

REGISTRATION

Germplasm

Four upland cotton germplasm lines with improved fiber quality

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Abstract

Yarns from all fibers traditionally were produced by aligning the fibers and adding twist. That technique was mechanized over time and today is referred to as ring spinning. About 1970, open-end spinning technology was introduced that offers increased speed of production while ring offers flexibility in size and quality of yarn. More recently, air jet spinning technology, also called vortex or Murata Vortex Spinning (MVS), provides spinning speeds that exceed that of open-end and is reportedly 20 times faster than ring. Vortex spinning technology is more suited for man-made fibers than for cotton (*Gossypium hirsutum* L.) fibers, which by their nature are variable in length, diameter, maturity, etc. For upland cotton fibers to compete with man-made fibers as MVS technology is adopted, breeders must develop genotypes with fiber properties different than current cultivars. The average fiber length of U.S. upland cotton in 2024 was 28.8 mm and average strength was 296 kN m kg⁻¹. These and other characteristics must be improved if upland cotton is to remain a natural fiber of choice that is spinnable on the new MVS technology. TAMJG-255 ESU (Reg no. GP-1170, PI 709156), averaged 22% stronger fibers than the predominant comparison cultivar, Tamcot 73, TAM AU-095 ELSU (Reg no. GP-1169, PI 709155) averaged 9% stronger fibers, and TAM 18J-13 ELSU-ESU (Reg no. GP-1167, PI 709153) and TAM 18L-37 ELSU-ESU (Reg no. GP-1168, PI 709154) averaged 13% stronger fibers. The MVS yarn quality, as defined by yarn tensile strength and appearance of yarn produced with TAM JG-255 ESU was superior to Tamcot 73.

Plain Language Summary

Aligning fibers and then twisting together to produce a yarn is technology that dates to antiquity. Technology that utilizes air to wrap fibers without first paralyzing fibers was introduced in the 1960s and called open-end spinning. Today, air-jet or vortex spinning utilizes this open-end technology to produce yarn up to 20 times faster than

Abbreviations: Elong, elongation of fibers before rupture; ELSU, extra long staple upland; ESU, extra strength upland; FBRI, Fiber and Biopolymer Research Institute; FBS, fiber bundle strength; Hair, hairiness of yarn; Hs, standardized fiber diameter; HVI, high volume instrument; IPI, imperfections index; LP, lint percentage; Mic, micronaire; MVS, Murata vortex spinning; RBTN, Regional Breeders Testing Network; SFCw, short fiber content by weight; Ten, yarn tenacity; UHML, upper half mean length; UI, uniformity index; WTB, work to break.

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the align and twist technology. However, spinners need stronger and longer fibers to produce quality yarns with the newer vortex spinning method. The Texas A&M AgriLife Research cotton breeding program at College Station has developed and released several germplasm lines of upland cotton (*Gossypium hirsutum* L.) with significant improvements in fiber strength and fiber length. The four germplasm lines described in this release article have fiber strength up to 22% stronger than today's standard upland cotton varieties and up to 20% longer that produce vortex yarn up to 26% stronger.

1 | INTRODUCTION

Cotton's (*Gossypium* spp.) share of the global fiber production was only 28% of all fibers produced in 2023 (Materials Market Report 2024 - Textile Exchange, accessed 4.15.25), compared with a 78% market share in 1960 (Cotton Incorporated's Company History—A Timeline of Events, accessed 4.15.25). Polyester's share of the textile market has replaced much of cotton's loss. Man-made fibers have improved over the past 65 years and can be manufactured to specific demands for length, diameter, and other characteristics. Historically, yarns from all fibers and for all textiles were produced by aligning the fibers and adding twist. That technique was mechanized over time and culminated in the ring spinning frame developed by Thorp in 1828 (Smith et al., 1999). About 1970, open end spinning was introduced that produced yarn faster than ring but with a different yarn structure that was suitable initially for lower count, or larger diameter, yarns. Open-end technology offers speed of production while ring offers flexibility in size and quality of yarn. This open end structure results in a weaker yarn compared with ring spinning, when all other variables are held constant. Cotton breeders developed cultivars with stronger fiber bundle strength (FBS) by the 1990s to offset that inherent weakness in open end yarns. More recently, air jet spinning technology, also called vortex, provides spinning speeds that exceed that of open-end and is 20 times that of ring. Vortex spinning technology is more suited for man-made fibers than for cotton fibers, which by their nature are variable in length, diameter, maturity, etc. Thus, 100% cotton yarns produced on vortex spinning frames are weaker than when spun on a ring frame.

For upland cotton fibers to compete with man-made fibers as this newer technology is adopted, breeders must develop genotypes with fiber properties different than current cultivars or the industry risks losing more market share to polyester. The average upper half mean length (UHML) of U.S. upland cotton (*G. hirsutum* L.) in 2024 was 28.8 mm, average FBS was 296 kN m kg⁻¹, average micronaire (Mic) was 4.4, and average length uniformity

index (UI) was 81.7 (<https://www.ams.usda.gov/mnreports/cnmmcq.pdf>, accessed 4.17.25). The Cotton Improvement Program at Texas A&M Agrilife Research in College Station has developed and released upland cotton germplasm with UHML equal or near equal to that of pima, *G. barbadense* L., minimum of 36.6 mm, and with FBS greater than upland cultivars currently marketed (Smith et al. (2009, 2014, 2018a, 2018b, 2020, and 2021)). These lines tend to exhibit finer fibers with more uniform lengths, both desirable traits.

Uyanik & Baykal (2018) reported that Murata Vortex spinning (MVS) was suitable for spinning 100% upland carded cotton fibers but that cotton was the least desirable of the fiber types tested. Parthiban et al. (2023) reported that vortex was suitable for 60:40 cotton blends, 60 % cotton and 40 % polyester. Tursucular (2024) reported that no more than 60 % of carded cotton fibers should be blended and spun on MVS frames. These three reports did not indicate the type of cotton fiber used, i.e., pima or upland. Limited unpublished spinning data derived by Texas A&M AgriLife Research suggests that breeders must create genotypes with UHML equal to or exceeding 31 mm and FBS exceeding 370 kN m kg⁻¹ in order to produce 100% upland cotton MVS yarn that is equal to ring spun yarn with today's cultivars.

This article describes four germplasm lines that are stronger than what is currently available: TAM JG-255 ESU (Reg no. GP-1170, PI 709156), TAM AU-095 ELSU (Reg no. GP-1169, PI 709155), TAM 18J-13 ELSU-ESU (Reg no. GP-1167, PI 709153), and TAM 18L-37 ELSU-ESU (Reg no. GP-1168, PI 709154).

2 | METHODS

New populations of upland cotton are initiated each year by crossing unique parents possessing desirable fiber traits. The four germplasm lines in Table 1 were developed by Texas A&M AgriLife via standard pedigree procedures. Parents were crossed at College Station in 2014. Single plants were selected in the F₃ generation for TAM 18J-13 and TAM 18L-37 with subsequent generations treated as pure lines with

TABLE 1 Germplasm lines with improved UHML and FBS, their parents, and reference data^a

Germplasm line	Parents	UHML mm	FBS ^b kN m kg ⁻¹
TAM JG-255 ESU	13 P-54	35.9	312
	Tamcot 73 (Smith et al., 2011a)	29.9	312
	TAM JG-255 ESU (Table 2)	31.8	400
TAM AU-095 ELSU	13P-54	35.9	312
	TAM 11K-13 ELSU (Smith et al., 2018a)	33.7	339
	Del Cerro (Bowman et al., 2006)	33.6	345
	TAM AU-095 ELSU (Table 2)	36.6	358
TAM 18J-13 LSU-ESU	TAM 04WB-33s (Smith et al., 2011b)	33.3	335
	09PP-03-2/9917	33.9	328
	TAM 18J-13 LSU-ESU (Table 6)	35.8	377
TAM 18L-37 LSU-ESU	Tamcot 73	29.9	312
	TAM T-08 ELSU-ESU (Smith et al., 2018a)	34.3	360
	TAM 18L-37 LSU-ESU (Table 6)	34.5	375

^aReference data for parents from breeding program's historical data; UHML = upper half mean length of fibers.

^bFBS = fiber bundle strength.

rogueing of any off types. TAM JG-255 ESU (extra strength upland) resulted from single plant selections in the F₃ and F₄ generations, with reselection of the F₄ based on high volume instrument (HVI) FBS. TAM AU-095 ELSU was derived from a single plant selection in the F₂ and again in the F₃ generation with reselections based on HVI UHML. All were planted in a progeny row nursery following individual plant selection and reselected as a progeny row based on agronomic appearance and HVI fiber properties, followed by performance testing at College Station. All nurseries and performance trials conducted at College Station were managed as general cotton production in Central and South Texas with furrow irrigation. Fiber properties, unless otherwise noted below, were from hand harvested, 30 to 50 bolls taken from the middle of the fruiting zone, ginned on a laboratory 10-saw gin, and lint forwarded to the Fiber and Biopolymer Research Institute (FBRI) at Texas Tech University for HVI analyses.

2.1 | Characteristics of TAM JG-255 ESU and TAM AU-095 ELSU

TAM JG-255 ESU and TAM AU-095 ELSU were grown in a randomized complete block design with plots 2 rows × 12.1 m × 1 m and four replications in 2021 and 2022 at College Station, TX. Soil type was Weswood sandy loam, a fine-silty, mixed, superactive, thermic Udifluventic Haplustepts and all cultural practices were normal for the locale with furrow irrigation as subjectively determined. Controls were a high yielding cultivar, Tamcot 73 (Smith et al., 2011a), and

a high quality germplasm line, TAM BB-2139 ELSU (Smith et al., 2018b).

TAM JG-255 ESU yielded equivalent ($p = 0.05$) to TAM BB-2139 ELSU but lower than Tamcot 73 (Table 2). As with previous extra long staple upland germplasm lines developed and released by Texas A&M AgriLife Research, lint percentage (LP) was lower than that observed in modern cultivars. TAM JG-255 ESU exhibited shorter UHML than TAM BB-2139 ELSU but longer than Tamcot 73, and stronger FBS than either control at 400 kN m kg⁻¹, exceeding the minimum proposed above for vortex spinning. UI of TAM JG-255 ESU was significantly better than either control and elongation of the fiber bundle before rupture (Elong) was equivalent to the commercial Tamcot 73.

TAM AU-095 ELSU was lower yielding ($p = 0.05$) and exhibited the lowest LP at College Station across 2021 and 2022 than the high yielding control, Tamcot 73 and the high quality control, TAM BB-2139 ELSU (Table 2). The Mic of this germplasm line as well as for the TAM JG-255 ESU line was lower than the controls but were within the premium range of 3.9 to 4.2. UHML of TAM AU-095 ELSU was 36.6 mm, which is equivalent to pima (<https://www.ams.usda.gov/mnreports/cnmmcq.pdf>, accessed 4.17.25) and longer ($p = 0.05$) than both controls. FBS was lower than TAM JG-255 ESU but higher than either control genotype. UI was lower than TAM JG-255 ESU but higher than either control.

TAM JG-255 ESU and TAM AU-095 ELSU, along with Tamcot H12 (Smith et al., 2024) were included in an unrelated experiment at Lubbock, TX in 2024. Soil type was Pullman clay loam, a fine, mixed, superactive, thermic Tor-

TABLE 2 Agronomic performance and fiber properties of TAM JG-255 ESU and TAM AU-095 ELSU compared with Tamcot 73 and TAM BB-2139 when grown in College Station, TX in 2021 and 2022

Genotype	Lint yield kg ha ⁻¹	LP ^a %	Mic units	UHML mm	UI index	FBS kN m kg ⁻¹	Elong %
TAM JG-255 ESU	838 b	35.1 c	4.1 b	31.8 c	89.0 a	400 a	5.9 a
TAM AU-095 ELSU	626 c	30.3 d	4.0 b	36.6 a	86.3 b	358 b	5.6 b
TAM BB-2139	787 b	35.2 b	4.6 a	33.7 b	83.6 c	323 c	5.7 b
Tamcot 73	1037 a	37.1 a	4.6 a	30.4 d	83.9 c	327 c	5.9 a
Mean	699	32.0	4.1	34	86.2	373	5.6
CV	14.6	2.3	4.1	2.4	1.1	4.2	3.1

Note: Values within columns followed by the same letter are not different according to the Waller LSD at $k = 100$, which approximates the 0.05 probability level.

^aLP = lint percentage; Mic = micronaire; UHML = upper half mean length, UI = uniformity of fiber lengths; FBS = fiber bundle strength; Elong = elongation of fibers before rupture.

TABLE 3 Agronomic and fiber performance of TAM 18J-13 LSU-ESU, TAM JG-255 ESU and TAM AU-095 ELSU compared with Tamcot H12 when grown at Lubbock, TX in 2024, irrigated culture

Genotype	Lint yield kg ha ⁻¹	LP ^a %	Mic unit	UHML mm	UI index	FBS kN m kg ⁻¹	Elong %
Tamcot H12	1885 a	41.0 a	4.7 a	29.4 c	84.3 b	290 c	6.5 a
TAM 18J-13 LSU-ESU	1704 ab	35.3 b	4.4 ab	33.5 ab	86.9 a	349 b	5.7 b
TAM JG-255ESU	1581 b	35.5 b	4.1 b	32.8 b	86.7 a	360 a	5.8 b
TAM AU-095 ELSU	1309 c	31.5 c	4.0 b	34.6 a	86.5 a	347 b	5.7 b
Test mean	1133	36.5	4.2	31.2	84.5	332	5.9
CV	13.8	2.9	3.7	2.2	1.0	2.5	3.6

Note: Values within columns followed by the same letter are not different according to the Waller LSD at $k = 100$, which approximates the 0.05 probability level.

^aLP = lint %; Mic = microware; UHML = upper half mean length, UI = uniformity of fiber lengths; FBS = fiber bundle strength; Elong = elongation of fibers before rupture.

TABLE 4 Agronomic and fiber performance of TAM JG-255 ESU and TAM 18L-37 averaged over seven locations in the 2024 Regional Breeder's Testing Network

Genotype	Lint yield kg ha ⁻¹	Mic ^b units	UHML mm	UI index	FBS kN m kg ⁻¹	Elong %	SFCw %
TAM JG-255 ESU	902 b	4.4 a	32.5 b	86 a	361.1 a	6.2 b	4.0 c
TAM18L-37 ELSU-ESU	897 b	4.2 a	33.0 a	86 a	363.8 a	6.5 a	4.7 b
Test mean ^a	1204 a	4.7 a	31.0 c	85 b	328.5 b	6.5 a	6.1 a
CV	14.5	5.1	2.8	1.2	4.3	6.4	12.9

Note: Values within columns followed by the same letter are not different according to the Waller LSD at $k = 100$, which approximates the 0.05 probability level.

^aTest mean is average of 24 total entries.

^bMic = microware; UHML = upper half mean length, UI = uniformity of fiber lengths; FBS = fiber bundle strength; Elong = elongation of fibers before rupture; SFCw = short fiber content by weight.

tertic Paleustolls, and cultural practices were consistent with the locale with full irrigation. Both strains yielded lower ($p = 0.05$) than Tamcot H12 and both exhibited lower LP (Table 3). Both germplasm lines exhibited better UHML and FBS with TAM JG-255 ESU averaging 360 kN m kg⁻¹, 24% higher than Tamcot H12. TAM AU-095 ELSU averaged 34.6 mm UHML, which was 18% longer than Tamcot H12. Other HVI traits of both germplasm lines were within accept-

able levels with lower mic that was within the premium range, better UI, and lower Elong.

TAM JG-255 ESU was grown in the 2024 Cotton Incorporated Regional Breeder's Testing Network (RBTN) at seven locations from South Carolina to Texas (preliminary data; final data will be available at <https://rbtn.cottoninc.com/>, accessed 4.17.25). This germplasm line averaged 902 kg ha⁻¹, which was 75% of the test average (Table 4). The LP was not

reported in the preliminary report but UHML and FBS were greater ($p = 0.05$) than the test average at 32.5 mm and 361 kN m kg⁻¹, respectively. Other HVI standard traits were similar to their test mean. This national nursery also reported HVI derived short fiber content by weight, SFCw, which indicated that TAM JG-255 ESU had fewer fibers that were <12.7 mm in length. This SFCw value supports the general observation across all data reported herein about the improved UI of this germplasm line. Reduced SFCw is a desirable characteristic since it represents less wastage in the yarn making process.

TAM JG-255 ESU and TAM AU-095 ELSU were grown as progeny rows, 12.2 m × 1 m, in 2019. The entire row was hand harvested, ginned on a 10-saw laboratory gin, HVI data obtained, and fibers spun as 30 Ne carded yarns on an MVS frame at the FBRI. In 2020 and 2021, a large block, 4 rows × 100 m × 1 m, of each were grown to produce at least 20 kg of lint that was evaluated as described for 2019. The lint produced in 2020 and 2021 were passed through a single lint cleaner in the ginning process. The standard HVI fiber properties (Table 5) were similar to those reported above in Table 3. SFCw again revealed that TAM JG-255 ESU had fewer ($p = 0.05$) short fibers by weight than the controls and also averaged finer fibers, Hs, after standardizing to fiber maturity, than the standard or high yielding control, Tamcot 73. The strength or tenacity (Ten) of the Murata Vortex System (MVS) yarn produced from the high FBS TAM JG-255 ESU averaged 15.2 mN tex⁻¹ while TAM AU-095 ELSU, which expresses significantly longer UHML fibers, average only 12.8 mN tex⁻¹ and not different than the two controls. The energy required to break the yarns reported in Table 5 support the Ten data. Significantly more energy, defined as work to break (WTB) and reported in cN, was required to break TAM JG-255 ESU than the comparison genotypes. While TAM AU-095 ELSU was longer ($p = 0.05$) at 34.5 mm than either of the controls, it was equal in FBS and similar to one or both controls in Ten and WTB. These results agree with other, unpublished, data from our program that indicate that improved FBS in future cultivars will be vital to producing acceptable cotton yarns on the new MVS system to produce acceptable and improved vortex spun carded cotton yarns.

Appearance of yarn is measured in the number of thin and thick places per km of yarn that are less than or greater than 50% of the average yarn diameter and the number of fiber entanglements, i.e., neps, per km of yarn that are 200% or larger than the average diameter of the yarn. The sum of those is referred to as an imperfection index or IPI. The IPI of MVS yarn from TAM JG-255 ESU was lower ($p = 0.05$) than the extra long staple TAM AU-095 ELSU line and not different than the two controls (Table 5). Lower values are desirable and again support the superiority of the type of quality found in TAM JG-255 ESU. The other measurement of appearance of yarns produced on MVS is hairiness, which is a measure of ends of fibers that protrude from the yarn as a result of not get-

TABLE 5 High volume instrument (HVI) fiber statistics and 30 ct Murata Vortex spun carded cotton yarn statistics when grown in College Station, TX, 2019 – 2021

Genotype	Mic ^a units	UHML mm	UI index	FBS kN m kg ⁻¹	Elong %	SFCw %	Hs mtex	Ten mN tex ⁻¹	WTB cN	Hair ct cm	IPI ct
TAM JG-255 ESU	4.0 a	31.0 c	84.8 a	338 a	5.6 b	6.7 b	166 c	15.2 a	373 a	4.8 a	569 b
TAM AU-095 ELSU	3.7 a	34.5 a	83.2 b	323 b	5.6 b	8.6 a	172 b	12.8 b	290 c	5.1 a	1717 a
TAM BB-2139 ELSU	4.0 a	32.5 b	82.3 b	314 b	5.4 c	8.5 a	165 c	12.8 b	281 c	5.1 a	1097 ab
Tamcot 73	4.2 a	29.0 d	82.7 b	299 b	6.0 a	8.8 a	184 a	12.1 b	313 b	4.9 a	733 ab
Test Mean	3.9	1.2	83.2	33.2	5.6	8.1	171	13.2	314	5.0	1034
CV	4.9	1.5	0.9	3.8	1.6	8.0	1.2	2.6	1.9	2.7	49.8

Note: Values within columns followed by the same letter are not different according to the Waller LSD at $k = 100$, which approximates the 0.05 probability level.

^aMic = microware; UHML = upper half mean length; UI = uniformity of fiber lengths; FBS = fiber bundle strength; Elong = elongation of fibers before rupture; SFCw = short fiber content by weight; Hs = standard fineness; Ten = yarn tenacity; WTB = force required to break a bundle of fibers; Hair = hairiness or protruding fibers from yarn; IPI = imperfection index.

TABLE 6 Agronomic performance and fiber properties of TAM 18J-13 ELSU-ESU and TAM 18L-37 ELSU-ESU compared with Tamcot 73, ALLTEX 7A21, and TAM BB 2139 ELSU when grown in College Station, TX in 2021 and 2022

Genotype	Lint yield kg ha ⁻¹	LP ^a %	Mic units	UHML mm	UI index	FBS kN m kg ⁻¹	Elong %
TAM 18J-13 ELSU-ESU	1172 a	33.3 bc	4.0 c	35.8 a	87.4 a	377 a	5.9 a
TAM 18L-37 ELSU-ESU	1182 a	32.4 c	3.9 c	34.5 a	86.8 a	375 a	5.9 a
ALLTEX7A21	1088 a	38.7 a	4.8 ab	30.2 b	84.8 b	317 b	5.9 a
TAMBB2139	1032 a	34.8 bc	4.2 ab	34.3 a	84.7 b	324 b	5.4 b
Tamcot 73	1095 a	36.6 ab	4.9 a	30.5 b	84.3 b	333 b	6.0 a
Test mean	1113.0	35.1	4.4	33.0	85.6	355	5.8
CV	8.6	3.7	4.8	1.7	0.4	2.2	2.0

Note: Values within columns followed by the same letter are not different according to the Waller LSD at $k = 100$, which approximates the 0.05 probability level.

^aLP = lint %; Mic = micronaire; UHML = upper half mean length, UI = uniformity of fiber lengths; FBS = fiber bundle strength; Elong = elongation of fibers before rupture.

ting twisted into the yarn. There were no differences among these experimentals and the two controls for this appearance trait.

2.2 | Characteristics of TAM 18J-13 ELSU-ESU and TAM 18L-37 ELSU-ESU

TAM 18J-13 ELSU-ESU and TAM 18L-37 ELSU-ESU were grown at College Station, TX with cultural practices as described above. Controls were two high yielding cultivars, Tamcot 73 (Smith et al., 2011a) and ALLTEX 7A21, plus a high quality germplasm line, TAM BB-2139 ELSU (Smith et al., 2018b). Both TAM 18J-13 ELSU-ESU and TAM 18L-37 ELSU-ESU yielded equivalent ($p = 0.05$) to the three controls despite having lower LP than the two commercial controls (Table 6). As with TAM JG-255 ESU and TAM AU095 ELSU, these lines exhibited lower mic, better fiber UI, and similar Elong before rupture compared with the controls in this trial. Both lines averaged longer UHML at 35.8 and 34.5 mm compared with the two commercial cultivars, ALLTEX7A21 and Tamcot 73, and were numerically well above the U.S. average upland UHML in 2024 of 28.8 mm and approaching the 36.6 average UHML for U.S. pima in 2024 (<https://www.ams.usda.gov/mnreports/cnmncq.pdf>, accessed 4.17.25).

TAM 18L-37 ELSU-ESU also was evaluated in the 2024 RBTN at seven locations across the U.S. Cotton Belt (Table 4). Compared with the test average of 24 total entries, TAM 18L-37 ELSU-ESU possessed longer and stronger fibers, along with similar Mic, Elong, and slightly better UI. The SFCw of TAM 18L-37 ELSU-ESU was lower ($p = 0.05$) than the test mean and lightly higher than TAM JG-255 ESU. At 363.8 kN m kg⁻¹ FBS, TAM 18L-37 ELSU-ESU was 16 % stronger than the weakest entry and 11% stronger than the average of all entries.

3 | SUMMARY

All four of the proposed germplasm lines exceeded the controls in UHML and FBS, two major HVI properties that contribute significantly to yarn quality and appearance. The UHML of the four new germplasm lines are meaningfully longer, 31.0 to 36.6 mm across the trials reported herein, than the average UHML for upland cultivars grown in the U.S. in 2024, 28.8 mm, and compare well at their maximum values with the U.S. 2024 average for pima at 36.6 mm. The FBS of TAM JG-255 ESU averaged 22% stronger than Tamcot 73, TAM AU-095 ELSU averaged 9% high FBS, while TAM 18J-13 ELSU-ESU and TAM18L-37 ELSU-ESU averaged 13% stronger FBS than Tamcot 73, across all trials reported herein. MVS yarn quality, as defined by yarn Ten and IPI, of TAM JG-255 ESU was superior to that produced with TAM BB-2939 ELSU, Tamcot 73, or TAM AU-095 ELSU, which has superior UHML but lower FBS. These germplasm lines should provide breeders with another source of improved upland cotton fiber length and/or fiber bundle strength for developing cultivars that will produce fibers suited to spinning 100% cotton yarn on the newer Vortex spinning technology.

4 | AVAILABILITY

Inquiries regarding availability of seeds for research purposes should be directed to the corresponding author. Inquiries regarding commercial use should be directed to the Office of Technology and Commercialization, 3369 TAMU, College Station, TX 77845 (979-847-8628). Texas A&M AgriLife Research (Texas A&M University, college Station) warrants that these germplasm lines were developed using traditional, that is non-transgenic, breeding methods. Texas A&M AgriLife Research warrants that no crosses were made intentionally with materials containing transgenes for herbicide tolerance,

insect resistance, or any other known transgene. TAM JG-255 ESU, TAM AU-095 ELSU, TAM 18J-13 ELSU-ESU, and TAM 18L-37 ELSU-ESU are experimental in nature. Seeds and all plant parts are not proposed for human consumption, and seeds are provided for additional research on an as-is basis, without additional warranties or representation of any sort, expressed or implied. Seeds of TAM JG-255 ESU, TAM AU-095 ELSU, TAM 18J-13 ELSU-ESU, and TAM 18L-37 ELSU-ESU have been deposited in the USDA-ARS National Center for Genetic Resources Preservation at Ft. Collins, CO and will be available for distribution five years after publication.

AUTHOR CONTRIBUTIONS

C. Wayne Smith: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; writing—original draft. **Marshall tolleson:** Data curation; investigation; writing—review and editing. **Don Jones:** Funding acquisition; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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