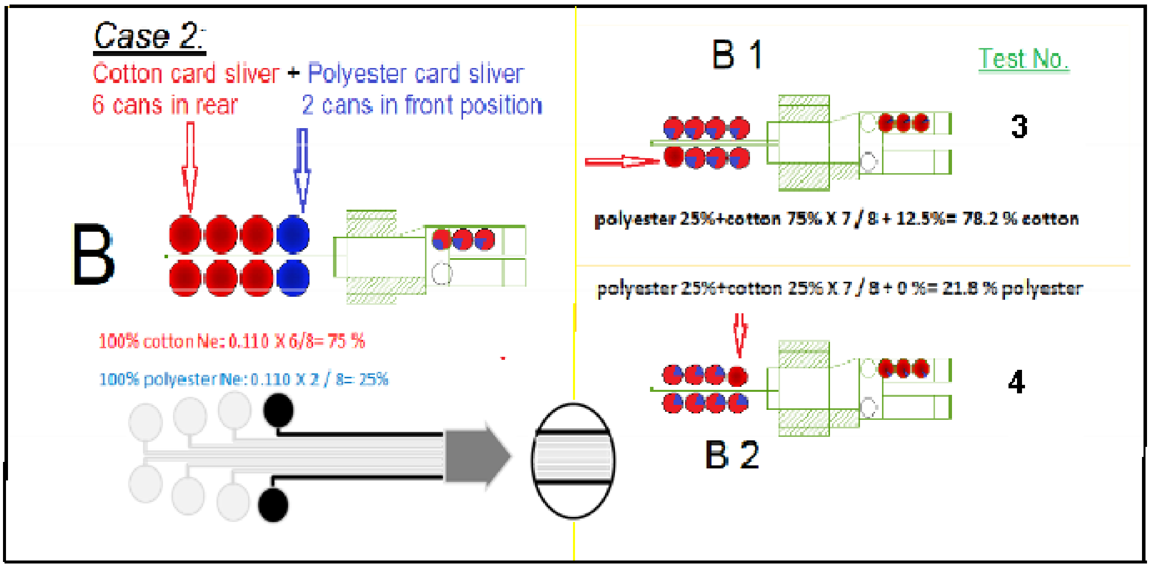

Figure 2. Case 2, blending cotton/polyester in 1 &2 passage

RESULTS AND DISCUSSION

Yarn quality data

The average values of measurement results of the yarn's quality parameters are shown in whereas in Table 1, the results of the statistical analysis are presented. The statistical analysis of single yarn strength at 30 Ne (C/P) blend was shown in Table 1 which showed that the effect of different blending techniques during fiber to yarn spinning were highly significant.

The results obtained from the statistic analysis indicate that the blending technique of the yarn manufactured and the can position of cotton fibers in the blends with polyester fibers have highly significant influence on the elongation %. Regarding to Table 1, the mean values of yarn elongation % for Ne 30 were observed as 7.71 for intimate blending and 5.9, 5.7, 5.7 and 6.4 in case of draw-frame blending and can position techniques respectively the best yarn elongation was recognized for intimate blending due to the best fiber spreading in yarn cross-section. On the contrary, no significant influence of the blending technique of the yarn manufactured and the can position on the yarn evenness and IPI of the yarns tested was stated.

Regarding to Uster statistics professional results, the yarn evenness, thin and thick places recognized below 5% Uster level for all cases analyzed.

The results of the statistical analysis indicated that the influence of the blending techniques of the fibre blend significantly influences the hairiness as measured by the Uster apparatus. The data showed in Table 1 that yarn manufacturing from blow-room blending techniques was smallest yarn hairiness and recognized at 50 % Uster level. On the contrary, the draw-frame blending techniques recorded the highest values of yarn hairiness and recognized at 75% to 95% Uster level. It could be stated that the fiber migration played the vital role in yarn hairiness.

Yarn Count	**30/1**						
Material	**Blend CO/PES**						
Blending percentage	**78% Cotton / 22% Polyester**						
Blending type		Blend in Blow-room	**Blend in draw frame**				Statistical analysis
Sample Code			**AA1-1**	**AA1-2**	**BB1-1**	**BB1-2**	
Yarn Count	Count	29.38	29.80	30.00	29.29	29.21	N.s
	CV%	0.86	0.53	1.22	0.85	1.03	
Twist / m	T/m	683.76	684.0	679.4	686.2	675.4	N.S
	CV%	2.30	2.5	1.9	1.9	2.7	*
Force test	Tenacity	15.68	14.2	14.2	14.7	14.8	**
	CV%	7.57	6.04	6.71	9.17	4.56	**
	Elongation%	7.71	5.9	5.7	5.7	6.4	**
USTER IPI	CV m%	13.42	12.82	13.22	13.96	13.84	N.S
	USP07	< 5	< 5	< 5	< 5	< 5	
	Thin -50%	0	0	1	0	0	N.S
	USP07	<5	< 5	< 5	< 5	< 5	
	Thick +50%	84.40	65	73	109	82	N.S
	USP07	<5	< 5	< 5	< 5	< 5	
	Neps+200%	178.00	166	173	189	173	N.S
	USP07	16.20	13	15	19	15	
	H %	5.24	6.2	6.8	6.5	6.5	**
	USP07	50	75	> 95	> 95	> 95	

N. S. insignificant   * significant   ** highly significant

Fiber migration

Migration means the variation in the radial position from near the yarn axis to near the yarn surface as the fiber follows the helical path defined by the yarn twist. With the ring spun yarn structure, the majority of fibers appear to lie almost parallel to each other with the same helix angle of twist. The various projected longitudinal migration of slivers carried out different polyester and cotton can positions were expressed in figure 3

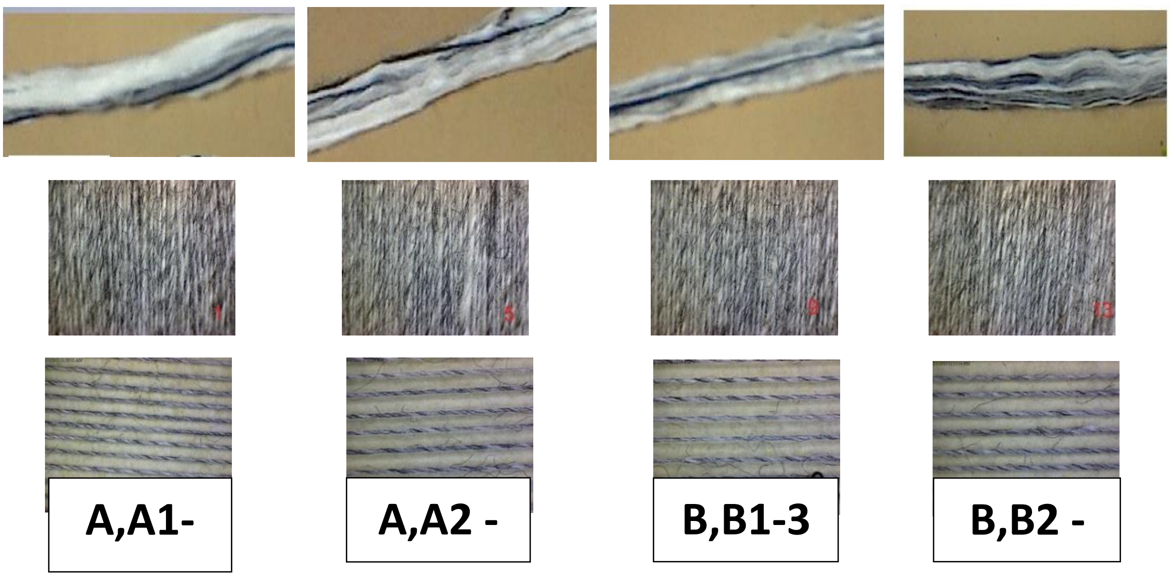

Figure 3. Representative image of slivers and yarns

As a results, fiber migration and fluctuation of the fiber position are higher in back polyester can position AA1 and AA2 than the front polyester can position BB1 and BB2. It was noticed during their examination of the projected yarn cross-section that the two components are arranged throughout the sections in small groups or clusters. The polyester fiber clusters were positioned in different location in yarn cross-section according to the can position in draw-frame. In another point of view, the yarn cross-section in blended yarn carried out at blow-room that the two components are spreading across the yarn body and tended to lie on the same cylindrical layer throughout its length. The distribution of the particular components of the blends can be accepted as random for all the cases analysed.

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BLENDED YARNS WITH A CONTENT OF ANTIMICROBIAL BAMBOO FIBERS

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Abstract

This study investigated the effect of bamboo fiber, which has recently begun to be commonly used in textiles, on the performance of antibacterial and also the properties of yarn. The present study used 100% bamboo yarn of 30 and 16 Ne which was ring-spun under industrial conditions, bamboo/cotton with varying blend ratios and 100% cotton yarns. The tenacity and Elongation at break and unevenness, of the yarns were measured. The results indicated that the ratio of bamboo fiber in the blend had an effect on the properties of yarn. The antibacterial properties of bamboo knitting fabric was significantly higher than those of 100% cotton and its blends fabric.

INTRODUCTION

Due to the wide spread and important role of textiles in life and considering the fact the textiles, especially when combined with factors such as heat, humidity, dust, soil and fat-stains (on the surface) are one of the best and most common environments for the growth and distribution of microorganism, which endanger hygiene and also create unpleasant odors, the importance of bamboo crop has been increased due to its use in textiles as a naturally antibacterial, antifungal and anti-static. Bamboo has a unique anti-bacterium and bacteriostasis bio-agent named "bamboo kun" which bonds tightly with bamboo cellulose molecules during the normal process of bamboo fiber growth.

The absorbent nature of bamboo fiber has lead to its various applications in textiles. Textiles demand varies from year to year with the hanging fashion; the consumer's preference influences the demand for different types of fibers. The increase in the world demand for textile fibers is expected to continue not only due to increase in the world population but also due to the standards of living. Therefore, the focus of fiber research has shifted towards the exploration of the new fibers and their combinations with the older ones, Ahmed et.al, 2012.

Bamboo clothing is an excellent organic choice that has many benefits and advantages over cotton: Bamboo fabric is softer than cotton, with a texture similar to silk; it is a natural antibacterial product grown without the use of chemicals or pesticides; it is also quick to absorb moisture, thereby keeping you dry and odor free. Moreover, pure bamboo clothes can dry twice as fast as cotton ones, Anon 2009.

Bamboo fibers have a wide variety of applications. In addition to traditional uses in apparel and home furnishings, bamboo fibers are also important for geotextiles, industrial belts and filters, tire cord, ornamentation inside vehicles, motorways, building construction, medical implants and aviation. They also form the basis for today's high-tech composite materials, offering light weight, high-performance alternatives to metals. Bamboo fiber is used in many products that protect the environment, ranging from geotextiles for land stabilization and erosion prevention, such as liquid filtration, to filtration materials that clean air and water. It is also used in special absorbents designed to remove spilled oil from waterways and wetlands, Karahan and Seventekin 2006.

Chen et al. (2007), compared the antibacterial properties of bamboo-viscose (jersey knit) and common wood-viscose (jersey knit) and found that the antibacterial properties of bamboo fabrics were significantly higher than those of common wood-viscose fabric. They reported that the reason for the high antibacterial property of bamboo fabric was that it rapidly absorbs and evaporates water due to its structure, and that bacteria cannot survive in such a dry environment.

Sarkar and Appidi (2009) analyzed the ultraviolet protection and antimicrobial effects of bamboo fabric and concluded that untreated raw fabric had low as well as insufficient protection and antimicrobial effects.

The combination of bamboo and cotton proved as a supreme blend component for modern and luxurious lifestyle. However, the tensile strength of the yarn produced by the bamboo fibers is lower than viscose rayon as reported by Shanmugasundaram and Gowda, (2010).

The present study was conducted to try different blend combinations of bamboo and Egyptian cotton for the optimum quality of the yarns with excellent Properties and antibacterial.

MATERIALS AND METHODS

In this study, 100% bamboo were supplied by a textile yarn manufacturing company, CSA textile Egypt, Borg El-Arab, Alexandria, Egypt. Regenerated bamboo fibers were processed using a conventional short staple carded yarn spinning system. Then yarn samples of three different blend ratios and two yarn counts were produced in a ring spinning frame.

The study used ring-spun 16 Ne and 30 Ne 100% bamboo yarn, 100% cotton yarn and bamboo/cotton yarn, blended in two different ratios. The properties of the fibers are given in Table 1.

Table 1. Cotton and Bamboo physical parameters.

Cotton physical parameters	**Cotton Fiber data**	**Bamboo physical parameters**	Bamboo
Upper Half Mean mm.	32.8	Fiber length “mm”	38
Uniformity Index (%)	86.5	Fiber fineness “D”	1.5
Short fiber index	7.8	Dry tenacity “cN/Tex”	23.0
Strength “cN/Tex”	43.8	Wet tenacity “cN/Tex”	15.0
Elongation (%)	6.3	Elongation “%”	12.0
Micronaire value	4.3		
Fineness	145		
Reflectance Rd%	74.4		
Yellowness +b	9.6		

Tests were carried out with knitting manufactured from yarns with a linear density of 16 Ne of the following compositions:

The knitting was tested for the presence of spores of the anaerobic sporogenous micro-organisms, and the total amount (number) of micro-organisms in accordance with standards PN-93/A-86034/12 and PN-A-82055-6. During the test, the standard agar and the agar with glucose were used as the breeding-grounds. The presence of spores of the anaerobic sporogenous micro-organisms was organoleptically estimated in accordance with standard PN-93/A-86034/12. The presence of anaerobic bacteria, which in the conditions prescribed by the standard method create black colonies or cause blackening of the medium, was denoted by the (+) sign, and their absence by the (-) sign. The total number of micro-organisms was determined by the plate method, by observing the number of micro-organisms in one gram of the sample.

Unevenness, thin, thick, neps and hairiness values were measured using a USTER TESTER 3 Evenness Tester. The yarn tenacity and elongation at break were measured using Statimat-ME yarn strength tester.

RESULTS AND DISCUSSIONS

Physical and mechanical properties of the yarns manufactured are given in Table2. Table 2 and Figure (1) indicates that differences between the single yarn strength (cN/tex) of the yarns were statistically significant at a 5% significance level. To make a pairwise comparison of the single yarn strength (cN/tex) means, a Least Significant Differences test was performed. In 16/1 Ne, there is a statistically significant difference between 100% cotton yarn and 70/30% bamboo/cotton and 30/70 bamboo/cotton. In 30/1, there was a statistically significant difference between 100% cotton yarn and 70%30% bamboo/cotton yarn and 30/70% bamboo /cotton yarn.

Apart from 30 and 16 Ne, physical properties of bamboo yarn including single yarn strength (cN/tex) and elongation at break (%) decrease as the yarn becomes changed from 16 Ne to 30 Ne and bamboo ratio increase form 30% to 70 %. These results are consistent with the results obtained by Shanmugasundaram, and Gowda (2010).

Table 2. Physical and Mechanical properties of Bamboo/cotton blended yarns.

Cotton varieties	Yarn count	Tenacity (cN\tex)	Elongation %	CVm%	Hairiness (H)	No. of Neps/Km
Bamboo 70% Cotton 30%	Ne 30/1	12.34	6.0	11.79	3.3	36
Bamboo 30% Cotton 70%	Ne 30/1	14.43	6.5	12.54	3.4	46
Cotton 100%	Ne 30/1	20.48	5.5	12.21	3.4	68
Bamboo 100%	Ne 30/1	12. 67	9.15	10.34	3.2	20
Bamboo 70% Cotton 30%	Ne 16/1	16.77	5.9	10.36	3.5	26
Bamboo 30% Cotton 70%	Ne 16/1	17.86	6.4	11.54	3.6	25
Cotton 100 %	Ne 16/1	21.55	6.2	12.13	3.7	50
Bamboo 100%	Ne 16/1	12.47	10.33	9.87	3.3	16
L.S. D. at 0.05 level		1.54	0.07	0.63	0.07	7.88

As the fiber elongation % translated to yarn elongation, a high elongation value of regenerated bamboo fiber results in a high yarn elongation value as shown in Figure 2.

Results of unevenness values from the statistical analyses can be interpreted as follows: There was a statistically significant difference between 70/30% bamboo/ cotton and 30/70% Bamboo/cotton in terms of CV% yarn unevenness in both 16 Ne and 30 Ne, as shown in Figure 3. The data presented in Table 2 was analyzed for statistically significant differences. The differences between the unevenness values of the yarns were statistically significant at a 5% significance level.

It was important to indicate that the thin and thick places section numbers of the yarns are similar; bamboo/cotton blended yarns and 100 % cotton had the lowest recorded numbers. The thin and thick places ranged from 0 to 1. Since the variation in thin and thick sections of the yarns were not notices (ranged from 0 to 1) and statistically insignificant, this property was not included in the subsequent Lease Significant Differences test.

It was observed from Table 2 and Figure 4, that as the proportion on bamboo fiber increase the hairiness in tested yarns decreases. Regenerated bamboo fibers are having longer and even staple length than that natural cotton fiber. Moreover, short fibers were totally absent in the bamboo fiber. he hairiness indices of the bamboo yarn samples are of comparable quality: between 5 and 15% of the world level for viscose rayon and carded and combed cotton ring spun yarns.

Apart from Nep/Km, the quality of bamboo yarn was more satisfactory in relation to the level of 100% carded cotton ring spun yarn. With regard to number of neps/Km places, bamboo yarn has a higher level of quality in relation to 100% carded cotton ring yarns as shown in Figure 5. As the ratio of bamboo in the blend increases, unevenness decreases.

Microbial test

Knitting manufactured from 100% bamboo yarn which were placed onto the agar with glucose breeding ground were characterized by a lower amount of micro-organisms than the same knitting placed with 100% cotton. Bamboo fiber content of 70% a distinct difference in the amount of micro-organisms is also visible in comparison with knitting of 30% bamboo fiber content.

The lowest content of bamboo (30%) bamboo fiber in the yarn blend causes a fundamental inhibition in the growth of microorganisms and entirely prevents the growth of sporogenous bacteria.

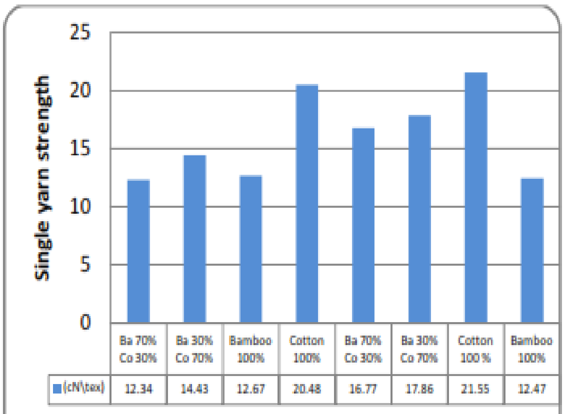

Fig 1: Single yarn strength (cN\tex) of different blends

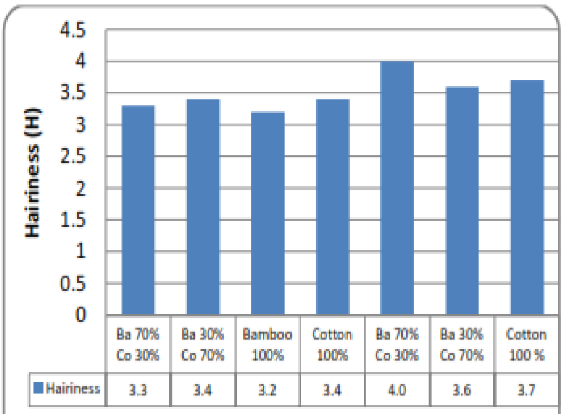

Fig 4: Yarn hairiness (H) at different blends

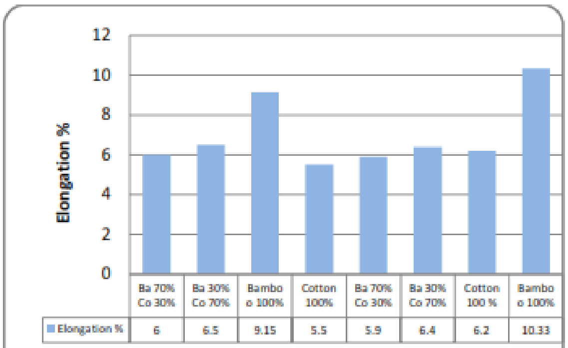

Fig 2: yarn Elongation % of different blends

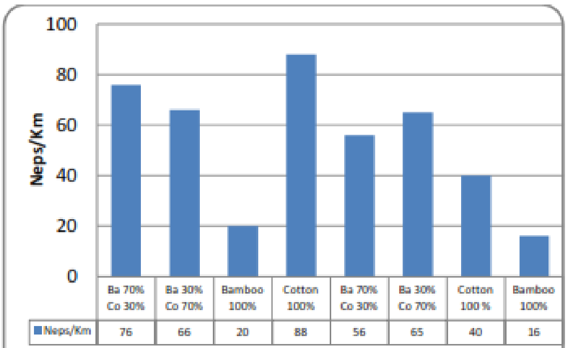

Fig 5: No. of Neps/Km of different blends

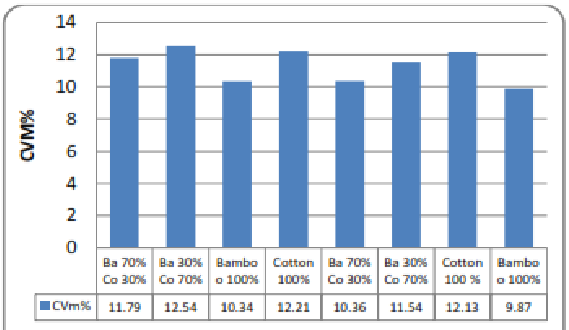

Fig 3: CVm% of different blends

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TECHNOLOGY TO BOOST COTTON PRODUCTION: EFFECTS OF PLANT DENSITY (STAND DENSITY) ON COTTON PRODUCTIVITY IN KENYA

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1.0 Background

The agricultural sector currently contributes 21% to Kenya's Gross Domestic Product (GDP). Additionally, it contributes 27% through manufacturing, distribution, and service-related sectors. It is clear that the sector plays a pivotal role in the country's economy and it is also a source of livelihood as employment accounting for 40% of the employment of the total population and 70% of the rural population. Under the government Vision 2030, which is the country's long term development strategy, agriculture is one of the key economic sectors expected to drive the country's economy to the projected 10% annual economic growth. The Fourth Medium Term Plan (MTP IV) 2023 - 2027 that implements the Bottom-Up Economic Transformation Agenda (BETA) identifies agriculture as one of the core pillars of the economy that will bring down the cost of living, eradicate hunger, create jobs, and foster inclusive growth. The Industrial crops sub-sector is a significant component of the sector that generates income for the country and provides employment for the citizens.

The Ministry of Agriculture, in line with the National Development Agenda, developed the Agriculture Sector Transformation and Growth Strategy (ASTGS) 2019 – 2029, whose overall goal is to revolutionize agriculture from subsistence to an innovative, commercially-oriented, and competitive sector capable of providing Kenyans with employment opportunities and increased incomes. The strategy singles out cash crops such as cotton as major avenues for creating employment opportunities, especially for the youth and generating incomes through value addition and processing along the value chains. To achieve this, the Ministry has prioritized the country's value chains.

Cotton was at one time a main foreign exchange earner, reaching peak production in the 1970s and 1980s. In 1985 the country produced 13,000 MT of lint. This production declined in the 1990s to less than 4000 MT following liberalization policies in the sector and the collapse of the cotton inputs supply structures, cooperative societies, extension service and seed supply system. Despite these set-backs, there are great opportunities that can be exploited for the benefit of the country. There is a big demand for lint and seed cake in the country as well as a conducive environment for export market-oriented manufacturing in the export processing zones through trade agreements with EAC, COMESA, AGOA, and ACP-EU.

The country targets to increase production by expanding the area under cotton to 65,000 ha, with an average yield of 1,900 kg per ha from the current 572 kg per ha. It also aims at enhancing efficiencies in post-production handling by improving the processing capacities of ginneries with the overall goal of providing raw material for locally manufactured products in its textiles industry. This garment industry is dominated by manufacturers with a strong export orientation who utilizes imported materials. It is for this reason the government embarked on identifying technologies that would improve its cotton production and productivity in the shortest period possible.

2.0 Production system

Cotton is solely produced by smallholder farmers on fields of less than one hectare on average under rain-fed conditions with minimum inputs. The Country is estimated to have 20,000 to 45,000 smallholder cotton farmers in 20-24 counties in any season, depending on seed cotton price in the previous season. The farmers are scattered and unorganized in their production where majority are not affiliated to producer groups such as cooperatives. This complicates mobilization, advisory service delivery, access to credit facilities, and collective marketing. Plant spacing of 90cm x 30cm with 1 plant per hole giving a plant population of about 44,000 plants/Ha is commonly practiced.

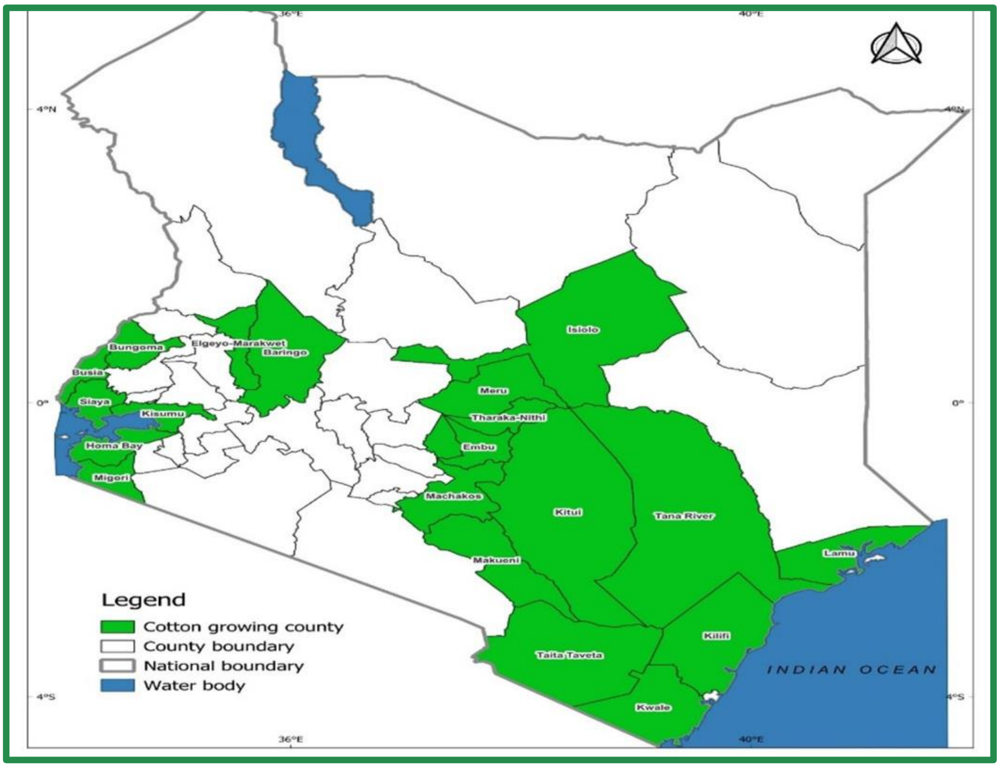

Figure 1: Cotton growing Counties, Source, AFA

2.1 Effects of plant density (stand density) on cotton productivity in Kenya

Following are results from 3 sites which were planted during the long rains season at KALRO Kibos, Tom Mboya University College (TMUC) and Miyare Agriculture Training Centre in 2021 and 2022 seasons.

Objective

a. To assess cotton crop performance under different plant densities (spacing) in Kenya

Cotton KSA 81M variety was used in the experiment and has the following traits:

- ❖ Seed cotton yield is 2000 kg/ha.
- ❖ Cotton cycle up to flowering is 61 days.
- ❖ Plant height in centimetres is 130 cm.
- ❖ Cotton cycle up to harvest is between 130 and 150 days.
- ❖ Early ripening takes about 126 days.

b. Methodology

This trial was based on four treatments of variety KSA 81M planting 1 plant per hole

T1: 33cm spacing by 70cm.

T2: 25cm spacing by 70cm.

T3: 20 cm spacing by 70cm.

T4: 20cm on furrow by 70cm.

Layout plan

Table 1. Plant Density trial lay out

Replication	Treatments			
RIV	T3	T4	T1	T2
RIII	T1	T2	T4	T3
RII	T2	T1	T3	T4
RI	T4	T3	T2	T1

The experimental area was of 33.8m by 83m (2805.4m^2).

ACTIVITIES

Field laying out, planting and thinning/gapping were done simultaneously in all sites. Three weeding were effected. Other standard agronomic and crop management practices were applied. Two harvestings (1st and 2nd) were done.

RESULTS

Figure 2: Cotton Emergence % at different spacing in two sites in 2021

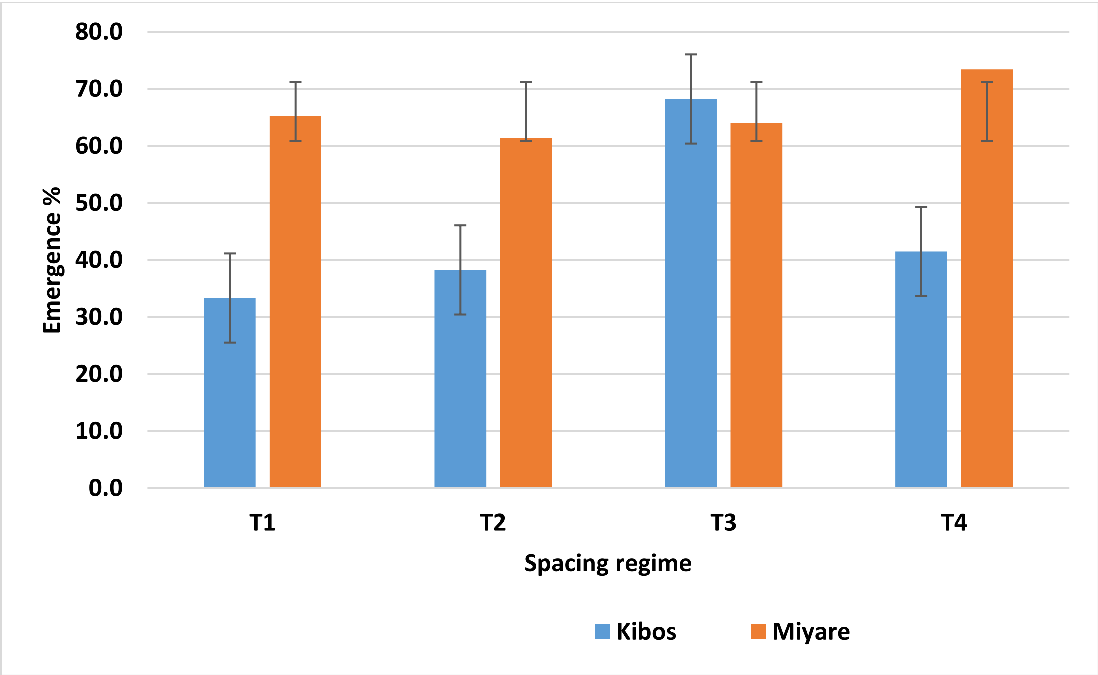

Figure 3: Mean plant height (cm) of cotton at flowering stage at different spacing in Kibos and Miyare in 2021

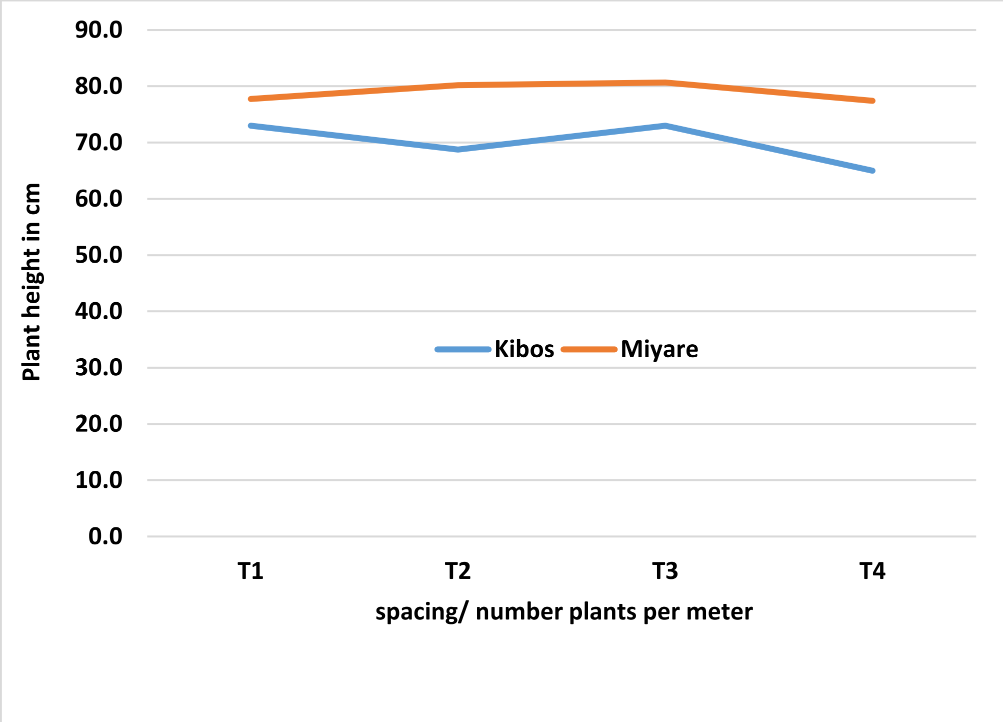

Figure 4: Average number of green bolls at different plant densities in three sites

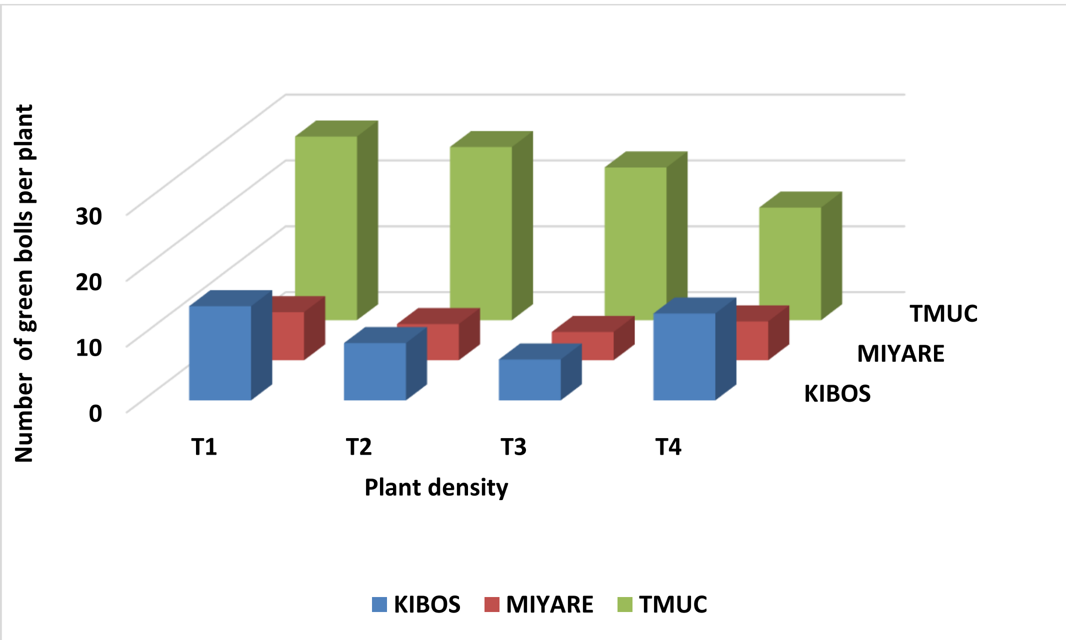

Table 2: Average cumulative weights for different treatments (1st & 2nd harvest)

Treatment	1st harvest(kg)	2nd harvest(kg)	Cumulative yield(kg)	Yield kg/ha
T1:	31	24.6	55.6	902.5
T2:	34.8	17.2	52.0	844.2
T3:	35.8	20.8	56.6	918.8
T4:	49.2	11.2	60.4	980.5

3. Conclusion

- Germination and emergence varied from treatment to treatment;
- Plant height (at first flower opening) did not vary much between treatments and sites.
- T4 had the highest lint yield with a plant population of slightly over 71,000/Ha
- Increasing plant population from the current 44,000 plants/Ha to 71,000 plants/Ha will likely double yields even under the current rain-fed production system in Kenya.

PICTORIAL

The images below show the activities that were undertaken:

Field before 1st harvesting, plant density trial

Kibos: Pictorial results of plant density trail for 1st harvest (2022)

Kibos: Pictorial representation of plant density trail for 2nd harvest