REPORT OF COTTON INCORPORATED TO THE SECRETARY'S OFFICE

Year-End 2020

Cotton Incorporated

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OVERVIEW OF CONTENTS

Each year Cotton Incorporated prepares a formal Strategic Plan that covers the key principles that guide the Company's long-range activities. The major priority areas over the next five years for programs at Cotton Incorporated are:

- **Growing cotton demand to 135 million bales by 2028**
  - Cotton product innovation and implementation
  - Cotton sustainability
  - Global presence for cotton

- **Growing U.S. cotton demand and production to 20 million bales by 2028**
  - U.S. cotton sustainability
  - Farm profitability – cost of production
  - Fiber quality / contamination
  - Cottonseed value
  - Cotton Management System: EFS® implementation
  - CCI contribution

In order to fulfill these priorities, specific strategic objectives are outlined for each of Cotton Incorporated's four Operating Committees and related subdivisions:

- **Agricultural Research Committee**
  - Agricultural and Environmental Research
  - Sustainability

- **Research and Development Committee**
  - Fiber Competition: *Fiber Quality Research*
  - Fiber Competition: *Cotton Management System (EFS®)*
  - Product Development and Implementation (PDI)

- **Global Supply Chain Marketing Committee**
  - Global Supply Chain Marketing
  - Importer Support Program

- **Consumer Marketing Committee**
  - Advertising, Corporate Communications, and Brand Partnerships
  - Corporate Strategy and Program Metrics (CSPM)

Operating Committees determine tactics and activities to meet the strategic objectives identified for their program area or divisions within their program area and provide deliverables of their activity to the Board.

This bi-annual report includes the following sections:

1. ***Executive Summary***: Overview of year-to-date progress report toward achieving Cotton Incorporated's mission and strategic objectives, organized by program committee and its related divisions.
2. ***Report of Activities by Program Committee and Strategic Objectives***: Detail of year-to-date progress report toward achieving Cotton Incorporated's mission and strategic objectives, organized by Program Committee and its related divisions.
3. ***Explanation of Terms and Activities***: Summary descriptions of ongoing projects and key terminology used to explain activities within each Program Committee and its divisions are included as a reference guide.

EXECUTIVE SUMMARY

This Executive Summary section provides an overview of the report from each of Cotton Incorporated's four operating committees and related divisions.

Agricultural Research Committee

Agricultural & Environmental Research (AERD)

Agricultural Research at Cotton Incorporated is directed by experienced research leaders and conducted by student workers alongside experienced university and USDA-ARS scientists. This model has adapted to COVID-19 by utilizing more video conferencing instead of site visits and by asking cooperating scientists to prioritize activities that accomplish the overall mission of improving cotton production profitability while meeting the safety guidelines imposed by their institutions and local governments. Cooperators funded by Agricultural Research were able to plant their field trials as this is conducted individually and further have spent more time on data analysis, grant writing, summarization, and coordination across teams. This last activity, coordination across teams on video calls, will pay significant dividends in the future, considering that traditionally researchers compete for grants to be leaders in delivering high impact science. With travel restrictions, the pandemic has allowed more time and encouraged scientists to better communicate and coordinate with each other.

Despite the challenges facing Cotton Incorporated staff and their cooperators, the challenges facing cotton producers have been even more intense. Low commodity prices, adverse weather (drought, extreme heat, flooding), and resistant weeds make cotton farming challenging. The realization that a year's investment of capital and long hours will only result in a financial loss would be impossible for most people to accept; but for cotton, corn, and soybean producers, this is the situation they face. Long-term grower investment in research is one strategy employed to maintain a resilient business model for these challenging times. In 2020 the benefits of this investment were seen, including: continued increases in cotton's yield and water productivity; gains in soil health from cover crops and reduced tillage; new tools to combat herbicide resistant weeds; novel strategies to preserve insect resistant cotton varieties; and new applications of data to improve the harvest and ginning process.

Sustainability Division

The Sustainability Division's main objective is to continue to create an improved sustainability reputation for the cotton industry. This is accomplished by focusing efforts in five major focus areas: 1) sustainability goals and U.S. Cotton Trust Protocol; 2) microplastics and cotton biodegradation; 3) sustainability assessments; 4) sustainability non-governmental organization (NGO) engagement and leadership; and 5) cotton sustainability communications. Delivering on objectives within these five major project categories helps to lay the foundation to create a strong, trustworthy, and competitive sustainability brand for cotton across the entire supply chain.

In 2020, the Sustainability Division supported our industry-wide sustainability goals, the U.S. Cotton Trust Protocol, and the Cotton LEADS℠ program with both grower engagement, participation in Field to Market®, metrics research, and technologies to reduce the environmental footprint of cotton production. Sustainability continued to focus on enrollment in the U.S. Cotton Trust Protocol and expand use of Field to Market's® Fieldprint Calculator by cooperators this year. Field to Market® is the flagship sustainability organization, and the division staff continue to serve on the Metrics Development Committee. Significant effort was invested in grower enrollment in the U.S. Cotton Trust Protocol (USCTP), with three associated projects with enrollment focus. A key component of enrolling in the USCTP is to complete a sustainability best management practice questionnaire and a Field to Market® Fieldprint Calculator. Participating producers will help the industry meet the ten-year sustainability goals and contribute to continuous improvement on their cotton operations. Sustainability continued to participate in organizations that support Field to Market®, such as the American Society of Agricultural and Biological Engineers and the Crop Science Society of America.

Research on microplastics and microfibers continued across both the Sustainability and Product Development and Implementation divisions. Several aquatic life microfiber feeding studies were initiated and this research, while exploratory, was designed to determine how microfibers impact aquatic health outcomes. Engagement with non-governmental organizations (NGOs) and other microfiber research cooperators continued, with an emphasis on implementing our current research results and developing further research to showcase the substantial impacts of synthetic microfibers. This work will ultimately lead to

future incorporation of microfiber emissions and impacts into life cycle assessments and industry tools, such as the Sustainable Apparel Coalition's Higg Index.

Sustainability efforts continued to expand across the entire cotton supply chain. Working with the Agriculture and Environmental Research and Product Development and Implementation Divisions, Sustainability implemented strategies and directives to increase sustainable cotton production. Additionally, collaboration continued with the Consumer Marketing and Global Supply Chain Marketing Divisions to communicate effective sustainability messages. Overall the aim to increase the visibility of Cotton Incorporated as a leader in sustainability and build relationships with NGOs and influential brands, retailers, and researchers in 2020 was successful.

Research and Development Committee

Fiber Competition

The challenges of 2020 are somewhat reflected in this year-end report. With many research efforts both internally and externally impacted by stay-at-home (SAH), some of the updates presented at year-end are not significantly different than the summaries provided mid-year. However, other efforts were minimally impacted, and in some areas, additional work was completed because SAH allowed the opportunity to do things differently.

Quality Research had 15 outside research projects for 2020, consisting of the renewal of seven projects and eight new projects. The top priority for 2020 was dealing with contamination issues. The other key priority was the Fiber of the Future effort, which involves improving fiber length uniformity and fineness. Several projects made good progress owing to work being conducive to SAH work. A few projects are somewhat delayed but will continue into 2021. Only one project was canceled due to SAH challenges, but those funds were redirected into a related effort to create a new project.

Product Evaluation Laboratory (PEL) activities focused on regular day-to-day testing but were impacted by installing the new chiller system at the start of the year, SAH mid-year, and then limited staffing through the end of the year. The lab had one retirement mid-year, and efforts are underway to replace that fabric technician. The impact of these events is reflected in the lower testing levels for the year. Routine testing on two high volume instruments (HVI®) inter-lab evaluations involved a lower number of round-robin tests than previous years, monthly check cotton sets, and elongation calibration trials on each instrument. A total of nine proficiency tests for fabric were run throughout the year, but the yarn proficiency was missed due to SAH. Once staff returned to the lab after SAH, all testing services were very active for all research and implementation areas for both Agricultural and Environmental Research and Product Development and Implementation divisions.

The Cotton Management System (CMS) Product Development team continued to support MILLNet™ software products, focusing on updates and enhancements for the latest version. The latest version of the MILLNet™ software is being used for all new licensee installations. The Product Development team provided an additional range of programming services while the textile industry was on pause. These efforts included completing the updates to use the Android® version of handhelds, a low priority wish list for features and options from the textile industry, and a significant fine-tuning of the programs to improve consistency in look and efficiency in use.

The CMS Technical Service and Marketing teams assisted customers 2,913 times by phone, email, text, video, TeamViewer, and face-to-face. Yearly service visits were completed for licensees located in Mexico, Nicaragua, and the U.S. before travel restrictions were set. Marketing visits were made to prospective clients in Mexico and Peru and with a group based in El Salvador to consider implementing the system at their Honduras facility. Both the Technical Service and Marketing teams continued remote communications, technical support, and marketing messaging during SAH. The team continued to provide support from home through the end of the year to reduce the building's staff number on-site. Four new MILLNet™ software licenses were signed. One installation was completed in the first half of 2020 before SAH, and the second installation and training were completed through partial on-site and partial remote efforts. A third installation and training represented the first-ever completely remote attempt and was started at year-end. The fourth group asked to delay until next year. One software conversion was completed before travel restrictions were put into place, which leaves one group remaining on the older version of the software; however, this is a group with declining U.S. cotton levels that is likely to cease using the software system soon.

In 2020, the pandemic brought many challenges including travel limitations, working from home, 50% staffing, outside research lab closures, as well as operation interruptions caused by failures in the air and water systems, etc. However, these issues were overcome and PDI continued to have a very productive year by adopting new practices and safety protocols. The PDI division undertook key topics within sustainability such as biodegradation, recycling, natural fleece, and the Higg Index. Contamination support continued, including the creation of round module wrap standards, trials with Visual Imaging Plastic Removal (VIPR®) system cameras, and the in-house purchase of a new contamination detection system. The division made significant progress on technology releases on both fabric and performance finishing, including TOUGH COTTON™ technology for yarn, non-fluorine WICKING WINDOWS™+PCM technology, WICKING WINDOWS™+PCM+Sweat Hiding™ technology, WICKING WINDOWS™+TOUGH COTTON™ technology, TransDRY® + PUREPRESS™ technology, and two FABRICAST™ collections. Through implementation efforts, Polo Ralph Lauren became the first major brand to adopt Cotton Incorporated PUREPRESS™ technology for dress shirt products. Implementation momentum continued with Lands' End®, Kohl's®, and Duluth Trading Company® adopting TOUGH COTTON™ without resin technology.

The Fiber Processing lab (FPL) installed a new opening/cleaning line which included a coarse cleaner, fine cleaner, and contamination detection system to offer additional research capabilities. The Fiber Processing (FP) team was present at the VIPR® trials in Georgia to experience this technology first-hand. All the bales processed in this trial were purchased to run through the new contamination detection system in house. An area of focus for FP has been recycled cotton. The FP team took a novel approach to this topic and created slubs of recycled denim in virgin yarn. This unique novelty yarn was developed for the knit market and work will continue into 2021. Nonwovens typically utilize short fiber and, therefore, could be a good match for recycled cotton fiber. The FPL ran outside trials using recycled t-shirt and denim material to create hydroentangled wipes and batting. Nonwovens is an important market to focus on as the European Commission is poised to ban plastic material in some single use applications, creating an opportunity for cotton fiber. In preparation, FP supported Cotton Incorporated's Nonwovens Marketing division in creating samples and providing manufacturers with a road map to replace synthetic fibers with cotton in wipes and hygiene materials.

Two FABRICAST™ collections were developed by Product Development (PD) with a total of 76 fabrics. The collections included performance cottons through construction, blends, and finishes for shirting fabrics, outdoor activewear, athleisure wear, bottom weight fabrics, and denim. With sustainability as a focus, no-waste knit shoe uppers were part of the collection. Trends that inspired collection developments were athleisure and home attire. Crepes, waffles, and jacquards brought depth and interest to athleisure and included sweatsuit inspired styles. Comfort categories experienced posh trends using more textured fabrics in this space. Denim developments included Dry Indigo®, TransDRY® technology integrated into selvedge denim, and a new twist on patchwork, embroidery, and texture. Synthetic fleece alternatives continued to be a development focus with more brands showing interest in these fabrics which helps cotton gain traction in outdoor markets. Innovative developments included performance through construction to enhance breathability in some fabrics and warmth in others. A successful warp knit trial was run in Germany before the pandemic and demonstrated the versatility of cotton. Work continues in the development of smart textiles or e-textiles. This year over 200 Cotton Incorporated fabric developments were converted to digital 3D computer files for use in well-known 3D apparel software applications. These 3D ready computer fabric files of the FABRICAST™ collection were made available on the CottonWorks™ Website for brands and retailers use. The PD lab (PDL) purchased and installed a new flatbed knitting machine with yarn inlay and a semi-automatic drawing in machine.

The Textile Chemistry Research (TCR) team continued to focus on sustainability in 2020. The microfiber biodegradation project continued, this year research examined the impact of dyes and finishes on cotton's ability to degrade in aquatic environments. Aerobic and anaerobic environments were studied to answer the question of degradation in low oxygen environments. In addition, a simulated landfill study began, comparing several cotton samples to a polyester fabric. In this case CO_2 and CH_4 (carbon dioxide and methane) were the byproducts. There were two cotton-to-sugar projects underway in 2020. These projects transform waste cotton into chemical intermediaries. One is a chemical approach, and the other is mechanical. Utility patents are planned and will be filed to protect both technologies. A new development in Cotton Incorporated technology was TOUGH COTTON™ technology for yarn. This exhaustible process will provide more flexibility with the same level of performance.

Despite the pandemic, Technology Services and Implementation (TSI) continued to assist mills, brands, and retailers with technical and implementation services. PUREPRESS™ technology received its first adoption with several mills under agreement to supply the technology. Two mills have had samples tested and one mill is developing a bottom weight product with

PUREPRESS™ technology. Brand interest remains very high for TOUGH COTTON™ technology which accounted for 51% of all test submissions, qualifying a mills' use and licensing. Ranking this one of the top adopted technologies in 2020. The STORM COTTON™ finish also remains a very popular technology with four North American brands continuing to produce treated fabric throughout the pandemic. Roughly 30% of all test submissions qualifying technologies has been for the STORM COTTON™ finish. The WICKING WINDOWS™ finish continued to receive interest in the U.S. market. Additionally, South America, Mexico, and Asia have growing interest in this technology for their domestic markets.

Product Integrity (PI) has long been involved in the textile committee of the International Organization for Standardization (ISO). In the textile committee, revisions were made to two standards that are important for laboratory testing of cotton and to the technical part of the standard symbols on care labels. This year PI also joined the new Circular Economy technical committee of the ISO. Across five working groups, the definitions, principles, business models, and metrics for measurement of Circular Economy began to be developed. After much criticism, the Sustainable Apparel Coalition (SAC) announced the next update of the Higg Index will include the elimination of the single score currently used. This is excellent news for cotton, whose score was previously 10X that of polyester. This makes the field a bit more even now.

Global Supply Chain Marketing Committee

Global Supply Chain Marketing (GSCM)

The Global Supply Chain Marketing division is responsible for all aspects of communication and marketing to the companies and organizations in the supply chain—those responsible for manufacturing, sourcing, and marketing fiber products such as apparel, home textiles, and nonwovens products.

An important tactic for maintaining a global presence for cotton is through direct account interaction with mills, manufacturers, brands, and retailers for the apparel, nonwovens, and home products markets. GSCM staff focus their efforts on influencing major brands and retailers through coordination of various Company resources, with the goal of influencing the use of cotton versus other fibers. During 2020, GSCM staff conducted more than 575 meetings with companies in both the manufacturing supply chain and with brands and retailers.

Forty-five technical education workshops were held in 2020 with over 1,530 attendees from over 150 major brands and retailers. All workshops in the last six months of the year were held virtually due to business closures and travel restrictions related to COVID-19. Two new active workshops were held as well as four new topic workshops: digital printing, seamless knitting, intimate apparel, and introduction to cotton. The purpose of these workshops was to provide detailed technical information and training on relevant topics important for cotton.

The CottonWorks™ Website is a marketing tool and educational resource (www.cottonworks.com). It is the leading innovative education and information resource for current and emerging textile industry professionals who are actively seeking connections to cotton. New content, both educational and marketing, continues to be added on a regular basis. In 2020, cotton fabrics from Cotton Incorporated's FABRICAST™ library were digitized and added to the FABRICAST™ page. Additionally, a small number of existing fabrics were divided into four categories as additional search criterion: Trending Fabrics, Denim Basics & Beyond, Natural & Sustainable, and Comfortable & Cozy. Recently released FABRICAST™ collections and digital fabric capsule collections were promoted in a similar manner. Staff also implemented a new section to the Website, Tariff Engineering, as well as new content to support recent webinars including Cotton Sustainability Basics and additional content in Biodegradability of Cotton.

CottonWorks™ webinars offer a unique way to reach the industry and amplify the Company's message. In 2020, 16 webinars were held. These webinars concluded the sustainability series and incorporated topics such as economics, nonwovens, knit development, and consumer opinions. Two webinars were hosted specifically for the Asia market. Each webinar reaches between 200 and 400 individuals.

In its seventh year, the Cotton LEADS℠ program continues to educate and inform retailers, brands, and manufacturers worldwide about responsible U.S. cotton production. Cotton Incorporated participates in this program with the National Cotton Council of America, the Cotton Foundation, Cotton Australia, and Cotton Council International. The program reached 662

partners by the end of the year. Two *Partner Post* newsletters went out to partners in five languages in the second half of the year. A new trade campaign was also created in the latter part of 2020 for the 2021 year.

Eleven new Seal of Cotton trademark licensees were added in the U.S. in 2020. Eight new Seal of Cotton trademark licensees were added in Mexico during 2020 with 200,000 cumulative garments labeled. The largest Colombian hygiene brand extended its use of the **cotton enhanced**™ trademark to panty liners and pads, while adopting the **natural**™ trademark on tampons, reaching several countries in Latin America.

A well-known U.S. fabric supplier has marketed the TOUGH COTTON™ technology at their retail stores. A U.S. workwear brand has featured both TOUGH COTTON™ and STORM COTTON™ trademark logos on marketing materials at retail and online. A U.S. workwear brand has adopted the TransDRY® technology on their men's tee shirt program. A luxury Italian textile manufacturer has adopted the PUREPRESS™ technology for their men's dress shirt collection. A major U.S. retailer has expanded TOUGH COTTON™ technology program on girl's woven shorts and pants. A well-known U.S. retailer has implemented TOUGH COTTON™ technology in their school uniform program.

Consumer Marketing Committee.

Advertising

In 2020 Cotton Incorporated continued with the third year of the *Life Is Uncomfortable* campaign, in addition to creating specific creative work, *Comfort in Cotton* in response to COVID-19. These 360° campaigns reached consumers through TV, video streaming, and digital media, including social media and search engine marketing; driving qualified traffic to our consumer Website, TheFabricofOurLives.com.

In February 2020, the Advertising department launched the *Rosie Reborn* campaign, a digital-focused campaign celebrating denim in collaboration with The GREAT, brand designers who created a denim jumpsuit in the same look and feel of the original Rosie the Riveter jumpsuits. Campaign support included 30-second digital creative running across streaming platforms such as Hulu, Video Amp, and Tremor, and social media channels. A concerted public relations effort yielded pickup across *Women's Wear Daily, Rivet, Bustle, LA Times,* and *Forbes* among others as well as a dedicated segment on the *Today Show.*

In March 2020, *Your Cotton Your Way,* the anthemic work for 2020, was well into production for an April 2020 launch when the pandemic halted production. The Department quickly pivoted to speak to the current climate and produced a user-generated TV spot, *Comfort in Cotton* around the messaging of "Stay Home. Stay Safe. Stay Comfortable." TV Media launched in April across networks such as FOX, ABC, CW, Roku, Bravo, E!, HGTV, and Food Channel. Additionally, network spots were secured during key prime moments like *The Masked Singer, The Bachelor,* and *American Idol*. This year, the creative *Comfort in Cotton* was the first Cotton Incorporated spot in three years to run as a 30-second TV spot on Prime TV.

Comfort in Cotton was also supported across paid and organic social and additionally through YouTube pre-roll video. To further support the "Stay Comfortable" messaging during this time, *Ode to Sweatpants* (#sweatpantslife) was a light-hearted look at stay-at-home life during May 2020. This work ran as a social-first campaign across Facebook, Instagram, and Twitter.

May – November 2020 continued with the third year of our *Life Is Uncomfortable* campaign, targeting women and men 18 – 49. This 360° campaign reached consumers through TV, and digital media, including social media and search engine marketing.

In addition to these campaigns, the Department also ran a health and wellness-themed video campaign consisting of three videos: *Skin Irritation, Underwear*, and *Sheets*, as well as the continued Sustainability campaign. The Department continued to work with existing sustainability (*Know Your Clothes*) and health & wellness assets while developing a robust 2020 digital customized content plan with a variety of digital platforms.

The year concluded with creative development of the new campaign, *Your Cotton Your Way,* which will debut in the second quarter of 2021.

The Department continued its successful Youth Marketing effort with Young Minds Inspired (YMI), targeting grade-school and middle-school aged youth with cotton STEM-focused activations. Additionally, the Digital plan was extended into younger-focused sites like Buzzfeed and Spotify.

Regarding Trade advertising, the Department ran a total of 94 trade print ads across Q1-Q4 and focused on a variety of topics including: Seal of Cotton trademark adoption, denim, commodity analysis, sustainability, and textile innovation, in addition to specific ads geared toward nonwovens and the Cotton LEADS℠ program.

Corporate Communications

For the 2020 calendar year, the Corporate Communications department estimates there have been 3,929 news items about the Company and its activities, representing a potential audience of two billion, and an advertising value of more than $5.6 million (See appendix for media report summary).

Notable among the Corporate Communications Department accomplishments were activities in support of the sustainability of U.S. cotton, the Corporate Strategy & Insights (CSI) department and its consumer and retail trends data, and consumer-facing corporate initiatives such as the Blue Jeans Go Green™ denim recycling program, as well as the *Rosie Reborn* advertising campaign. Expanded synopses of these activities are in the respective section.

Brand Partnerships

The year began with the Brand Partnerships (BP) team planning exciting new retail programs and continuing collection and distribution activities for the Blue Jeans Go Green™ denim recycling program; however, by early March, the COVID-19 pandemic caused BP to react, revise, and adjust to the rapidly changing environment. While the retail industry was greatly affected by the global pandemic, the Brand Partnerships team quickly and strategically adjusted their programming, events, and retail experiences to adapt to the restructured retail landscape.

Despite the conditions that affected our industry largely since March, we were able to continue with most of our planned promotional activity and messaging for the fashion and retail programs as well as the Blue Jeans Go Green™ denim recycling program.

As our industry and consumers' lives in general were affected with nearly the entire country sheltering in place, we considered our messaging and activities carefully. The program continued to be well received and generated strong participation throughout 2020. Throughout the year we were able to receive denim for recycling. With increased time spent online, visitors to BlueJeansGoGreen.org increased and the Recycle Denim page continued to remain the most trafficked page across the site, which is great, since it's the most actionable and relevant to the program, and Cotton's mission. While onsite college promotion and collection wasn't able to come to fruition in 2020, and as much insulation could not be distributed as was hoped, staff continued to work with retailers to offer customers in-store recycling when available as well as increased mail-in options. Additionally, planned content and campaigns to educate and encourage participation around Earth Day and America Recycles Day and all the days in between continued.

Although there were many unprecedented challenges in 2020, through collective efforts to make a strong impression and impact for cotton sustainability with the Blue Jeans Go Green™ program: over 460,000 pieces of denim were collected in 2020 resulting in diverting over 230 tons of denim textile waste from landfills.

Fashion and retail programs moved full steam ahead once the team reworked plans to accommodate the state of the general environment. Messaging was thoughtful, sensitive, and feel-good. All promotions went virtual except for select market shop-in-shops at a national department store. Curated cotton collections reflected how consumers were shopping during the year and focused on loungewear, denim, and comfortable apparel. In addition to promoting men's and women's apparel, childrenswear, home goods, and holiday gifting items were introduced. The updated timing for programs inadvertently allowed for a holiday campaign, which came as a welcomed adjustment since The Fabric of Our Lives™ aligns perfectly with the most wonderful time of the year.

In 2020, CSI led efforts to identify opportunities and threats for cotton using market intelligence gathered through ongoing studies of U.S. consumer attitudes from the *Lifestyle Monitor*™ survey, assessments of cotton's share at retail through the *Retail Monitor*™ research, and comprehensive global market and economic research and analysis. CSI provided over 230 information requests; participated in 65 meetings and presentations; authored 240 publications, videos, TV/radio segments, and podcasts; and worked on 26 projects.

Work completed by CSI in 2020 includes, but is not limited to: the collection and examination of data on more than 10MM products offered at retail in the U.S. and China; the evaluation of over 20K U.S. and 35K global consumers; the update of a comprehensive database of monthly apparel and home furnishing imports to assess sourcing patterns and tariff impacts; the management and analysis of global quantitative research in China; the management of Cotton Incorporated's brand tracking metrics; and the delivery of consumer and economic outlook presentations. Descriptions of major projects in each area are provided.

AGRICULTURAL AND ENVIRONMENTAL RESEARCH

Strategic Objective 1: Increase the short-term profitability of U.S. cotton production.

Cottonseed

In an effort to further develop and expand the use of whole cottonseed in cattle feeds, two projects were initiated in 2020 to assess the benefits of feeding higher levels of cottonseed in feedlot finishing rations and lactating cow diets. Previous research has been very positive; and there is currently an opportunity to further the use of cottonseed during these times of uncertainty in the feed business, especially with the fluctuations in the supply of distiller byproducts coming from the ethanol industry. Unfortunately, the beef research was delayed until 2021 due to the lack of availability of suitable test animals. The dairy cow feeding study completed the animal feeding portion of the research and the data is being analyzed. Preliminary results indicated that feeding cottonseed at the maximum recommended feeding rate of 15% (about 7 pounds per day) significantly increased butterfat production.

Cottonseed oil research that is evaluating the health benefits of consuming a diet rich in cottonseed oil with both human subjects and mice got off to a good start this year but was suspended by the university during the first quarter. At year's end, university researchers are planning to return to campus and resume the clinical trial with "at risk" subjects during the first quarter of 2021.

For many years, one of the cottonseed processors was producing a high-protein cottonseed flour that has had strong demand and a high price as a feedstock in antibiotic production. Changes in the demand for this product have produced an excess capacity situation, so there is now a need to find additional uses and markets for this product. Preliminary aquaculture feeding studies with this product were completed and are very encouraging. It was shown that cottonseed protein flour can effectively replace some of the fish meal in Red Drum and Hybrid Striped Bass diets. Follow-up studies are underway, and a positive outcome will provide a marketing opportunity for high protein cottonseed flour.

The utilization of cotton gin byproducts for the creation of value-added products is also the focus of a small portion of the cottonseed research budget. Cotton burs have unique physical and chemical properties that allow burs to be used in a wide range of products. The reduction of oil well drilling has resulted in the loss of a substantial market for cotton bur products. Research is underway to evaluate these cotton bur products as a carrier for nutraceuticals in poultry feeds and as an ingredient in asphalt, which represent two potential novel uses for burs.

A couple of projects that seek to find a mechanical means to remove linters, rather than acid, made progress during the year with the Beta testing of a commercial-scale brush delinter at a commercial planting seed company.

The cottonseed processing research plant that was originally installed in New Mexico and subsequently moved and reinstalled near Lubbock was brought on-line during 2020. The pandemic delayed further testing and use of this equipment. Eventually it will be used to prepare small batches of cottonseed meal for animal feeding studies.

An ACALA variety of glandless cotton has become somewhat popular with organic cotton producers due to its superior lint quality. A seed increase of foundation seed for this variety was accomplished in 2020. Progress was also made in the ongoing effort to increase the yield of glandless varieties and further study the molecular biochemistry of gland formation and development.

Crop Improvement

Cotton Incorporated staff led an effort by 16 scientists and engineers to evaluate what factors led to the impressive increase in the water productivity of cotton product systems over the last 40 years. Those findings were recently published in the American Society of Agricultural and Biological Engineering *Journal of Applied Engineering.* This study has shown that over the last 40 years the amount of irrigation water used by cotton in the U.S. has decreased while yields have increased. Factors contributing to higher water productivity and decreased irrigation water use include: 1) migration of cotton out of the far western U.S. states to the east, where more water requirements are met by rainfall, 2) improved irrigation delivery systems, 3) improved irrigation scheduling tools, 4) improved genetics and knowledge of cotton physiology, and 4) improved crop models that help evaluate new irrigation strategies, both rapidly and inexpensively. This considerable progress, along with the promise of emerging

technologies, suggest that this trend will continue. The project also considered what strategies should be used to maintain the trend in increasing water productivity and those include continuing the increase in use of on-farm water storage systems in more humid regions, maintaining genetic gains in cotton yields, and increased adoption of irrigation scheduling tools by growers. Consistent with these recommended strategies, on-farm demonstrations of soil moisture sensors were conducted in Oklahoma, Texas, Mississippi, and Georgia. Additionally, the Smart Irrigation app developed at the University of Georgia was updated to allow use of weather data from the Oklahoma Mesonet. A project to collect on-farm runoff was continued in Arkansas where shallow ground water recharge is being studied. A similar water storage study was launched mid-year in North Carolina after delays due to the pandemic. Despite delays, the site is nearly instrumented and will be ready for data collection in early 2021.

In 2020 there was an increased emphasis on the application of machine vision (MV) tools to cotton production. The near-term applications of MV will be for pest identification, particularly herbicide resistant weeds. In order for MV to be dependable in agricultural applications with various soil backgrounds, different crop growth stages and varieties, and various light conditions, large image data sets are needed for training the system. Agricultural Research sponsored a review paper of current image databases to support machine vision applications in agriculture and have been working with the USDA-ARS in Lubbock to develop a simulated environment that will accelerate the ability to generate training data sets for cotton field applications. An image database of weeds that are of major threat to cotton was started this year and progress was also made on using machine vision tools to identify hardlock bolls in the field in Florida.

Harvest and Ginning

Autonomous cotton harvest system development has continued in 2020. Cotton harvest is in a unique position to benefit from small equipment frequently and continuously removing mature bolls during the season as that should limit risk of yield and quality loss due to rainfall and extreme weather events. Development of harvester prototypes continue at the University of Georgia and Clemson University. Data from hand-harvest cotton plots spread across Texas, Tennessee, and Georgia in 2018 and 2019 has been compiled and is being analyzed. Kansas State University (KSU) has also made tremendous progress on economic models to compare to our current harvest system and work on materials handling in the field is taking place at KSU as well. There are many design criteria that must be considered in developing automated systems for cotton harvest, including the number of passes to be made through the field per season, the mass of seed cotton to be transported, and number of machines needed to harvest a given area. The early part of this year was spent examining how these design criteria vary for a base scenario of a single row autonomous harvester traveling at 5 km per hour (3.1 mph), with an end-of-season yield of 1,500 kg fiber per hectare (1,340 pounds per acre) and an average field length of 0.5 km (0.3 miles) for a farm with 800 ha of cotton (1,976 acres). For this base scenario, if harvest was conducted in a single event, as is currently done with most mechanized systems, the system would need eight single row machines each harvesting 95 bolls per second and have a storage capacity of 2 cubic meters (70 cubic feet) in order to cross the field one time over a period of 28 days. Increasing the number of harvest events per year reduces both the bolls removed per second and storage capacity requirements but increases the number of machines needed. For example, increasing to five harvest events per season over 60 days for the otherwise same base scenario would increase the number of machines needed to 17, but reduce the boll harvest rate to 19 bolls per second and storage capacity to 0.4 cubic meter (14 cubic feet) per machine. Based on the rate of bolls that must be harvested per second in all of the scenarios considered, it is likely the first commercially viable system for cotton harvest will require a number of individual “arms” with one to two degrees of freedom. Additional design criteria will be dependent on the results from the economic models.

Cotton Incorporated has been working in collaboration with the National Cotton Ginners Association (NCGA) to develop a data collection standard for cotton gins. A great deal of data is automatically measured during the ginning process. Additionally, the ability to add automated data collection on parameters such as processing rate and energy use is possible with minimal costs and modification to the gin. There are also emerging needs to share data to support sustainability, trackability, and other certification programs. Therefore, to help ginners capture the maximum value from these data and allow for efficient data sharing, a possible voluntary data standard(s) for gin data is under consideration. Preliminary objectives and data associated with the standard have been developed based on discussions between all three USDA-ARS gin labs, NC State and Texas A&M universities, the NCGA, Cotton Incorporated, and commercial gin manager representatives. To date, at least ten gins have expressed interest in participating in a 2020 pilot project to share data from their operations to determine what value is gained from the combined dataset. Two examples of what is hoped to be learned in this process are 1) a better understanding in the relationship between leaf grade, weather conditions, and variety and 2) the impact of these variables on ginning rate. If successful, staff should be able to start creating “variety specific” ginning recommendations. Varieties change quickly, and

another goal will be to quantify why varieties perform differently so that a predictive model for cotton varieties can be released in the future.

In 2020, there were several hurricanes that impacted the Mid-South and Southeast near the time of harvest. Cotton Incorporated led efforts to produce a brochure to inform producers of best practices to prevent water damage to seed cotton stored in the field. The brochure was focused on the newest cotton harvesters that can provide a real time estimate of seed cotton moisture content. For traditional cotton modules, seed cotton moisture content above 12% wet basis will result in loss of color grades, and higher moisture contents can risk complete loss of the cotton due to overheating. Current studies of both picked and stripped cotton stored in round modules indicate this threshold still applies to the new round module harvest systems. There is also evidence that round modules are generally better at preventing moisture from entering seed cotton, and they will also retain moisture if the cotton is harvested too wet. A study was initiated in 2020 to determine if current recommendations need to be refined to account for increased density of the latest modules built; this study continues in 2021.

The challenging weather conditions at harvest also resulted in a historic number of seed coat fragments (SCFs) in Alabama, Florida, and Georgia bales this year. SCFs are particularly challenging to study as they are only a significant problem in limited geographies every three to five years. Cotton Incorporated has had a long-term research program to better understand and address SCFs since 2003. To date, we have found that there is a clear environmental component as illustrated by the wet weather at harvest this year. In some years it has also been determined there are some varieties more prone to SCF formation than others. SCFs can form throughout the harvest and ginning process, with the greatest number generated at the gin stand and the number of SCFs are increased if the gin stand is overloaded. Work at the USDA gin lab in New Mexico has identified grid bar designs that can improve SCF removal in the lint cleaner at gins. Current work continues to examine the generic component of SCF generation, including detailed chemical and physical measurements of the seed coat wall at Texas Tech, genetic markers for attachment force by the USDA-ARS in Stoneville, MS, and development of instrumentation for laboratory gin stands to measure ginning energy with hopes that it will become a tool breeders can use in screening new varieties.

Crop Improvement

Germplasm

Eleven joint germplasm releases were made in the *Journal of Plant Registrations* between three universities and Cotton Incorporated in the second half of 2020. These include eight with the University of Georgia (UGA), two with Texas A&M University, and one with the University of Arkansas.

Plant Pathology

FOV4 Field Screening Project

The FOV4 field screening trial near Clint, TX, was a huge success in 2020. In addition to a team of 11 scientists visiting the site in June to collect plant leaf tissue for genotyping and early season scoring of plant response to the lethal FOV4 pathogen, another dozen visited the site in November to dig thousands of plots, score for vascular staining, and collect plant material for PCR analysis. While the pandemic hampered efforts because the field site is close to the hard hit El Paso area, the work was still accomplished. Most importantly for growers, the FOV4 screening project identified highly FOV4 tolerant, traited, elite varieties that have already been extensively tested in yield trials. This is the first identification of field-tested elite cultivars that are highly tolerant to the devasting FOV4 pathogen.

Cotton Leaf Roll Dwarf Virus Projects (CLRDV)

A substantial breeding effort was directed towards this aphid vectored virus in 2020 because of the widespread detection across the Cotton Belt in 2019. A Beltwide epidemiology program to expand CLRDV testing and to understand the symptoms and crop impact of CLRDV confirmed the complexity of the 2019 observations. During the 2020 growing season, asymptomatic and symptomatic plants were tested for the presence of the virus in the leaf tissue at multiple times during the year. Symptoms vary as the season progresses, with many plants recovering later in the year, resulting in minimal yield impact in both research plots and commercial fields.

Target Spot

The National Plant Modeling Tool Initiative (NPMTI) was established in the second half of 2020 with multi-year funding from the USDA-ARS. This 12-state cooperative effort builds upon the previously developed Target Spot management guidelines to develop predictive tools based on regional spore counts and local weather. Due to the late funding of this project, NPMTI cooperators used 2020 to refine spore trap protocols, pathogen models, and field protocols in preparation for the 2021 season.

Ramularia (Aerolate Mildew)
Ramularia is a devastating fungal pathogen of cotton in South America that has grown in severity in the Southeast U.S. PCR detection tools were developed in 2020 that will allow widespread detection of this defoliating pathogen in cotton. Ramularia will be included in the NPMTI 2021 program.

Agronomy
Numerous research trials and outreach efforts were completed in the areas of soil nutrient management and soil health to improve soil stability, soil water holding capacity, nutrient cycling, and reduction of soil compaction and soil erosion. However, many new projects were initiated in 2020 and will need one to two more years before solid conclusions can be drawn. These efforts involve various soil health management aspects, including evaluation of reduced tillage systems, increased crop rotations, increased use of cover crops, evaluation of soil microbial composition, and other soil health parameters. Although these various forms of soil management have increased in adoption rate, there remains considerable opportunity for improvement in adoption, economic viability, and best management practices (BMPs) of these more complex cropping systems. Outreach efforts were supported in these areas to improve long-term adoption and will continue. A new area of research includes the evaluation of living cover systems, which create both challenges and opportunities with pest management and nutrient availability. However, these systems could have broad reaching sustainability benefits for suppressing weeds and reducing dependence on herbicides. In nutrient management, Beltwide Nitrogen Refinement studies were initiated at more than ten locations to improve nitrogen use efficiency, and the first year of data is being summarized. Similar soil testing and data collection protocol was implemented at all locations for these trials to strengthen the impact, and this project will continue in 2021.

In cooperation with the Extension Cotton Specialists (ECS), Cotton Incorporated supported the Beltwide Seed Quality project at a dozen locations across the Cotton Belt. Commercial planting seed was collected by ECS and the eight to16 seed lots were rigorously tested for germination (cool and warm) and other seed quality parameters with lab tests. The seeds were also evaluated for field establishment, early season growth, and yield. These data will provide in-depth information on the quality of seed being sold to cotton growers. Additionally, this extensive key seed quality testing will allow more knowledge on seed quality characteristics and improve the seed quality provided to the growers long-term. With the ECS, large-plot on-farm variety trials were continued in 2020, where commercially grown varieties are tested on growers' farms with the farmers managing and harvesting the cotton. These data are currently available from most ECS and are highly utilized by growers to make variety selection decisions.

Weed Management
Reliance on a few effective herbicides, including pre-plant, at planting, postemergence, and as residual tankmix partners, has put tremendous selection pressure on a few herbicides. As a result, the Delta region has reported metolachlor and dicamba resistant Palmer amaranth. With ALS, glyphosate, and PPO herbicide resistance previously documented, the heavy dependence on glufosinate creates tremendous selection pressure on this one product. Applied research is being conducted to evaluate BMPs for various weed species to slow the development and spread of herbicide resistant weeds. On-going research efforts include alternative practices to herbicides, weed seed bank management, and better understanding how herbicide resistance develops at a molecular and genetic level.

The herbicide era has had many benefits, including reduced tillage and very cost-effective weed control. However, with an exponential increase in herbicide resistant weeds over the past two decades and no new modes of herbicides developed, weed management options have dwindled and simultaneously increased selection pressure on existing herbicides. Evaluation of new application technology which integrates GPS, image analysis, and machine learning to implement "see-n-destroy" technology, robotics, autonomous swarm systems, precision placement of herbicides, and precision tillage will be the keys to reduce herbicide use and provide alternative management options for herbicide resistant weeds. Results from 2020 are currently being summarized, but preliminary indications are favorable for several of these projects. For many of these projects 2020 was the first year of research trials, and most will continue again in 2021.

Pest Management
Southeast: Insect pests can be major yield-limiting factors in the production of cotton in the U.S. In the southeastern U.S., major insect pests of cotton include thrips (primarily tobacco thrips, *Frankliniella fusca*), bollworm (*Helicoverpa zea*), and stink bugs (multiple species). Recently, however, plant bugs (primarily tarnished plant bug, *Lygus lineolaris*) have increased in importance, and cotton/melon aphid (*Aphis gossypii*) has been implicated in vectoring a new and potentially costly viral pathogen to the crop. Members of the Southeast Row Crop Entomology Working Group (SERCEWG) involved with entomological research and

Extension programming for cotton in the region continued to work collaboratively to address these issues with a 2020 regional study.

Mid-South: In 2020, entomology research efforts in the Mid-South focused on bollworms, thrips, and TPB management. Growers are currently able to control these pests but at a high cost. A regional study with locations in Arkansas, Louisiana, Mississippi, and Tennessee focused on mitigating insecticide resistance in thrips and reducing the number of sprays needed to control TPB and worms.

Cotton in the Mid-South is affected by a variety of insect pests that reduce yields and increase production costs. Tarnished plant bugs, thrips, and cotton bollworm are the three most important pests. The Mid-South regional project focused on research needed to provide growers with timely information on the most effective management practices to maximize returns on investment, and to predict, respond to, and if possible, delay the development of resistance.

Southwest. In Texas, preventive insecticidal seed treatments are used over 85% of cotton acreage. Annual investment into insecticidal seed treatments accounts for greater than $50 million in Texas cotton. For thrips, as an example, seed treatments provide control for up to two to three weeks after planting. However, growers in the Plains region may need to put at least one additional foliar insecticide application (e.g., acephate) targeting thrips post-emergence. The major challenges growers face are the lack of preventive insecticidal seed treatments with different modes of action and the lack of research-based information on efficacy and economic profitability of different insecticidal seed treatment packages available in the market. To address this in 2020, research focused on evaluating the efficacy of foliar insecticides against thrips and determining impact of spray tips on insecticide efficacy in cotton.

The level of host plant resistance that cotton cultivars have against plant bugs varies to unknown degrees. We found that some cultivars withstood pest pressure by compensating with new bolls, but there were maturity delays. The delay in maturity differed across the cultivars. In growing areas where earliness is desirable, the issue of plant bug-induced delay in boll maturity is very relevant to cotton production. Research in 2020 focused on evaluating cotton cultivar sensitivity to plant bugs.

With increasing incidence of resistance in *H. zea* to Bt technologies, cotton producers have been forced to rely heavily upon supplemental insecticide applications of pyrethroids and the diamide, chlorantraniliprole, targeting *H. zea* to prevent excess economic injury. In Texas, outside of the High Plains, *H. zea* susceptibility to pyrethroids has not been ascertained in over ten years and never for diamides. Efforts in 2020 focused on monitoring for resistance in *H. zea* field populations to diamides and pyrethroids.

Far West: Few arthropod IPM systems have advanced in their strategic use of insect control technology more than cotton in Arizona. Over nearly 30 years, insecticide use has declined in dramatic terms, and cost of insect pest control has stabilized. However, with increasing interest in the source and production processes of food and fiber supply chains, growers are both challenged and potentially rewarded financially through practices of sustainability (e.g., via the U.S. Cotton Trust Protocol, the Better Cotton Initiative, etc). Future incentives for demonstrating sustainability will require rigorous, credible verification of the safety and sustainability of these production systems. Research in 2020 was aimed at demonstrating and verifying that the gains made in arthropod IPM are in fact linked with significant reductions in risks and hazards to human health and the environment, and further reduce remaining risks to human health and the environment including non-target arthropods needed for conserving in-field biological control agents.

Strategic Objective 2: Increase the long-term profitability of U.S. cotton production.

Crop Improvement

Genomics and Genetics

Significant progress has been made toward an upland cotton pangenome to help bolster breeding and genetic improvement efforts. Reference grade genome assemblies and annotation of three elite varieties are complete. The pangenome will be

comprised of these three varieties plus two other private sector elite lines that are widely used parents in many public and private sector breeding programs.

A U.S. based team published results in *BMC Developmental Biology* showing that regeneration of embryogenic callus (EC) formation in the *Gossypium hirsutum* L. Chinese cultivar Jin668 is 96%, a twenty-fold improvement over what is seen in the widely used cultivar Coker312. This is the first demonstration in the U.S. and will drive gene editing progress in the future.

Plant Pathology

FOV4 Germplasm Advancement and Increase

During this reporting period the NIFA-Cotton Board funded FOV4 genetic study was advanced from the F4 to the F5 generation during July to November. In December, the F5 to F6 generation was planted in the Costa Rica Cotton Winter Nursery. Extremely wet weather from two category four hurricanes hindered the selfing and other field activities during late summer and fall.

Cotton Winter Nursery (CWN)

The sixth CWN crop was planted in October and November despite the myriad issues presented by the pandemic. Difficulty of movement was again caused by local government shutdowns. Excessive rain from the aforementioned hurricanes that directly hit Nicaragua saturated the farm near Liberia, Costa Rica, which is only 65km away.

Strategic Objective 3: Increase number of future scientists of U.S. cotton and improve the reputation of U.S. cotton production.

Cotton Incorporated Fellowship (CIF) Program:

Eight CIF candidates were supported during the second half of 2020 and two completed their course of study. Several CIF candidates were reviewed for support starting in 2021 during the past reporting period.

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SUSTAINABILITY DIVISION

Strategic Objective 1: Improved sustainability and reputation of U.S. cotton production.

Sustainability Goals and U.S. Cotton Trust Protocol

U.S. Cotton Trust Protocol

The U.S. Cotton Trust Protocol fully launched in July 2020. This year, the U.S. Cotton Trust Protocol team completed an updated grower enrollment interface featuring a streamlined cotton-centric version of Field to Market's® Fieldprint Calculator integrated directly within the enrollment portal. The Sustainability Division collaborated with the Agriculture and Environmental Research Division, key National Cotton Council staff, and U.S. Cotton Trust Protocol leadership to enhance the grower questionnaire experience. The team populated "more information" buttons associated with key questions where important sustainability and best management practice information is now displayed within the questionnaire. The team also successfully executed a marketing and communications campaign designed to build awareness of the program. Grower enrollment kits were created and distributed to gin managers and other supply chain partners responsible for enrolling producers prior to full launch. During the 2020 growing season, approximately 550 growers enrolled in the U.S. Cotton Trust Protocol, representing nearly 1.2 million acres of cotton.

Agrible West Texas and Georgia Sustainability Programs

The Agrible West Texas Sustainability Program continued in 2020 and expanded to cover Georgia as well. The project enrolled 25 cotton producers in the U.S. Cotton Trust Protocol with 25,000 measured acres in each region (Texas and Georgia). Measured acres were examined using the Fieldprint Calculator Platform to determine Field to Market's key performance indicators (KPIs): water quality, land use, soil conservation, soil carbon, irrigation water use, greenhouse gas emissions, energy use, and biodiversity. The results of these Fieldprint Calculator assessments were compiled into a comprehensive report that will be shared with participating growers to encourage measuring, sharing, and continuously improving their cotton productivity, resiliency, profitability, and sustainability.

University of Georgia and Peanut Council

The University of Georgia and Peanut Council collaborative research project continued in 2020 with the goal of exploring the environmental benefits of cotton and peanut rotations using the Fieldprint Calculator. The project enrolled 60 Georgia growers who rotate both cotton and peanuts into the Fieldprint Calculator platform. The results gathered during the 2020 growing season were compared to the 2019 baseline for Georgia cotton and peanut growers. The baseline Fieldprint Calculator results were also compared to subsequent years' data to determine relationships between production practices, economics, and sustainability. A new goal of the project in 2020 was to gauge interest in U.S. Cotton Trust Protocol enrollment and attempt to enroll producers in this program as well. During 2020, approximately five producers showed interest, with one confirmed enrollment.

Pheasants and Quail Forever Precision Partnership for Working Lands

In 2020, Cotton Incorporated continued the partnership with the American Society of Agronomy (ASA) and Pheasants/Quail Forever to execute the objectives of the National Fish and Wildlife Foundation (NFWF) precision conservation grant that was awarded last year. The precision agriculture and conservation specialist overseeing the project assisted landowners with farm operation return on investment (ROI) analyses using precision agriculture data and tools to promote conservation opportunities on grower's cotton production acres in Georgia. The ROI analyses were shared with growers to determine if it was more cost effective to continue planting in unproductive regions of their fields, or if other options existed that were better suited to increase their profitability. In 2020, 33 growers were engaged, representing approximately 78,000 acres of cotton. Many of these producers are already enrolled in the Conservation Stewardship Program with the NRCS, and plan to renew their conservation efforts once those agreements expire. Eleven producers are either enrolled in the program or plan to enroll in the near future. By converting unproductive lands to conservation areas, the project has been successful towards helping the U.S. cotton industry meet its sustainability goals, increase grower profitability, and promote wildlife and pollinator biodiversity in and around planted cotton acreage.

Microplastics and Cotton Biodegradation

OceanWise Microfiber Partnership

The Sustainability Division and the Product Development and Implementation Division jointly joined the OceanWise Microfiber Partnership. The partnership is a group consisting of business and government agency partners who sponsor microfiber

research in support of science-based solutions to reduce microfiber pollution in the ocean. The project started in May and investigated three core areas: 1) microfiber shedding from fabrics and the role of textile construction, 2) time-dependent variation in microfiber pollution in wastewater treatment plants, and 3) development of an ocean particle library using a novel database of infrared spectra of natural particles and microplastics obtained by FTIR technology from coastal and open-ocean environments. The goal of this research is to increase the understanding of fiber shedding mechanisms to help inform industry and consumer best practices, textile design, and wastewater treatment to mitigate microfiber flow to our oceans.

University of North Carolina Wilmington (UNCW) Fish Feeding Study

A microfiber fish feeding study was initiated in June with UNCW to compare the effects of synthetic and cotton microfibers on growth performance and health in black sea bass. This study tested the hypothesis that ingestion of synthetic microfibers by early juvenile black sea bass has an adverse effect on fish growth performance and health, whereas ingestion of cotton microfibers does not. The study established the experimental design to conduct feeding trials with the goal of determining the effects of fish consuming natural and synthetic microfibers. A control diet was formulated with fish meal and other practical protein sources (soybean meal and poultry byproduct meal). An evaluation of growth performance and body composition will be completed in 2021 to determine the effects of these fibers on the health of the fish.

Texas A&M University Fish Feeding Study

A microfiber fish feeding study was initiated in June with Texas A&M University to assess the effects of synthetic and cotton fibers in the aquatic environment on red drum, shrimp, and oysters under controlled aquaculture conditions. The project established the experimental design to determine the fate of the fibers in water systems and various tissues and metabolites of the cultured organisms using a mass balance approach. The pandemic caused permitting delays with setting up the aquaculture trials and the health outcome assessment for shrimp had to be postponed to 2021.

Sustainability Assessments

Cottonseed Oil Life Cycle Assessment (LCA) and Allocation Study

The Sustainability Division completed a full (cradle-to-grave) comparative LCA that explored the reductions in life cycle greenhouse gas (GHG) and other environmental impacts of cottonseed oil relative to representative mixes of vegetable oils and palm oil. A full comparative International Standards Organization (ISO) LCA report was completed in May and has been reviewed and approved by the ISO review panel. A publication was drafted and submitted to the *International Journal of Life Cycle Assessment* that highlights the environmental benefits of refined cottonseed oil relative to other vegetable oils in the market. Further, using the data and insight gathered from the comparative cottonseed oil LCA, Sustainability also considered how this new information can alter the allocation methods implemented in future cotton lint LCAs. Allocation is a method of partitioning environmental impacts to the co-products in an LCA framework. Because cotton has a main product (lint) and co-products (mainly seed), the environmental burdens must be split in some way between these two products. Depending on what assumptions are made and which allocation method is implemented–ultimately determining how much of the environmental burden is placed on lint and how much is placed on seed–the outcomes can be drastically different. In the current cotton lint LCA, economic allocation is used, with 84% of the burden placed on lint and 16% on seed. Other common allocation methods used in the LCA are mass/volume, physical allocation, energetic basis, stochastic allocation, and system expansion. In 2020, Sustainability commissioned a study that tested a variety of allocation scenarios and evaluated the sensitivity of each choice in how they impact the results to determine if a more accurate story for the life cycle impacts of cotton may be supported by changing the allocation choice. A draft publication was completed for this allocation study which will be submitted to the *Journal of Cleaner Production.*

Global Plastic Leakage Assessment for the Apparel Industry

Last year the Sustainability Division joined the Plastic Leakage Project (PLP), which is a collaborative, multi-stakeholder initiative designed to identify, measure, and develop scalable solutions to close the tap on plastic leakage and pollution. The group developed the first ever Plastic Leak Project Methodological Guidelines, which filled an important gap in managing the plastic pollution crisis by enabling companies to locate and measure plastic leakage along their value chains. These insights have provided businesses with a strong foundation to help define meaningful and effective strategies for eliminating plastic pollution in their value chains. In 2020, Sustainability completed a study using the Plastic Leak Project Methodological Guidelines to conduct a Global Plastic Leakage Assessment for the Apparel Industry. The project compared the leakage from both cotton and synthetic clothing in key product categories. The project quantified the plastic leakage intensity from each of these project categories for the global apparel industry, and results further highlighted the issues with synthetic apparel and its contribution

to the microplastic and macroplastic pollution problem. The study showed that, of the product categories considered, synthetic apparel emitted up to 50 times more plastic (both microplastic and macroplastic) than cotton garments across their value chains.

USDA-ARS Conservation Cropping System Research at Judd Hill Foundation Farm

A conservation cropping system project was initiated early in 2020, which explored the long-term environmental and agronomic impacts of conservation practices in irrigated and non-irrigated cotton production. Studies on various conservation cropping practices, such as minimum tillage, vegetated buffer strip, cover cropping, and non-irrigated cropping have shown to improve cotton growth and yield. This project combined all these practices into one management cropping system to assess the multiple benefits associated with these conservation practices. During the early growing season, GHG emissions were near ambient concentrations for carbon dioxide (CO2) and nitrous oxide (N2O) fluxes (<0.03 mg N2O/m2/hr and <180 mg CO2 /m2/hr). Emissions of N2O and CO2 started to increase as temperature started to warm in late spring. The first peak of N2O and CO2 occurred following 0.34 inches of rain. In all management treatments, methane fluxes were low and below the detection limit of measurements. N2O emissions ranged from -0.1 to 1.6 mg N2O m-2 h-1 throughout the growing period. High N2O emissions occurred after rainfall in early summer in conventional treatments while high N2O4 emissions occurred after nitrogen fertilization combined with heavy rainfall in conservation treatments. The largest N2O emissions were measured in the furrow between rows compared to the top of planted beds. Cumulative seasonal N2O emissions ranged from 0.15 to 5.0 kg N2O ha-1 season-1 with no significant difference among management system treatments (P=0.107). In contrast, total seasonal CO2 emissions (3.79-11.3 Mg CO2 ha-1 season-1) were significantly different among four management system treatments (P = 0.02-0.001) with the largest emissions measured in the conservation irrigated system treatments (34- 40% higher compared to conventional irrigated treatments). Emission of CO2 was the main contributor to seasonal global warming potential (GWP) in all treatments during the growing period. Across all management treatments, lint yields ranged from 524 to 1,218 kg ha-1 (385-1,199 lb ac-1) with significantly higher yields in the irrigated compared to rainfed treatments (P=<0.0001).

Pilot to Demonstrate Implementation and Benefits of the U.S. Cotton Trust Protocol (USCTP) and Better Cotton Initiative (BCI)

Demonstration field plots were established in Arkansas in 2020 to show similarities in both the U.S. Cotton Trust Protocol (USCTP) and Better Cotton Initiative (BCI) production practices. Additionally, a second cotton field was established to exemplify conventional approaches in cotton production to contrast the best management practices incorporated in the USCTP and BCI fields. In response to demand from retailers, suppliers, and interested farmer groups, programs such as BCI and the USCTP have been established to increase awareness of the fact that many cotton producers are farming responsibly and striving for continuous improvement. While BCI has operated in the U.S. market for many years, it was created with a more global focus and some key differences. While both programs have similar goals in supporting farmers in addressing certain sustainability challenges and improving environmental performance, BCI fails to consider some of the key components of what is required to grow cotton in the U.S (adherence to labor laws, environmental regulations, worker protection standards, etc.). This project helps provide data to support a “substantial equivalency” between the two programs and will simplify adoption of the USCTP within the supply chain. This project also helped scale up awareness and adoption of the USCTP across the industry. The primary objective of this project was to provide educational opportunities for extension, researchers, producers, crop consultants, and other key segments of the supply chain to better understand the USCTP to increase overall adoption. However, due to the pandemic, education opportunities were limited to online presentations as travel was significantly impacted due to the pandemic.

<u>Sustainability Non-Governmental Organization (NGO) Engagement and Leadership</u>

Collaborations with the textile NGO community remained strong in 2020, with the most significant achievement being the addition of the U.S. Cotton Trust Protocol to the Textile Exchange’s preferred fiber list. Sustainability has also remained actively involved in The Sustainability Consortium’s (TSC) Responsible Pest Management Task Force, where efforts are being made to have the U.S. Cotton Trust Protocol best management practices questionnaire accepted as equivalent to the new Responsible Pest Management Framework that TSC is developing. The Sustainability Division also actively engages in the Outdoor Industry Association’s Microfiber Research Cohort, the Sustainable Apparel Coalition’s Product Environmental Footprint working group, and the ISO Circular Economy technical working group. Most recently, the Sustainable Apparel Coalition (SAC) retired their use of the “single score” in the Higg Index. The Higg MSI was originally created by Nike, and is a tool used by many brands to analyze the environmental performance of various materials in their product portfolios. The “single score” had been a point of contention for many natural fiber organizations and members within SAC. The single score was based on flawed and biased methods not in line with best life cycle assessment practices, which resulted in cotton’s score being roughly ten times that of polyester. Now, the Higg MSI shows that cotton performs favorably from a greenhouse gas emissions and energy perspective, while still having higher water scarcity and water quality impact scores: a “win two-lose two” scenario. This points out that there

are pros and cons to each fiber and that tradeoffs should be examined between fiber choices looking at more than a single score. This important change comes after several years of Cotton Incorporated and other natural fiber organizations providing critical feedback in technical realms and public settings.

Cotton Sustainability Communications

The Sustainability Division and Corporate Communications jointly engaged in a sustainability communications project in 2020 to update the CottonToday Website. The project also focused on fundamental cotton sustainability communications, using the CottonToday Website as the main communications platform, highlighting the environmental advantages of cotton. During 2020, a messaging strategy was created which will define the final Website redesign. Final Website redesigns are under final development and will become live in the first quarter of 2021.

Special Topic Section: Addressing the Contamination Threat

Agricultural & Environmental Research, Fiber Competition, and Product Development & Implementation Divisions

There is a clear threat from plastic contamination to the value of U.S. cotton; therefore, Cotton Incorporated is maintaining a multi-divisional strategy to address this threat. The first part of the strategy is to detect and remove contaminants at both the field level prior to harvest and at the gin during processing. The current research focus is detection and removal at the gin, as that gives the opportunity to remove plastic contamination from both the field and gin. Additional strategies include exploration of new materials (ideally cotton-based) to wrap both cotton modules and cotton bales, support modification of current materials to be more easily detected (and removed), and further investigation of the detection and removal technologies in Spinning and Nonwoven Industries.

Gin Level Detection Efforts

One of the earliest projects to address plastic contamination at the gin was the use of a video camera monitoring the module feeder through a Texas State Support project. In 2018, the National Cotton Council took the lead in deploying several of these systems in U.S. gins to further evaluate the value of this approach, and that continued in 2020. Based on the consensus that such a system demonstrated clear value, researchers at the Lubbock Gin Lab published a paper on a simplified version of a "Module Feeder Inspection System." The paper provides specifications for which cameras and lights to use, and how to install them, along with instructions and fabrication drawings to construct the camera housing enclosure. This system allows for the ginners to view the module feeder rollers manually whenever they stop ginning. Work has continued towards an advanced version of this system to enable full automation with software that will control the module floor's feed and automatically detect when plastic is present on the module feeder rollers.

Another gin-level detection system is an affordable machine vision system deployed on the feeder apron of the gin stand. An initial prototype of this camera-based detection system detected and ejected samples of yellow, round module wrap embedded in cotton flowing down a slide and simulating the feeder apron on a gin stand at a rate of 85%. The work resulted in a full-size research prototype that Lubbock Gin Lab researchers installed and tested at a commercial gin during the 2018 and 2019 ginning season. A commercial prototype of the system was installed at a gin in the southeastern U.S., and the evaluations were favorable. Minor airflow modifications were needed as well as adjustment to the pivot of the lower apron to allow for the full ejection of detected contamination. Testing of this system installed on three gin stands averaged 91.6% removal for yellow and green wraps. The system is officially named VIPR™, Visual Imaging Plastic Removal. Researchers have worked on a monitoring system based upon the VIPR technology to allow gins to evaluate their contamination risk level before committing to installing detection/removal systems. Researchers are targeting to have this system, called VISN, Visual-Inspection Single-Node System, installed for testing at two gins during the 2021 ginning season.

Removal Efforts at the Gin

In addition to the successful air removal system at the feeder apron, past studies at the USDA-ARS gin lab in Stoneville found current cleaning equipment at the gin removes a significant amount of plastic. They also had some success in adjusting seed cotton cleaning machine settings to remove even more plastic. Follow-up work is continuing at Texas A&M, where the research gin in College Station was upgraded to have a mini-module feeder to better simulate plastic contamination events. In 2019 a Texas State Support project focused on developing an inexpensive way to automate the removal of plastic found at the module feeder. The system involves a rotating brush that can be lowered into the module feeder when plastic is detected and remove the plastic. A prototype was constructed in 2020 for the mini-module feeder at Texas A&M and testing is ongoing.

A major gin manufacturer in China sells a contamination cleaner designed to remove foreign matter from seed cotton utilizing three different cleaning sections that remove long strings and large pieces of plastic film; open seed cotton and remove fine trash; and remove small foreign matter/contamination objects by exploiting differences in settling characteristics in an air stream. An 18 bale per hour model of the machine was purchased by Cotton Incorporated and delivered to the Las Cruces Gin Lab in early December of 2018. The installation of the system was completed in April 2019. Initial test of the machine's ability to remove round module plastic and plastic shopping bags were completed. On average, the removal rate was approximately 60% at the highest air flow rate, with lighter plastics more effectively removed; however, more seed cotton is also ejected at these higher flow rates. Video of the machine running also shows that there are instances when plastic is captured on the condenser but gets blown off before removal can occur. Trials comparing the removal capability of the plastic machine versus typical stick cleaning and cylinder cleaner systems are underway. The primary purpose of these tests is to evaluate the plastic machine's potential

effectiveness for use in U.S. cotton gins. The outcome will result in either a recommendation for the Chinese plastic machine or theoretical ideas capturing the best learnings to implement alternative options for the U.S. gin industry.

Another project started in 2019 at the Las Cruces lab is a test to see if plastic mixed with cotton falling onto heated cylinders will melt and stick to the cylinders. A model cylinder was developed for testing, and it was found that plastic would melt and stick to the cylinder at 200 degrees Fahrenheit. While progress was slowed in 2020 due to the pandemic, a set of cylinders were built and additional testing will take place soon.

Field Detection Efforts

Tests at the Stoneville, MS, gin lab in 2020 are focused on identification of an optimal spatial resolution for images from Unmanned Aerial Systems (UAS) to identify plastics in the field. The goal is to balance detection success with the area covered. Once better defined, UAS images will be an on-farm tool to scout for plastic near harvest time and a research tool to identify areas where plastic is most likely to be found in the field and relative to roadways and population centers.

Research efforts continue to monitor modules as they travel from the field to the gin. Video footage was collected by placing cameras on module handlers in the field and gin yard, as well as video cameras at the module feeder at four U.S. locations with diverse production (picker and stripper) and environmental conditions (humid to arid). This image collection continued in 2020, and an intermediate report was released fall 2020 to share common problems noted during the 2019 season. Problems noted include setting modules on cut stalks, sliding modules on flatbed trailers and turning too quickly when loading and unloading.

Alternative Materials

Some U.S. producers have used hay balers to package seed cotton in the field. One challenge to this approach is the contamination potential that is introduced by the baler twine used on those machines. The twine is typically based on a synthetic fiber or sisal, both of which could contaminate cotton if not carefully removed at the gin. Therefore, work is in process to see if a cotton twine can be engineered to meet both the strength and diameter limitations of modern large bale hay machinery. Work has also begun on examination of other materials to better protect traditional and round bale cotton modules in the field. In addition, technical support is being provided to modify current materials to be more easily detected and/or removed.

Spinning Level Efforts

A comprehensive report was written in 2019 to help explain contamination detection technologies available to yarn spinners and nonwoven manufacturers. In textiles and nonwovens, contamination can be anything, including seed-coat fragments, bark, grass, oil, straps, ropes, textile garments, different types of plastic, such as plastic mulch, shopping bags or module wrap, or even roadside trash. Contamination can be introduced at many points along the cotton supply chain and can cause significant problems for gins, mills, and customers. This is by no means a new problem, and many detection machinery manufacturers have been offering solutions for 20 years or more to remove contamination through innovation and technology. If contamination does find its way to a spinning mill, several solutions are commercially available to remove contamination in the opening and cleaning line to minimize the effect it has on downstream processes. If contamination is still present at spinning, mills rely on yarn cleaners designed to remove manufacturing defects and contamination/foreign matter.

Commercial Contamination Detection and Cleaning Line Installed

One of the world's technology leaders in the field of cotton contamination detection machinery was used to conduct a successful contamination trial run at their company facility in 2019. The machine used in that trial was selected to bring in-house and the new cleaning and contamination detection installation was completed in 2020. The state-of-the-art contamination detection technology utilizes five methods of detection to remove plastic contamination down to 1.5 square mm in size. The Fiber Processing Laboratory is now uniquely positioned to lead future industry trials and evaluate ginning research trials on behalf of all our cotton constituents. This provides additional capabilities to further collaborate with Agricultural Research and Fiber Competition teams as the possibilities of this latest generation of cleaning and contamination detection technology are explored.

Development of Round Module Wrap Performance Specifications

The patent for the round module cover material is nearing expiration, and there is concern that manufacturers could begin to offer generic module wrap that will not provide sufficient containment and protection of seed cotton and further increase the incidence of plastic contamination events. Coordinated efforts across multiple divisions at Cotton Incorporated and USDA-ARS cooperators are underway to collect data to develop needed modifications for the ASABE Standard S615 "Cotton Module Cover Material Performance." The modifications will add performance criteria for round module wrap films. Three rounds of sample

testing were obtained from outside testing laboratories to help the staff understand applicable test methods and potential data variation. With these results, a draft of the ASABE standard containing details about round module wraps has been developed and discussions with companies involved in the current wrap manufacturing took place in December.

FIBER COMPETITION: *FIBER QUALITY RESEARCH*

Strategic Objective 1: Improve quality measurements of cotton fiber, yarns, and fabrics.

Quality Research: Quality Measurements Improvement

Enhancing the Marketability of U.S. Cotton through Length Uniformity Improvement

2020 Objectives: Identify salient features of the fibrogram, which can be useful to isolate pertinent fiber length distribution traits. Once identified, check for repeatability, stability, and reproducibility. Perform calibration of the salient features within the fibrogram, followed by sharing the protocol with fiber labs across the U.S.

In previous years it was shown that the fibrogram length curve from the High Volume Instrument (HVI®) contains information about within-sample variation in fiber length that is currently unused. This information appears to explain as much knowledge about the variation in yarn quality as information captured by the Advanced Fiber Information System (AFIS®) length distribution. All three HVI® units were used for fibrogram retrieval. From a mix of various trials, 1,274 samples were selected to evaluate the repeatability of HVI® fibrogram measurements across multiple HVI® units. The samples were tested using the three HVI® and AFIS® machines. Examination of the fibrograms across HVI® units obtained on two sample sets reveals that most of the differences among HVI® samples are concentrated in the middle portion of the fibrograms [between 10% and 70% span length (SL)]. All samples observed so far behave the same. It is interesting to note that with the current HVI® outputs based on 1.8% SL and 7.8% SL, all HVI® length measurements look very similar.

Data from the objective to find the best-fit equation for the fibrogram curve to enable calculation of the different fiber length parameters showed that it was possible to determine the curve's equation to fit the fibrogram. This allowed the researchers to calculate different fiber length parameters based on two different methods historically proposed by literature. The research revealed that the method to calculate Mean Length (ML) and Upper Half Mean Length (UHML) proposed by researchers should be preferred to the Hertel method. These results also show that Lower Half Mean Length (LHML) may not be appropriate to estimate the AFIS® Short Fiber Content (SFC). Further validation with larger sets of samples is needed to confirm this work. Work on testing 931 commercial samples showed that it was possible to estimate the AFIS® SFC by number and by weight using the data from the fibrogram curve if micronaire is included in the interpretation. Revalidation of these results will be done in 2021 with a larger number of independent samples.

This project was initially delayed somewhat by the pandemic, but lab technicians were able to work overtime to allow progress to be made in the second half of the year. This effort is continuing in 2021.

Maturity and Standard Fineness: Determination, Calibration, and Use

2020 Objectives: Survey commercial cotton crop to provide recommendations to cotton breeders. Identify commercial candidate bales for calibration cotton production and determine the variability of the standard fineness within varieties of cotton commercially produced in the High Plains of Texas. The goal of this project is to develop reference material for maturity and standard fineness based on fiber cross-section analysis.

Nine levels of maturity and fineness combinations are required for this project, out of which eight bales of cottons have been identified. Six of these bales have been blended per International Cotton Calibration Standard Committee (ICCSC) calibration material protocols. Three of the blended bales have been fully tested to provide cross-sectional reference values. Each bale has 60 samples pulled for fiber cross-sections. Cross-section work on a fourth bale has nearly been completed. The two remaining bales that have been acquired are currently undergoing blending, following the exact protocol used for the project's first six bales. The samples will be tested on both HVI® and AFIS®. The ninth bale will be acquired after the researchers have all the HVI® and AFIS® results on the eight bales. SAH impacted this project, and cross-sectional work is too laborious to ask the technicians to work overtime. This effort is continuing in 2021.

Finding Ginning Methods That Improve Fiber Length Uniformity

2020 Objectives: To develop, test, and report on ginning methods that improve fiber length uniformity index.

Into the third year of this project, results indicated significant differences in the length uniformity when using the experimental lint cleaner connected directly to the gin stand, thereby eliminating the lint cleaner feed mechanism. A significant difference was found with the lint cleaner that places fiber onto the cleaning saw in the same direction as the rotating saw with a non-conventional feed mechanism. Roller ginning provides the best values for length uniformity. Comparing the saw ginning treatments, the saw gin coupled lint cleaner and the saw gin lint cleaner with the non-conventional feed mechanism had longer fiber, better length uniformity, fewer neps, and less lint trash than the saw gin with a conventional lint cleaner. Data entry, analysis, and manuscript writing was completed and submitted for review. Work began on the spinning trials on lint from the gin tests, which are being conducted at the USDA-ARS Southern Regional Research Center (SRRC). But the shutdown of USDA sites delayed this project's progress. Gin-associated testing has been completed, but data has not been gathered and was not available due to shutdowns. A final statistical model will be decided upon when the ginning test's trash and moisture content data are available. The manuscript will be submitted to the AgriEngineering Journal. That draft manuscript is 90% complete without this required data. This effort is continuing in 2021.

Determining Fiber Properties from Full- and Model-Sized Saw and Roller Gin Stands

2020 Objectives: To evaluate the differences in fiber properties, lint percent, and lint turnouts when processed with table-top versus full-size gins spanning a set of nine gin treatments.

The principal objective of this project is to evaluate the effects of gin treatments on fiber properties tested with HVI® and AFIS® machines. This year was the second year for this project, which employs machine and hand-picked cotton with varying fiber traits, especially uniformity and fineness. To cover a good range of properties; a barbadense type (Pima) and two Upland varieties were utilized. Refurbishment of the full-size reciprocating knife gin stand needed for this study has been completed. The refurbished roller gin reclaimer was installed in the roller ginning lab. SAH impacted this project. The gin stand trials with two bales of Pima cotton began towards the end of the year and will continue next year.

Developing and Evaluating Analytical Tools for Improving Fiber Trait Distributions

2020 Objectives: Develop statistical modeling tools for fiber trait distributions as provided by AFIS® testing. This effort will explore an array of programming languages and statistical packages (including SAS® and JMP®) to provide standalone procedures/add-ins for use by cotton breeders/processors.

This is a new project initiated in 2020. The ultimate objective of this research is to provide reliable tools that will help cotton breeders, biotechnologists, and processors interpret and exploit fiber trait distribution data. In the first year, progress was made in writing the code for batch distribution data processing and model fitting. The procedure developed to date allows achieving the following tasks: a) Input an AFIS® distribution spreadsheet (as provided by the lab at Cotton Incorporated); b) Format the data and export it to a JMP-Pro® (SAS®) table using a combination of Visual Basic for Applications (VBA) code and JMP® Excel add-in; c) Perform the length distribution model fit using a customized JavaScript Standard Library (JSL) script and test for model fit on datasets consisting of batches of multiple samples and; d) Output a summary table with parameter estimates of the sample batch; generate plots showing the probability density function model fits. This modeling methodology will continue in 2021 to develop a statistical procedure enabling analysis for fiber length distributions. SAH did not impact this project.

Dual-beard Fibrography for Cotton Length Distribution Measurement

2020 Objectives: The objective of this project is to develop a portable, economical, and easy-to-use system for fiber length distribution measurement based on dual-beard fibrography and an iterative separation principle.

The project objective is to develop a portable, economical, and easy-to-use system for fiber length distribution measurement based on dual-beard fibrography and an iterative fiber separation algorithm. The goals specific to the current year include improving testing by eliminating the need for fiber alignment/entanglement, allowing the beard to be scanned entirely to include SFC enabling comprehensive measurements on fiber length distributions and length uniformity and other major fiber parameters. In the validation and comparative data testing against HVI® and AFIS® data, the researchers compared 29 samples with the dual-beard technology. These samples had a length uniformity range of 78-86%. Correlations showed a positive relationship between the machines. Researchers are investigating the differences in SFC observed in distributions data between

the AFIS® and dual-beard methodology. For this purpose, fiber beards were tested using the dual-beard method and were sent to the fiber lab to have AFIS® testing performed on the same beard. This project ended in 2020.

Cotton Contamination Detection at Gin Stand Feeder Apron

2020 Objectives: Assess the best method for detecting and removing plastic contamination at the gin-stand feeder apron.

A commercial version of this detection system is now available, while researchers continue to add sophisticated upgrades to the Visual Imaging Plastic Removal (VIPR™) system. To help lower the hurdle to industry adoption, researchers ported the software from Linux® to run under Windows®. For module camera systems, a white paper and a peer-reviewed publication were published, which provides a blueprint for building a simplified version of the module feeder inspection system. This provides a system where ginners can monitor periodically when the module feeder is stopped to view rollers for contamination. The publication is titled "A Cotton Module Feeder Plastic Contamination Inspection System" (published in the AgriEngineering Journal.) Researchers conducted one commercial trial of the technology, using a USDA prototype, and then conducted three commercial trials (at two commercial gins). The tests examined the efficacy of VIPR™ technology to prevent plastic contamination from entering the gin-stand. The testing results indicate that the combination of the VIPR™ plastic-contamination detection-ejection system coupled with the gin-stand feeder removed over 90% of the plastic from the system. Preliminary work has begun on a lower-cost alternative to the VIPR™ system that would allow gins to estimate the contamination level that their gin is experiencing. This system has been coined as a "Visual-Inspection Single-Node System" (VISN) and only provides images, no removal. SAH did not impact this project other than limiting how many staff could travel to the test gins. The development and enhancement of the VISN system will continue as a new project in 2021.

Exploring Methods to Extract Plastic Contamination from Cotton (GoldenLion)

2020 Objectives: Evaluate the plastic removal ability of a Chinese manufactured system that was developed to remove various foreign matter from seed cotton, including plastic sheets and strings. Investigate other methods to effectively remove plastic contamination from the cotton flow at the gin.

Based on the tests done in 2019, the first quarter of 2020 involved plans to address the GoldenLion system with modifications to optimize the plastic contamination removal. Researchers designed, built, and installed a new hopper, which doubled the amount of seed cotton going into the system, therefore, doubling the test run time. The new hopper also has a lid to prevent airflow from bypassing the proper air inlet. Comparative testing will be done across the GoldenLion, stick machine, and cylinder cleaner. Three types of plastics will be tested: 1) thicker/stiffer heavier round module wrap (RMW), 2) thinner/pliable lighter RMW, 3) plastic grocery bags all at various sizes (2x2", 4x12", 6x72", and whole bags). The test will involve three airflow rates (10,000, 15,000, and 20,000 cubic feet per minute (the highest corresponding to the highest air flow recommended by the manufacturer). Seed cotton to be tested will be raw and directly from the module and then also seed cotton that has been opened and previously processed through one seed cotton cleaning machine. SAH impacted this project, but the researchers ran the trial at year-end, and the results will be presented to the industry at the 2021 Beltwide Cotton Conference.

Establish the Suitability of U.S. Cotton for Vortex Spinning

2020 Objectives: This project was initiated in 2020 with the predominant goal of determining the impact of fiber properties on vortex yarn quality (MVS). A special emphasis will be put on fiber length, length distribution parameters, and tensile properties as limited results from previous work have indicated the importance of these qualities for vortex yarn.

The advent of faster and modern spinning systems such as vortex has led to the demand for higher quality U.S. cottons as compared to quality requirements for open end spinning. Currently, most vortex spinners prefer to use cotton blends with polyester or other fibers to produce high-quality yarns. This research project was initiated to utilize higher quality cottons from the current commercial bales and high-quality cottons from cotton breeders to generate data to make recommendations to spinners for generating 100% cotton yarns using vortex technology. In the first quarter, the research team procured 20 bales comprising of an array of fiber properties from a few U.S. growing regions. HVI® and AFIS® tests were done on these bales to verify classing office fiber properties. Hand-picked seed cotton from other labs with exceptional fiber strengths and lengths was procured and ginned, and fiber tested as well. The commercial bales with the best fiber qualities performed best at the vortex spinning system. The experimental material from the cooperating breeding program had exceptional quality and was hand-picked and had elevated performance at the spin. Results show that vortex spinning yarn quality, notably yarn tenacity, is lower than ring spinning yarn quality, indicating vortex is more sensitive to fiber quality. The most critical fiber attributes for vortex spinning include fiber diameter, fiber strength, fiber length, and length distribution. SAH somewhat impacted this project, but

with lab technicians working overtime, progress was made at year-end. This trial will be repeated in 2021, with commercial material exhibiting exceptional fiber fineness. Ring spinning will also be included for comparisons.

Measurements for Improved Cotton Quality

2020 Objectives: The objectives of this project involve the development of a robotic system to acquire fiber quality information at the gin, and to determine the relationship between seed strength and seed coat fragments.

Before starting this new project, a robotic arm was developed and set up to acquire fiber quality measurements in a commercial cotton gin. There were three sensors on the arm to determine the color (colorimeter), micronaire (Near Infrared NIR), and leaf grade (camera) information. The NIR and colorimeter were removed because of a lack of stable results. The stationary camera has been replaced with an improved digital camera system to mimic the HVI® color head. The mount and set up in the prototype allow for a 3-inch x 3-inch image to be collected without glare. This system will capture digital images of the sides of bales during the ginning season. These images will be processed using a python program (under development) to report the color grade and leaf grade from the collected image and compare them to the USDA-Agricultural Marketing Service (AMS) HVI® data for those bales. Images obtained in previous seasons using the original camera system and AMS samples are being used to develop the software system. Software and hardware development are continuing with off-site development and configuration of the camera and lighting systems. The initial work has been performed using a FLIR Blackfly-S machine vision camera. Lower cost cameras are being assessed to determine if a cheaper, more commonly available camera can be incorporated into the system with no performance loss.

For the seed coat research, samples from the 2019 National Cotton Variety Test were collected. These seed samples are to be tested for seed strength on an Instron Universal Testing Machine after extended conditioning at standard atmospheric conditions per ASTM D1776 to allow the seed moisture to equilibrate. The lint samples from these cottons will be tested on the AFIS® machine, and seed coat nep counts will be analyzed for relationships to the initial seed strength results. Samples from Australia (having reports of seed coat fragment issues) have also been received. With the lab conditions at SRRC down, a plan is being developed to relocate the Instron Universal Testing Machine to either a different conditioned laboratory in the SRRC or the Cotton Ginning Research Unit in Stoneville, MS.

This project was impacted by the pandemic and will continue in 2021.

Targeting Fiber Quality Attributes for the Fiber of the Future

2020 Objectives: Identifying novel fiber quality breeding targets using the yarn and fiber quality database previously created, investigating a potential tool employing holographic principles for high-speed fineness and maturity measurement, and determining length distribution attributes using micro-ginning.

This is a new project initiated in 2020 to mine data from previously created datasets from commercial U.S. cotton bales and identify/explore the potential for breeding traits that may lead to length uniformity and fineness improvement. Progress on holographic methods is ongoing in the partner lab, where 14 samples have been sent for testing from the 104 reference cottons. The researchers have collected over 60+ holographic images spanning three diverse samples from the reference cottons. The first step in this research is to check the granularity of the detection system. A lens-free imaging system was modified to generate digital holograms of each subsample of fibers from the representative samples. The phase holograms have revealed many fiber structural components, such as the fiber lumen and cell wall, contributing to the maturity and fineness complex. Each phase hologram captures the fibers samples' internal structure and, therefore, a stack of images. Holograms were then segmented into 1mm segments to develop a deep learning algorithm that will be used to generate a measurement of fiber maturity and fineness. SAH did not impact this aspect of the project, which will continue in 2021.

Samples from the micro-gin trial were ginned, tested, and data comparisons were made between table-top research gin and micro-gin processing. Fiber quality variation was observed for length distributions, color grades, maturity ratio, SFC, and standard fineness. SAH did impact this aspect of the project.

Boll Samples to Assess Gin Effects on Fiber Quality

2020 Objectives: The objective of this project is to test variation in fiber quality observed across research gins when testing fiber quality in cotton.

This is a new project initiated mid-year to replace a canceled project (due to SAH). This project will address any fiber quality variation coming from table-top gins in breeding programs. When performing variety trials as a group, it has been assumed that gins impart no variation to tested fiber quality. For this project, three sets of boll samples from a high-quality variety trial have been harvested by the researchers. Three different gins from breeding programs in the U.S. cotton belt have participated in the ginning protocol. Fiber samples from two gins have been sent for testing with HVI® and AFIS® machines. The third location is currently ginning the trial. This field trial and testing will be repeated in 2021.

Genetic Effects of Exotic Genes on Fiber Quality in Upland Cotton

2020 Objectives: The objective of this proposal is to elucidate the genes conferring fiber length and fineness, respectively. Fiber resilience to withstand fiber processing will also be tested to decipher any potential genetic abilities from improving fineness and length as a complex.

This was a new project initiated in 2020 to address the potential of improving fiber fineness biologically by testing Gossypium barbadense chromatin on Chromosome 25 harboring the fiber length quality loci trait (QTL) and micronaire QTL. The research goal is to explain the genes conferring fiber length, length uniformity, and fineness. Researchers will also simultaneously look at fiber resilience to withstand fiber processing at the microgin conferring to genetic, environmental, and mechanical effects. The researchers have worked on greenhouse plants to obtain seed, which were planted late-season this year owing to SAH. Hand-harvest for boll samples was done in the first week of December, with machine picking to follow. Seed prep is underway for the multi-location fiber trial in 2021. The pandemic somewhat impacted this project.

Genetic Dissection of Fiber Traits in a Subset of the Exotic Cotton Nested Association Mapping (NAM) Populations

2020 Objectives: The objective of this study is to identify QTLs associated with critical fiber traits and utilize AFIS® to attempt to separate complexities from HVI® micronaire and length uniformity measures.

This is a new project initiated in 2020 with the long-term goal of realizing high-throughput phenotyping in plant breeding using AFIS® traits. For decades, AFIS® testing has documented immense value in improving fiber quality and understanding spinning constraints; however, it is nearly impossible to screen fiber quality using AFIS® technology when developing new varieties. Owing to the time consumed and, consequently, the expense involved with AFIS® testing, this project aims to decipher markers associated with valuable traits from AFIS® results, which could be camouflaged from HVI® data.

With past support from the National Science Foundation and Cotton Incorporated, researchers invested ~$1.5 million in the development of 27 NAM populations (of >100 individuals each) involving crosses between multiple representatives of each of the wild/feral botanical races of Gossypium hirsutum (Upland cotton), and widely used breeding lines DES 56 and or Acala Maxxa. Single plant plots from most of the lines grown in 2019 were hand-harvested and fiber was ginned. Fiber testing is underway. Activities on seed preparation stalled due to the pandemic until early Fall, which led to postponing large field trials to 2021. However, genetic mapping of the three target populations has been performed, and data analysis continued. Seed preparation is currently underway for large-scale field trials in 2021.

Preliminary Comparison of Cotton Fiber Cross-Section Geometric Values with Instrument Values Measured by the Optical Fibre Diameter Analyser (OFDA)2000, Cottonscope, and Single Fiber Analyzer (SIFAN)

2020 Objectives: The objective of this study is to conduct a preliminary comparative analysis of cotton fiber cross-sectional values on a subset of the maturity reference cotton with values measured using the OFDA2000, Cottonscope, and SIFAN. The analysis will provide insight into the best comparative specimen sizes for each test and describe possible and preliminary adaptations to the SIFAN to accommodate cross-sectional measurements along the length of single cotton fibers. This work extends on two decades of U.S. and Australian research to develop reference and instrument test methods for measuring cotton fiber fineness and maturity.

In this new project for 2020, two fiber sets consisting of four of the 104 reference cottons developed by Texas Tech University were mounted and prepared for SIFAN analysis. Each sample has a set of 20 fibers. One set was sent to BSC Electronics to analyze the latest version of the SIFAN. The other set was retained at Commonwealth Scientific and Industrial Research

Organization (CSIRO) to analyze the older local SIFAN instrument. Preliminary data work was also performed on fiber base-to-tip pieces to determine the maturity and fineness using the Cottonscope. Data will be available from the reference material analysis in the year-end research report (due February 2021). I'm assuming that this is a report from the PI?

Research and Fiber Quality Meetings

Staff participated in a variety of meetings including Cotton Beltwide Conference; hosted researchers from Australia, USDA New Orleans, and USDA Lubbock for discussions about future project collaborations; the Joint Cotton Industry Bale Packaging Meeting and the virtual mid-year meeting to learn about the National Cotton Council (NCC) bale package survey; a conference call for the Permanent Bale Identification (PBI) Tag Subcommittee; conference calls on RMW specification testing; a conference call on cotton bale bagging; conference calls on Federal Trade Commission (FTC) reassessment of the need for care labels; two virtual NCC Quality Task Force meetings; a virtual meeting with a seed company; conference calls about traceability concerns with a retailer, with the Cotton Board, and internal meetings with the Traceability Task Force; virtual Agronomy Society of America meetings; and virtual National Association of Plant Breeding Annual meetings. Webinars viewed included traceability options. A virtual Fiber Quality presentation was made for one gin association annual meeting. A virtual Cotton & Coffee presentation was made for the Cotton Board. Staff conducted virtual meetings with all research program teams during the second half of the year.

Strategic Objective 2: Provide accurate test data to support research and marketing efforts.

Product Evaluation Laboratory

The Product Evaluation Laboratory (PEL) acquired a new HVI® machine in January for measuring cotton fiber properties, including length, uniformity, micronaire, strength, color, etc. With this new purchase, the lab was able to retire the refurbished HVI® and keep the 2006 model HVI® and the new model running in the lab concurrently. The PEL also added two Universal Wear Tester (UWT) systems during the summer. A UWT is an instrument that tests the flex abrasion and durability of fabrics and is used for testing TOUGH COTTON™ technology and PUREPRESS™ technology. The lab was also able to get Windows® updated on the 2006 HVI® model, as well as the lab's AFIS® Pro 2.

Agricultural and Environmental Research

Testing for Agricultural and Environmental Research (AER) was focused on general Agricultural Research Initiatives and Variety Improvement. Work continued on single versus multiple-pass harvesting, robotics, target spot, nematode, gene combinations for cotton improvement, and fiber length uniformity improvement by ginning methods.

Fiber Competition

The Standards reference covers a variety of proficiency and calibration practices as follows. For fiber testing, the following routine HVI® studies were completed on each of the two HVI® systems during the year: twelve monthly check cotton tests, three Commercial Standardization of Instrument Testing of Cotton (CSITC) round robins, and one Bremen Institute round robin. Elongation calibration trials were completed on both HVI® units, and these trials will continue into 2021. No USDA-AMS 220 Calibration Sets were tested due to mechanical issues followed by SAH timing. For fabric testing, six AATCC and three ASTM proficiency studies were completed. For yarn testing, the TestTex yarn proficiency study was missed due to SAH.

Under the Agricultural Research reference, a collaborative project looking at maximizing cottonseed oil while maintaining fiber quality continued to be evaluated. For Technical Services, the lab assisted a textile company with AFIS® testing multiple times until their unit was repaired.

PEL continued work to create standard specifications for the RMW. This has been a cross-division effort between PEL, AER, and Textile Chemistry Research. Data from testing at outside labs were used to draft an updated version of the existing American Society of Agricultural and Biological Engineers (ASABE) Cotton Module Cover Material Performance standard. This draft was presented and discussed with relevant industry partners that would be impacted by the standard. A summary report will be presented at the 2021 Beltwide Cotton Conference.

PEL worked to evaluate and provide test data for currently available cotton bale bags. This project is another cross-division effort between PEL, AER and Product Development. This work will continue in 2021. Data gathered will be kept on file should the need to develop a better cotton bale bag arise in the future.

PEL staff also implemented a correction to AFIS® distributions as exported from the lab's software program and issued updated reports to all cooperators impacted. The lab staff also implemented a process for providing an updated leaf grade for AER cooperators that are focused on projects where Commodity Credit Corporation (CCC) Loan value is essential.

Global Supply Chain Marketing

Technology Marketing (TM) submitted research projects for 100% cotton 'knit denim' NATURAL STRETCH™ fabric and a lightweight blister fabric from a garment manufacturer for physical testing.

Product Development and Implementation

Highlights of work are listed by department:

- Fiber Processing (FP): Research efforts involved typical support work for bale checks, recycled fiber research, effects of open end rotor profiles and diameters on yarn characteristics, comparisons of new weighting arms for yarn, yarn for evaluating new knitting equipment, 30s ring spun compact 'S' twist for skew control, testing irregular bobbins from a compact ring-spinning frame to diagnose the issue; and Technical Service for causes of barré and working with a brand on 'breathable' bottom weights.

- Product Development (PD): Testing consisted of samples for the FABRICAST™ line, which were tested for basic fabric properties. If the samples contained a technology, the performance of that technology was also evaluated. Research covered efforts such as testing bale twine for baseline characteristics, air permeability on weave structures and laminate fabrics, and general fabric performance testing. Technical Service was done for a denim company on NATURAL STRETCH™ fabric and colorfastness for natural dye yarn packages. Testing on cotton bale bags was performed for data collection.

- Technology Implementation (TI): Testing services (often involving multiple trials for many different groups) were provided to support the implementation of all Cotton Incorporated technologies.

- Technical Services (TS): Testing services (often involving multiple trials for many different groups) were provided to support the implementation of all Cotton Incorporated technologies. Technical Service projects included moisture management evaluations, barré analysis, stretch and recovery, and dimensional stability for various customers. Abrasion trials were performed to differentiate the effectiveness of finishes for a brand supplier. Additional abrasion trials were performed on socks and sweaters for brand suppliers. And abrasion sample demos were created for brands.

- Textile Chemistry Research (TCR): Research efforts included continued work on newness retention, soil release finishes (cleanCOTTON), moisture management work including phase change material, TransDRY®, WICKING WINDOWS™, STORM™, TOUGH COTTON™, and PUREPRESS™ technologies. Work was performed on endure™ and dual functionality technologies for the FABRICAST™ line. Implementation support and Technical Service continued to focus on PUREPRESS™ technology efforts.

PEL Testing Summary for 2020, January 1 – December 31:

Cotton Incorporated
Activity Summary Report

Date Range: 01/01/20 - 12/31/20 Completed Projects

Department	Reference	Fabric (Projects/Samples/Tests)			Fiber (Projects/Samples)		Yarn (Projects/Samples/Packages)		
Agriculture Research	AG PRODUCTION				2	399			
Agriculture Research	AG RESEARCH				26	4,604			
Agriculture Research	VARIETY IMPROVEMENT				28	8,471			
Agriculture Research	Totals:				56	13,474			
Fiber Competition	AG RESEARCH				5	165			
Fiber Competition	FIBER COMPETITION				6	937			
Fiber Competition	RESEARCH				1	1			
Fiber Competition	STANDARDS	7	11	87	107	590			
Fiber Competition	TECHNICAL SERVICES				6	107			
Fiber Competition	Totals:	7	11	87	125	1,800			
Fiber Processing	RESEARCH				7	33	24	24	230
Fiber Processing	TECHNICAL SERVICES				2	14	7	8	56
Fiber Processing	Totals:				9	47	31	32	286
Product Development	FABRICAST	76	178	1,084			3	3	17
Product Development	RESEARCH	5	15	128					
Product Development	TECHNICAL SERVICES	2	4	40					
Product Development	Totals:	83	197	1,252			3	3	17
Technical Services	IMPLEMENTATION	4	10	16					
Technical Services	TECHNICAL SERVICES	4	15	27					
Technical Services	Totals:	8	25	43					
Technology Implementation	IMPLEMENTATION	266	760	1,867					
Technology Implementation	Totals:	266	760	1,867					
Technology Marketing	RESEARCH	2	2	15					
Technology Marketing	Totals:	2	2	15					
Textile Chemistry Research	FABRICAST	11	79	371					
Textile Chemistry Research	IMPLEMENTATION	11	67	161					
Textile Chemistry Research	RESEARCH	70	526	1,204					
Textile Chemistry Research	STANDARDS	1	2	6					
Textile Chemistry Research	TECHNICAL SERVICES	3	19	28					
Textile Chemistry Research	Totals:	96	693	1,770					
	Totals:	462	1,688	5,034	190	15,321	34	35	303

Strategic Objective 3: Develop and maintain software tools to buy, sell, move, and use cotton with improved efficiency and profitability.

Software Development and Maintenance

Updated Software

MILLNet™ software was modified to add the suggested electronic warehouse receipt (EWR) bale tie codes for electronic data interchange (EDI) import/export and database reporting purposes. Additional programming updates for the MILLNet™ software primarily based on customer requests have been completed. Staff also completed a file conversion to include support for U.S. mills that require contracts priced using the CCC loan table to include the new plastic extraneous matter discounts. For the USCROP™ system, staff updated the CCC Loan tables to include the 2020 table.

The beta version of the Android™ handheld barcode readers that link to the MILLNet™ program was turned over to the Technical Service team for testing in the first half of the year. As bugs and issues were reported back, programming updates were made. Staff completed extensive testing and added support for Android™ handheld barcode readers, leading to the roll-out of MILLNet™ for the Android™ operating system. This update is significant because Microsoft® no longer supports current Windows® mobile operating system programs.

Staff also worked with the Technical Service team on a MILLNet™ polishing project to improve consistency throughout the programs. Items improved included: various tasks within the data editor, including control chart display, Upland and Pima recap summary reports, preview options, and security settings. The transfer program added double click to open options, un-receive bales added several enhanced options, and enhanced transfer options were provided. In the picks section, modifications were made to pick edit, configure, and template editor. Import/export enhancements were also made. Other minor additions were completed to bring consistency throughout the program.

The staff completed evaluations on how less expensive, smaller handheld color systems read color versus HVI® color readings. The staff assessed those systems' abilities to transmit data and, based on those assessments, initiated a project to allow the use of these handheld systems with MILLNet™ software. The MILLNet™ program had previously been interfaced with a portable spectrophotometer for scanning cotton samples in a laboratory environment. The new release expanded on this option by interfacing a low-cost spectrophotometer to a mobile computer that can be used in the warehouse to scan cotton samples and integrate the bale number with the color results. This option allows for correcting for a color shift when necessary. The development of this MILLNet™ option required several steps. Staff developed a software/hardware interface and a software algorithm that would better correct the raw data read from the handheld spectrophotometer to USDA Rd and +b values. The system provides a report to show the differences between the measured Rd and +b and the USDA data. And if a color shift has occurred, it allows a merge of the new data to bale data fields used for processing the cotton for laydowns.

With all these new features and improvements, a new version of MILLNet™ software was released (5.1.009). The update includes all improvements/fixes and polishing made to the core program, the update for Andriod™ handhelds, and the release of the color testing module in MILLNet™ software.

Programming also worked on a simple program to convert the PEL HVI® data for trash count and percent area into the USDA-AMS leaf grade using AMS information. This convert program was updated to allow the lab staff to import an excel test report with HVI® data and export an updated excel spreadsheet containing upgraded leaf grade. This software will remain internal, but the AMS leaf grade is critical for many of the AER projects that rely on information for determining the impact of processes and agricultural systems

Strategic Objective 4: Service and market CMS products that promote cotton as the most efficient and profitable fiber in the marketplace.

Software Service and Marketing

Updated Trax® Software

Staff coordinated with the vendor for new updates to the TRAX® customer database. The updates include reports of licensees by country showing hasp expiration dates, lease dates, and the number of facilities with software.

MILLNet™ Software Conversions

The goal for the retirement of the previous version of MILLNet™ software was December 2020. Staff was able to complete conversions for all licensees except for two as of the end of 2019. In the first quarter of 2020, the software conversion was completed for one group in Mexico. This leaves only a group in China remaining on the old version, but travel restrictions prevented staff from doing this conversion. A conversion involves transitions of the database containing information about the textile mill inventory. At this time, the team is not comfortable with making such a radical change remotely because problems, should they occur, could result in shutting the mill down if the software conversion fails. Additionally, the group that is still on the old system has declining U.S. cotton levels and is likely to cease using the software soon.

New Licensees

Four new MILLNet™ software licensees were added this year. One is a Nicaragua facility's addition for an existing global licensee that processes 100,000 U.S. bales per year (Nicaragua site only). The team was able to complete installation and training before SAH orders occurred. The second new licensee is located in Korea and processes 38,500 U.S. bales each year. The installation and training for this group were done partially in-person before SAH and then completed remotely. The third group is the first-ever client in Bangladesh, and the first mill site processes 29,400 U.S. bales per year. This group represents a change in the software marketing approach because the staff has never visited the mill in person. This group's extensive vetting was done through both a U.S. merchant and a consultant group based in the UK. Staff spent many hours communicating via email and in virtual sessions before agreeing to sign this group. This group also represents the first-ever 100% remote installation and training, which was started in mid-December. The final group to be signed is the first mill in Turkey. This Turkish facility is another part of an existing global licensee and processes 38,000 U.S. bales per year. The Turkish facility is targeted for installation and training in the first quarter of 2021.

Technical Service Efforts

On-site Technical Service visits to provide yearly routine services were done in Mexico, Nicaragua, and the U.S. before travel restrictions were set. Remotely, the team provided additional MILLNet™ training for new staff at one facility in Peru and one in Vietnam. The team supported several clients in setting up remote options for accessing MILLNet™ software during SAH orders in numerous locations. Technical support was provided for a data crash at one site in China and a more significant issue with data at another group in Peru. The team responded to general support requests from clients that were still operating in the office as well as remote offices. Throughout 2020, the staff fully supported customers in the same capacity as before the pandemic. Users received data corrections, tutorials, training, and remote office setup assistance, among other services. The feedback received from users for the service provided has been positive, with few realizing the team is primarily working from home.

With the programming for Android™ handhelds complete, the Technical Service team initiated quality assurance testing for the system, entering the test cycle, program update requests/bug fix, and retest. The new MILLNet™ program updates based on customer service requests have also undergone quality assurance testing before the planned release. The team also completed the second round of complete MILLNet™ testing and submitted change requests to development. The overall functionality of the MILLNet™ software is solid, and most of these requests consisted of user interface and user experience changes to increase the usability and consistency of the program. In the last half of the year, the Technical Service team initiated a MILLNet™ software polishing project going through the entire program, searching for bugs and inconsistencies. Every program in the MILLNet™ system has been updated to reflect functionality and usability changes.

The teams also completed a customer contact sheet and gathered data for MILLNet™ software customer statistics from 1985 to 2020.

To transition to remote installation and training, the team created a new remote/virtual training package. MILLNet™ installation and training typically consist of several on-site preparation visits followed by a weeklong visit consisting of three full days of classroom training and then two days of handholding to get them started in the mill. The on-site mill portion is to physically help the licensee tag bales and do the first laydown. Staff used free screen capture software to convert existing powerpoints into training modules that now contain step-by-step videos of how to run the software. IT provided a means to host this on a protected Website that only licensees can access. All this was done at no additional cost to the company.

Marketing Efforts

In the first quarter, staff visited with potential clients in Mexico and Peru and an existing client in El Salvador seeking possible expansion of EFS® system into their newer Honduras facility. Once travel restrictions were in place, staff continued communications with target clients, including two groups in Indonesia, one long-term target in Mexico, one long-term target in

Peru, one existing client with a new acquisition in Turkey, a new target in Vietnam, and discussions with a representative for a group in Bangladesh. That group in Bangladesh was signed, and the target in Vietnam has made a verbal commitment for signing in 2021. Marketing efforts continued throughout the year, but staff shifted efforts towards remote installation and training preparation activities as a more significant team effort. The team also provided Technical Service for the target group in Peru on a barré challenge and to build up their confidence in Cotton Incorporated as a future partner.

The package of software products currently being marketed include:

EFS® System MILLNet™ 5.1.009 software

EFS® System MILLNet™ for Merchants 8.2 software

EFS®-USCROP™ 8.7 software

Cotton Communicator™ 1.0.025 software

PRODUCT DEVELOPMENT AND IMPLEMENTATION

Strategic Objective 1 Concentrate efforts on broadly defined key market categories where cotton has suffered significant market share erosion. Identify and research sustainable innovations in technology and product development that can recover, grow, and preserve cotton market share.

Package Preparation for Functional Finish Research

Since January 2020, FP staff have performed package preparations on two projects in support of Cotton Incorporated's TOUGH COTTON™ technology. Six additional projects, collectively totaling 419 pounds, were performed on a mixture of doubling, twisting, and backwinding of yarns for PD projects.

Spun Yarns for PUREPRESS™ Technology Developments

During the fourth quarter, a second iteration of yarns treated with PUREPRESS™ technology were produced on three spinning systems (240 pounds) in FP to support PD and TSI fabric research. The FP team also provided ongoing support for inter-departmental teams throughout 2020, including yarn and dye package preparations for many PUREPRESS™ technology developments.

Novelty Twisted Yarns for Flatbed Knitting Developments

Exploration of novelty engineered, plied, and cabled yarns continued into the fourth quarter, involving color blends and twist levels for unique fabric developments in flatbed knitting. Fiber Processing conducted research on minimum, medium, and maximum twist levels to achieve desired fabric effects. Five-ply yarns, of various colors in fine-count yarn, were supplied to PD to create novelty appearance in fabrics containing 100% cotton yarn. Novelty yarn research will expand into 2021.

Cotton/Wool Blend for Fleece Developments

The FPL produced a combined 215 pounds of cotton/wool, composed of Ne 30/1 ring-spun yarn using an 80/20 blend, and an opposing twist Ne 30/1 compact ring-spun "S" twist yarn to support PD research with improved fire retardancy of fleece fabrics and skew control of sinker loop terry fabrics.

Nonwoven Developments Utilizing Recycled Fiber and Low Value Cotton

Prototype nonwoven trials were conducted by FP using recycled t-shirt and denim fibers as well as highly discounted, low micronaire cotton, to create additional value for these low-cost raw materials. Just before all Company travel halted in March, an FP team member worked with engineers at a manufacturer in Clover, SC, to develop several nonwoven prototypes using recycled denim and t-shirt fibers. Hydroentangled t-shirt and denim wipes were produced along with a composite substrate which had denim fibers on one side and t-shirt fibers on the other side. The success and interest of these prototypes has led FP to run additional nonwoven developments with the manufacturer in 2021.

Novelty Yarn Evaluation of Utilizing Recycled Fiber

Circularity remains a very important topic for today's textile manufacturers and brands. A recycled fiber yarn development was initiated by FP utilizing denim shoddy to create random slub yarn, a novel effect ring-spun yarn. Spinning mills have always been efficient in directing their reworkable waste right back into the spinning process. However, the use of recycled fibers from fabric cuttings or other pre- or post-consumer waste streams present more of a challenge to yarn spinners. Even small additions of just 10 or 20% of recycled fibers mixed in with the mill's cotton bales can have negative effects on the resulting yarn and fabric properties. The FP team developed a novel approach, controlling the introduction of recycled denim fibers to minimize the negative impact on yarn properties. The denim fibers provide a unique look to the fabric. This initial iteration was well received by the PD team and FP will continue yarn developments with recycled fibers into 2021.

Nonwoven Technical Industry Article on New Cotton Co-Form Meltblown Technology

Members of FP and Global Supply Chain Marketing (GSCM) co-authored an article published in the March 2020 edition of Nonwovens Industry Magazine. The article highlights an innovative new process for introducing cotton flock to two meltblown streams of synthetic fiber. This work was supported by Cotton Incorporated and reported in 2019. The result of the new process was a fabric comprised of up to 90% cotton by mass. The cotton co-form structures have the soft and pleasant hand needed for applications such as cosmetics.

FABRICAST™ Information System – Textile Collections for Marketing Toolkits

Two FABRICAST™ Collections were completed in 2020. Collection 2020-1 debuted in January at the Outdoor Retailer Show in Colorado and at the ISPO Sports Trade Show in Germany. Collection 2020-2 was completed in October and distributed to account managers globally. The collections contain 76 new textile projects, that possess a variety of technical and aesthetic features and encompass the coordinated efforts and capabilities of all PDI labs and teams. The new apparel and home fabrics served to replenish assets for the fabric/product marketing toolkits utilized by GSCM, trade advertising, and corporate social media in their interactions with manufacturers, brands, and retailers. The collections include performance cottons via construction, blends, and finishes for shirting fabrics, outdoor activewear, athleisure wear, bottom weight fabrics, and denim. Yarn, color, stitch, and weave effects serve as inspiration, and the focus on sustainability endures with new projects for denim and synthetic fleece alternatives. Additionally, knit-to-shape, next-to-zero-waste cotton shoe uppers round out sustainability options offered in the collections. Main categories for the 2020 collections follow.

- Functional Performance Knits - TransDRY® technology is the performance moisture management process that allows cotton fabrics to wick and spread perspiration. Because TransDRY® technology starts at the yarn phase, the possibilities to engineer moisture management fabrics are endless. STORM COTTON™ technology provides water resistance and reduces the absorbent capacity for jersey and French terry fabrics. Feeder stripes, of cotton and synthetic yarns, allow for contrast dyeing and visual interest. Silver coated yarns combined with STORM COTTON™ technology provide antimicrobial properties, plus water resistance. Novelty yarns, in a heavier weight French terry, present a more athleisure feel while offering water repellency.

- Performance Cotton | Dual Technologies - To create additional levels of performance, this knitted collection includes the combination technologies of WICKING WINDOWS™ + TOUGH COTTON™, TransDRY® + TOUGH COTTON™ (moisture management and improved abrasion/durability), WICKING WINDOWS™ + PCM technology, and Sweat Hiding™ + WICKING WINDOWS™ + PCM technology (moisture management and phase change material). In continuation, projects with dual technologies were applied to cotton woven fabrics, producing additional levels of performance. The woven collection includes combination technologies of TransDRY® + TOUGH COTTON™ (moisture management and improved abrasion/durability) and TransDRY® + PUREPRESS™ (moisture management and wrinkle resistance). Some of the fabrics were printed for enhanced visual interest.

- Athleisure Flat Knits - Adding stretch to cotton provides all the benefits that are inherent to cotton and pushes it to the forefront of the ever-increasing athleisure market. Flat knitting technology allows various structures to be body mapped around the garment giving a sporty look and feel to the fabric. To achieve the looks, cotton novelty yarns with a techy feel were integrated with textural stitch combinations in engineered placed patterns.

- Inlay Technique for Cotton-Rich Synthetic Fleece Alternative - Inlaying yarn into a flat knit machine allows a heavier yarn to be tucked into a lighter-weight ground knit stitch. This provides the ability to use a wider size range of yarns without having an extremely heavy finished fabric. The inlay technique can also give a woven, tweed, or terry appearance to the knit fabric.

- Woven Lightweight Performance Blend | Cotton and Wool - This blend combines the performance of wool with the softness of cotton. Two plaids and a herringbone are in this collection of new flannels that have been mechanically brushed, or peached, on both sides for extra softness. No additional finishes were used.

- Textured Dobby | Garment Finishing Effects - This addition to a previous line of texture dobbies employs floats in the weave structure and contraction in finishing to create a heavily textured fabric. Shadow dye garment finishing effects were used to enhance the visual depth of the weave structures.

- Denim Embellishment | Embroidery - This fabric combines technology from the FPL, the PDL, and the Dyeing, Finishing, and Applications Lab (DFAL). Fiber Processing's new AGTEKS® yarn twister was used to create a three-end blue and white yarn with regions of over-twist. Product Development's new ZSK® embroidery machine was used to cord the yarn onto denim. The fabric was then washed down using the DFAL's Tonello NoStone® garment finishing technology.

- Texture + Warmth | Bedford Cords - These 100% cotton bottom-weight fabrics are an alternative to traditional twills and corduroys. The vertical cords in the fabric create visual and physical texture. The higher surface areas of the raised stripes were sueded to add a soft hand, like a corduroy. STORM COTTON™ technology was applied to the fabric to add water resistance properties which would make this a great choice for the outdoor market. This fabric would also be an appropriate option in the home market for light duty upholstery or top of the bed blankets.

- Texture + Warmth | Moleskin - A 100% cotton moleskin-base fabric was laser marked in an allover topographic pattern and finished with STORM COTTON™ technology. Moleskin is a filling face sateen that has been brushed and sheared for a velvety surface, an ideal fabric for adding a layer of warmth without adding too much weight. At a distance, the fabric appears to be a solid color, whereas up close the texture of the topographic pattern can be seen. This fabric would be a great addition to the outdoor market with its inherent warmth and water resistance.
- Lamination | Shiny Look, Technical Feel - These woven and knit fabrications have been laminated on the surface with a polyurethane film. The addition of the layer of clear polyurethane adds a shiny appearance to the surface of the fabric. All the fabrics have an unusual techy hand and look that will work for fashion and home markets.
- Mock Leno Weaves for Performance Through Construction - Breathable shirting-weight fabrics and sheeting textiles potentially offer performance benefits and were researched through open pore, mock leno, and leno structures, using the in-house Sampling Dobby Loom. Finishing trials to optimize the ventilating structures commenced while additional yarn and construction experimentation continued. Full width weaving, at an outside facility, will follow on the most successful prototype once the optimum structure is determined.
- Performance | Through Blends - Mechanically blending cotton with other yarns gives the opportunity to obtain a variety of fabric attributes desirable for the active market. When creating a cotton blend, yarns such as nylon and polyester provide a technical hand feel as well as a lighter weight. Flexibility in contrast dyeing allows for endless color combinations and custom dyeability without having costly inventory of dyed yarns.
- Performance | Through Construction and Blends - Lightweight Insulation | Knit Fabrics - Double knit blister fabrics are constructed by knitting and holding a series of stitches to create pockets within the fabric. Combining different yarns (size and fiber content) in these structures can cause differential shrinkage to occur in wet processing, creating a puckering effect. This provides light weight insulation, desirable in base layer fabrics. Knitting cotton and nylon together gives the opportunity for contrast dyeing and provides quick drying. Cotton remains the dominant fiber in the fabrics providing comfort and breathability.
- Performance | Through Construction - Breathability | Woven Fabrics - Textile structures can be manipulated using traditional and novel techniques to change air permeability, insulation, and other factors that affect environmental comfort. Mock leno weaves create small pinholes in the fabric by deflecting yarns and opening air passages. These integrated structures created air permeability without sacrificing the strength of the fabric.
- Performance | Through Construction - Durability | Woven Fabrics - The tricotine construction is traditionally known for its durability to abrasion. It is a variation of a twill, also known for its toughness, with double twill lines on the face to protect the integrity of the fabric over time with wear. Visual and surface texture is seen in this fabric by the placement of a slub, jaspé yarn in the filling. One version included a striking print on the technical face of the fabric lending itself to be used in a garment with a double-sided option. This version also has an additional layer of performance with a STORM COTTON™ technology finish.
- Color Stitch and Weave Surface Design - Black and natural stripes provided an appealing canvas for bold print patterning. Varying widths of stripes from front to back created the prospect for dual sided garments. Sparse loops in a jacquard sinker-loop terry gave the illusion of a novelty yarn. Using polyester in the ground and cotton for the loop provided endless color combinations through contrast dyeing with reactive and disperse dyes. Plated constructions were comprised of a yarn on the front of the stitch and a separate yarn on the back of the stitch for double sided visual effects. On a single jersey this gave different appearances to the face and back of the fabric. The plated stitches of this fabric highlight jersey and reverse jersey zigzags while creating a grin-through effect for a noisy appearance. Fabrics knitted with jersey and reverse jersey stitches have the tendency to pull in which gives great stretch and recovery and a multi-dimensional aesthetic. Due to its construction, this fabric naturally pleated as it was knitted. The black and natural theme continued in woven developments with a traditional color and weave effect, Glen plaid variation, and a geometric dobby. The 2x2 twill, color and weave effect fabric is shown in two very different versions. The first is printed with a discharging paste in a distressed pattern that highlighted the use of vat (bleach resistant) dyed yarns and direct dyed yarns. The second offered a sueded soft, flannel like side and was enhanced with STORM COTTON™ technology for water resistance. A geometric, drapey dobby was shown on its own and is also printed. The printed fabric has visual appeal due to its colorful, organic geode pattern juxtaposed against the square textures of the base.
- Yarn Effects - Two sophisticated woven fabrics were developed in-house on the CCI dobby loom. A textured crowfoot weave was constructed with a natural warp and a multicolored novelty yarn in the filling. The novelty yarn was

developed in the FPL with an indigo plied yarn variably twisted with a white yarn for a beautiful effect. The resulting fabric would be a great alternative addition to a denim collection. In another construction a diamond twill was enhanced with a subtle, silver sheen due to the novelty yarn in the filling, a perfect choice for women's wear and home markets. This natural blend of cotton and hemp fibers encompassed both a home spun look and a dry hand feel. The hemp and cotton novelty yarn were combined with traditional cotton yarn to create an understated sophistication. The 18-gauge single knit jersey fabrics were constructed with double covered yarns (spandex covered with two ends of fine cotton yarn). This yarn provides stretch without requiring the use of special spandex feeders typically used with bare spandex. The fine yarn count used on coarser gauge machinery created a loosely knit fabric that allowed the fabric to contract in wet processing, creating textural crepe-like interest in simple jersey constructions. A cabled yarn was created by twisting a variety of colored, fine gauge yarns into a heavier count, providing the opportunity for a vast array of color combinations. Another swatch uses three yarn dyed yarns to create three different combinations that work together to give a tie-dye or ombré effect to the fabric. From a sustainability standpoint, this is a great way for companies to create new looks with overstocked yarn, a continual problem in garment production. Woven look fabrics were created by inlaying or weaving yarn between the knit stitches, giving horizontal floats that are a common characteristic of woven fabrics. The inlay technique gave minimal horizontal stretch while maintaining the vertical stretch you would expect from a knit. These fabrics are perfect for knit garments that require more structure. STORM COTTON™ technology makes these garments ideal for updated fashionable water-resistant outerwear.

- Collaboration – Translating Art and Design to Digital Printing - Product Development participated in research with students and faculty at Hariot Watt University on a challenging project around printing on cotton warps prior to weaving. A group of students in the textiles program created original woven designs with one being selected for FABRICAST™ collection inspiration. The winning design was a handwoven piece, and the student wove enough yardage for PD to be able to show alongside the FABRICAST™ collection development. A 100% cotton satin was digitally printed in Cotton Incorporated's Research and Technical Center using a scan of the original handwoven piece.

- Sustainability Focus | Synthetic Fleece Alternatives - Studies have shown that synthetic fleeces are sending microfiber plastic to waterways; therefore, these biodegradable cotton rich fabrics were developed as a step towards a natural solution. Terry fabrics for mid or outer layer apparel took on other dimensions when the intarsia technique was incorporated. Intarsia added a wide array of patterning opportunities and allowed for placement of terry sections that could be used for patterning or even body mapping. Cotton terry with a low percentage synthetic blend and natural cotton/wool fabrics were created as alternatives to all synthetic fleeces that are prevalent in the current apparel market.

- Sustainability Focus | Biobased Dyes + Lower Impact Garment Processing - As more mills and brands express interest in biobased dyes for their textiles, the cotton biomass EarthColors® denim fabrics woven at a major U.S. mill continued to be important. This current project was based off two jean samples that were developed during a trial with a major machinery manufacturer. These jeans were shown to several mills which demonstrated a keen interest in developing similar product. The TCR team used technical experience, alongside instructions provided by the machinery manufacturer, to create on-trend lower impact denim pant legs. Additional denims highlighted the use of pre-reduced indigo that was foamed onto the warp yarns via the IndigoZERO™ process.

FABRICAST™ Collection Metrics

During the stay-at-home order, PD prepared sample requests for major brands and retailers in a creative digital format in lieu of physical fabric sample booklets. Once the office reopened, certain requests were transformed to physical booklets. To date, a total of 151 companies have submitted 197 requests, for a grand total of 3,144 fabric samples disseminated to the industry. The following tables represent the top-requested fabrics in 2020.

Circular Knit Fabrics

Project Number	Number of Requests	Description
SK-2099-1B	30	Cotton/wool/spandex blend, sinker loop terry sherpa
SK-2088-1A	29	Cotton/wool blend, three-end fleece
SK-2101-1	29	Natural Story – Mushroom fabric
SK-2088-1B	27	Cotton/wool blend, three-end fleece sherpa look
SK-2099-4	27	Cotton/wool blend, sinker-loop terry sherpa

Flat Knit Fabrics

Project Number	Number of Requests	Description
FK-1078	17	Lasered indigo-inlay bouclé
FK-1069-1	17	Foil printed needle out with monofilament nylon
FK-1077	16	Laminated inlay bouclé
FK-1081	13	Plated Links – Links with STORM COTTON™ technology
FK-1080	12	Jacquard ottoman with STORM COTTON™ technology

Woven Fabrics

Project Number	Number of Requests	Description
7236-3	25	Lasered velvet – STORM COTTON™ technology
7236-4	19	Lasered velvet – STORM COTTON™ technology
7236-1	18	Lasered velvet – STORM COTTON™ technology
7236-2	18	Lasered velvet – STORM COTTON™ technology
7075-3B	17	Lasered moleskin – STORM COTTON™ technology

Internal Swatch Cutting Services

The PD sample cutting area prepares fabric swatches and information for Cotton Incorporated's fabric marketing and technical activities. The 2020 FABRICAST™ collection, including fabric hangers and technical swatch books, were distributed to Cotton Incorporated offices worldwide. Additionally, fabric swatches were provided to the Fashion Marketing department for trend presentations, to GSCM for Importer Support Workshops, and additional swatches were used for customer meetings and presentations. In total, the sample cutting room produced 2,541 fabric hangers and 10,700 swatches for distribution to Cotton Incorporated brand/mill account managers globally, in addition to accommodating fabric requests.

TOUGH COTTON™ No Resin Technology for Sweaters

A project involving a sweater treated with TOUGH COTTON™ no resin technology, targeting opportunities to promote cotton in outdoor active apparel, progressed with additional lab trials planned. For a longer lasting product, the technology will increase resistance to abrasion especially at the elbows, a feature sought after by outdoor brands. The logistics of processing the sweaters to maintain a clean smooth surface while imparting the needed performance finish will continue.

Lighter Weights and Construction

A study on yarn sizes and stitch length commenced on the newly installed fine gauge knitting machine to continue work on performance through lighter weights and construction. With the delays caused by the pandemic stay at home orders, this project was postponed until 2021.

E-Textiles

Research and development (R&D) continued into wearable electronics and smart textile technology. To monitor what is happening in this space, PDI attended virtual smart textile and e-textile conferences. By tracking e-textiles through industry connectivity, PDI stayed abreast of technology trends. It is clear the technology trajectory is still full of possibilities. Efforts focused on how to best include cotton in the evolution of smart textiles. Ensuring cotton is included in the future of e-textiles is important as most of the work that is occurring is with synthetics. For an e-textile innovation project, PD partnered with a specialized materials company for printing electronic circuits onto thermoplastic polyurethane (TPU) film which could then be applied to cotton fabrics for wearable electronics. The goal is to have display quality cotton-rich fabrics, enabled with digital heating technology using printed conductive ink on TPU film, for future trade shows and other events. Fabrics with some degree of stretch have been used to take advantage of the printed TPU circuits pliability.

Cotton Knit Shoes

The development of 3D-knitted cotton shoes continued with a successful version released in the FABRICAST™ collection 2020-2. Yarn sourcing for adequate stretch and compression continues, and the wait for the spandex feeders to be installed continues. This will aid in compression and shape retention. The first prototypes of cotton knit shoes with soles were completed and

presented a variety of problems, as anticipated. The 3D-electronic flatbed knitting machine acquired in September will have added features to aid in building greater functionality.

Cotton-Bale Twine Research

The PDI team participated in collaborative research into a cotton alternative to synthetic hay-bale twine, engaging a team of researchers from FP, PD, Agricultural & Environmental Research (AERD), and Fiber Competition (FC). Challenges for this project remain including strength, durability, and cost. The plan is to continue exploring potential opportunities and to build a knowledge base of existing products in use.

Cotton and Graphene

In coordination with TCR and PD, the PDI team commenced research into yarns containing graphene. A nylon 6,6 yarn with graphene molecularly attached was combined with cotton yarn in a prototype double-face knit construction. Manufacturers claim graphene possesses a variety of properties, including heat capture and retention. The next phase is to move from small lab scale work to producing adequate yardage for garments to be made and tested.

Woven NATURAL STRETCH™ Fabrics

Interest from the industry for stretch in pants without the use of synthetics, including spandex, prompted a renewed push to develop updated NATURAL STRETCH™ cotton woven fabrics. Comfort stretch in 100% cotton woven fabric is achievable via fabric construction and slack mercerization. Identifying partners to collaborate with on mill-based trials has been a challenge because of the worldwide COVID-19 pandemic. Once there is more stability in the supply chain and retail reopens, mills will be more inclined to conduct collaborative R&D activities. Lab-scale preliminary work will be done in the Research and Technical Center; however, getting suppliers in place for industry adoption remains essential.

Fit and Flare Knitwear

The fit and flare concept created excess fabric in certain areas to allow a garment to fit the form or to create desired flare (volume) in specific areas. Three-dimensional shaping in fabric through machine programming lends itself to sustainability by reducing yarn and fabric waste. Two different methods are being employed for fit and flare. One method is doubling, to create a pleat or ruffled effect by using a larger number of needles and then transferring over to a smaller number of needles. Another method is gore, used to create an A-line shape by knitting triangular pieces to other similarly shaped pieces. By turning the fabric for mounting, a garment is finished smaller at the top and wider toward the bottom of the hemline.

Cotton Warp Knit Initiative

A PDI team traveled to Germany during the first quarter to meet with a major warp knitting machinery company. Successful, collaborative trials were run using Upland cotton yarn. This is an exciting development as warp knitting technology is mostly synthetic based and this work can open new markets for cotton. Several rolls of fabric were produced in the R&D center at the machinery manufacturer's facility and recently shipped to the Cary Textile Research Center. A plan will be put in place for dyeing and finishing the fabrics followed by testing and evaluation.

Performance Through Construction Knits

Yarns produced by the FPL (Compact RS & MVS) were used to knit several iterations of the novel mushroom fabric to reduce weight, decrease cost, and create different looks. Minimal finishing will be used in processing these fabrics to show sustainable focus for the Natural Collection.

3D Digital Fabric Files

Over 200 Cotton Incorporated fabric developments were converted to digital 3D computer files for use in well-known 3D apparel software applications. These 3D ready computer fabric files of the FABRICAST™ collections are available on the CottonWorks™ Website for brands and retailers to work with. Playing an active role in the digital transformation of the apparel industry in the way garment design and pattern making is performed keeps cotton highly relevant and forward thinking.

TOUGH COTTON™ Technology on Sweater Knits

To improve the performance characteristics of 100% cotton sweaters, trials were designed to develop a process to improve the durability and abrasion resistance of sweater knit fabrics by using TOUGH COTTON™ technology. The goal of this research was to establish a process for applying TOUGH COTTON™ technology to sweater knit fabrics utilizing the machinery capabilities typically found in sweater garment finishing facilities. Trials were conducted and documented using two typical procedures: the

dip & extract method, and the metered addition process (MAP). Lower cure temperatures were also studied and determined to be possible in a lab setting. TOUGH COTTON™ technology exhaust trials, conducted in-house on purchased sweaters (GPPL#2020-035), were completed simultaneously with trials conducted in Asian mills in coordination with the Asian staff. Results from the in-house sweater trials were inconclusive due to the nature of the purchased sweater's finish and construction. New trials were then conducted under controlled conditions on controlled sweater knit fabrics. Sweater (GPPL#2020-045) fabric was knit in the PDL using yarn dyed in the DFAL and then scoured and exhaust treated with TOUGH COTTON™ technology in the Garment Processing Lab. The four trials are being submitted to the Product Evaluation Lab (PEL) for testing.

TOUGH COTTON™ Technology for Yarn

Research has been conducted to provide a method for applying TOUGH COTTON™ technology to cotton yarns that can be knitted into socks or other substrates. Various suppliers' products have been evaluated and approved. Abrasion tests were consistently good for the fabric knitted from the yarns treated with TOUGH COTTON™ technology. In addition, it was found that the fabric made from the treated yarns can be scoured as well as scoured and dyed while maintaining the abrasion resistance. All completed yarn application trials in DFAL have been written into technical reports. Another report will be written about the fifth set of pilot scale trials on the Thies machine in DFAL; the fabric samples knitted from the treated yarns have been overdyed into two different colors. The latest dyeing was performed in the Mathis JFO with Reactive Blue 19, and there were no shade differences between untreated and treated fabrics. A mill in Asia is currently running a production trial for an interested brand.

TOUGH COTTON™ Technology for Denim – Lasering

The goal of this project is to investigate lasering of denim, either prior to application of TOUGH COTTON™ technology (garment application) or after the TOUGH COTTON™ finish is applied (pad application). This could create new uses for TOUGH COTTON™ technology, as brand interest is on the rise for this technology, and laser etching of denim is a more sustainable option. Pad application of TOUGH COTTON™ technology, followed by laser etching, on chambray denim has been very successful. There have been some challenges in the application of TOUGH COTTON™ technology to pre-lasered pant legs. Even without laser etching, the abrasion resistance has been marginal at times when applying TOUGH COTTON™ finish by metered addition or dip/extract. Trials are now in progress to apply the new exhaust version of TOUGH COTTON™ technology.

Flame Retardants for 100% Cotton Fleece

The scope of this project is to develop an environmentally friendly flame-retardant system for 100% cotton fleece fabrics. Preferably, the flame-retardant system can be co-applied with STORM COTTON™ technology. The previous DFAL trial had problems that appear to be due to hydrolysis of the non-formaldehyde flame retardant finish in hot, humid conditions from the DFAL and warehouse during summer climate. Plans are in place to continue the lab trials and aging tests. A test was developed in the environmental chamber in the DFAL to simulate the aging of the finished fabric. The most recent lab trial indicated that a "buffer wash" in lieu of the water-only process wash may help to alleviate the hydrolysis of the finish, so the new trials will focus on the buffer wash. A cotton fleece fabric that was re-engineered for stability and appearance was treated with the non-formaldehyde finish at the beginning of the summer in DFAL using the buffer wash procedure. This fabric was left in hot, humid conditions in the DFAL for three months, and it still passed the flammability test after refurbishing. If lab trials succeed, a dyed fleece fabric will be run in the DFAL on un-napped and pre-napped samples. In the fourth quarter, one technical report was written regarding the aging trials.

PUREPRESS™ Finish Optimization on Cotton Knit Fabrics

Optimization studies help determine the best overall parameters for applying recently developed non-formaldehyde resin technology to cotton knit fabrics. In addition to durable press performance, wicking, and drying time performance will be examined. A division-wide project tested a set of cotton knit fabrics using different spinning systems and fabric constructions, both with and without yarns treated with TransDRY® technology. Lab trials have been conducted to apply variations of the PUREPRESS™ finish for knit fabrics. The results were very good regarding durable press, shrinkage control, and burst strength, except for a jersey fabric made from MVS yarns, which was too weak even before the application of the PUREPRESS™ finish. The same knit fabrics from the initial study were scoured in a garment machine to improve wicking prior to the PUREPRESS™ finish application. Wicking tests were evaluated at the end of fourth quarter in the PEL. Samples of the fabrics that have different yarn types (MVS, ring-spun, compact ring-spun) will be lab finished in 2021 to determine if there are any differences in fuzzing/color retention after 20 home laundry tumble dry cycles (HLTD).

Dual Technologies

Combining Cotton Incorporated technologies debuted in 2019, with a continuation into 2020. Combinations of technologies create cotton fabrics with additional levels of performance to better compete with synthetics. Various combinations are evaluated for strength, comfort, and increased levels of performance.

- WICKING WINDOWS™ + TOUGH COTTON™ Technologies – Teams investigated the potential to combine WICKING WINDOWS™ + TOUGH COTTON™ finishes for improvements in both moisture management and abrasion resistance. Rotary screen print trials using WICKING WINDOWS™ finish were conducted at the end of fourth quarter in 2019. The trials included C6 fluorinated prints and non-fluorinated prints, on both knit and woven fabrics. The TOUGH COTTON™ finish had a negative impact on wetting time for prints with the non-fluorinated WICKING WINDOWS™ finish. Print trials of WICKING WINDOWS™ finish and pad applications of TOUGH COTTON™ finish were conducted in-house to optimize the performance of both components for this project. The TOUGH COTTON™ finish showed a tendency to cover the print on tightly woven fabric constructions. Trials were conducted to investigate the effects of increasing the concentration of water repellent components in both C6 and non-fluorine print pastes using WICKING WINDOWS™ finish and reducing the concentration of the softeners in the TOUGH COTTON™ finish. After successful lab scale application of modified TOUGH COTTON™ with non-fluorine and C6 WICKING WINDOWS™ finishes on navy twill, the lab scale trials were continued to explore the application of modified TOUGH COTTON™ with non-fluorine C6 WICKING WINDOWS™ finishes on jersey fabric. The results of the trials on jersey fabric were unfavorable. Further trials to improve the combined performance features are planned in 2021.

- Soil Release + STORM COTTON™ Technology – This project seeks to develop a STORM COTTON™ finish treatment that is dual action and can repel water and release stains after 30 HLTD. This combination evolved from a brand request for a STORM COTTON™ finish treatment that also released stains. Multiple lab trials have been run attempting to release corn oil staining after five HLTD with a five rating (perfect) and a four rating after 30 HLTD, plus repel water with a 70-spray rating or higher. The industry standard for soil release, when tested with corn oil, is a three rating after five HLTD. Soil Release + STORM COTTON™ technology (TCR20-05) surpasses the established industry standards when tested in the TCR lab. Confirmation testing was ongoing in 2020. Lab trials have affirmed that the wickable C6 soil release can be applied alone and in combination with the TOUGH COTTON™ finish treatment permitting the removal of 100% of the corn oil, soil release rating of five, when tested (American Association of Textile Chemists and Colorists (AATCC) Test Method (TM) 130) after five HLTD. A wickable non-fluorine soil release from a U.S. company provides self-curing capabilities and lab testing results suggests that this treatment provides the best soil release performance (rating of five) when applied alone. Additional soil release technical reports were finished in the fourth quarter.

- WICKING WINDOWS™ + PCM + Sweat Hiding™ Technologies – The goal of this project is to develop a soft hand, durable print combination that is applicable to knits, and allows sweat to absorb into the back side of the fabric but not soak through. Acrylic Phase Change Material (PCM) 28°C combined with non-fluorinated WICKING WINDOWS™ technology was screen printed on large rolls of fabric offsite. In addition, a C6 version of the Acrylic PCM + WICKING WINDOWS™ technology was printed on one side and C6 Sweat Hiding™ finish was printed on the other side of the fabric. The dual print technology containing WICKING WINDOWS™ with PCM technology for non-fluorine chemistry and WICKING WINDOWS™ with PCM plus Sweat Hiding™ technology with C6 formulation were successfully scaled up on the knit fabric constructions at this trial.

- Incorporating NATURAL STRETCH™ Technology - The goal here is to develop new NATURAL STRETCH™ woven samples for the FABRICAST™ collection, in combination with TransDRY® and PUREPRESS™ technology. There are new opportunities for 100% cotton stretch fabrics to replace blends with cotton and elastic fibers or yarns, especially in view of the concerns about synthetic microfibers in the environment. Production trials have been successfully run combining NATURAL STRETCH™ with PUREPRESS™ technology. A mill has been contacted by PD to provide quotes for creating NATURAL STRETCH™ fabrics, with and without yarns treated with TransDRY® technology. There are also efforts to find a denim mill that would process engineered denim fabrics for NATURAL STRETCH™ technology. An order has been placed for NATURAL STRETCH™ bottom-weight woven fabrics and work will continue into 2021.

Bis-ether-di-quat (BEDQ) Cationization of Cotton

Pursuing development of a new cationization of the cotton platform, based on a newly patented cationization molecule from a major chemical supplier, is the goal of this project. Throughout the second quarter, the TCR team worked through data collected

in experimental trials and created graphs and analysis. Prior to the pandemic, TCR planned to collaborate with a brand, highlighting the usage of this chemistry. It is unknown if the collaboration will proceed soon. Discussion continues with Marketing and Industry Programs about the possibility of doing a new cationic cotton webinar. This webinar would potentially discuss work with a new chemical company product and be an update to the last cationic cotton webinar, which aired in June 2016.

Newness Retention for Cotton

This project seeks to develop a finish application for cotton that will extend the as-new appearance of a cotton garment. This includes improving smoothness, abrasion resistance, and color retention. The TCR team has zeroed in on a complex multi-functional recipe and a simple three-component recipe for color retention only. The next phase will be to evaluate these finishes on similar fabrics and colors as previous trials. To do so, the process of obtaining large quantities of previously evaluated fabrics and colors is underway. These requests have been in DFAL and are expected to be completed as time permits. Initially, plans intended to focus on the simple combination formulation but just recently learned that the main components are being phased out of production by the main supplier, which is a large obstacle. The approach will need to be changed and will likely focus on the more complicated version or the identification of alternative components, which has proved unsuccessful thus far.

Cotton to Sugar

Refining a process that allows cotton-based textiles to be enzymatically digested into sugar for the potential to further obtain ethanol or other value-added products is the goal of this research. Many experiments have been carried out to strip and/or remove and mitigate color on garments to improve hydrolysis efficiency. The use of co-additives, such as bovine serum albumin (BSA) and a sodium surfactant, have been evaluated to improve hydrolysis efficiency. Both additives appear to function by different mechanisms but noticeably boost hydrolysis efficiencies when added to the process. More recently, experiments have started with the usage of a water treatment polymer commonly utilized to flocculate impurities. Interestingly, even though this polymer is highly charged, initial results found considerable hydrolysis efficiency boosts when added to bleached and reactive black-five dyed cotton. The agitation in the hydrolysis process has been extensively studied by varying the amounts of stainless-steel beakers included in the process. This was a very time-consuming process, but success was found by scaling the process from five to 30 and even 60 grams of fabric obtaining consistent and, in some cases, even higher glucose conversions than with five-gram samples. Highly correlated data was produced, clearly showing the impact and importance of agitation and reactor ratios. Numerous attempts failed to accomplish the expected efficiency for this hydrolysis before the aforementioned studies occurred. Scaled up hydrolysis experiments have been accomplished by garneting only, without grinding the samples. The TCR team is in the process of preparing a full patent filing from the provisional patent filed almost a year ago.

Durable Thermal Regulation Finish for Cotton

This project looks at researching a non-formaldehyde thermal regulation finish for cotton that is durable and incorporates a moisture management technology. The TCR team worked with new vendors to find different sources for PCM to print on substrates. Multiple lab trials have been conducted for different formulations on various types of both knit and woven fabrics. The best formulation and recipe to work with on cotton substrates was identified and the differential scanning calorimetry (DSC) results for the prints came out very well. The binder that worked out well with PCM for blotch print was further optimized based on the concentration by blotch printing using different binder concentrations and laundering the samples. Samples have been submitted to DSC for evaluation but visually the samples seemed to have retained the PCM well on the fabric surface. Further work was done with laser on the blotch print samples where different size pores were lasered onto the fabric. Air permeability results for the fabric have been promising. The print formulation for screen printing was reformulated with a new binder which worked well for blotch print. The mill trial with PCM screen printing and blotch printing was successfully completed in 2020.

3D Printing and Injection Molding

This project's focus was continuing developments with cotton-rich 3D print filament and injection molding resins by printing 3D objects, using the newly developed filaments, then evaluating their performance. The 3D printing market is growing with opportunities to introduce cotton in the mix. The TCR team is working with a new company to compound cotton/polylactic acid (PLA) and then test the material to help identify the best combination for large scale production of 3D print filaments and injection molding. Several cotton-based concepts produced in 2019 are being put into production in 2020, including makeup brushes and the Bogobrush toothbrush (which will be carried by a major drug store chain). New designs were developed of a clutch, used to hold a facemask securely on the face and 3D samples were printed. The company assisting with this project provided an update with more data collected from the study. They also sent plaques of the cotton-PLA at different cotton concentrations for in-house R&D.

Thermal Technology

The TCR team is researching ways to improve the thermal behavior of a cotton rich substrate using resources that contain graphene or minerals. Data was collected on different knit structures of fabric containing graphene to help identify the proper structure and dye combinations useful for thermal application. Fabric was knitted using the selected structure pattern. The TCR team is working with an outside lab to analyze the complete data collection. Plans for conducting a wear trial with the fabric to collect data in real time scenario were underway in the second half of 2020. A large roll of 100% interlock cotton and the cotton/nylon (graphene) were dyed in DFAL. The fabrics have been sent out to be made into eight long sleeve T-shirts for the next step of wear trial. Technical reports based on the data collected were completed in the fourth quarter.

Ozone Dischargability Characteristics of Reactive Dyes on 100% Cotton

This study is a preliminary segment of a much larger study to document and display the effect of more sustainable methods of discharging color on 100% cotton substrates dyed with reactive dyes. This study was designed to determine the optimum level of ozone needed to effectively discharge reactive dyes on 100% cotton-interlock knit fabric using the Tonello G1 70LJ1N2 ECOfree garment dye machine equipped with an ozone generator. Specifically, this study measured the effect that various levels of ozone exposure had on the amount of color loss of 100% interlock knit fabric dyed with Novacron® Super Black R. The results of this study determined the level of ozone exposure applied to various reactive dye primaries. Multiple ozone trials were performed on three-kilogram loads of interlock knit previously dyed with five percent (owg) Novacron® Super Black R, and color difference measurements were obtained. The data from the spectral color-difference readings was used to determine the ozone parameters for the ozone portion of the Sustainable Discharge Study of Reactive Dyes.

Cotton /Polypropylene Performance Blends

This project was undertaken with the aim of evaluating different blends and blending concepts of cotton and polypropylene (PP) to produce an inexpensive, chemical free, quick drying fabric. Earlier this year, in follow up collaborations with a chemical company, a new cotton/ PP blend concept was developed by air tacking the yarn. This approach allows a very easy creeling and knitting process as compared to working with alternate feeds and paying strict attention to balancing an alternate feed cotton/PP. Recently, a few yards of fabric were knitted and bleached from an air tacked Ne 40/1 cotton and 50-denier PP. The blend percentage is roughly 75/25 cotton/PP. Encouraging dry time results were obtained for AATCC TM 201 and the internal one-milliliter dry time test. Nearly identical dry time results were found in AATCC TM199. Additional work and evaluations may be warranted on this concept.

Natural Finish for Cotton

To explore the feasibility of a natural finish concept for cotton fabric, research is underway to explore the concept of a natural topical finish which produces a measurable improvement in a property. The application of chitosan has been chosen and chitosan finished fabrics have been evaluated for abrasion, with no change in performance. Interestingly, it was found that chitosan applied with or without polyfunctional blocked isocyanate (PBI) lasts up to 25 HLTD. Next steps will determine how to test chitosan treated fabric for odor control.

Pre-Treatment for Disperse Dyeing of Cotton

This project aims to develop an economical pretreatment that would enable cotton to be dyed with disperse dyes. This would facilitate a one bath dyeing of a cotton/poly blend and allow cotton to be dyed with neon shades. Various experimental finishes were prepared utilizing currently available water repellents and those were applied to cotton. The treated fabrics were dyed with various disperse dyes and staff is working to document those findings. Although these finishes do not work as well as previous exotic finishes, the simplicity and availability of these chemicals is promising. A patent was granted fourth quarter on the approach developed with another company several years ago.

SportDRY™ Cotton

The goal for this project is to create a faster drying cotton which absorbs less water for activewear applications. Development of the SportDRY™ treatment when applied to jersey knits requires additional lab testing to confirm that the standard treatments, co-applied with several different finish auxiliaries, can dry over three times faster than an untreated control after 30 HLTD. Water Retention (WR) dry time testing results on treated jersey knit fabrics after 30 HLTD were inconsistent without the complete removal of residual detergents after 30 successive launderings. A technical report, TCR19-09, has been written to present a solution. A simplified, economical finish that provides durable softness was also created. Display boards have been made and softness measurements are scheduled in Germany and in the U.S. to compare after different wash cycles. Further technical reports were in progress in the fourth quarter regarding the development of this finish.

Outside Research: Recycled Textiles to Bio-Based Building Blocks — Technology and Business Development Toward Pilot Demonstration

The goal of this study is to further evaluate the use of mechanical refining to pretreat cotton textiles for enzymatic hydrolysis. With the labs' closures, due to the pandemic, the principal investigators carried out an in-depth literature review to determine the current state of the research and technology of converting cotton into sugar. The goal was to publish this information, then have it serve as a baseline for future work. It was discovered that since there are limited studies on this concept, it is challenging to have a meaningful literature review. Therefore, the relevant literature will be included in a paper highlighting the findings of this project. The principal investigators updated their work making very exciting progress. The principal investigators have been able to obtain 80-90% conversion with the utilization of fiber refining even with low enzyme loading. The researchers have continued to carry out experiments refining the formula and parameters of the experiment. Researchers have also carried out several literature searches to determine the most profitable and realistic new value-added chemicals that could be made from glucose produced from cotton. A press release was prepared which briefly summarized the work Cotton Incorporated and North Carolina State University (NCSU) have done and are planning to do in this area of research. Work began on preparing a provisional patent application for the process being developed at NCSU.

Outside Research: Producing Nanocellulose Reinforced Lightweight Composites Using an Integrated One-Step Process from Cotton Waste Fabrics

The goal of this research is to study the effect of cotton-waste fabric pretreatments on fiber nano-fibrillation and fiber dispersion in compounding and extrusion. To investigate compounding/kneading parameters on nano-fibrillation and composite properties, PP, PLA, and acrylonitrile butadiene styrene (ABS) matrix polymers are being used. Applications of the reinforced composite will then be demonstrated through 3D printing. The final step will be to compare the reinforcing effect of cotton waste fabric to that obtained from the pulp. Different procedures to optimize the chemical modification of cotton nanocelluose were performed. The modified cotton fibers were used to reinforce PP by compounding and running tensile tests on the cotton reinforced PP. The tensile strength of the reinforced material seemed to increase with an increase in the degree of substitution (DS) of the modified cotton fiber. Work is being done on producing a modified polymer blend containing cotton from denim material with PP.

Outside Research: Anaerobic Decomposition of Cotton Fabric Under Simulated Landfill Conditions

This research was designed to evaluate the rate and extent of the anaerobic biological decomposition of three types of cotton fabric under simulated landfill conditions, and then compare the decomposition behavior of the cotton fiber to a synthetic polyester. Materials for this project were prepared in the DFAL and collected by a graduate student in January. Once laboratory work at NCSU began in mid-June, the reactors were initiated, but it was determined that the inoculum in the reactors was not functioning sufficiently. The fabric samples were retrieved from the reactors and photographed to record the degradation at that point. The reactors were reinitiated with fresh inoculum and results were presented after 62 days of degradation for this second round of samples. The methane generation of these samples is more consistent and in-line with expectations, except for one of the triplicate samples treated with silicone softener. The bleached fabric sample is showing the greatest amount of degradation, both through visual assessments and by volume of methane generated.

Outside Research: Microfiber Degradation in Aqueous Conditions

In 2019, PDI began a new phase of this work to study how finishes affect degradation in freshwater and seawater environments. In 2020, 100% cotton fabrics, finished with different dyes and chemicals, were exposed to the same conditions as in previous trials. The treatments included a reactive blue dye, a silicone softener, a C6 water repellent, and a formaldehyde containing durable press (DP) resin. The cotton fabrics are being compared against a micro-crystalline control as well as against an oak leaf, something that would naturally find its way into the water supply. The above samples were exposed to wastewater inoculum and the results indicated that while all the treated cotton samples degraded, the finishes that were cross-linked to the cotton (DP and water repellent) do slow the degradation rate of the samples. Work in freshwater environments was concluded and demonstrated again, that while some finishes slow the degradation, the cotton fabric will still degrade. In this experiment the samples exposed to fresh water had an overall higher level of degradation than the samples subjected to wastewater. This demonstrates the variability of biological systems. The seawater degradation results were pending at the end of the fourth quarter. This work will continue into 2021.

Outside Research: Fundamental Studies of Cotton Fabric Dyes, Finishes, and Their Degradation Products in Aquatic Ecosystems

The goal of this study is the identification and quantification of degradation products generated in previous aquatic degradation projects. Water samples from aqueous degradation of cotton fabrics treated with reactive blue 19 (RB19) dye were analyzed and multiple forms of RB19 could be identified in mass spectra. Also, water samples from aqueous degradation of cotton fabrics with different types of finishing, including DP finishing, were analyzed and data suggested that dimethylol dihydroxy ethylene urea (DMDHEU) crosslinker with one substitution of diethylene glycol could be observed after biodegradation in an aqueous condition. Laboratory work at NCSU resumed in early June. Work was conducted using enzymatic extraction and four forms of RB19 dye were identified; the hydrolysis form and several derivates connected to a glucose, cellobiose, and cellotriose. Initial results indicated that most finishes reduce the efficiency of enzymatic treatment for dye extraction. Water repellent finishes seemed to provide the greatest hindrance to enzymatic degradation. Samples that were dyed with RB19 and finished with nine different standard finish formulas were subjected to a standardized washing procedure prior to enzymatic treatment. The results were compared to those from unwashed samples. There was little difference between the washed and unwashed samples of fabrics finished with either type of permanent-press finish. Samples finished with PP softener also did not show a significant difference. Silicone softener increased slightly, from 90% before washing to 100% after washing. Samples finished with PBI only, C6 + PBI and wax acrylate + PBI each had a significant increase after washing, indicating that the finish had poor durability.

Outside Research: Cottonseed-Oil Based UV-Curable Resins for Composites and 3D Printing

This research was undertaken to synthesize UV-curable resins from cottonseed oil and then characterize the resin properties. To convert most of the cottonseed oil into a modified version, the process parameters must be optimized. To show proof-of-concept, 3D printing will be used when developing final composite material. The preliminary synthesis was completed on the cottonseed oil before the lab was closed due to the ongoing pandemic. When the lab reopened, epoxidation of cottonseed oil was optimized using various catalysts. A 78% conversion from cottonseed oil into epoxidized material was achieved. The epoxidized cottonseed oil was then acrylated and the process optimized. The physical properties of the acrylated polymer were evaluated at different curing wavelengths. Properties evaluated included hardness, thickness, adhesion, flexibility, deformation, and chemical resistance. Acrylated cottonseed oil was studied with respect to different concentrations of reactive diluent and photo-initiator. The tensile properties of the cured material were then evaluated using a tensile tester. Physical properties of acrylated epoxidized cottonseed oil (AECO), commercially existing acrylated epoxidized soybean oil (AESO), and a petroleum-based resin Ebecryl® 150 were compared. The AECO resin was used to successfully print a 3D ring at 25% and 50% concentration.

Outside Research: Ocean Wise Shedding Study

Cotton Incorporated is part of a research consortium funding Ocean Wise, Vancouver, CA, as they evaluate different fabrics and their degradation performance. In Phase I, fabrics are subjected to various weathering situations. Several dyed and finished cotton samples were submitted and the evaluation ongoing. In Phase II, evaluating the shedding propensity of different polyester fabrics when subjected to accelerated laundering has been the goal. An experimental design was developed to evaluate virgin verse recycled polyester, yarns with different denier per filament, different fabric constructions, and different types of mechanical finishing. The fabrics were still being constructed in the fourth quarter. This study will continue in 2021.

Strategic Objective 2: Optimize and implement products and technologies to advance cotton in global markets.

New Cotton Cleaning Line and Contamination Detection

In March, FP finalized purchase arrangements for a new cotton opening/cleaning line with contamination detection equipment. Planning and lab preparations with peripheral items such as electrical controls, compressed air, and ductwork modifications were completed prior to the machinery arrival, and included removing all existing obsolete machinery and ductwork. The new equipment arrived in September, and the installation was completed by the end of November. The FP team is now uniquely positioned to lead future industry trials and evaluate ginning research trials on behalf of all our cotton constituents. Fiber Processing looks forward to future collaborations with the AERD and FC teams as the possibilities of this latest generation of cleaning and contamination detection technology are explored.

Gin Stand Contamination Detection Trials

In February, the FP team traveled to a gin in Georgia to assist with commercial gin testing of the new VIPR™ Contamination Detection System in association with the U.S. Department of Agriculture (USDA) and major machinery manufacturers. The VIPR™ system is the result of Cotton Incorporated's previously sponsored development work with the USDA ginning labs and

research staff. It is retrofittable to most gin stands now available. During the trials, the VIPR™ system removed over 86% of plastic samples of various sizes and colors. Fiber Processing purchased all eleven cotton bales from the trials and aims to run the bales through the new contamination detection line in the first quarter 2021, providing key evaluation numbers on any plastics that made it through the gin stand and VIPR™ system. The resulting data will help finalize the report for this collaborative industry evaluation.

Production of High-Quality Yarns for Fine Gauge Knitting Evaluation

Fiber Processing prepared over 350 pounds of Ne 40/1 combed cotton yarns on the Vortex (MVS) compact ring and conventional ring spinning systems for evaluation on a recently installed fine gauge knitting machine in the PDL. Additionally, finer 100% cotton ring-spun yarns in Ne 50/1 and Ne 60/1 yarn counts are planned for production in the FPL in the first half of 2021 using U.S. Upland cotton.

Support of Product Development's (PD) Woven Yarns

In support of PD's efforts to develop "breathable" woven bottom weights in collaboration with a large industry producer, the FP team selected appropriate U.S. Upland cotton to engineer Ne 14/1 carded rotor spun yarn. The yarn was then delivered for weaving trials. Fiber Processing spun an Ne 40/1, 100% CP, compact warp yarn, for PD shirting research. A strong, smooth seersucker fabric with improved breathability performance was created.

Spinning Component Effect on Fabric Appearance

Technicians in FP conducted a rotor component study on the open end (OE) spinning frame to determine effects of rotor profile on 100% cotton yarn physicals and performance in fabric. Initial tests indicated improved hand based on usage of specific rotor profiles. Results will be utilized by the FP team in providing technical service to spinning mills regarding production of fabrics engineered to meet specific tensile, appearance, or hand standards.

Technical Service Support with Yarn Spinners and Manufacturers

The FP team provided technical service through a plant visit with a large U.S. vertical manufacturer as well as numerous technical service requests from both U.S. and international textile mills and brands. Contact encompassed the sharing of information vital to finalizing decisions surrounding the installation of contamination detection machinery and removal of existing equipment in the FP opening/carding line. Technical assistance included cooperation with the EFS® Technical Service group to evaluate barré issues with a potential customer in South America. New questions and analysis efforts resumed in June as staff returned to the Research and Technical Center. Additional FP technical service efforts included instruction and advice to a spinner in Mexico regarding the consequences of using by-products in virgin cotton laydowns, guidance to a spinner in Bangladesh regarding cotton physicals and expected fabric results, and participation in collaborative efforts with the EFS® Technical Service group and GSCM, advising large textile operations in Central America to optimize compact spinning and improve cotton utilization and overall yarn quality.

Evaluation of Recycled Denim Fiber

A project initiated in the FPL aimed to develop a novel approach to utilize recycled denim shoddy to create an opportunity for circular cotton recycling. This development incorporated denim shoddy in various percentages and methods of introduction into the sliver process to create interesting random slub effects in ring spun yarn. Feedback from the PD team on the initial yarn and fabric trial proved very positive. Additional yarn and fabric developments will continue in 2021 to create opportunities for use of recycled denim fibers in new cotton fabric developments.

Nonwovens Technical Service

The FP team continues to provide technical support to nonwovens accounts supported by GSCM's Nonwovens Marketing team.

Nonwovens Support to Develop Plastic-Free Wipes and Acquisition Layer Substrates

Historically, many personal care, household, and industrial wet wipes have been made using mostly, if not 100%, synthetic fibers. The European Commission is approving directives to ban plastics in many single use products, including wet wipes and some components of hygiene products. The FP team provided technical support for a 2020 collaborative project initiated by the Nonwovens Marketing team. The important goal of this work was to provide nonwoven manufacturers with a road map to replace synthetic fibers with cotton in wipes and hygiene products. Trials proved to be very successful and samples will be shared with cotton fiber suppliers and the wipes industry.

Evaluation of High-Performance Ring Spinning Components

Fiber Processing spinning technologists performed multiple spinning studies on advanced pendulum drafting components for ring spinning technologies in the FPL. Studies revealed that pendulum arms provided an improved level of fiber control in the draft zone compared to the older drafting components. Based on improved yarn quality and relatively low cost of the components, FP upgraded one of its ring spinning frames with these new pendulum arms.

Evaluation of Industry Technology in Fiber Processing

Before March, FP team members initiated in-house meetings with machinery manufacturers to improve yarn torque and control knit fabric skew using the latest conditioning technology. Throughout the year the team also investigated newly available novel-yarn technologies that offer effect yarns for increasing interest/demand in cotton or cotton-rich yarns and fabrics. Research and production of novel and effect yarns will continue in 2021.

Increased Fiber Processing Library of Technical Knowledge

Six technical/research reports were completed by the FP team regarding technical services provided to mills, manufacturers, and retailers worldwide. The team also increased their knowledge base through online training resources and participation in many webinars. The scope of R&D efforts can be narrowed based on learnings from these studies.

Technical Assistance

Product Development provided technical fabric development expertise to evaluate spinning systems, new finishes, and fabric defects. Mill and cut and sew sourcing requests, especially for U.S. based suppliers, saw an increase. Fabrics were developed in support of the ISP workshop program and for research into new yarn treatments. The PD lab completed knitting yardage for 20 research projects for departments across PDI, used in both internal and outside research including TOUGH COTTON™ technology for sweaters and socks. The production- and sample-prototyping scale equipment for weaving and knitting were used to produce many fabrics used throughout Cotton Incorporated, including Marketing toolkit collections; fabric production and research services for the TCR, TSI, and FP departments; and Technical assistance for the industry. Two notable, technical support knitting projects for PDI were TOUGH COTTON™ technology for sweaters and socks and a recycled denim shoddy novelty yarn evaluation.

Cold Pad Batch (CPB) Bleach Wetter Evaluation

For CPB dyeing to be successful, the fabric must wet out thoroughly, evenly, and instantaneously in the dye trough prior to being squeezed through the pad nip rolls. The purpose of this research is to develop a CPB Bleach formula that adequately prepares 100% cotton knit fabric for dyeing using chemical auxiliaries currently available in the market. In all, 21 lab trials have been conducted, over the course of six trial sets, on swatches of 100% cotton-interlock knit fabric. Samples have been submitted for testing and preliminary results indicate that modifications to the bleach formula as well as the addition of a specific wetter are required. Lab trials have been completed and three scour formulations are awaiting scale up trials in the DFAL. However, in the interim, there has been a change in the source of the stabilizer used in these trials and work is currently being conducted on various replacement stabilizers prior to DFAL trials.

Effect of Multi-Functional Reactive Dyes on the Dye Uptake Differences Between Non-Fluorine Yarn Treated with TransDRY® Technology and Untreated Yarn

An initial research project, designed to determine the cause of the dyeability difference between non-fluorine yarn treated with TransDRY® technology and untreated yarn at a Peruvian mill, concluded that the number of reactive groups in the dye molecule had the biggest effect on the increase in dye uptake. The goal of the second phase is to research the effect that multi-functional reactive dyes have on the dyeability differences between non-fluorine yarn treated with TransDRY® technology and untreated yarn. Initial lab dip formulas have been created to dye-out primaries of the multi-functional dyes on jersey knit fabric containing wide stripe (1.5 inch) feeds of non-fluorine yarn treated with TransDRY® technology and untreated yarn. Lab trials and spectral readings have been completed and the project is currently in the documentation part of the process. A technical report on the topic was pending completion in the fourth quarter.

Non-Fluorine Durable Water-Repellent Optimization (Non-Denim)

The goal is to evaluate the performance of non-fluorine water repellents for use in STORM COTTON™ technology formulations. The standard testing procedure for STORM COTTON™ technology is run on a white twill fabric at four cure temperatures, to compare different STORM COTTON™ treatments including spray testing evaluated by AATCC Test Method (TM) 22, water absorbency spray rating (WASR), and water retention (WR) dry time testing. A technical report is available, TCR20-31, to

present the four cure durations that are required to equally cure the STORM COTTON™ technology treatments between 137-170ºC and the effects of residual detergents. Further technical reports were in progress discussing non-fluorine water repellents from multiple chemical companies during the fourth quarter.

Non-Fluorine STORM COTTON™ Technology Treatments Applicable to Denim

The evaluation of performance and durability of non-fluorine water repellents for use in denim-treatment formulations using STORM COTTON™ technology were the project goal. Formulations developed for "rinsed only" dark shades of denim fabrics, the most difficult, were not applicable for light shaded indigo-dyed denim test specimens. In lab production results, the STORM COTTON™ finish produced a green tint after curing on light shaded indigo-dyed denim fabrics. One theory was that the indigo dyes were reduced into their water-soluble states by the emulsifiers within the non-fluorine finishes, because water rinsing easily removed this discoloration. Based on spectrophotometer readings, two methods were found to reduce discoloration. Lowering the cure temperature to 137ºC reduced green discoloration by over 75%. A non-fluorine water repellent, REPELLAN V5 provided durable water repellency with the least shade change after curing. Further research has focused on the application of the STORM COTTON™ finish treatments for two large denim brands. One brand has run production trials in Asia with a preference to finish components supplied by two international chemical companies. The other brand ran production trials elsewhere in Asia, and applications were based on the chemical costs when applied via wet-on-wet, dip-extract application. Multiple technical reports are in progress discussing the different chemicals and brands.

TransDRY® Technology Component Evaluation

The goal of this project is to evaluate new chemistry for use in TransDRY® technology. As demand increases, more options are becoming available for C6 and non-fluorine water repellent applications. This project continually evaluates new chemistries in an effort to optimize both performance and price. A shear stable C6, excellent for the rigors of yarn application, was approved for production. The non-fluorine workhorse TransDRY® technology is no longer available, but an alternative was found that can be applied at lower levels. In replacing a large particle size PBI, a macro-emulsion (looks like milk when diluted in water), was found to reduce the application concentration needed of a micro-emulsifiable PBI (looks clear in water when diluted). Further application tests are being carried out in the TCR lab.

Cold Pad Batch Bleach Stabilizer Evaluation

The bleach stabilizer and lubricant currently used is no longer available to purchase in the quantities required. This project was created to evaluate alternative stabilizers available. These trials are designed to coincide with the CPB Bleach Wetter Evaluation already in progress, with the goal to provide DFAL with a modern, optimized CPB Bleach formulation. Initial stabilizer chemicals have been requested from various textile chemical companies, and the products are currently being evaluated in the analytical laboratory. CPB Bleach Stabilizer Trials (CSL#2020-021) have been designed around the various peroxide bleach stabilizers to be evaluated while utilizing the surfactant auxiliaries established in the CPB Bleach Wetter Evaluation (CSL#2020-002). Lab dip trials will be conducted once all samples have been obtained and analytical analysis is complete.

Exhaust Caustic-Peroxide Bleach Evaluation and Optimization

The bleach stabilizer and lubricant currently used in the exhaust bleach procedure is no longer available to purchase in the quantities required. As well, recent observations have noted consistently poor rewettability on fabrics bleached with the current bleach formula. As a result, this project was created to evaluate alternative stabilizers and other auxiliaries available in the market and available for purchase in the order quantities customary for operation. These trials are designed to provide DFAL with a modern, optimized Caustic-Peroxide Exhaust Bleach formulation. Initial bleach auxiliary chemicals (i.e., stabilizers, and surfactants, etc.) have been requested from various textile chemical companies, and the products are currently being evaluated in the Analytical laboratory. Exhaust Bleach Stabilizer Trials are being designed around the various peroxide bleach stabilizers and scour chemical systems to establish an optimized exhaust bleach formula for all subsequent bleaching requests in DFAL and Garment Processing Print Lab (GPPL). Lab trials are to be conducted once all samples have been obtained and analytical analysis is complete in 2021.

Non-Fluorine WICKING WINDOWS™ Production Trials

The goal of this project is to validate alternative products for non-fluorine WICKING WINDOWS™ technology print applications. Feedback from the Product Implementation team has indicated that supply chain issues are impacting the availability of the recommended non-fluorinated water repellent for WICKING WINDOWS™ technology. Alternative products with global distribution have been identified. Production scale print trials have been scheduled to validate the performance of these products.

Wellness Chemistries Evaluation

This project was undertaken to evaluate the wellness chemicals from different vendors for cotton substrate and determine the ones that work well on cotton. Initial steps included obtaining some wellness chemistries and conducting a literature review for finding methods to screen the chemistry on the fabric and the impact of the chemistry on the wearer. Most recently, different types of wellness chemistries (i.e., aloe vera, CBD, and coenzyme Q10, etc.) have been padded on fabric samples and researchers have started working with the Analytical lab to help identify the chemistry present on the fabric using the Fourier Transform InfraRed Spectrophotometer (FTIR) instrument and worked on having the chemistry exhausted directly onto the fabric surface.

PUREPRESS™ Technology

Several brands continue to run mill trials on the PUREPRESS™ technology. While the pandemic has slowed or delayed some mill trials and brand activity progress has been made bringing the technology closer to market. The most interest continues to be from a major U.S. shirting brand.

- Eight mills in Asia were approved as shirting suppliers, with two additional mills submitting shirting samples for testing.
- Four mills in Asia were approved as bottom weight suppliers.
- One mill in South America was approved as a shirting supplier and has run initial trials on bottom weight fabrics.
- A total of five projects were submitted internally for testing in TSI during 2020, consisting of 21 fabric samples.

TOUGH COTTON™ Without Resin Technology

Brand interest remains very high with TOUGH COTTON™ technology. Several new brands have adopted the technology or incorporated it into various product categories. In Asia, TOUGH COTTON™ technology trials were run for new product categories. Globally, 29 mills were approved as knit fabric suppliers, 20 mills were approved as woven fabric suppliers, and eight mills were approved as garment suppliers.

Internally, 107 total projects (51% of all submissions) and 342 total samples were submitted to TSI for testing in 2020.

STORM COTTON™ Technology Implementation

Three prominent programs by American brands, and one Canadian brand, continue to run production on STORM COTTON™ technology. One of the programs is 100% manufactured in the U.S. and this program continues to produce a strong product. Additionally, several other American and European brands began running production trials, advancing to production, during 2020. Globally there are 72 suppliers of STORM COTTON™ technology fabrics.

In total, 62 projects have been submitted to TSI in 2020 (29% of all submissions) with a total of 147 samples.

WICKING WINDOWS™ Technology Implementation

Global interest in the WICKING WINDOWS™ technology has remained strong in 2020. A major U.S. brand continues to run production on the technology from mills in Mexico, Turkey, and Asia. Additionally, there have been adoptions and product launches in Mexico, South America, and Asia for their domestic markets. Globally, there are 34 mills currently licensed to run production WICKING WINDOWS™ technology on knit and woven fabrics. Interest continues to grow in dual technologies using WICKING WINDOWS™ technology in combination with new finish developments from TCR.

In 2020, a total of 15 projects and 25 samples were submitted to TSI for testing.

TransDRY® Technology

Two new suppliers submitted trial fabrics treated with TransDRY® technology for approval in 2020. Additional activity for TransDRY® technology has been light, with a total of seven projects and 12 samples submitted for testing and technical services in 2020.

NATURAL STRETCH™ Technology

A joint meeting among TSI, TCR, GCSM, and a major supplier, met virtually to discuss NATURAL STRETCH™ technology and next phases of implementation for the supplier in the second half of 2020.

New Technology Releases

The TSI team worked closely with the PDI team to release new technologies ready for mill implementation such as, C6 WICKING WINDOWS™ + PCM + Sweat Hiding™ technology and non-Fluorine WICKING WINDOWS™ + PCM technology.

Dual Technologies

Technical Services and Implementation worked with the TCR, PD, and FP teams to develop new applications of current technologies by combining finishes for use as dual technologies in the market. Seven different combinations were evaluated throughout the year.

- Non-Fluorine C6 WICKING WINDOWS™ + TOUGH COTTON™ technology
- TOUGH COTTON™ + Non-Fluorine TransDRY® technology
- TOUGH COTTON™ + PUREPRESS™ technology
- STORM COTTON™ + Soil Release™ technology
- TOUGH COTTON™ technology applications on yarn and garments, for use on sweaters and socks
- PUREPRESS™ technology on knit fabric developments and applications
- PUREPRESS™ + TransDRY® technologies

Routine Technical Service Projects for Mills, Brands, and Retailers

With the onset of the pandemic and subsequent shutdowns, technical service activity for mills, brands, and retailers was slower than normal, but steady after the initial shutdowns. During 2020, a total of 24 projects were submitted covering issues related to barre, pilling, abrasion, color retention, and analytical work.

DFAL Activity

With the reduced schedule beginning in March, and limited staffing continuing, the number of projects in the DFAL were lower than normal. During 2020, these labs processed 116 total projects. Out of the total projects the DFAL processed 7,000 yards of fabric and 53 pounds of yarn. The Analytical Lab processed 570 samples. These samples consisted of 452 analysis requests for internal research and 118 analysis requests for external technical service requests.

Strategic Objective 3: Augment cotton marketing activities/influence industry decisions through technical avenues such as standardization and education.

International Standard Evolvement

Proposals for international standards on sustainability-related topics continued to increase in 2020. Product Integrity contributed, as an expert to the Technical Committee (TC) 323 on Circular Economy (CE), to the creation of three new standards that describe (1) the principles, terminology, and framework; (2) guidance on implementation of business models for CE; and (3) methods of measuring CE. The first draft version of a standard on principles, terminology, and frameworks by Working Group 1 was presented in December. In the ISO TC 38 on Textiles, PI is involved in a new standard on environmental vocabulary for textiles and two new methods related to creation and analysis of microplastics in effluent from home laundering. In AATCC, a ballot on Lab-scale Accelerated Generation and Measurement of Microplastic Release did not garner enough votes to move ahead. ASTM has many activities in two sustainability committees, but the most important work for PI has been in the U.S. Technical Advisory Group for ISO/TC323, which formulates U.S. positions.

The Higg Materials Sustainability Index (MSI)

Other major activities or PI staff this year were involvement in the Sustainable Apparel Coalition (SAC) efforts in the European Union (EU) and on the Higg Product tools. In the EU, Product Environmental Footprint (PEF) category rules are being written to direct life cycle assessment (LCA) of all apparel and footwear categories. Product Integrity has provided data on cotton-dominant products and reviewed sections of the draft related to *Use, Durability, and Circularity*. With the release of the Higg MSI v3.0 and the Higg Product Tool, Part 1, SAC is hoping to use the now complete Higg Product tool methodology as a basis for much of the PEF. Based on feedback after the MSI release, and the continued push by the Product Advisory Council (to which PI has contributed much expertise), SAC announced the elimination of the MSI's single score as of January 2021. This objective has been a long-term goal for PI, and its achievement provides a boost to cotton by unmasking the climate benefits of choosing cotton as a material, while allowing a better understanding of the tradeoffs present for any fiber.

Supply Chain

Product Development provided fabrics for the GSCM digital-supply chain initiative. The goal is to convert physical fabrics into digital image files of fabric for use in 3D-apparel modeling software programs. All the provided fabrics were sent to agencies, that can scan and measure the fabrics to create the specific file type the 3D software program requires. The goal is to have digital avatars of each FABRICAST™ collection development accessible to customers who visit the CottonWorks™ Website. Product Development is also offering neutral technical input on fabric physics as a volunteer member of the 3D.RC Group.

Digital Fabric Marketing Toolkits for Social Media and Product Marketing

During the stay-at-home order issued during the pandemic, special digital fabric collections were created for Cotton Incorporated social media channels and Websites; LinkedIn®, Facebook®, cottoninc.com, and CottonWorks™. Digital summaries and descriptions from FABRICAST™ collections were provided to support the digital collection on social media channels and Websites. This expanded reach resulted in thousands of page views. Pivoting efforts to provide digital cotton inspiration, enabled the PDI division to continue marketplace influence.

Fabric Development for Outdoor Retailer Trade Show

Cotton Incorporated technologies, plus fashion focused techniques, were integrated in a garment collection created for the outdoor active market. These garments served as a main focal point at Cotton Incorporated's booth at the January Outdoor Retailer Show held in Denver, CO. In addition, PD coordinated with GSCM to highlight cotton fabrics as both functional and fashionable in the Trend Display. Four apparel categories were identified for the display: insulation, shell, base/mid layer, and outer layer. A total of 14 knit and woven fabric developments addressed these categories featuring water resistance, thermo-regulation, antimicrobial, breathability, and moisture moving.

Garment Collection of FABRICAST™ Collection Developments

The PD team provided original fabrics for two physical garment collections featuring active and outdoor apparel produced by an innovative garment design company in the U.S. These garments will be an important resource as marketing collateral for in-person and online activities.

Industry Engagement

The PDI division pursues industry engagements to develop new ideas, source new cotton yarns, fabrics, finishes, and equipment as well as, meet with vendors to discuss possible collaborations. Technical staff from PDI assisted Account Managers at Cotton Incorporated booths during trade shows, presenting new fabric developments and answering technical questions. Listed below are trade shows, conferences, committees, advisory boards, and presentations the PDI team participated in.

In-person attendance:

- Outdoor by ISPO Trade Show, Europe
- Pitti Filati, Europe
- Outdoor Retailer Winter Market/Snow Show, U.S.
- Premiere Vision, Europe
- First International Conference on Cellulose Fibers, Europe
- UNC Wilmington: Research Meeting, Fish Ingesting Textile Fibers, U.S.
- Southern Textiles Association Winter Technical Conference, U.S.
- AATCC International Conference Event, U.S.
- AAFA Safety and Compliance Seminar, U.S.

Virtual participation was utilized throughout the second half of the year because of the pandemic.

- Innovate Textiles America
- Kingpins
- Jeanologia Nano Laser Training
- IPC E-Textiles Virtual Summit
- Smart Fabric Summit

- Innovate Textile and Apparel
- Transformers ED
- Functional Fabric Fair
- Training Your Visual Color Apparel Team
- Texas Cotton Ginners' Association Meeting on Plastic Contamination
- INDA RISE Conference
- INDA World of Wipes (WOW) Nonwovens Conference
- INDA Webinar – Highlights of the North American Nonwoven Supply Report
- Sustainable Nonwovens Webinar – Facemasks & COVID-19
- Webinar Series – Nonwovens Technology: On the Frontlines of a World Pandemic
- NCSU Webinar Series – PPE Properties, Production & Testing (6-part series)
- Southern Textiles Association Fall Meeting
- Nonwovens Industry Magazine Webinars – Safety Versus Sustainability, adjusting to the Health & Hygiene Future, Disposing Disposables: Nonwovens Get a Second Life, Wiping Unsustainable Worries Away
- In November, FP staff made a virtual presentation on 'Cotton in Nonwovens' during the large National ASA, CSSA and SSSA Conference aimed to educate the Breeder and Agronomy community
- Nonwovens Industry: The New Mobility: Lightweighting with Nonwoven Technologies
- NCSU Wilson College of Textiles Webinar: Hanesbrands & NCSU Tackle Sustainability Challenges
- Ocean Wise: Research Meeting, Microfiber Shedding and Degradation, Canada 69
- Functional Fabric Fair
- Jeanologia Seminar: How to Design Sustainable Collections With EIM
- Jeanologia Seminar: LSF Test – Choosing Correct Fabric
- Jeanologia Seminar: eDesigner Software
- AATCC Forum on Sustainability
- How to be a More Effective Chemical Hygiene Officer Webinar
- Denim and Jeans Virtual Tradeshow
- AATCC Committee and Interest Group Meetings
- Trotec Laser "Textile Processing" Webinar
- North Carolina Hazardous Waste Compliance Workshop
- MicroPack Seminar Series
- Southern Textile Association Technical Meeting
- ASTM D13 Executive Committee Meeting
- USDA Panel Orientation Meeting
- ISO TC323 Circular Economy Planning Meetings
- AAFA Product Safety and Compliance Meetings
- ISO TC323 Circular Economy Committee Meetings
- ASTM Committee Week
- Product Integrity Apparel Europe
- Best Practices for Repairing Your Neglected Chemical Catalog
- AATCC Committee and Interest Group Meetings
- AATCC/SGIA Digital Print Conference

- Fate of Textile Microfibers Released During Home Laundering
- Tonello Seminar: The Laser Launch
- AATCC/SGIA Digital Print Conference
- Technical meetings with three international chemical companies
- UNC Greensboro Career, Apparel & Retail Studies, Industry Advisory Committee Meetings
- 3D.RC Fabric Physics

Technical Conference Participation

The FP team attended grower, ginning, and textile technical conferences consisting of the Beltwide Cotton Conference in Austin, TX, in January and the Southern Textiles Association's Winter Technical Conference in Gastonia, NC, in February. Both conferences offered technical updates for the industry and networking opportunities for the FP team. These conferences supported FP's ability to expand collaborative research and testing efforts with industry partners in 2020, especially in contamination reduction throughout the supply chain.

Participation and Advisory Roles for the USDA Ginning Research Stations

All USDA Gin Schools were cancelled in 2020 due to the pandemic. Fiber Processing optimistically looks forward to participation in 2021.

Nonwovens Technical Certificate Earned

An FP team member expanded nonwoven knowledge by completing NCSU's Nonwovens Institute Graduate Certificate of Nonwovens Science and Engineering.

Industry Influence

Product Development and Implementation staff provided in-depth presentations and tours to students and instructors from technical community colleges and universities at the Research & Technical Center during the first quarter. Members of PDI routinely assist AATCC not just in membership, but by servicing committee members, contributing to publications, and judging panels in research and competitions. Product Development staff served as judges for an AATCC apparel design competition as well as, for student projects at the university level. An article published in the AATCC Journal, *Bringing Fabrics Alive with Special Pigments and Finishes*, focused on PD innovations. An article in Rivet also focused on a PD denim collection. Special fabric kits were prepared and provided by the PD team, featuring performance and sustainability for a cotton focused virtual active workshop offered through the CottonWorks™ platform, which was attended by 68 brand decision makers. Additionally, PD provided 480 fabric samples for a cotton textile fundamentals workshop offered to brands.

Digital Content for Marketing Activities

Digital fabric files and descriptions were provided for Cotton Incorporated's social media Websites such as www.cottoninc.com, CottonWorks™, and other corporate social pages such as, Facebook® and LinkedIn® accounts. Virtual curated fabric presentations, containing new FABRICAST™ collection developments, were uploaded to the sites as well. The expanded reach resulted the following metrics.

- 11,292 fabric page views of the FABRICAST™ collection on Cotton Incorporated's Website.
- 87,845 impressions on corporate Facebook®, Twitter®, and LinkedIn® accounts.
- 27,122 page views on the CottonWorks™ Website.
- 76 new fabrics were uploaded to CottonWorks™ Website.

Garment Review

Product Development provided the Fashion Marketing department support through technical analysis of fabrics intended for the general, active, and denim trend presentations. The PD team spent numerous hours analyzing hundreds of fabrics, then held meetings with the trend team to provide detailed fabric descriptions. Adjustments were made, offering digital fabric images and information to support the trend presentations which took place virtually because of the pandemic. The feedback and response to the digital format and video meetings achieved a broad reach. A total of 14,966 fabric swatches from the FABRICAST™ collections were produced for inclusion in apparel, active and denim trend presentations.

Technical Bulletin: Laser Etching on Cotton Textiles

To educate the industry about the developments in laser finishing technology on cotton textiles, a technical bulletin is being written. The bulletin will cover the general history of laser technology, the types of lasers, and the categories of lasers. It will also cover many other subjects such as the earliest applications for lasers in the textile industry and the common uses of lasers for textile applications, focusing on denim garment finishing. Laser finishing techniques used in the Cotton Incorporated FABRICAST™ collection line will also be included.

Test Method Development: Water Absorbency Spray Rating (WASR) Testing

The goal with this testing is to develop a measurable water-repellency testing procedure that can be run in conjunction with AATCC TM 22. Technical report TCR19-08, was written to describe WASR testing, the internal test methodology that was developed to measure the percent of wet pick-up after spray testing. The developmental specification requires that test specimens treated with a water repellent dry 70% faster and have a water absorbency spray rating of 70 after 30 HLTD. The WASR testing met developmental specification requirements and prevents discoloration on the outside fabric surface. This project was considered successful, WASR testing quantifies both the depth and duration of discoloration after spray testing. A presentation, including time lapse videos, was presented virtually to the AATCC RA63 subcommittee in November, describing how WASR testing can be run in conjunction with AATCC TM 22.

Test Method Development: Water Retention Dry Time (WR) Testing

The goal of this project is to accurately represent the phenomenon of saturating a garment with perspiration during exercise followed by subsequent drying. Technical report TCR19-13 was written to describe the development of this test methodology. Submerging samples in 100ºF for 60 seconds, under continuous agitation, ensures that test specimens are subjected to an actual-use testing protocol by being close to the temperature of perspiration (95ºF). Water Retention (WR) Dry Time testing measures submerged water retention (SWR), residual water retention (RWR), and the drying speeds of test specimens. This thereby enables the calculation of the dry rates, per the percent of water absorbed, and the total dry time of each test specimen at maximum uniform-water saturation. A correlation between AATCC TM 22 and WR dry time testing suggests that, after 30 HLTD, spray rating values of 90 are required to dry three to five times faster than an untreated control. The WR Dry time testing of the untreated controls should be run after 30 HLTD, and the test specimens should be tested on multiple moisture balances to calculate averages.

GLOBAL SUPPLY CHAIN MARKETING

Strategic Objective 1: Maintain a global presence for cotton.

An important tactic for maintaining a global presence for cotton is through direct account interaction with mills, manufacturers, brands, and retailers for the apparel, nonwovens, and home products markets. GSCM staff focus their efforts on influencing major brands and retailers through coordination of various Company resources, with the goal of influencing the use of cotton versus other fibers. During 2020, GSCM staff conducted more than 575 meetings with companies in both the manufacturing supply chain and with key brand and retailer accounts.

Staff exhibited at ISPO in Munich, Germany in January. ISPO is the largest outdoor sportswear show globally with more than 85,000 visitors from 120 countries. This year is the first year that Cotton Incorporated exhibited at the show and the booth themes focused on sustainability and product innovation with displays showcasing the latest garment and fabric collections, market adoptions, and marketing materials.

As tradeshows continued online throughout the remainder of 2020, Cotton Incorporated sponsored Home Textiles Today Market Week, and the Material Changes Conference. The virtual conference focused on the latest initiatives within the home market including sustainability drivers, circularity models, sourcing, and the most updated insight into omnichannel business models in the home textile industry. Cotton Incorporated's virtual booth highlighted the resources available on the CottonWorks™ Website, a circularity model, and an informative session on dispelling common myths regarding cotton and water usage and promoted the sustainable value of cotton home products.

Also, Cotton Incorporated sponsored World Textile Information Network's (WTiN's) Innovate Textile Apparel & America digital tradeshow. The virtual conference focused on the latest innovations in manufacturing processes, materials, and emerging business models in the textile and apparel industry. Cotton Incorporated's digital booth focused on technologies and promoted CottonWorks™--the division's primary marketing platform--as an industry resource.

Staff worked with the Clothing Industry Training Authority (CITA) in Hong Kong on a promotional display at CITA's industry training facility. The display markets the CottonWorks™ Website and the digital cotton fabric collection. The display covers an entire wall outside of the digital training lab and will be seen by key brands, sourcing companies, and mills in Hong Kong.

During 2020, Mexico City office staff continued to connect with the industry through a digital strategy; over 11 live presentations were completed, and two videos were posted on the CottonWorks™ Website on topics ranging from fashion to economic trends reaching over 800 executives.

Mexico City staff participated as either a keynote speaker or panelist in four digital forums in Latin America about cotton innovation and sustainability, including the World Cotton Day organized by CCI and sponsored by International Cotton Advisory Committee (ICAC).

Participation in industry events included:

- Staff hosted a virtual webinar series for the Outdoor Retailer market and had more than 300 live views.
- Staff participated in the Home Market Week and had over 900 booth visits.
- Staff attended the Sourcing Journal Summit.
- Staff presented at the U.S. Fashion Industry Association (USFIA) Virtual Apparel Importers Trade & Transportation Conference.
- Staff hosted two virtual sessions of Cotton On The Move workshops in conjunction with the University of Oregon for industry professionals with 69 attendees.
- Staff presented at a virtual event, 2020 China Spinning Technical Forum, in Shanghai, China. More than 60 executives from spinning, fabric, and denim mills attended the event.

- Staff presented virtually at the "Secret Behind Fashion" event. Over 3,000 people streamed the presentation on U.S. and Chinese apparel markets.
- Staff presented virtually at the China Textile Information Center's streaming platform to a group of more than 3,000 participants. Presentations covered U.S. and Chinese apparel markets and performance technologies.
- Staff attended and managed a virtual booth at COTTON USA's virtual COTTON DAY events in Vietnam, Taiwan, Korea, Japan, Indonesia, Bangladesh, Thailand, and China. These events were conducted virtually and consisted of three main components: exhibition, presentations, and virtual networking.
- Staff attended the PI Apparel 2020 virtual event in Hong Kong. The event was attended by more than 5,000 global visitors from the textile and clothing industry.
- Staff attended the 2020 China Cotton Futures Forum in Shanghai, China. More than 200 participants from local spinning mills and cotton trading companies attended the event.

In its seventh year, the Cotton LEADS℠ program continues to educate and inform retailers, brands, and manufacturers worldwide about responsible U.S. cotton production. Cotton Incorporated participates in this program with the National Cotton Council of America, the Cotton Foundation, Cotton Australia, and Cotton Council International. The program reached 662 partners by the end of the year. Four *Partner Post* newsletters went out to partners in five languages in 2020. A new trade campaign was also created in the latter part of 2020 for the 2021 year.

During 2020, six new Cotton LEADS℠ partners were added in the U.S. including a well-established workwear brand, a well-known sock licensee, and a west coast home textiles brand. Also, Mexico Office staff continued promoting the Cotton LEADS℠ program for which two new members were added and another two produced videos to communicate their commitment to U.S. cotton while another partner labeled 50,000 garments with the Cotton LEADS℠ mark. A total of 25 new Cotton LEADS℠ partners were recruited in Asia, from China, Hong Kong, India, Pakistan, and Bangladesh.

The GSCM division is responsible for all messaging to the trade. In 2020, consistent messaging and imagery was implemented throughout, including tradeshows, tradeshow promotional items and outlets, and other publications. Over 75 different print and digital assets were created to focus on multiple messages in the most effective platforms. Messages focused on the CottonWorks™ Website platform as a leading resource for cotton, performance, denim, sustainability, and circularity. Publication channels included *Textile Insight, WSA, EcoTextile News, Sourcing Journal*, and tradeshow magazines and Websites. A significant effort was made to promote cotton through LinkedIn social channels to reach the industry who may be on the site to network and seek new opportunities.

In 2020, the GSCM division developed marketing materials to highlight cotton's circularity story. Staff developed a 2-D model that illustrates cotton's circularity, an interactive digital model that will be featured on the CottonWorks™ Website, a brochure, and an animated video. The overall goal is to show that cotton is a circular fiber that comes from the earth and returns to the earth. These materials will be featured in future marketing efforts. Circularity is a priority throughout the textile supply chain and a new message has been defined and identified from a cotton perspective across multiple categories and utilizations.

Efforts continued to re-establish cotton as a leading fiber in home textiles by participating in key industry tradeshows, conferences, and maintaining a consistent presence in marketing cotton products in trade publications.

Staff presented at significant industry events including the U.S. Fashion Industry annual conference, the International Textile Manufacturers Federation (ITMF) annual conference, the MAGIC conference, and at the Curve intimates conference.

Strategic Objective 2: Promote product and marketing ideas that advance cotton use.

The GSCM team continues collaborating with Product Development to feature garment collections which highlight creative innovation. The staff continued working with a design studio in Portland to create an engaging collection of cotton garments which feature technologies and innovative structure. These garments are photographed and featured in virtual meetings and tradeshows in addition to being showcased on the CottonWorks™ Website. These garments are also being utilized to show a connection between the digitized fabrics in the FABRICAST™ collection and the actual sample garments timelining the process from concept through production.

The Digital Supply Chain initiative in the GSCM division is an effort to enhance the division's marketing capability by incorporating the latest and most widely used 3D textile design tools. Work in this initiative included several activities such as:

- Identifying an industry partner to facilitate the creation of digital fabric files for FABRICAST™ collection developments using the CLO software;
- Working with a Hong Kong based design institute to initiate an activewear design collaboration;
- Partnering with a design laboratory at the SUNY Fashion Institute of Technology to explore visualization;
- "Digitizing" an inventory of featured cotton fabrics; and
- Reengineering the CottonWorks™ Website to market digital fabric files.

Eleven new Seal of Cotton trademark licensees were added in the U.S. in 2020. Eight new Seal of Cotton trademark licensees were added in Mexico during 2020 with 200,000 cumulative garments labeled. The largest Colombian hygiene brand extended the use of the **cotton enhanced™** trademark to panty liners and pads, while adopting the **natural™** trademark on tampons, reaching several countries in Latin America.

Additional trademark adoptions included:

- A U.S.-based yarn supplier was licensed to use the Seal of Cotton trademark on 100% cotton yarns.
- A U.S.-based sock manufacturer was licensed to use the Seal of Cotton trademark on 100% cotton socks for infants.
- A U.S.-based sweater manufacturer was licensed to use the Seal of Cotton trademark on 100% cotton premium sweaters and fashion knitwear.
- A well-known U.S.-based department store was licensed to use the Seal of Cotton trademark in home goods and apparel.
- A widely circulated U.S.-based direct-to-consumer catalog was licensed to use the Seal of Cotton trademark in their cotton sleepwear program.
- A U.S.-based handbag retailer was licensed to use the Seal of Cotton trademark on handbags and travel bags.
- A U.S.-based sock and hosiery manufacturer was licensed to use the Seal of Cotton trademark on their legwear products.
- A U.S.-based bedding manufacturer was licensed to use the Seal of Cotton trademark on pillows and mattress toppers.
- A U.S.-based athleticwear manufacturer was licensed to use the Seal of Cotton trademark on their casual sportswear.
- A U.S.-based manufacturer of infant products was licensed to use the Seal of Cotton trademark on their specialty products for newborns.
- A luxury upholstery manufacturer was licensed to use the Seal of Cotton trademark on their fabrics circulated throughout many major furniture retailers in the U.S.

Staff worked with a Hong Kong home textile brand on Seal of Cotton and Cotton LEADS℠ trademark adoption and promotion programs. Hangtags were provided for over 100,000 cotton home textile products which included bedsheets, quilts, pillowcases, and baby's sleeping bags. Products were available in the Hong Kong and Chinese markets.

Seal of Cotton trademark and technology joint promotions included:

- Staff provided 7,500 WICKING WINDOWS™ technology hangtags to a fast-growing urban outdoor sportswear company in China.
- Staff provided 250,000 Seal of Cotton and Cotton LEADS℠ trademark hangtags to a Chinese retailer with two well-known local brands for men's underwear and men's casualwear products.
- Staff provided 10,000 WICKING WINDOWS™ technology hangtags to a high-end underwear brand for their launch of men's under shirts. Products were available at over 100 sales outlets across China.
- Staff provided 2,500 TransDRY® technology hangtags to a Chinese childrenswear brand, on the launch of their collection for Q3 2020.

- Staff provided 33,000 WICKING WINDOWS™ technology hangtags to a leading Chinese sportswear brand for their launch of WICKING WINDOWS™ technology performance shirts.

Staff organized joint marketing activities with a leading Chinese sportswear/casualwear brand on the launch of WICKING WINDOWS™ technology tee shirts. The technology was promoted to Chinese consumers via in-store displays, advertisement videos, and at many local sporting events.

During 2020, Mexico City office staff completed three technical assistance projects on WICKING WINDOWS™, SWEAT HIDING™, and STORM COTTON™ technologies with three mills supplying to U.S. brands. Currently, technical assistance is being given to a Peruvian mill to supply TransDRY® technology finished socks to a U.S. brand.

Commercialization and adoption of cotton technologies included:

- An Australian clothing brand commercialized around 1.5 million units of ladies' cotton underwear for the Australian and European markets.
- A leading French apparel brand commercialized 60,000 units of TOUGH COTTON™ technology knit tee shirts for the European and Latin American markets. The products were developed by a vertical mill in Bangladesh.
- A fabric mill in Japan adopted the TOUGH COTTON™ technology and promoted it to the local industry using a well-designed brochure.
- An apparel manufacturer in Japan developed TOUGH COTTON™ technology without resin tee shirts which would be promoted to their local suppliers for Spring/Summer 2021.
- A leading Chinese textile company developed and supplied 10,000 yards of STORM COTTON™ technology fabrics for an American athletic apparel brand.
- A leading Chinese textile company developed STORM COTTON™ technology on cotton products for an international sportswear brand. Around 52,000 pieces of casualwear were released into the Chinese market.
- A leading Hong Kong fabric supplier with production based in China, received a bulk order of 23,000 yards of woven bottom weight fabric treated with the TOUGH COTTON™ technology for a U.S. outdoor brand.
- A Hong Kong yarn manufacturer with production based in China, successfully adopted TOUGH COTTON™ technology without resin on yarns for socks. This was part of an initiative by Cotton Incorporated to promote this technology in a new application.
- A Hong Kong textile group with production based in China, successfully developed a double knit TransDRY® technology fabric which was promoted for a uniform collection.

Technical marketing and technical assistance continue to be essential for helping companies bring cotton products to market. Several important activities were carried out to provide technical assistance for marketing cotton including:

- Staff provided technical assistance for the adoption of the STORM COTTON™ technology for the programs below:
    - A Hong Kong garment manufacturer and a Vietnamese laundry mill developed STORM COTTON™ technology on denim for a German brand.
    - A Vietnamese garment manufacturer with laundry capacities developed STORM COTTON™ technology on denim for a British motorcycling brand.
    - An Indian woven fabric manufacturer adopted STORM COTTON™ technology on cotton/spandex woven fabrics for the Indian arm of a U.S. casualwear brand.
    - An Indonesian knitting factory adopted STORM COTTON™ technology on fleece. The development was promoted to a U.S. casualwear brand and some domestic brands in Indonesia.
    - A vertical factory in Bangladesh adopted STORM COTTON™ technology on fleece for a U.S. skate brand.
    - An Indian woven fabric manufacturer adopted STORM COTTON™ technology on cotton woven fabrics for an American skate brand. The adoption was conducted through the Indian office of an international sourcing company.
    - A Chinese mill developed STORM COTTON™ technology on woven fabrics for ladies' outerwear for the Summer 2021 collection for a leading U.S. apparel brand.

- A Chinese fabric supplier developed STORM COTTON™ technology on woven fabrics for a leading German based retail store.
- A fabric supplier in Bangladesh developed STORM COTTON™ technology for cotton fleece for hoodies for a leading U.K.- based sportswear retailer.
- A fabric supplier in Vietnam developed STORM COTTON™ technology canvas fabric for the Japanese arm of an American shoe brand.
- A Chinese fabric manufacturer developed STORM COTTON™ technology fabrics for a Japanese apparel manufacturer.
- A Hong Kong textile group with production based in China adopted STORM COTTON™ technology for a U.S. apparel brand.

- Staff provided technical assistance for the adoption of the TOUGH COTTON™ technology for the programs below:
  - A Vietnamese garment manufacturer with laundry capacities developed TOUGH COTTON™ technology with resin for chino pants for a British motorcycling brand.
  - A South Korean fabric and garment manufacturer developed TOUGH COTTON™ technology without resin fabrics for an American workwear brand. The fabrics were sourced from another Vietnamese fabric and garment manufacturer.
  - A South Korean fabric manufacturer adopted TOUGH COTTON™ technology without resin on neon and hotmelt fabrics for an American department retail store.
  - Two fabric and garment manufacturers in South Korea developed TOUGH COTTON™ technology without resin on girl's leggings for an American chain of membership-only retail warehouse clubs.
  - A Hong Kong woven fabric manufacturer with production based in China, adopted TOUGH COTTON™ technology on 100% cotton woven fabrics for a U.S. casual apparel brand.
  - A Hong Kong knit fabric manufacturer developed TOUGH COTTON™ technology on cotton/spandex knit fabrics for an Australian clothing brand.
  - Two Bangladesh garment manufacturers developed TOUGH COTTON™ technology on woven bottom weight fabrics for a U.S. casualwear brand.
  - A Bangladesh supplier developed TOUGH COTTON™ technology on fleece for a leading French apparel brand.
  - A Hong Kong yarn supplier and a Chinese sock manufacturer developed TOUGH COTTON™ technology on cotton blended socks for a leading Australian based apparel brand.
  - Three fabric suppliers in China developed TOUGH COTTON™ technology on cotton fabrics for tee shirts and outerwear for the same leading Australian based apparel brand.
  - A Hong Kong woven fabric mill with production based in China, developed TOUGH COTTON™ technology on double weave fabrics for a U.S. workwear brand.
  - A Chinese textile company adopted TOUGH COTTON™ technology without resin on tee shirts for a Japanese apparel maker. Products will be on sale in the Japanese market in Spring/Summer 2021.
  - A leading Chinese textile mill developed TOUGH COTTON™ technology products for a Japanese casualwear brand.
  - A Chinese textile manufacturer developed TOUGH COTTON™ technology products for their Japanese and U.S. customers.

- Staff provided technical assistance for the commercialization of the PUREPRESS™ technology for the programs below:
  - A fabric manufacturer in Vietnam adopted PUREPRESS™ technology on shirting fabrics for a U.S. casualwear brand.
  - An Indian vertical mill and two Chinese shirting fabric suppliers developed PUREPRESS™ technology shirting fabrics for a U.S. casualwear brand.

- Staff provided technical assistance for the commercialization of the dual technology programs below:
    - A Malaysian fabric manufacturer developed TOUGH COTTON™ without resin and STORM COTTON™ technologies for a U.S. brand.
    - Three mills developed woven fabrics treated with dual technologies, namely, STORM COTTON™ and TOUGH COTTON™ for a U.S. workwear brand.
    - A Hong Kong based fabric mill and two mills in Bangladesh developed STORM COTTON™ and TOUGH COTTON™ technologies on fleece for a leading global sportswear brand.

- Staff provided technical assistance for the commercialization of the NATURAL STRETCH™ technology for the programs below:
    - Two Hong Kong woven fabric manufacturers, both with production based in China, developed NATURAL STRETCH™ technology on 100% cotton woven fabrics for an American workwear brand.
    - A Chinese fabric supplier developed NATURAL STRETCH™ technology fabrics for a U.S. workwear brand.
    - A Chinese woven shirting fabric supplier developed 100% cotton comfort stretch fabrics for promotion to their customers.

- Staff provided technical assistance for the commercialization of the TransDRY® technology for the programs below:
    - A Hong Kong fabric manufacturer developed TransDRY® technology on denim which was then sent to another Hong Kong garment manufacturer to be produced into garments for promotion purposes.
    - A Vietnamese mill developed TransDRY® technology tee shirts for a Japanese sports apparel maker for Spring/Summer 2021.
    - A Chinese knit fabric supplier developed TransDRY® technology fabrics for a Japanese converter.

- Staff provided technical assistance for the commercialization of the WICKING WINDOWS™ technology for the programs below:
    - A fabric supplier in Hong Kong with production based in China developed WICKING WINDOWS™ technology twill shirting fabrics for a U.S. workwear apparel brand.

- Staff provided technical assistance to a Chinese textile mill to develop SWEAT HIDING™ technology for a U.S. design brand.

Commercialization of cotton technologies also included:

- Two major U.S.- based workwear brands have featured both TOUGH COTTON™ and STORM COTTON™ technologies across multiple product categories.
- A U.S.-based company that manufactures functional safety gear has adopted the TOUGH COTTON™ technology.
- A U.S.-based licensee company has applied the TOUGH COTTON™ technology on a back-to-school boy's pant program for products sold at national retailers.
- Two major U.S.-based retailers are featuring the TOUGH COTTON™ technology on girl's leggings.
- A U.S.-based department store is promoting the TOUGH COTTON™ technology on girl's leggings.
- A well-known U.S.- based catalog retailer has adopted the TOUGH COTTON™ technology on their girl's leggings program.
- A U.S.-based manufacturer has adopted STORM COTTON™ technology on their men's denim products.
- A U.S.-based manufacturer has adopted TOUGH COTTON™ technology on their men's denim products.
- A U.S.-based outdoor performance brand has adopted the STORM COTTON™ technology on their jacket program.
- A U.S.-based lifestyle brand has adopted STORM COTTON™ on their men's outerwear products.
- A well-known U.S.-based manufacturer has adopted TransDRY® technology on their men's tee shirts.
- A well-known U.S.-based apparel company has adopted TransDRY® technology on their outerwear products.

- A premium U.S.-based menswear brand is continuing the TransDRY® technology program on shirts.
- A well-known U.S.-based high-end menswear brand has launched PUREPRESS™ technology on their dress shirt program.

Additional technology adoptions occurred during 2020. A well-known U.S. fabric supplier has marketed the TOUGH COTTON™ technology at their retail stores. A U.S. workwear brand has featured both TOUGH COTTON™ and STORM COTTON™ technology logos on marketing materials at retail and online. A U.S. workwear brand has adopted the TransDRY® technology on their men's tee shirt program. A luxury Italian textile manufacturer has adopted the PUREPRESS™ technology for their men's dress shirt collection. A major U.S. retailer has expanded TOUGH COTTON™ technology on girl's woven shorts and pants. A well-known U.S. retailer has implemented TOUGH COTTON™ technology in their school uniform program.

Technical marketing and technical assistance continue to be essential for helping companies bring cotton products to market. In 2020, several important activities were carried out to provide this type of technical assistance for marketing cotton:

- Staff provided technical assistance to a leading U.S. womenswear retailer on their indigo program.
- Staff provided technical assistance to a well-known U.S. promotional product company for digital garment printing.
- Staff provided technical insight to a women's specialty brand to develop TransDRY® technology.
- Staff provided technical assistance to a leading textile company in China to develop TOUGH COTTON™ technology on products for a U.S. clothing brand and retailer.
- Staff provided technical assistance to a leading Chinese textile company doing bulk production for a U.S. retailer. 28,000 pounds of TOUGH COTTON™ technology fabrics will be produced.
- Staff assisted a Chinese textile company to develop the SWEAT HIDING™ technology on knitted fabrics. Development is part of their marketing efforts for the Chinese market.
- Staff provided WICKING WINDOWS™ technology technical assistance to a leading Chinese textile company supplying many major U.S. sports and casual brands.
- Staff provided technical assistance to a Chinese textile company to develop TransDRY® technology denim fabrics for a U.S. denim brand.
- Staff provided technical assistance to a leading Chinese textile company to develop TOUGH COTTON™ technology products for their U.S. customer.
- Staff provided technical assistance to a medium-scaled knit fabric supplier for expanding their WICKING WINDOWS™ technology product range from cotton underwear to cotton bedsheets.
- Staff provided technical assistance to one of the world's largest shirting fabric suppliers to develop PUREPRESS™ technology shirting fabric. This Chinese supplier was asked to develop this product by one of their long-term customers based in Europe.
- Staff provided technical assistance to some sourcing companies and suppliers in Pakistan, China, and Hong Kong to develop TOUGH COTTON™ technology without resin on both knit and woven fabrics for a U.S. outdoor functional brand. Products included knit tees and woven bottoms.
- Staff provided technical assistance to a large-scale Chinese knit fabric supplier to develop STORM COTTON™ and TOUGH COTTON™ technologies for a U.S. functional outdoor brand.
- Staff provided technical assistance to a knitter in Bangladesh to develop TOUGH COTTON™ technology on men's, women's, and children's tees for the French and Russian markets.
- Staff provided technical assistance to two knitters, one in Hong Kong and another in China, to develop TOUGH COTTON™ technology on underwear, tees, and outerwear. They worked under the initiative of a leading Australia-based apparel brand.
- Staff provided technical assistance to a woven fabric supplier in Hong Kong to develop WICKING WINDOWS™ technology on men's shirts for a leading U.S. based apparel retailer.
- Staff provided technical assistance to two denim suppliers, one in China and another in Indonesia to develop TOUGH COTTON™ technology on denim for a leading U.S. based workwear brand. They worked through a Hong Kong-based sourcing company.

- Staff provided technical assistance to a cotton yarn supplier and a socks supplier in China to develop TOUGH COTTON™ technology blended socks for a leading Australia-based apparel brand.
- Staff provided technical assistance to a Japanese yarn-dyeing, knitting, and dyeing & finishing plant in Bangladesh to develop TransDRY® technology yarn and fabric. Technical advice on improving evenness was provided.
- Staff provided technical information to one of the largest Japanese department store chains on the TOUGH COTTON™ technology. Promotion materials at point-of-sale were discussed.
- Provided technical assistance to a Taiwanese knitting mill to develop TOUGH COTTON™ technology without resin, which was initiated by a U.S. retail store.
- Provided technical assistance to a Hong Kong woven fabric manufacturer with production base in China, to develop TOUGH COTTON™ technology on 100% cotton and cotton/spandex woven fabrics for a U.S. fashion brand.
- Staff provided technical support to the Japanese arm of an international shoe brand with their interest in developing TOUGH COTTON™ and STORM COTTON™ technology on shoes for 2022 and 2023. Information on fabric suppliers was also provided.
- Staff provided technical assistance to a woven fabric manufacturer in Hong Kong with production base in China to develop TOUGH COTTON™ technology canvas fabric for an international shoe brand in Japan.
- Staff provided technical assistance to a woven fabric manufacturer in Hong Kong to develop TOUGH COTTON™ technology on cotton/spandex twill fabrics for distribution in the U.S.
- Staff provided technical assistance to a leading Chinese textile company to develop TOUGH COTTON™ and STORM COTTON™ technologies for a Japanese clothing chain store.
- Staff provided technical assistance to two leading textile companies developing TOUGH COTTON™ technology for a U.S. workwear brand.

Nonwovens Marketing

As with most everything in 2020, the year was dominated by influences from the pandemic. Meetings were conducted via web, phone, or messaging platform. There was no travel domestically or internationally. Work continued but, in some cases, at a slower pace as companies restricted access to labs and production lines to socially distancing arrangements to protect employees. Even though these challenges constrained this group's ability to travel and connect personally, the work continued through use of creativity and shifts in focus to projects that were more feasible within these constraints.

Technical development work on two important projects was completed. Both projects position cotton as a solution to the EU Single Use Plastic Directive which has wet wipes that contain plastic in the crosshairs. "Plastic" is yet to be firmly defined but it will include polyester and polypropylene and may include viscose and lyocell. One project involved material development. Nonwoven base trials of cotton/pulp airlaid and cotton/pulp, airlaid/spunlaced technologies were run. The first material was engineered as a non-plastic solution to a global market leading brand. The second was intended as a flushable wipe material. The team worked around limits on attendance at the first pilot facility in Memphis which would only accommodate our consultant. The second location was intended to be Germany, but quarantine restrictions made that impossible. That work was then moved to a pilot facility in France.

The second important technical project also addressed a different need resulting from the EU Single Use Plastics Directive proving to supply chains that cotton is in fact plastic free. This work has ramifications for all cotton markets, not just nonwovens. Cotton was run through a series of seven standardized tests at a lab in Belgium. Test methods, ASTM, ISO, EN, and OPPTS measured the presence of heavy metals and fluorine, soil decomposition, home and industrial composting, and marine biodegradation. Results for six of the seven test results are in and cotton passed all. The last test will be completed by year's end.

Trademark licensing continues to be highly important and active around the world. In the nonwovens space in 2020, 30 new licensing projects were completed in Taiwan, Japan, Korea, Mexico, Switzerland, Germany, Belgium, Poland, Sweden, Russia, India, Turkey, Canada, and the U.S. Some of the notable companies included global consumer brand companies, leading retailers and important supply chain partners in North America, Europe, and elsewhere around the world. Products were largely in key markets including baby diapers, feminine hygiene, adult care, wet wipes, skin care, and personal care products.

Marketing communications in 2020 included advertising, university lectures, webinars, brochures, virtual conference talks, and conference leadership. Major tradeshows were all postponed to 2021 or cancelled. New trade ads spoke to baby care, simple ingredients, hypoallergenic properties of cotton, and cotton's degradation in aquatic environments. Both print and digital ads were developed. One CottonWorks™ webinar was given communicating the results of a clinical evaluation of cotton on skin. New brochures were developed for innovative work done with cotton flock and the hypoallergenic clinical evaluation results. Two university lectures were given: one to the Fashion Institute of Design & Merchandising (FIDM) on innovation with cotton and the other, covering several topics, to Saxion University in the Netherlands. That class of students was working on innovation projects related to personal care. They learned about Cotton Incorporated, innovative work in nonwovens related to personal care products, hypoallergenic research, and sustainability research related to composting and aquatic degradation. Also, in 2020 a conference talk was recorded on the topic of the hypoallergenic clinical evaluation and given during the Hygienix Conference. Furthermore, staff chaired the World of Wipes Conference for the fifth year delivering an introductory message, moderating a panel, hosting a table-top, and participating in other networking events. Both conferences were completely virtual, a new learning experience for all.

Fashion Marketing

With the world-wide catastrophic events of COVID-19 in the first half of 2020, Fashion Marketing (FM) activities experienced a complete shift in production and presentation. January saw staff working on the production of the Fall/Winter 2021/2022 season. The final production and editing were done from home offices and the presentation was launched virtually in April. Presentation, microsite, and materials all came out in the expected timeframe. Over a dozen presentations were delivered to key companies.

Fashion Marketing staff continued to present Fall/Winter 2021/2022 to clients both domestically and abroad. At the same time, FM staff was in production for Spring/Summer 2022, Denim 2021/2022, and Active 2023. While in production for these seasons, FM staff presented specially made preview presentations to clients for both Denim and Activewear. By the Summer/Fall, all components of comprehensive presentations were completed; color cards (digital versions), interactive presentations, all micro-sites, and swatch packets.

FM staff has continued to meet with clients through the platforms of Microsoft Teams and Zoom. FM staff has met with various clients in Latin America utilizing the "simultaneous translation" feature on Zoom. In September, virtual meetings were held with clients in Asia. FM staff has also met with dozens of clients in the United States. Presentation attendance ranged from two people to more than 250 clients. The virtual platform has been extremely successful and has enabled FM staff to keep in constant contact with clients.

Full scale Denim 2021/2022 was released in September, Spring /Summer 2022 was released in October and Activewear 2022/2023 was released in early December. In just the last quarter alone, FM staff gave over 35 presentations.

FM staff also took this unusual year as an opportunity to take physical color cards and go digital with them. Incorporating all the elements of a traditional color card into a digital file and instituting I-phone compatible versions turned out to be the right direction. Clients were able to access the trend information they have come to depend on via a link sent out by account managers. The digital format allowed greater creative freedom as there were not constraints like paper size, printing costs, or shipping expenses.

Additionally, FM staff created specialized versions of presentations for Latin America, Turkey, and Bangladesh. For Latin America, presentations were deconstructed (Seasonal/Denim) into PowerPoint versions with audio explanations that were dubbed in Spanish.

The bi-monthly travel and trend inspiration blog featured Montevideo, New York Fashion Week, Sydney, Auckland, Wellington, Berlin, Paris, Barcelona, and Stockholm.

Fashion research was conducted both locally in New York and abroad. Research was conducted in Sydney, Wellington, Auckland, Berlin, Paris, Stockholm, and Barcelona. Staff worked with schools and universities both in the New York City office and virtually. FM staff did research both locally in New York and online for cotton samples.

FM staff participated as guest speakers and presenters in webinars for the CottonWorks™ Website as well as special events, like the guest influencer spot for Amazon for their special holiday buying report.

Strategic Objective 3: Conduct technical education and training to support cotton use.

The GSCM division manages the Importer Support Program (ISP), which provides programs that meet the mission of Cotton Incorporated and specifically benefit the importer segment of the supply chain. The CottonWorks™ site is the main marketing platform of the Global Supply Chain Division and is supported by the ISP program. The CottonWorks™ platform includes technical education workshops, webinars, education for emerging professionals, events such as the farm tours, and numerous other activities to increase and support the use of cotton in products.

Forty-five technical education workshops were held in 2020 with over 1,530 attendees from over 150 major brands and retailers. All workshops in the last six months of the year were held virtually due to business closures and travel restrictions related to COVID-19. Two new active workshops were held as well as four new topic workshops: digital printing, seamless knitting, intimate apparel, and introduction to cotton. The purpose of these workshops was to provide detailed technical information and training on relevant topics important for cotton.

The CottonWorks™ Website is a marketing tool and educational resource (www.cottonworks.com). It is the leading innovative education and information resource for current and emerging textile industry professionals who are actively seeking connections to cotton. New content, both educational and marketing, continues to be added on a regular basis. In 2020, cotton fabrics from Cotton Incorporated's FABRICAST™ library were digitized and added to the FABRICAST™ page. Additionally, a small number of existing fabrics were divided into four categories as additional search criterion: Trending Fabrics, Denim Basics & Beyond, Natural & Sustainable, and Comfortable & Cozy. Recently released FABRICAST™ collections and digital fabric capsule collections were promoted in a similar manner. Staff also implemented a new section to the Website, Tariff Engineering, as well as new content to support recent webinars including Cotton Sustainability Basics and additional content in Biodegradability of Cotton.

CottonWorks™ webinars offer a unique way to reach the industry and amplify the Company's message. In 2020, 16 webinars were held. These webinars concluded the sustainability series and incorporated topics such as economics, nonwovens, knit development, and consumer opinions. Two webinars were hosted specifically for the Asia market. Each webinar reaches between 200 and 400 individuals. In addition, the recorded webinar lives on the CottonWorks™ Website and makes for great Web content. Webinars are one of the most successful methods to share information with many industry professionals from the global cotton industry.

The 2020 "Cotton in the Curriculum" university education program was concluded in December. Specifically, 23 university projects across the U.S. were completed. The objective of the university grants is to increase the awareness of cotton in the classrooms. In mid-March, all universities transitioned to online classes. Staff worked closely with each grant recipient to adjust project proposals into the new digital format.

A portion of our efforts at the university level included an influencer program. The program identified approximately ten emerging professionals on campuses across the U.S. to promote cotton on campuses. The influencer program was focused on social media platforms of Instagram and LinkedIn. In total, the university programs resulted in 1,973 new student registrations and 678 new faculty registrations.

The 2021 "Cotton in the Curriculum" grant program has awarded grants to eighteen universities for the 2021 calendar year.

ADVERTISING, CORPORATE COMMUNICATIONS, BRAND PARTNERSHIPS, AND CORPORATE STRATEGY AND INSIGHTS (CSI)

Strategic Objective: Use advertising, public relations, and brand partnerships to build consumer demand and trade awareness for cotton and cotton products as well as use market intelligence to assess opportunities and threats for cotton, influence corporate strategy efforts, and leverage program metrics to evaluate and improve tactics for fulfilling Cotton Incorporated's mission.

Advertising

In 2020, Cotton Incorporated TV commercials were seen by 57% of women 18-49, 10.4 times and delivered approximately 380MM Impressions.

A total of 4,429 television exposures appeared across broadcast networks such as ABC, The CW, and FOX in addition to ten cable networks (BET, Bravo, CMT, E!, Freeform, Food Network, HGTV, MTV, TLC, and VH1). Units were scheduled during popular prime time programming such as *American Idol, The Masked Singer, Empire Finale, Riverdale, Station 19, House Hunters, Beat Bobby Flay*, and *The Real Housewives.* The Department focused on two, five-week campaign flights (April-May 2020: *Comfort in Cotton* and October-November 2020: *Life is Uncomfortable*) due to the optimal programming in the second quarter as well as the fourth quarter. The commercials also ran on Roku, an over-the-top (OTT) streaming platform, and Hulu, a subscription-based streaming service, in order to reach younger, light-TV viewers and those who do not have traditional cable subscriptions. The video buys delivered an additional 20 MM+ impressions to women 18-34.

In response to the pandemic, television budgets shifted to reserve funds. Because of this, only ABC, FOX, and CW were purchased on network TV for the second quarter. The media plan shifted from the planned *Your Cotton Your Way* creative to the new creative *Comfort in Cotton*. The *Comfort in Cotton* creative was a direct response to the pandemic and ran on networkTV and cable April through May. In addition, CMT was removed from the roster and re-invested across (BET, Bravo, E! Food, Freeform, HGTV, MTV, TLC, & VH-1) in cable for the fourth quarter of 2020 as well as the second quarter of 2021.

Comfort in Cotton testing results indicated that 73% of respondents correctly identified the spots as Cotton Incorporated. This indicates that there is strong brand recall. Additionally, awareness for *Comfort in Cotton* was higher than the previous TV work *Life is Uncomfortable*, when it originally aired in 2018. Those who recall seeing the ad were more likely to say they "love cotton" and that they check fabric content labels.

Life is Uncomfortable (First Day) was in its third year of airing. The Ad Tracker remained strong in the fourth quarter of 2020 (compared to the fourth quarter of 2019) with users "wanting more cotton in my life" remaining at 53%. An increase against "intrigues me to find out more about cotton" which rose to 46% as of October 2020 (from 44% in fourth quarter 2019) – the campaign ran through November 2020.

<u>Campaigns</u>

In February 2020, *Cotton Equals Denim Phase 2* launched with a new asset *Rosie Reborn* which focused on the story of the denim jumpsuit worn by Rosie the Riveter. Through a collaboration with TheGREAT, Cotton Incorporated along with a third-party agency developed both long and short form video spots to run across video ad networks, streaming, and YouTube. The first portion of the campaign ran across the top performing Phase 1 partners: Hulu, Tremor, and VideoAmp, making it exclusively a video campaign. These assets delivered 19MM impressions and a Video Completion Rate (VCR) of 86%, which is an increase from the 2019 Denim Phase 1 VCR of 81%. *Rosie Reborn* generated over 17B impressions across earned and paid media. The campaign increased belief that cotton makes denim last longer, helped to further associate a beloved fabric with cotton, all while strengthening the emotional connection to the fiber.

Utilizing a consumer public relations campaign; *Rosie Reborn* had a dedicated segment on *The Today Show* along with pickup in *Women's Wear Daily*, across *Yahoo* properties, *Rivet,* and others.

In mid-April, Cotton Incorporated along with a third-party agency developed two new spots in response to COVID-19 and the stay-at-home order. The first spot, *Comfort in Cotton,* was rotated across the existing digital partners, in addition to TV and Zefr

(a digital-ad delivery service) and was introduced to complement the current plan and extend reach, between April 20-May 23, 2020. This creative delivered 7.4MM impressions and a VCR of 73% and ran until mid-May. The second spot, *Ode to Sweatpants* was rotated on VideoAmp and Zefr. BounceX, a new media partner, was introduced as an added value opportunity. BounceX utilized the creative across their premium sites like *People*, *Southern Living,* and *Time*), and was a brand-new partner for Cotton Incorporated that centers on targeting users as soon as they have finished reading or engaging with content, providing ads that are contextually relevant and timely for the users. This creative saw 832K impressions and a VCR of 72% which ended on May 31 and brought the full campaign to a grand total of 27MM delivered impressions across all three creatives.

The 2020 campaign, *Life is Uncomfortable (First Day)* launched online in June, as the previous 2020 creative strategy *Your Cotton Your Way* was not able to be completed due to the pandemic's impact on the production schedule. Amplifying the emotional connection between the consumer and the brand remains a strategic imperative. Overall, the objective for this campaign was to focus on educating consumers on the cotton message, its relevancy, and why cotton should be the preferred fiber of choice.

Three health and wellness 15-second videos (*Sleep, Irritation,* and *Underwear*) along with three sustainability videos (*Plant, Flower vs. Oil,* and *Ocean*) have been running in rotation across the digital plan. Banner ads for the health and wellness (*Sheets* and *Women's & Men's Underwear*) and the sustainability (*Quality-In & Quality-Out*) creatives along with native ad units, and other custom elements had been running in conjunction with the videos while driving users to TheFabricOfOurLives.com Website.

Digital Media: Custom Content

The *Life is Uncomfortable* digital campaign launched in late May, showcasing the pillar messaging for the third year: Health & Wellness, Sustainability, and Fashion. The campaign launched with cross-platform display and video across both new and historic partners, featuring the following creatives: Health & Wellness (*Sleep*, *Irritation*, and *Underwear* videos, and *Sheets* and *Women's & Men's Underwear* banners); Sustainability (*Plant, Flower* vs. *Oil*, and *Ocean* videos and *Quality In*/*Quality Out* banners); and Fashion *(Life is Uncomfortable: First Day* video and sustainability banners). The campaign ended in October and delivered 407MM impressions, and 1.9MM clicks. Additionally, Health & Wellness videos (*Sleep, Irritation,* and *Underwear*) on streaming only (Hulu+Roku) generated 3.49MM impressions.

Working with a third-party agency and digital partners, over 100 pieces of custom content across 12 publishers and several new test-and-learn partners were created. The full list of 2020 publishers include: The Weather Channel, Pandora, Spotify, MindBodyGreen, Goop, Well+Good, Buzzfeed, Urban Daddy+Bustle, ATTN, Who What Wear, Verizon, and Undertone.

WhoWhatWear, ATTN, Pandora, The Weather Channel, Urban Daddy, Bustle, Verizon, and Undertone featured both the Health & Wellness and Sustainability messages, applying either contextual targeting or placing Cotton Incorporated within relevant edit on their sites to ensure the most qualified, engaged audience was experiencing the creative. These partners focused on maximizing awareness and increasing brand favorability, enabling the emotional connection between consumers and cotton.

Health & Wellness remained a key and top performing pillar this year, for both custom experiences and standard, targeted content. The Department partnered with Well+Good and Goop to take advantage of authoritative, endemic audiences to the health and wellness space, while partners like Verizon and Undertone were able to leverage contextual interest targeting to increase reach and aid in awareness. In addition to Goop's standard media, Goop was able to create an expansive native program including themed sponsorships and podcasts. The Department worked with Goop on selecting topics that aligned with the benefits and attributes of cotton, while also taking advantage of top talent, like Goop's episode with Cameron Diaz and Gwyneth Paltrow. To date, all four podcast episodes have garnered 700K+ downloads and aired between July – September. According to a third-party study, brand favorability across Health & Wellness creative remained at 88% across digital and online ad awareness saw a 4.4% lift (as of 09/2020). The strongest partner favorability lift came from Verizon, a new publisher, at 9.8%.

To boost presence for Sustainability, Advertising partnered with MindBodyGreen, for the first time, and created a customized program including World Cotton Day support in October. Podcasts, infographics and custom videos spoke to the benefits of living a more sustainable life and the role cotton plays. Content included: "Breathe Easy, Sleep Better: The Science of Cotton Sheets", an Instagram infographic entitled "Farm to Closet: Where Your Favorite Cotton Clothes Come From," and "Sustainable Sundays" in which a MindBodyGreen editor chronicled how they live sustainably. The Department partnered with

MindBodyGreen on customizing the podcast content and secured two episodes. The August 16 episode featured Cotton Incorporated's Chief Sustainability Officer and MindBodyGreen's CEO, where they discussed weekly plastic consumption and what that means for the environment. To date, both episodes have accumulated over 100K downloads, with featured episode receiving over 53K downloads.

Lastly, the *Check the Label Project* launched for the second year with Urban Daddy + Bustle, where we were able to apply learnings to further enhance the content on the microsite. The site featured over 20+ pieces of content spanning Fashion, Health & Wellness, and Sustainability. The partnership included top performing content, interactive infographics, and quizzes which drove increased performance. In 2020, Cotton Incorporated had 815K article page views. Both partners maintained 2019's cobranded traffic drivers and top performing tactics such as Urban Daddy's dedicated emails, which delivered 93% click-through-rate over the 75% benchmark.

Paid Search Engine Marketing (SEM) and Organic Search (SEO)

Paid search advertising on Google and Bing continued to drive qualified visitors to TheFabricOfOurLives.com Website, resulting in over 700K clicks to the site. Of these clicks, 350K landed on the Shop Cotton section, resulting in over 200K clicks on cotton-rich products to the respective retailers' e-commerce Websites. The newly introduced "Benefits of Cotton" page on TheFabricofOurLives.com delivered campaign efficiencies, specifically lowering cost per clicks by 15%. The top-performing paid search campaign averaging a 17% click-through-rate was consistently "Cotton Care" helping consumers with cleaning and care tips.

Gmail, MSAN, and YouTube tactics introduced in 2019, were included in the fourth quarter plans to support Cotton's Amazon Style House, increasing awareness for the brand. This tactic supported Cotton Incorporated's Amazon specific site, as well as Shop Cotton as a whole.

TheFabricOfOurLives.com

TheFabricOfOurLives.com Website was updated throughout 2020 to implement search optimization insights. These updates resulted in increased site performance and searchability as well as promoted partner programs like Sak's, The Great, REVOLVE, and Amazon. To further improve optimizations, there was collaboration with the Sustainability Division to update sustainability content. Similarly, Advertising worked with Legal, Corporate Communications, and Human Resources to update the About Us section to reflect Cotton Incorporated's established Equal Opportunity Employer statement.

(*Hanes Cool Comfort Women's Underwear* received 20% of Underwear clicks). Additionally, there was clear year-over-year increases against Shop Women's, Cotton Care, and Cotton Fabrics.

Amazon x Cotton Collaboration

Advertising supported Brand Partnerships in their collaboration with Amazon, this time putting the full digital investment behind the partnership. The objective for advertising was to build traffic to the site through various tactics via Amazon's DSP and Fire Tablet platform. Users were targeted based on gender, contextual relevancy, and their search habits through Amazon's DSP. These audiences are then grouped into consideration and conversion pools, and then served the appropriate messaging. This program launched in mid-November and ran through the end of December, with an estimated delivery of 65MM impressions. The collaboration was also supported by Paid Search and Social to drive additional reach and traffic to the custom landing page.

Social Media

Paid and organic social media was used to reach and engage with users across Facebook, Instagram, Twitter, Pinterest, and Snapchat. Messaging included Cotton Incorporated program promotions (Blue Jeans Go Green™ denim recycling program, Retailer Support, Amazon Style House), a social extension of the *Comfort in Cotton* messaging (*Ode to Sweatpants*) during the early months of COVID, and fashion and lifestyle content (including the continuation of the 2019 denim campaign showcasing "Modern Rosies" in denim and cotton's effects on health & wellness) as well as cotton sustainability.

In 2020 the advertising department ran the following paid Social Media campaigns:

- *Comfort in Cotton* ran on Facebook in April-May 2020. The campaign complemented the same messaging running in TV during the early days of COVID and was optimized towards video completions and delivered 17.6MM impressions and 12.3MM video completions.

- Blue Jeans Go Green™ ran on Facebook and Instagram from August - November 2020. The campaign was optimized towards reaching unique users and reached a total of 17.5MM unique users across 122MM impressions. BJGG ultimately drove a total of 82.6K clicks.
- America Recycles Day ran on Facebook and Instagram in November 2020. The campaign reached a total of 6.7MM of unique users by serving 15MM impressions and drove a total of 13K clicks.
- Health & Wellness was a video campaign that ran on Facebook, Instagram, Pinterest, and Snapchat. This campaign ran from July to September and served over a total of 116MM impressions, 24.3MM video views, and 2.9MM video completions.
- *Rosie Reborn* was an awareness campaign that ran on Facebook and Instagram from February to April. It served a total of 73.2MM impressions and reached a total of 12.4MM unique users. This campaign also had 8.4MM video views and 2.4MM video completions.
- Sustainability was a video campaign that ran on Facebook, Instagram, and Twitter. This campaign ran from September to November. It served a total of 84.3MM impressions and reached 12.4MM unique users. It also delivered 16.6MM video views and 14.2MM video completions.
- Cottonworks Trade ran on LinkedIn from August to December and to date (11/20) had a total of 3.2MM impressions served with over 9.5K clicks and 162K video completions.
- The Retailer Support campaign ran on Facebook and Instagram from November to December. In support of four retailers, this campaign generated a total of 3.2MM impressions and reached 1.5MM unique users to date (11/23).

Additionally, the Department Tested & Learned with a Facebook In-Stream Buy for *Comfort in Cotton* which saw 13.6+ Brand Lift Points (the benchmark is 11.7) and saw 5.76M Reach and 3.06 Frequency.

Production

Production was completed or began on the following items:

- *Rosie Reborn* campaign, which celebrated the resilience of the denim jumpsuit and the strength of the women (symbolized by fictional character Rosie the Riveter) who worked in male dominated industries to support their family and country during World War II. At the heart of the campaign is the denim jumpsuit, designed by female-owned company, The GREAT, which reimagines the jumpsuit for women who are breaking barriers today. Each jumpsuit incorporated a piece of denim from the 1940's as a reminder of denim's durability and the women who made the fabric powerful in their actions. The campaign consisted of digital and social videos and still photography explaining cotton's role in the denim jumpsuit and featured Modern Day Rosies in fields such as tech, architecture, welding, and professional sports to serve as a reminder to women everywhere to embrace their power and continue to break barriers. The campaign launched on February 19 on Cotton Incorporated's, The GREAT's, and the Modern Day Rosie's social channels. The campaign also received public relations support with interviews by three of the Modern Day Rosies on the *Today Show*, and editorial coverage from *Bustle, AdAge*, and other media sources. Digital components began February 24 running on Hulu, Roku, and other digital partners.
- 2020 consumer campaign, *Your Cotton Your Way,* aims to highlight the comfort of cotton, the confidence it provides, and reinforces The Fabric of Our Lives™ message. The campaign spotlights four individuals talking about their favorite cotton item while a pianist plays The Fabric of Our Lives™ jingle. This production was originally postponed in the spring due to the pandemic and resumed in the fall of 2020. The new creative is set to launch in April 2021 on broadcast, digital, and social.
- In March and April 2020, the team quickly pivoted from the original, postponed 2020 *Your Cotton Your Way* production and production for *Comfort in Cotton* was completed for broadcast, digital, and social channels. This concept was born out of the stay-at-home order. The spot was meant to be a positive, hopeful snapshot of what life now looks like. It showcases beautiful moments in everyone's life during these trying times, while tactfully drawing attention to the fact that wearing comfy, cozy cotton is the key to the "Stay Comfortable" portion of the tagline "Stay Home. Stay Safe. Stay Comfortable."
- Updated the voice over and end-card on the *Life is Uncomfortable (First Day)* spot which ran in the summer digital campaigns and the October/November television plan.

- *Updated the Know Your Clothes* and the Health & Wellness banners to run across the 2020 digital plan. The *Know Your Clothes* banners communicate the importance of knowing what your clothing is made of - that what goes on your body is just as important as what goes in it, in addition to communicating the health benefits of wearing cotton underwear to prevent infection and using cotton sheets for a cooler night's sleep.
- *Ode to Sweatpants* was a build-off of the *Comfort in Cotton* work as a nod to the current times of work-at-home/stay-at-home order of Spring 2020. The campaign featured roughly 15 videos that were posted on social media each day for one week, and all demonstrated different reasons consumers love cotton sweatpants. The digital assets were distributed across platforms and streamed on Hulu and Roku and made into a playlist on YouTube.
- *2020 Instagram Photoshoot* was meant to capture social content in a creative and cohesive look and feel. It was developed with Instagram in mind and delivers on the content pillars for social—Health & Wellness, Comfort, and Sustainability.
- *World Cotton Day* social influencer campaign featured three influencers wearing clothing items from around the world that are traditionally made of cotton fabric and explained the significance of these garments to them in their everyday lives.
- Two International Influencers were engaged to speak to *World Cotton Day* and how cotton fabrics are reflective of their country and culture (India and Ghana). A current influencer within our program spoke to the U.S. with or about? denim.
- *Sustainability Paid Social* creative made the connection that cotton is natural and comes from the earth and challenged people to not only think about what goes in their body, but what goes on it.
- *Created Warm & Fuzzies,* a content series for social intended to deliver on Cotton Incorporated's Comfort, Confidence, and Style pillars in a unique way. This series features cotton clothing with positive messages custom-embroidered, ranging from feel-good phrases to comfort benefits.
- Developed digital display banners to support the 2021 consumer campaign, *Your Cotton Your Way,* as well as showcase the various benefits of cotton. The campaign banners align with TV, highlighting the casts' favorite cotton item and how it makes them feel, while the benefit-driven banners communicate the benefits of choosing cotton—cotton underwear can help prevent infections; cotton sheets are breathable for a better night's sleep; cotton is natural and comes from a plant; cotton is hypoallergenic; and cotton washes cleaner and doesn't retain odors. As well, all banners reinforce The Fabric of Our Lives™ tagline.
- Production was completed on an influencer partnership with nine Instagram influencers who showed how cotton is essential throughout all stages of their lives and communicated messaging points through these three communication pillars: health and wellness benefits; cotton's natural advantages, including promotion of Cotton's Blue Jeans Go Green™ program; and comfort, confidence, and style.
    - Nine Influencers with micro (less than 10K followers) to macro (less than 100K) followers were engaged to produce five pieces of content each (45 in total) across all three pillars of Fashion & Comfort (including Denim), Sustainability, and Health & Wellness from September–December 2020. Metrics to follow in 2021. As of September 2020, 15 pieces of content across nine Influencers have been delivered at 125K Impressions.
    - Production for an influencer partnership with *Color Me Courtney* was completed, themed around cotton fashion for the holidays, yet centered around comfort, confidence, and style. This included an Instagram Reel video and Instagram Stories on @colormecourtney, and a supporting Shop Collection for TheFabricOfOurLives.com Website curated with Courtney's cotton holiday picks. Metrics to follow in 2021.

<u>Youth Marketing</u>

Advertising continued working with *Young Minds Inspired*, an educational site geared toward educators. In the first and second quarter of 2020, two e-blasts were sent to educators of 4th-8th graders across the country around STEM-focused learning in regard to the cotton lifecycle as it relates to fashion. An additional e-blast was delivered in the third quarter to support World Cotton Day. As of November 2020, the program materials saw over 100K downloads.

Within the digital campaigns, the department worked with digital publishers who speak to the current target market but also skew to a younger demographic, including Buzzfeed, Pandora (including its key platform Soundcloud, which is the fastest growing

user-generated music publishing platform among the 18-24 demographic), and Spotify which captures both Gen Z as well as Millennial targets.

Additionally, a Test & Learn with Snapchat (the "Swipe Up" Feature) exceeded benchmark and custom article content with Buzzfeed like "Curate Your Dream Wardrobe and We'll Identify Your Star Sign" reached an additional 25% of users above benchmark.

Trade Media

Digital trade activity has been active since the first quarter of 2020 for Macrotrade, Nonwovens, CottonLEADS℠ program, and Cottonseed across a variety of publishers including, *Women's Wear Daily*, *Sourcing Journal*, *Sustainable Nonwovens*, *Rivet,* and *Ecotextile News*. As of September, all four campaigns have delivered 18MM impressions and 60K clicks which includes a mix of newsletters, dedicated emails, and display media. Media concluded in December for most of the campaigns and properties.

Digital trade activity has delivered 18MM impressions and 59K clicks as of September 2020 which includes a mix of newsletters, dedicated emails, and display media. Additionally, the focused paid LinkedIn program saw over 3.7MM impressions.

A total of 11 Macrotrade print ads ran in 2020 in industry publications such as *Textile Insight, Ecotextile News,* and *Rivet*. The print campaign synced with the digital campaign to provide additional presence on key properties.

A total of 30 nonwovens print ads ran in 2020 in publications such as *Nonwovens Industry, Nonwovens Industry China*, *Nonwovens Industry South East Asia*, *Nonwovens Report International, Household Care & Personal Wipes, International Fiber Journal,* and *Sustainable Nonwovens*. The print campaign was complemented by digital banner ads on Websites such as Nonwovens-Industry.com and SustainableNonwovens.net. The messaging focused on the sustainability aspect of cotton from its simple ingredients to being environmentally friendly. Nonwovens saw a two-times higher click-through-rate on digital advertising placements from 2019.

A total of 46 cottonseed print ads ran in 2020 in publications such as *American Dairymen, Dairy Herd Management, Dairy Star, Feed & Grain, Progressive Dairyman, Farm & Dairy Magazine, Feedstuffs, Hoard's Dairyman,* and *Milk*. The cottonseed print campaign was complemented by digital banner ads on Websites such as AmericanDairymen.com, DairyHerd.com, FeedandGrain.com, Feedstuffs.com, and Hoardsdairyman.com. The messaging enticed users to purchase cottonseed long-term at a low price.

A total of six Cotton LEADS℠ print ads ran in 2020 in publications such as *Ecotextile News*. The print campaign was complemented by digital banner ads on Websites such as Ecotextile.com and SourcingJournal.com. It ran a combination of newsletters and run-of-site placements across multiple ad sizes.

Corporate Communications

Support of Consumer Programs

Corporate Communications supported key consumer-facing projects in the first half of 2020, including the Blue Jeans Go Green™ (BJGG) denim recycling program, as well as ongoing support of advertising campaigns and initiatives.

In support of the BJGG program, the department has increased the frequency of posts on the corporate-facing social media channels and helped review press releases and material assets. To date in 2020, posts about the program have organically reached approximately 40K people across the channels.

While several initiatives for the BJGG program have been put on hold due to the pandemic, the Corporate Communications department continues to work with the Brand Partnerships department to develop and review collateral and content for future campaigns and initiatives in the second half of the year.

Corporate Communications worked closely with the Advertising department to launch and promote the *Rosie Reborn* campaign in February. Working closely with Advertising and third-party agencies, Corporate Communications reviewed ideas, designs, campaign videos, as well as worked on developing media pitches and securing coverage.

The department also supported the *Comfort in Cotton* advertising campaign that was created to reflect the "stay at home" nature of the pandemic. The video for the digital campaign was shared across the corporate social media channels and inspired the creation of two additional videos, produced in-house, to help support the comfort messaging.

COVID-19 concerns forced the rescheduling of several consumer-facing programs supported by Corporate Communications to the fourth quarter. These included the Revolve and Amazon Style House promotions led by Brand Partnerships, which the department supported in conjunction with Brand Partnerships and its agencies.

Related to COVID, Corporate Communications promoted the Corporate Strategy & Insights department's four waves of COVID consumer research. These resulted in 520 news items with an estimated audience of 13.7 million, and an advertising value of $26,232.

In October the department represented the company in supporting the second World Cotton Day observance, in collaboration with other global cotton organizations. The department contributed two short videos that illustrated the sustainability of cotton, and the economic impact of the global cotton industry. Collectively, the October 7 observance generated 508 news items with an estimated audience of 79.4 million, and an advertising value of roughly $150,000.

To take advantage of the comfort opportunity present by stay-at-home orders, the department created two animations, one that addressed the comfort of cotton in general, and another to explain the breathability aspect of cotton. Inclusive of a modest paid boost on Facebook, the animation was exposed to an audience in excess of 7,000.

In December, the department collaborated once again with CSI to promote the Holiday Shopping intentions survey through a satellite media tour. The tour achieved 1,300 broadcasts and reached an estimated audience of 27.9 million across 19 U.S. media markets.

Trade Programs

Two notable media sponsorships in the first half of 2020 were the Denim Look Book and Circularity Survey & Report. The Denim Look Book, in collaboration with *Rivet*, filled the void of canceled denim trade shows by allowing denim designers a showcase for their work. Since June 17, the showcase has garnered more than 2K global views and will continue to be promoted through social media and dedicated e-blasts. The Circularity Survey & Report was an industry-facing survey designed to better comprehend the disparate definitions and approach to circularity. The report based on the responses was published to the *Sourcing Journal* site, and a webinar based upon the results took place on July 28. The webinar had 650 registrants.

In the second half of the year, the department sponsored a virtual Sustainability event with *Sourcing Journal*, and once again sponsored the *Sourcing Journal* Summit event in New York. The latter event was especially beneficial because the change to virtual resulted in greater exposure for the company and included a ten-minute speaking opportunity for the department's senior economist. The event broke live attendance records with 567 registrants; 244 of which attended the economist's remarks.

The department also collaborated with the North Carolina State University communications team to promote the joint Cotton Incorporated/NCSU research on recycling post-consumer cotton apparel into a sugar. These received positive coverage in desirable media outlets such as *Eco Textile News* and *Sourcing Journal*.

In China, the department launched three media partner programs, including the year-long China International Fabric Design Competition; an in-store Seal of Cotton trademark promotion with a major Chinese licensee; and the monthly Shanghai Mart Workshops. In addition, the department began sponsoring a denim-focused textile education platform called I-SKOOL. Additionally, the corporate WeChat social media platform increased its followers to 7,397.

Sustainability

The department sponsored an update to the Eco Textile News booklet, *The Insider Guide to Cotton & Sustainability*. Released in January 2020, the sponsorship underscores the Company's commitment to and authority in cotton sustainability.

The department worked closely with the Sustainability department to update and redesign existing fact sheets on key cotton topics such as pesticides, water, land use, and comparison of organic and conventional production systems.

In April, the department deployed six "graphically enhanced media" (GEM) units across the corporate social media channels. These GEMs feature the Chief Sustainability Officer at Cotton Incorporated, as spokesperson. Although evergreen content, they were featured as a weekly series on the corporate social media channels leading up to Earth Day in April. Across all three platforms (Facebook. LinkedIn, and Twitter), the videos garnered a reach of over 25K and have been viewed over 5.4K times.

Related to sustainability, the department has produced a new full-length "Cotton & Comfort" animation, which has been broken down into three vignettes showcasing the versatility of cotton – clothing, food, and shelter. The vignettes have started to be shared across the corporate social media channels and will continue to be distributed into the second half of the year, followed by the full-length video. The video is also showcased on the Cotton Today Website.

The department continued to work in concert with the Sustainability department, National Cotton Council, and Cotton Council International to support and promote the U.S. Cotton Trust Protocol.

In collaboration with the Sustainability Division, the department embarked on a redesign of the CottonToday Website and an integrated marketing program to promote it. The site is expected to soft launch in late first quarter 2021.

Cotton Incorporated *Lifestyle Monitor*™ Survey

The *Lifestyle Monitor*™ survey and other data resources within continue to attract interest in the media, as well as the industry. Corporate Communications continues to work closely with the Corporate Strategy & Insights (CSI) department to promote all the analytical resources of the company, and to integrate these data to support the direction of the Company's cotton-promoting programs.

The *Lifestyle Monitor*™ articles continue to remain a popular feature in the *Sourcing Journal* and in the denim-centric *Rivet* (as appropriate), where the articles are frequently the top reads of the week. Some of the most popular articles were about the evolution of denim, fashion designers embracing sustainability, and shopping for apparel during the COVID-19 pandemic.

Corporate Communications has also shared data and infographics about special surveys conducted by the CSI department. Special surveys were conducted about home textiles in the U.S., China, and Mexico, and two waves of surveys about consumers and COVID-19 were also conducted in the U.S., China, and Mexico. These results were shared on the *Lifestyle Monitor*™ Website and shared across all the corporate social media platforms.

The department continued its editorial partnership with the *Robin Report* in 2020 with articles promoting the *Lifestyle Monitor*™ survey and other analyses from CSI, as well as on cotton sustainability.

Social Media

The department has also focused on organically growing their social media presence (separate from the consumer-facing "Discover Cotton" pages). From January 1, 2020 through December 31, 2020, the corporate Facebook page grew followers to 11,878. This number of followers may appear small, especially relative to the consumer Facebook page, which has close to one million followers. However, given the smaller size of the trade/corporate audience, the number of followers is quite good.

Video and animated posts have continued to perform significantly higher than static image posts. During the first and second quarters, videos posted to the Facebook page garnered approximately 19.2K video views and a viewing total of 6.3K. The top videos during this time were: *Rosie Reborn* (11,034 total reach; video posted two times), *Comfort in Cotton – Thank You* (3,150 total reach), and the *Comfort in Cotton* ad campaign video (2,074 total reach).

The department continues to utilize Twitter (5,987 followers) and LinkedIn (16,320 followers) as social media tools, sharing articles and information pertinent to the cotton agricultural and textile industries – press releases, webinars, environmental videos, etc. While LinkedIn is still primarily for industry-related information, the department has found that posting more consumer-friendly information on the page has been beneficial and engagement and followers have increased.

The department has also increased promotion of the CottonWorks™ Website and FABRICAST™ collections across the social channels. The posts do particularly well on LinkedIn but receive great engagement across all the channels. While the posts have been shared all year, the direction of the posts and fabrics changed to reflect more "cozy" fabrics that were good for "staying at home" during the pandemic.

As part of the promotion of the 50th Anniversary of Cotton Incorporated, the department has created over 50 social cards featuring interesting facts about Cotton Incorporated and the cotton industry in general. The cards feature the 50th Anniversary, "50 Years Forward" logo and are shared weekly on Sundays. To date, the anniversary social cards have had over 90K impressions across all three channels. Additional elements of the program included the distribution of five video clips featuring key company spokespeople reflecting upon the past 50 years of cotton innovation; and a ten-page anniversary spread in the October issue of denim-focused *Rivet* magazine.

At the beginning of 2020, Corporate Communications also began a subscription to a social media tool that assists in scheduling posts across channels, reaching the right audiences on each channel, and also getting metrics on posts and campaigns.

Cottonseed Marketing

Both wholeseed and cottonseed oil programs for 2020 were significantly impacted by the pandemic, which led to the cancellation of all scheduled events for the year, but progress was made in both areas. In wholeseed, a new print ad was released with digital components, an advisory board representative of target audiences was assembled, and two quarterly meetings occurred. Forays were made into the beef cattle market including industry research surveys and the formation of a separate beef advisory board.

For cottonseed oil, a consumer-facing Website was developed and is expected to launch early in 2021. In addition, a curriculum for target audiences has been developed. This will help fill knowledge gaps about both the health and performance benefits of cottonseed oil. This curriculum will be delivered remotely, in light of the cancellation of in-person educational conferences. Research is also underway to determine whether cottonseed oil has a competitive benefit for french fries, especially in a takeout or fast-food situation.

Brand Partnerships

Consumer Sustainability Initiative: Blue Jeans Go Green™ Program

Throughout the first half of the year, the Blue Jeans Go Green™ (BJGG) denim recycling program continued to work with a variety of brands and retailers that are committed to cotton sustainability through recycling denim. Participants included American Eagle, Ariat, Garage, Levi's, Madewell, O.N.S., rag & bone, and Zappos. The BJGG program also welcomed online retailer, Industry Standard, to the program on April 22. All retailers offered incentives to their customers in-store (when open) and online to recycle denim made from cotton and close the loop by keeping textile waste out of landfills. On April 23, Madewell, a participant in the program since 2014, announced that they contributed over 1MM pieces of denim to the BJGG program. As a result of all participants' efforts and despite shelter-in-place orders, approximately 200,000 lbs. of denim have been contributed for recycling during the first half of 2020.

In April, to celebrate the 50th anniversary of Earth Day, the Blue Jeans Go Green™ program launched a special video series to educate followers on how they could "Do Good on Earth Day," by wearing natural, durable, and recyclable denim made from cotton. The video series kicked-off on April 19, with a video a day being featured across @DiscoverCotton social accounts. On Earth Day, April 22, the full-length Earth Day video from Cotton's Blue Jeans Go Green™ program was featured on BlueJeansGoGreen.org, @DiscoverCotton consumer social accounts, and Cotton Incorporated's corporate social channels.

While distribution was paused March through June as a result of the pandemic, during the first quarter, UltraTouch™ Denim Insulation was distributed to grant recipients and Habitat for Humanity affiliates; some of which include Wake County (NC) and Baton Rouge and New Orleans (LA).

Collection activities were active throughout the entire year with consumers participating by recycling in-store when able, and by mail especially, thanks to collaboration with Zappos. This year, an increase was seen in interest and participation in the mail in program with Zappos, which offers consumers across the country the ability to download a free UPS mailing label at BlueJeansGoGreen.org through the Zappos For Good initiative. Strong interest and participation continued from both endemic and non-endemic brands and retailers in the recycling program, both through corporate social responsibility and consumer-facing promotions. While brands and retailers are important facilitators of the program, especially in-store, recycling in-store and in-office collections were encouraged when able and appropriate, and focus on and attention to online opportunities increased as well. Most brands and retailers remained a part of the program during 2020 and only a handful were unable to participate in 2020.

In the fall around the America Recycles Day weekend, Vineyard Vines NYC stores participated in the program as a pilot to potentially expand to all west coast stores in 2021.

As the year was wrapped up with promotional activity to celebrate and encourage participation in America Recycles Day on November 15, the dedicated social campaign, the Denim Stack Challenge, designed to be a national awareness initiative in honor of America Recycles Day was resumed. A social call-to-action, the Denim Stack Challenge invited people across the country to inventory their own closets, snap, and share a picture of their denim on Instagram, and give those items they no longer wear new life by recycling them.

Strategic and Retail Partnerships

Due to the impact the pandemic had on the retail industry, retail programming and events that Brand Partnerships originally planned for the first half of the year were postponed to the second half of 2020. As a result, the team worked on alternative plans in partnership with Amazon, Saks, REVOLVE, and introduced a small business program. Most activities developed for brick-and-mortar and/or point-of-sale were restructured to be virtual experiences with the exception of in-store cotton displays ("shop-in-shops") that will launched at ten Saks Fifth Avenue stores across the country in October.

In August, the Brand Partnerships team re-launched The Cotton Shop for a three-month long program with online retailer, REVOLVE, that included a digital curated women's collection featuring over 1,500 cotton-rich styles and a highly integrated influencer program. The campaign generated awareness and drove cotton sales on REVOLVE.com while educating consumers on the many benefits of cotton. The program featured 22 notable fashion and lifestyle influencers such as Chanel Iman, Amanda Stanton, and Lily May.

For the month of October, Cotton and luxury retailer Saks Fifth Avenue developed a month-long integrated campaign, "Creating Moments in Cotton," which included the Cotton Shop – a digital cotton-rich curated collection for men and women, plus in-store shop-in-shops in the women's contemporary sections at ten of Saks Fifth Avenue's top performing stores, a digital media program across all Conde Nast titles, and a highly integrated influencer "social series" virtual shopping program. The campaign generated awareness and drove cotton sales on Saks.com and in-store while educating consumers on the many benefits of cotton. The program featured five notable influencers including Jenn Im, Ryan Clark, Jessica Clements, Karen Blanchard, and Sarah Butler, who created content promoting the curated collection featuring the fall's most-wanted styles from Of-the-Moment contemporary pieces, Cozy Cool luxe loungewear, and Elevated Classic fall essentials, which showcased the versatility of cotton, making it the most-wearable and desirable fabric for the Saks shopper.

Seeing how the pandemic greatly affected the retail industry, especially small businesses and brands, the Brand Partnership team developed a retail support program, which was a co-branded social media campaign to help build awareness of small businesses that offer a majority of cotton inventory and products. The campaign aligned with DEMESTIK, a natural lifestyle brand which uses bold cotton fabrics to showcase West African influence and creates designs meant to empower women; Big Drop NYC, a women's boutique in NYC and Miami featuring the latest trends and styles from contemporary and emerging designers; Meadow Collective, a modern bohemian lifestyle boutique based on wellness and sustainability; and Industry Standard, an American made, small, independent retailer that creates high end basics with good, cotton fabric, that lasts.

For a third time, Cotton reunited with online retail giant, Amazon, and this year, just in time for the holiday season with the Cotton Style House – Holiday Edition. Together, Amazon and Cotton Incorporated created an integrated program from November through December that was rooted in creating a virtual shopping experience. The collection offered a variety of on-trend cotton-rich styles that aimed to bring comfort and joy through the versatility of cotton and a seamless shopping experience on Amazon. The collection was curated by internationally recognized celebrity stylist, Irma Martinez, and spanned across categories including women, men, family, home, and gift giving. Actress Debby Ryan, along with eight hero influencers and 30 micro-influencers, showcased the collection, engaging consumers through virtual programming on social media. The Cotton Style House – Holiday Edition even offered consumers the option to shop the collection by influencer, just one of the many ways to shop.

Corporate Strategy and Insights (CSI)

Market Intelligence

This area encompasses ongoing research studies that assist Cotton Incorporated in monitoring the supply chain for changes in cotton use and/or market perceptions.

Lifestyle Monitor™ Survey

Recent research results will be used to better understand the attitudes of U.S. consumers toward cotton and competitive fibers, online shopping, sustainability, microfiber pollution awareness, denim jeans, and shopping preferences. In 2020, subject areas of research in the *Lifestyle Monitor*™ survey included, but were not limited to:

- Performance feature interest: Two-thirds of consumers (66%) say they are likely to seek out performance features in the activewear purchases, that is followed by a majority who plan to seek performance features out in their casualwear (58%), outerwear (53%), and dresswear (52%).
- Looking for fibers: The vast majority of consumers who look at fiber content labels say they are looking specifically for cotton (70%), followed by polyester (6%), spandex (3%), or silk (2%). For consumers, if a clothing product has more cotton in it then they believe it is more comfortable (55%), softer (49%), better quality (33%), more natural (32%), and lasts longer (24%).
- Holiday shopping: On average, holiday shoppers plan to spend about $725 on holiday gifts this year, down 5% compared to the $758 consumers planned to spend last year. Around three in five holiday shoppers say they plan to buy gift cards as a gift this season (57%, up significantly 53% last year), followed by clothing (52%, down significantly from 57% last year), toys (39%, down significantly from 48% in 2019), and electronics (32%).
- Closet usage: On average consumers say they have worn 39% of the clothes in their closet in the last month. Nearly half of consumers (45%) say they feel like they are wearing less of the clothing in their closets now compared to before the pandemic. The majority of consumers (62%) say they don't feel like the pandemic has changed their view on how much clothing they will need in the future.
- Social Media shopping: A fifth of consumers (20%) say they have purchased a product directly from a social media post by clicking on a link or image. About a third of consumers (30%) say they are likely to purchase a product that they see on a social media post directly from a link on that platform.

Retail Monitor™ Research

Retail Monitor™ research is used to better understand cotton's presence as well as the opportunities and challenges for cotton in major adult apparel categories offered at retail in the U.S. Below are highlights from the first quarter 2020 results. The Retail Monitor research was suspended for the remainder of 2020 due to the pandemic. A new methodology will be used in 2021.

- Womenswear**:** Cotton's share (weight basis) increased in five of the six major womenswear categories: knit shirts (+4.9 percentage points), denim jeans (+1.9 percentage points), athletic apparel (+1.2 percentage points), woven shirts (+0.6 percentage points), and pants (+0.1 percentage points). Increases in cotton's share of women's athletic apparel were driven by increases in women's athletic tops (+4.1 percentage points) while share in women's athletic bottoms declined (-1.8 percentage points).
- Menswear: Cotton's share (weight basis) increased in three of the five major menswear categories: athletic apparel (+5.1 percentage points), denim jeans (+0.6 percentage points), and knit shirts (+0.1 percentage points). Increases in cotton's share of men's athletic apparel were driven by increases in both athletic tops (+5.6 percentage points) and athletic bottoms (+4.3 percentage points).

Census-Based Import Database

Staff maintained a database to track U.S. apparel and home textile imports by month and source country. This enabled analysis of changes in sourcing patterns under supplemental tariffs imposed on China. It has also informed discussion of how COVID-19 has affected U.S. end-use demand for fiber.

Marketing Mix Model

A marketing mix model analysis was conducted in the beginning of the year to assess the combination of marketing and promotional efforts that would provide the best return on investment and garner the most exposure for cotton. Results indicated TV provides a solid base, while digital provides the best return for the marginal dollar. Collectively, marketing is estimated to drive 23% of cotton's market share.

Chinese Cotton Flow Chart

Due to concern surrounding cotton production and downstream manufacturing in the Xinjiang region of China, staff developed a flow chart describing how much cotton is grown, imported, exported, and processed within China. A result is an estimate of how much fiber remains in China for domestic end-use.

Corporate Strategy

This area involves the analysis and dissemination of the market intelligence that has been collected through both proprietary and secondary research studies. This information is used to drive internal and external strategies.

Industry Presentations and Meetings

Staff executed 65 presentations and meetings on fiber economics and market research with key global industry contacts, which included delivering domestic and global market intelligence presentations in the U.S. as well as virtually to Latin American and Asian audiences via webinars and recorded presentations. Key topics included the cotton economic outlook and response to the pandemic along with consumer behavioral shifts in shopping for clothes due to the pandemic and sheltering in place, sustainability, home textiles, children's apparel, and retail trend updates. Together the economic and market research presentations had over 3K attendees. Below are a few highlights:

- Staff presented two economic presentations at the Beltwide Cotton Conferences. These included a research talk on the relationship between USDA condition and progress data and yield as well as a cotton market outlook talk at an engineering session.
- A presentation on the cotton market outlook was presented to a group of Alabama growers.
- An economics webinar discussing the effect of tariffs on sourcing patterns was presented on the CottonWorks™ platform.
- Due to the pandemic, an extended trip through Latin America for both economic and consumer research was not possible. As a replacement, staff prepared presentations covering the cotton market situation and how it has been affected by the pandemic as well as research on consumers' shifting clothing and shopping preferences due to the pandemic. This was followed by webinars for targeted audiences in Peru and Mexico.
- Staff presented to almost 300 attendees at the Georgia Cotton Producers' Annual Meeting and the Ag Outlook Forum on the efforts of Cotton Incorporated's Consumer Marketing division to help build demand for cotton.
- Staff provided a recorded *Consumer and Retail Insights* presentation for use in the Chinese domestic market as well as a live webinar for the Hong Kong market. Account Executives in China used the market research presentations for multiple webinars in the domestic market reaching over 20K viewers.
- A virtual presentation on the Mexican Children's Apparel Market was recorded by staff and viewed by over 700 unique visitors.
- Staff presented a summary of the effects of COVID-19 on global apparel supply chains at the *Sourcing Journal* Summit in October.
- Staff provided cotton market outlook presentations to interested retailers and brands as requested. Between August and early December, there was high demand for discussion on the market and on the issue of Xinjiang.
- Staff presented three webinars on the cotton market to audiences in Asia. This included delivery to a group including companies from Bangladesh, Hong Kong, and Indonesia. There were also targeted presentations for China and Vietnam.
- Staff presented a webinar on *The New Normal: Accelerating Consumer Trends in the Current & Post-COVID World* in October to a total of 306 attendees from over 250 different companies across the apparel industry.
- Staff presented a webinar on *Consumer and Retail Insights* to DuPont Nutrition & Biosciences in conjunction with the Textile Chemistry Research team. The material focused on clothing trends and sustainability importance for apparel consumers since DuPont is focused on sustainable enzymatic processing for apparel manufacturing.
- Fall Asia Webinar staff provided *Consumers and Clothes: Adapting to a Changing World* presentation for use in the Chinese domestic market and a live webinar hosted on the CottonWorks™ platform for the Hong Kong market. The initial webinar was viewed by 145 visitors.
- CSI participated in a virtual holiday media tour, sharing Cotton Incorporated's *Lifestyle Monitor*™ survey findings on what shoppers planned to purchase and receive for the holidays. The tour yielded over 1,300 airings nationally with

placement on networks such as Food Network, Lifetime, Hallmark, Bravo, OWN, MSNBC, and Fox News, receiving 27.9M impressions. In addition, eight local stations posted the story on their Webpages (with a possible 1.5M unique visitors).

Economic Publications

The Corporate Strategy & Insights staff continually tracks cotton fundamentals and prices throughout the supply chain. Analysis of the cotton market is published and presented in a variety of formats:

- Twelve issues of the Monthly Economic Letter were published to inform participants in the cotton supply chain about developments in the cotton market in order to help them make better and more profitable decisions.
- Twelve issues of the Executive Cotton Update, which focus on the U.S. economy and is designed as a tool to inform clients about how changes in the U.S. economy might affect the cotton supply chain, were published.
- Twelve reports about how changes in cotton prices are "passed through" the supply chain were published and distributed.
- Staff provided weekly radio updates on the cotton market. These *Weekly Cotton Market Updates* are posted on the Cotton Board Website and distributed to nearly 50 different radio stations across the nation.
- Staff provided weekly television interviews to RFD-TV, which garners 11MM impressions weekly from a viewership of 45MM subscribers. An Agricultural Resource Management study revealed that RFD-TV is the number one source of information for farmers and ranchers.

Market Research Publications & Supply Chain Insights

Supply Chain Insights:

- *COVID-19*. Based on the results of Waves 1, 2, 3, and 4 of the 2020 Coronavirus Consumer Response Survey, 13 infographics were created and disseminated to key accounts and retailers and made available on Cotton Incorporated's Website. Key findings show high personal concern for the pandemic and adoption of online shopping as consumers adapt to safety concerns.
- *Home Textiles*. Based on the results of the 2020 Home Textiles Survey, three infographics were created and disseminated to key accounts and retailers and made available on Cotton Incorporated's Website. Key findings show the importance of cotton in conjunction with key attributes of quality, comfort, softness, and durability for consumers in the U.S., China, and Mexico.
- *Baby Care*. Based on the results of the 2018 Baby Care Study, one infographic was created and disseminated to key accounts and made available on Cotton Incorporated's Website. Key findings show parental anxiety about how to best raise their children, with cotton standing out as a trusted fiber that they want to see in diapers and wipes for their babies.
- *Seal of Cotton*. Based on the results of the 2020 Seal of Cotton Study, one infographic was created and disseminated to key accounts and made available on Cotton Incorporated's Website. Key findings show that the Seal of Cotton mark makes consumers' shopping experience easier by identifying cotton products that consumers feel they can trust.
- *Garment Care & Labels*. Based on the results of the 2020 Garment Label Consumer Survey and the 2020 Laundering and Face Mask Consumer Survey, one infographic was created and disseminated to key accounts and made available on Cotton Incorporated's Website. Key findings show that consumers rely on garment care labels to properly wash their clothing and most would hold the clothing industry responsible if labels were not included on clothing.

Lifestyle Monitor™ email. In collaboration with the Corporate Communications department, emails with trending topics from recent *Lifestyle Monitor*™ research are disseminated monthly via email to direct traffic to LifestyleMonitor.CottonInc.com.

Strategic Research and Program Metrics

The Strategic Research projects enhance knowledge in areas that are critical for cotton opportunities or challenges as well as help measure corporate efforts to support the Company's mission. The Chinese Consumer Survey and Chinese Retail Audit are ongoing market research studies conducted jointly by Cotton Council International and CSI. The latest findings from these projects as well as additional results from other strategic research studies are provided.

COVID-19 Research

CSI conducted four waves of a survey on consumers' responses to the pandemic. The first wave was conducted in March with 2K consumers in the U.S., China, Mexico, and Italy, while the second was conducted in May with 1,500 consumers in the U.S., China, and Mexico. The third wave was conducted in September and the fourth Wave in November, with 1.5K consumers in each wave in the U.S., China, and Mexico. Highlights from the results include:

- The percentage of consumers in all countries who were very concerned about the pandemic grew from Wave 1 to Wave 2, with the highest jump in Mexico, from 55% to 65%. Concern dropped slightly in Wave 3, then increased again in Wave 4, to 65% of consumers very concerned in the U.S., 66% in Mexico, and 67% in China.
- Consumers' wardrobes are more casual and emphasize comfort during this pandemic. On average, 60-70% of consumers in each wave and in each country say that they are wearing more comfortable clothes compared with before the pandemic.
- After a drop in spending on clothing in Waves 1 and 2, one third of consumers in Wave 3 and again in Wave 4 in each country say that they are spending more money on clothing than before the pandemic.

Home Textiles Research

CSI conducted a survey of consumer attitudes about home textiles among 6K consumers in the U.S., U.K., Mexico, Colombia, China, India, Vietnam, Thailand, Japan, Germany, and Italy in order to understand consumers' attitudes, purchase drivers, and shopping behaviors for bath towels, sheets, bedding, and blankets. Highlights from the results include:

- Most consumers (80%) believe quality sheets and bedding help you sleep better, and quality is the top purchase driver for bath towels (82%), sheets (83%), and bedding (83%). Quality is also the top reason consumers say that fiber content is important to them when choosing home textiles.
- Consumers on average experience fewer negative issues such as fading, fabric thinning, or roughness when they purchase 100% cotton home textiles, compared to manmade fibers or blends.

Face Mask Research

CSI conducted a survey of consumer attitudes and usage of face masks among 500 consumers in the U.S. Highlights from the results include:

- Consumers own an average of five cloth face masks and wear them for an average of 3.6 hours per day.
- Half of consumers (48%) prefer their cloth face masks to be made of 100% cotton, and another 10% prefer cotton blended with other fibers. One quarter of consumers (27%) have no fiber preference.
- Over three in four consumers are likely to look for cloth face masks with performance features. The most popular features are easy care (84% likely to look), anti-viral (83%), and breathability/airflow enhancement (82%).

Garment Label Research

CSI conducted a survey of consumers' attitudes and usage of garment care labels among 1K consumers in the U.S. Highlights from the results include:

- 77% of consumers say garment care labels are an important source of information on how to launder clothing, more than those who say washing machine instructions (73%) or brand/retailer Websites (68%) are important.
- If garment care labels were no longer included on clothing, two-thirds of consumers (68%) expect to have more garments ruined in the wash. Much of this clothing would end up as waste, as 63% of consumers throw garments away when they are damaged in the wash.

Laundering Research

CSI conducted a survey of consumers' laundering habits among 6K consumers in the U.S., the U.K., Italy, Germany, Japan, and China. Collected data was analyzed to calculate total lifetime washes for four types of garments: woven shirts, underwear, sweaters, and technical jackets. Additional data revealed how consumers wash and dry their clothing (machine wash and dry is more popular in the U.S. than in other countries) and what they do with clothing they no longer wear (donation is popular in the U.S. and Europe, while Japanese and Chinese consumers are most likely to throw garments away or give them to friends).

Denim Research

CSI conducted a survey of consumer attitudes about denim among 1.5K consumers in the U.S., Mexico, and China, to understand consumers' attitudes, purchase drivers, and shopping behaviors for denim jeans. Highlights from the results include:

- In both U.S. and Mexico, consumers are most likely to say a pair of jeans are their favorite piece of clothing, followed by a sweatshirt/hoodie, then t-shirts.
- Even with the pandemic persisting through most of the year in the U.S., consumers continued to wear jeans nearly the same as before the pandemic. A quarter of U.S. consumers said they are still wearing jeans everyday (26%), that is followed by 20% saying every other day, 14% once a week, and 40% less than once a week.
- When it comes to workwear for U.S. consumers, the majority of consumers say that denim jeans are their top bottomswear preference for workwear regardless of whether they are working in the office/field or at home.

Chinese Consumer Survey

Below are highlights from the most recent results:

- Apparel shopping channels: Chinese consumers say they buy most of their clothing from ecommerce platforms (25%), followed by chain stores (21%), department stores (16%), small independent shops (13%), and hyper- markets (6%).
- Clothing purchase factors: Over three-fourths of Chinese shoppers say fit (88%), style (84%), fiber content (82%), finishing (81%), color (79%), price (78%), and durability (78%) are the most important factors when considering what clothing to purchase.
- Clothing shopping next year: The vast majority of Chinese consumers say they plan to buy the same (69%) or more (17%) clothing next year.

Chinese Retail Audit

Below are highlights from the most recent results:

- Cotton's share (weight basis) of major menswear product categories audited in Shanghai and Xi'an stood at 75% in 2020, up slightly from 2019 (73%). Over the past year, cotton's share increased in men's denim jeans (4.4 percentage points), woven shirts (3.3 percentage points), knit shirts (3.0 percentage points), and activewear (2.9 percentage points), while decreasing for men's pants (-1.3 percentage points).
- Cotton's share (weight basis) of major womenswear product categories audited in Shanghai and Xi'an China stood at 61% in 2020, up from (58%) in 2019. Over the past year, cotton's share increased in women's pants (11.5 percentage points), activewear (3.7 percentage points), and denim jeans (3.6 percentage points), while decreasing in woven shirts (-5.2 percentage points), knit shirts (-1.9 percentage points), and dresses (-2.2% percentage points).

Brand Tracker

In 2020, 7.6K U.S. respondents were interviewed regarding their awareness and attitudes toward cotton and competitive fibers. The information provides insight into changing emotions toward fibers and shows that promotions are meeting objectives by maintaining cotton's significant lead in fiber awareness and emotional connection. The most recent results available from the fourth quarter indicate consumers' emotional connection to the fiber remains exceptionally strong with nine-in-ten saying cotton is a fiber they love or like, with those who recognize the cotton ad (93%) versus those who did not (89%) significantly more likely to love/like cotton. Key brand metrics show cotton continues to lead competitive fibers in awareness (81% unaided, 97% aided) and a significantly larger share of respondents consider cotton to be comfortable (83%) and a fiber they like to wear (80%). Almost three-fifths (57%) of consumers say they usually or always look at fabric content labels.

Seal of Cotton

Research was conducted among 2K men (40%) and women (60%) in the U.S. and Mexico, ages 18-60, to assess awareness and attitudes toward the Seal of Cotton mark. Highlights from the research include:

- Eight-in-ten consumers are aware of the Seal of Cotton trademark, significantly higher than other fabric-related logos.
- More than eight-in-ten associate the Seal of Cotton mark with positive attributes such as *natural* and *soft*, while more than seven-in-ten associate it with *comfortable, trusted,* and *sustainable.*

- Brands using the Seal of Cotton mark are seen by shoppers as caring more about quality (90%), are more trustworthy (89%), and care more about sustainability (87%) and the environment (85%).

Global Durability Research

Global research was conducted to better understand if consumers perceive a longer life in their cotton clothing than clothing made of manmade fibers. The survey was fielded among 6K consumers ages 18-60 living in the U.S., the UK, India, Germany, Mexico, and China. Highlights from the survey include:

- 85% of consumers say that it is important that the clothing they purchase is durable enough to last a long time.
- Consumers see fiber content playing a role in determining the longevity of their clothing, with 67% saying fiber content contributes a lot/great deal in determining how long clothing will last.
- 77% expect cotton clothing to last longer; 35% expect cotton clothing to last more than one year longer than clothes made from manmade fibers.
- The oldest clothing items in consumers' closets were an average of five years old. Among the oldest items, those that were 100% cotton were an average of six years old.

WGSN

Staff adapted information collected by WGSN from a wide range of online apparel retailers as a source for measuring changes in cotton's market share. The resulting database commonly includes more than one million observations per month

APPENDIX A: MEDIA OUTREACH COVERAGE

Generating press releases about noteworthy activities and accomplishments, as well as sharing information with the media, remain extremely successful means of securing press coverage. These proactive and reactive communications draw upon the knowledge of in-house experts and the full range of data and analyses generated by the company. What follows are media coverage highlights for calendar year 2020.

Trade

February 26, 2020	2019 Cotton Biotechnology Award Recipient – Dr. Baohong Zhang
March 25, 2020	Cotton & COVID-19
April 29, 2020	Cotton Incorporated releases new lectures on fast-paced wipes market
June 26, 2020	New Initiative
July 26, 2020	Covid Hasn't Dampened Consumer Appetite for Sustainability, Survey Says
August 3, 2020	Cotton Inc. Launches 3D Fabrics for Designers and Developers
Sept. 16, 2020	How To Store and Handle Whole Cottonseed
Nov. 28, 2020	How COVID-19 forced re-thinking the supply chain?
Dec. 11, 2020	Research to turn cotton into new raw materials

Consumer

February 19, 2020	Empowering Strength and Enduring Style: "Rosie Reborn" Campaign Celebrates Female Trailblazers
April 22, 2020	6 Sustainability Tips for Earth Day (BJGG)
May 21, 2020	Cotton Incorporated's Ode to Sweatpants Will Fit Your WFH Lifestyle Perfectly
June 15, 2020	Retail Struggles Point to Cotton Supply Glut, Stalling Rally
July 27, 2020	Old Navy tackles the tween market in a very different back-to-school season
August 16, 2020	3 Laundry Habits You Can Change To Better The Environment
Sept. 9, 2020	Got Stretched Out Jeans? Here's How To Shrink Them Back To The Perfect Fit
Oct. 9, 2020	Better ways to get rid of three unwanted items
Nov. 23, 2020	Cotton Style House Holiday Edition
Dec. 1, 2020	70+ brands and retailers that are giving back this Giving Tuesday

Television and Radio Coverage

The following is a partial list of Cotton Incorporated's television and radio coverage in the calendar year 2020.

Station	Affiliate	Market	Topic
Today Show	NBC	New York	Coverage of "Rosie Reborn" campaign
RFD-TV		United States	Mention of Cotton Incorporated
FM News 101 KXL		South Carolina	Mention of Cotton Incorporated
ABC 27	ABC	Harrisburg, PA	Mention of "Rosie Reborn" campaign
WTAJ-TV	CBS	West-Central, Pennsylvania	Mention of "Rosie Reborn" campaign
KTLA-LA (WB)		Los Angeles, CA	Mention of "Rosie Reborn" campaign
WAAY-TV	ABC	Huntsville, Alabama	Mention of Cotton Incorporated
KPVI	NBC	Pocatello, Idaho	Mention of Cotton Incorporated
WBBM Newsradio 780		Chicago, IL	Mention of Cotton Incorporated
KTAB (CBS)	CBS/Telemundo	Abilene, TX	Mention of Cotton Incorporated
KRQE	CBS/FOX	Albuquerque, NM	Mention of "Rosie Reborn" campaign
KSN	NBC/Telemundo	Wichita, KS	Mention of "Rosie Reborn" campaign
KNXV	ABC	Phoenix AZ	Holiday Shopping Survey
KOMO	ABC	Seattle WA	Holiday Shopping Survey
KOMO	ABC	Seattle WA	Holiday Shopping Survey
KABB	FOX	San Antonio TX	Holiday Shopping Survey
WMLW	IND	Milwaukee WI	Holiday Shopping Survey
WTLV	NBC	Jacksonville FL	Holiday Shopping Survey

WBMA	ABC	Birmingham AL	Holiday Shopping Survey
WTKR	CBS	Norfolk VA	Holiday Shopping Survey
KGUN	ABC	Tucson AZ	Holiday Shopping Survey
WSAZ	NBC	Charleston WV	Holiday Shopping Survey
KSCC	FOX	Corpus Christi TX	Holiday Shopping Survey
WZAW	FOX	Wausau WI	Holiday Shopping Survey
KBTV	FOX	Beaumont TX	Holiday Shopping Survey
CRN DIGITAL TALK/SALEM RADIO NETWORK	Syndicated	National	Holiday Shopping Survey
CONN TV	Syndicated	National	Holiday Shopping Survey
THE DAILY FLASH	Syndicated	National	Holiday Shopping Survey

Internet Coverage

The following is a partial list of the online mentions of Cotton Incorporated, or its initiatives or programs, in calendar year 2020.

Cotton Farming	Mention of Cotton Incorporated
Darling Magazine	Mention of the Blue Jeans Go Green™ program
Cotton Grower	Mention of Cotton Incorporated
Textile World	Mention of Cotton Incorporated
Southeast Farm Press	Mention of Cotton Incorporated
The Washington Post	Mention of the Blue Jeans Go Green™ program
Her Campus	Mention of the Blue Jeans Go Green™ program
Delta Farm Press	Mention of Cotton Incorporated
Ad Age	Mention of “Rosie Reborn” campaign
New York Latino News	Mention of “Rosie Reborn” campaign
Women's Wear Daily	Mention of Cotton Incorporated
Bustle	Mention of “Rosie Reborn” campaign
Forbes	Mention of “Rosie Reborn” campaign
Corn and Soybean Digest	Mention of Cotton Incorporated
Los Angeles Times	Mention of “Rosie Reborn” campaign
ecotextile.com	Mention of Cotton Incorporated
www.just-style.com	Mention of Cotton Incorporated
Star-Gazette	Mention of “Rosie Reborn” campaign
www.fibre2fashion.com	Mention of Cotton Incorporated
Oklahoma Farm Report	Mention of Cotton Incorporated
University Chronicle	Mention of Cotton Incorporated
Madison Mom	Mention of the Blue Jeans Go Green™ program
Arizona Daily Star	Mention of Cotton Incorporated
rockpaperglam.com	Mention of the Blue Jeans Go Green™ program
Manhattanweek	Mention of Cotton Incorporated
textile-future.com	Mention of Cotton Incorporated
TheWorldSeeds.com	Mention of Cotton Incorporated
Nonwoven Industry	Mention of Cotton Incorporated
Home Textiles Today	Mention of Cotton Incorporated

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CORPORATE ADMINISTRATION/FINANCE

The Corporate Administration Division includes Board of Director Services, Human Resources, Corporate Office and Facility Services, and Intellectual Property, Contracts and Legal Departments.

The Corporate Finance Division is comprised of Information Technology (IT) and Accounting.

New Board Members participated in a Multi-Region Producer Tour February 10, which included a tour of the World Headquarters in Cary, NC, and presentations by staff and representatives from the Cotton Board. The second day of the Orientation focused on specific topics related to the Board of Directors, such as USDA oversight of the Program, Accounting procedures, an overview of the Board structure, and training for the dedicated Board of Directors Web site.

The Board held an Executive Committee Meeting in Nashville, TN, March 2-4, in conjunction with the Cotton Board's meeting. The Cotton Incorporated Executive Committee participated in many of the Cotton Board sessions, including Program Committee meetings, the General Session, and the Business Session.

The Officers of Cotton Incorporated and the Cotton Board held a joint Board Strategic Planning Session via WebEx April 1. Topics of discussion included key issues affecting cotton markets and demand, sustainability strategy, and cottonseed marketing.

In addition, the Cotton Incorporated Board of Directors held a Directors Meeting June 15-18, via WebEx, in conjunction with Cotton Board Members. The key objectives of the meeting were for management, staff, and Board Officers to:

- Provide Updates on 2020 Program Activities
- Present 2021 Budget Framework for Discussion and Board Recommendation
- Present of 2019 Actual-to-Budget Report
- Provide a Response to the Cotton Board's Program Recommendations

Regional Caucus Meetings were held during July to nominate Board Members to serve on Cotton Incorporated's Board of Directors. Caucus meetings were held in 11 states and a total of 18 Director and 18 Alternate positions were up for nomination to serve on Cotton Incorporated's Board.
Cotton Incorporated's Board of Directors held a virtual meeting August 3-6 via WebEx. This was a joint meeting with the Members and Alternates of the Cotton Board. The key objectives of the meeting were:

- Presentation of 2021 Plan & Budget
- Presentation of Goals and Deliverables
- Nominations for 2021 Governance and Executive Committees

Staff presented the 2021 Proposed Plan, Budget, and Deliverables to the four Operating Committees. The Chairman's, Executive, Audit, Pension, Governance, and Joint Calendar Committees also met. During the Thursday Business Session, the Board voted to approve the 2021 Plan and Budget, and elected members to the 2020 Governance Committee.

The Board held its Annual Meeting virtually via WebEx December 7-10. Elections of Directors and Alternates for three-year terms beginning January 1, 2021, the Executive Committee, Administrative Officers, Standing Committees, and Operating Committees took place. Following are the Board Executive Committee members for 2021:

Chairman:	Van Murphy	Agricultural Research:	Jerry Davis
Vice Chair:	James Johnson	Consumer Marketing:	Lloyd Arthur
Secretary:	Marvin Beyer	Global Supply Chain Marketing:	Kent Dunn
Treasurer:	Jeff Hux	Research & Development:	Stephen Logan
President & CEO:	J. Berrye Worsham	Member-At-Large:	Donny Lassiter
Past Chair:	Bernie Jordan		

Other business included: The four Board Operating Committees met and staff presented the accomplishments of the program for 2020. The Board also conducted its 2020 Board Evaluation of Company Performance Survey during this meeting. The Chairman's, Executive, Audit, Pension, Compensation, and Governance Committees also met.

COTTON INCORPORATED
BUDGET DATA THROUGH DECEMBER 31, 2020

Program Area Expenditures	Budget	Actual
Agricultural Research	$ 16,009,000	$ 9,131,771
Research & Development		
➢ Fiber Competition	$ 5,068,000	$ 3,888,205
➢ Product Development & Implementation	$ 10,145,000	$ 8,489,171
	$ 15,213,000	**$ 12,377,376**
Global Supply Chain Marketing	$ 16,710,000	$ 12,874,055
Consumer Marketing	$ 34,707,000	$ 30,762,242
Corporate Administration	$ 5,681,000	$ 4,785,810
TOTAL:	**$ 88,320,000**	**$ 69,931,254**

EXPLANATION OF TERMS AND ACTIVITIES

Agricultural Research Committee

Cottonseed Marketing – The objective of this activity is to increase the value of cottonseed at the grower level through strategic, targeted marketing using print and radio advertising, trade shows, direct mail, and publicity (press releases and feature articles).

Cottonseed Research – The objective of this research is to eliminate the barriers to cottonseed usage. Activities include research to eliminate gossypol; testing the cottonseed nutrient profile to determine natural variation in germplasm and evaluating this germplasm for adding value and reducing input potential; and developing new products and utilizing advances with low-gossypol cottonseed products.

Disease Management – The minimization of plant pathogens as significant economically damaging pests in cotton production.

Insect Pest Management – The objectives of this activity are twofold: (1) Develop management recommendations for insect pests that meet the needs of a changing farm landscape using integrated pest management (IPM) strategies, and (2) Support boll weevil and pink bollworm eradication programs with research and technical expertise.

Weed Management – The minimization of weeds as significant, economically damaging pests in cotton production.

Research and Development Committee

Fiber Competition

Cotton Communicator Software™ – Provides merchants and gins options to create Electronic Data Interchange (EDI) files from three different input file types and uses the data to create EDI files in a format that when sent to cotton mills is easily imported into EFS® System MILLNet™ programs and databases using a third-party EDI import program.

Cotton Management System (CMS) – The Cotton Management System is a group of related software programs, including legacy applications such as the EFS® MILLNet™ System software, designed to work independently and cooperatively to manage cotton as a raw material and asset. By providing tools to manage most aspects of cotton's life cycle, CMS seeks to improve the efficiency of cotton flow, increase the efficiency and use of cotton, boost the profitability of cotton, and increase the demand for cotton.

EFS®-USCROP™ Software – Enables a user to review and analyze crop data using USDA high volume instrument classing information. Recap and Discount Premium reports are enhanced with a host of graphs and charts.

Engineered Fiber Selection® (EFS®) System MILLNet™ Software – Manages a mill's acquisition and use of USDA high volume instrument-classed cotton. Integrated programs create transparency for the different departments within the mill.

Product Evaluation Laboratory – The objective of this activity is to provide accurate, reliable, and unbiased test data on fiber, yarn, fabric, and products from Cotton Incorporated's research-to-marketing efforts and breeder initiatives to increase the global demand and use of U.S. Upland cotton.

Software Development and Maintenance – The objective of this activity is to plan and execute the development of new software products for managing and improving the efficiency of cotton as a raw material, asset, and commodity. The Product Development group services and adapts the existing software products that are in the growth and maturity stages of the product lifecycle.

Software Service and Marketing – The objective of the service activity is to provide high-quality customer service that is critical to the success of the efforts to increase cotton competitiveness through innovative cotton management software. This is accomplished by providing EFS® System users with the documentation and customer service support that enables them to use the products efficiently. Frequent customer contact builds relationships with existing customers and helps gather feedback on the product to guide product maintenance and new product development. The objective of the marketing activity is to develop a competitive advantage for cotton by defining potential markets for the EFS® System and researching potential customers for

current products in the CMS family. This area communicates EFS® System benefits to potential licensees. By maintaining a high level of customer contact, this group works with all segments of the EFS® System product lifecycle by providing information for the maintenance of established products and developing product requirements for future projects.

Quality Measurements Improvement – The objective of this activity is to provide better tools, measurement systems, and data analysis techniques to improve quality measurements of cotton fiber, yarn, and fabric.

Product Development and Implementation

Acrylonitrile Butadiene Styrene (ABS): Is a common thermoplastic polymer that is amorphous and, therefore, has no true melting point. The most important mechanical properties of ABS are impact resistance and toughness. Fibers and additives can be mixed with ABS to make the final product stronger and raise its maximum operating temperature as high as 176°F.

Agricultural and Environmental Research (AER): A team of scientists that provide research and technical services to cotton growers, ginners, and their support industries. The department is also a link between cotton production, the textile industry, and the research and extension communities.

Differential Scanning Calorimetry (DSC): Is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference is measured as a function of temperature.

Dimethylol Dihydroxy Ethylene Urea (DMDHEU): Is commonly used in durable press finishes as a non-formaldehyde binder and because of its relatively low cost.

Dyeing and Finishing Applications Laboratory (DFAL): This laboratory contains both production scale and lab scale equipment used for internal projects and for industry implementation trials. The machinery allows the application of dyes on textiles and mechanical and chemical finishes.

Engineered Fiber Selection® (EFS®) Technical Service Group: The objective of this group is to plan and execute the development of new software products for managing a mill's acquisition and use of USDA high volume instrumentation – classed cotton.

FABRICAST™ Collection: This is a collection of knit and woven fabrics used to provide the industry with direction and inspiration for product development. The fabrics also strategically market cotton performance technologies.

Fiber Competition (FC): A team of scientists dedicated to providing accurate, reliable, and unbiased test data on fiber, yarn, fabrics, and products from Cotton Incorporated's research-to-marketing efforts and breeder initiatives to increase the global demand and use of U.S. Upland cotton.

Fiber Processing (FP): A team of scientists dedicated to converting cotton fiber efficiently into yarn that will meet industry specifications, provide technical assistance, and develop innovative yarns.

Fiber Processing Laboratory (FPL): This laboratory contains opening, cleaning, carding, and spinning equipment for yarn manufacturing.

Hand: The tactile sensations or impressions, which arise when fabrics are touched, squeezed, rubbed, or otherwise handled.

Home Laundry Test Data (HLTD): A data set developed by AATCC Committee RA88, Home Laundering Technology, established to develop a consistent set of test conditions for all test methods involving home laundering.

Industry Associations: Cotton Incorporated maintains a presence and membership in several leading industry associations.

3D.RC – 3D Retail Coalition. A consensus-based group, working together to advance 3D technology for designers, retailers, manufacturers, and supply chains in apparel, accessories, and footwear.

AATCC – American Association of Textile Chemists and Colorists

ASTM International – consensus-based standards organization, committee D13 covers most textile standards

ISO International Organization for Standardization (ISO) – non-governmental, international organization that develops standards to ensure the quality, safety, and efficiency of products, services, and systems. With Technical Committees (TC): ISO TC38 for Textiles and ISO TC323 for Circular Economy.

SAC – Sustainable Apparel Coalition

Life Cycle Assessment (LCA): A technique to assess environmental impacts associated with all the stages of a product's life (i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).

Phase Change Material (PCM): A substance with a high heat of fusion which, melting, and solidifying at a certain temperature, can store and release large amounts of energy. Heat is absorbed or released when the material changes from solid to liquid and vice versa: thus, PCMs are classified as latent heat storage (LHS) units.

Polylactic Acid or Polylactide (PLA): A thermoplastic aliphatic polyester derived from renewable biomass, typically from fermented plant starch such as from corn, cassava, sugarcane, or sugar beet pulp. In 2010, PLA had the second highest consumption volume of any bioplastic in the world.

Polypropylene (PP): A thermoplastic polymer used in a wide variety of applications. It is produced via chain-growth polymerization from monomer propylene. It belongs to the group of polyolefins and is partially crystalline and non-polar.

Product Development (PD): A team of dedicated scientists and designers that provide the cotton industry with new, inspirational cotton fabrications, provide technical services, and collaborate with industry partners.

Product Development and Implementation (PDI): The textile research division within Cotton Incorporated that consists of Fiber Processing, Product Development, Textile Chemistry Research, Technical Services and Implementation, and Product Integrity.

Product Development Laboratory (PDL): This laboratory houses knitting and Computer Aided Design and Manufacturing equipment for producing fabric samples.

Product Integrity (PI): The department within PDI that is responsible for gathering information on standards and regulations that may threaten cotton's market share, as a liaison with other divisions on matters related to sustainability and acts as the Chemical Hygiene Officer to ensure a safe working environment for the researchers.

Textile Research Center: Cotton Incorporated's research center is located in Cary, NC. For the activities covered in the Research and Development Committee, annual funding for operating the research center is allocated to include expenses for machinery, chemicals, contract labor, and materials.

Technical Services and Implementation (TSI): The department within PDI that is responsible for assisting global mill partners with the implementation of new technologies and maintaining quality production of those technologies, provide technical services, and support the marketing efforts of those technologies.

Textile Chemistry Research (TCR): Textile Chemistry Research is comprised of a team of researchers who investigate methods of cotton wet-processing improvement, sustainable wet-processing techniques, and who evaluate new dyes, chemicals, and application methods to enhance the performance and reduce the environmental footprint of cotton.

Supply Chain and/or Suppliers: For each technology marketed by Cotton Incorporated, part of the marketing strategy often involves identifying and working with manufacturers in the supply chain who can market and provide products to interested retailers, brands, or other companies. Cotton Incorporated works with and through established industry manufacturers to further the Company's marketing ability and reach.

Global Supply Chain Marketing Committee

Global Supply Chain Marketing

Cotton Council International (CCI) – CCI is responsible for the international promotion of U.S. cotton primarily, but not exclusively, through the COTTON USA Mark program. The majority of CCI's promotion funds are from the USDA's Market Access Program, which is administered by the Foreign Agricultural Service. Cotton Incorporated is the largest private contributor to CCI, and these private funds are leveraged an estimated two to four times the amount of government funds. Cotton Incorporated staff work closely with CCI to ensure that the funded programs are complementary to the international activities. In many cases, CCI's programs are part of a joint effort with Cotton Incorporated staff.

Cotton Incorporated Sponsored Events – Cotton Incorporated is often the host or primary sponsor of industry trade events.

FABRICAST™ Collection – The FABRICAST™ collection is a collection of knit and woven fabrics used to provide the industry with direction and inspiration for product development.

Global Supply Chain – This refers to the network of companies and organizations involved with the manufacturing, sourcing, development, and retailing of textile products and related products such as chemicals and equipment.

ISP Workshops – These technical education workshops are funded under the Importer Support Program.

Suppliers – For each technology marketed by Cotton Incorporated, part of the marketing strategy often involves identifying and working with manufacturers in the supply chain who can market and provide products to interested retailers, brands, or other companies. Cotton Incorporated works with and through established industry manufacturers to further the company's marketing ability and reach.

Tradeshows – This term refers to industry events that often involve formal conference programs as well as exhibit and booth space. **Cotton Council International (CCI)** – CCI is responsible for the international promotion of U.S. cotton primarily, but not exclusively, through the COTTON USA Mark program. The majority of CCI's promotion funds are from the USDA's Market Access Program, which is administered by the Foreign Agricultural Service. Cotton Incorporated is the largest private contributor to CCI, and these private funds are leveraged an estimated two to four times the amount of government funds. Cotton Incorporated staff work closely with CCI to ensure that the funded programs are complementary to the international activities. In many cases, CCI's programs are part of a joint effort with Cotton Incorporated staff.

Cotton Incorporated Sponsored Events – Cotton Incorporated is often the host or primary sponsor of industry trade events.

Digital Supply Chain initiative – Refers to an initiative in the GSCM division in an effort to enhance the division's marketing capability by incorporating the latest and most widely used 3D textile design tools.

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Tradeshows – This term refers to industry events that often involve formal conference programs as well as exhibit and booth space. Examples of some of the more prominent tradeshows include Outdoor Retailer, Shanghai Intertextile, and Premiere Vision Examples of some of the more prominent tradeshows include Outdoor Retailer, Shanghai Intertextile, and Premiere Vision.

Consumer Marketing Committee

Advertising, Corporate Communications, Brand Partnerships, and Corporate Strategy & Insights

Chinese Consumer Survey – The Chinese Consumer Survey is an ongoing consumer survey in China that has been conducted quarterly since the third quarter of 2009 and is conducted jointly with Cotton Council International (CCI). Each year, the survey interviews 4,000 Chinese consumers between the ages of 15-54 who are primary shoppers for clothing in over 20 provinces and over 40 cities through random doorstep, face-to-face interviews. Results from the survey are representative of the urban Chinese clothing shopping population. The data are used both internally and externally for publications, presentations, and for strategic direction.

Chinese Retail Audit – The Chinese Retail Audit is an in-store retail audit of key retailers in Shanghai and Xi'an, China, that began in 2010 in Shanghai and is currently conducted each spring. In 2017, data were collected on nearly 30,000 apparel and home textile products from key brand specialty, hypermarket, and department stores as well as key specialty stores on Tmall (Tmall was added in 2016). Results from this audit are used to better understand the types of garments available at key retailers in China, pricing, performance offerings, and cotton's presence in the market.

Click Through Rate (CTR) – CTR is a way of measuring the success of an online advertising campaign for a particular Website. The click through rate of an advertisement is defined as the number of clicks on an ad divided by the number of times the ad is shown (impressions), expressed as a percentage. For example, if a banner ad is delivered 100 times (100 impressions) and receives one click, then the click through rate for the advertisement would be 1%.

Search Engine Optimization (SEO) – Search engine optimization is a methodology of strategies, techniques, and tactics used to increase the number of visitors to a Website by obtaining a high-ranking placement in the search results page of a search engine – including Google, Bing, Yahoo, and other search engines.

Video Completion Rate (VCR) - VCR is a way of measuring the success of an online advertising campaign for a particular Website. The video completion rate of a video advertisement is defined as the number of completed views the ad received divided by the number of times the ad is shown (impressions), expressed as a percentage. For example, if a banner ad is delivered 100 times (100 impressions) and receives one click, then the click through rate for the advertisement would be 1%.

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