SOUTH AFRICA’S COTTON SUPPLY CHAIN FROM FARM TO RETAIL:
APPLYING THE TRIPLE TOP LINE TO SUSTAINABLE APPAREL
SUPPLY CHAINS

by

Crescent Scudder

A thesis submitted to the Faculty of the University of Delaware in partial fulfillment
of the requirements for the degree of Master of Science in Fashion and Apparel
Studies

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ABSTRACT

Growing concerns over the environmental and social impacts related to the production of clothing and textiles have created a need for more discussion about supply chain practices. Currently, there are no guidelines or strategies for addressing sustainable supply chains in the apparel industry that minimize environmental impacts and uphold socially responsible practices. This exploratory case study traces an apparel supply chain, with a focus on cotton, in South Africa that is under a development strategy to create a sustainable supply chain from farm to retail. In-depth interviews were conducted across the supply chain, including cotton farmers, cotton gins, a cotton yarn manufacturer, a textile mill, an apparel manufacturer, and a retailer. The purpose of the study was to gain an understanding of the business decisions at each node of the supply chain that influence the economic, social and environmental dimensions of sustainability by applying the triple top line model (McDonough & Braungart, 2002). This study identifies strengths and weaknesses in sustainable practices that adhere to the triple top line model within each node of the supply chain. Results found economic factors were drivers for good social and environmental practices, with the latter being the smallest segment of the three. The study makes recommendations for improving practices at each node of the supply chain and recommendations for strategies for developing sustainable apparel supply chains.
Chapter 1

INTRODUCTION

The life cycle of an apparel product has many phases from creation to consumption, spanning multiple industries, and often multiple countries, that are interdependent upon each other. The globalization of the textile and apparel industries over the last 15 years has led to tremendous growth of manufacturing regions in developing countries, with low labor costs often outpacing environmental precautions (Hurley & Miller, 2006). Across the supply chain, from fiber-textile-garment-retailer-consumer, there are many actors involved in the environmental performance of each product and workplace standards. While many brands and retailers attempt to minimize environmental degradation and uphold labor standards through engagement with suppliers, it can be difficult to trace all of the environmental and social impacts each product creates. Furthermore, there can be challenges when dealing with the capabilities of manufacturers in developing countries due to lack of environmental regulations and poor infrastructure, as well as poor enforcement of labor laws.

Because of the buyer driven relationship of the supply chain, larger brands have a disproportionate amount of power in the relationship (Hurley & Miller, 2006; Gereffi & Frederick, 2010) causing top-down pressure across the supply chain for fast and cheap production of apparel products. Gereffi (2005) described this relationship as a ‘flat’ supply chain where powerful apparel firms dictate product demand and terms to their direct suppliers, known as tier 1 suppliers, who then proceed with all of the operations necessary to provide those products, often contracting out to other
suppliers below them. While brands/retailers may require their tier 1 suppliers to adhere to certain codes of conduct for social and environmental responsibility measures, downstream suppliers have little, if any, oversight by the brands. Management of the supply chain by brands is difficult due to the complexity of the supply chain and the need for enforcement of better social and environmental standards at each stage of apparel production, while also remaining profitable (Carter & Rogers, 2008). Numerous international and national certifications and assessments have arisen to address standards at different nodes within the apparel supply chain for social (e.g. WRAP, SA 8000, Fair Labor Association) and environmental (e.g. ISO 14000 series, Oeko-Tex, BlueSign) practices. In general, apparel firms use these standards and assessments to address their tier 1 suppliers for apparel and textile products, yet not often are these standards used farther down the supply chain. Across an apparel supply chain different standards, certifications and assessments are applied to the different nodes but none are designed to be applied to an entire apparel supply chain.

Companies are seeking ways to implement a healthy balance between social responsibility, environmental sustainability, and profitability, also known as the theory of the triple bottom line (Elkington, 1998). In this manner, the term sustainability reflects the ability for businesses to maintain healthy economic, environmental, and social well-being. Social well-being includes the ability to provide workplace standards that uphold decent work conditions and improves the lives of workers in the industry. Sustainable practices are often linked to environmental practices that reduce resource use, lessen negative impacts, and negate pollution which in turn directly impact the social well-being of the workers engaged in the business, as well as the
larger community living in the environment for which the business is directly impacting. Therefore, the ability to maintain environmental sustainability also supports social well-being. The theory of the triple bottom line was adopted into a sustainable design model called the triple top line by McDonough and Braungart (2002). The authors distinguished the difference between triple bottom line and triple top line to reflect the desire to create a higher standard, or reaching for the top, rather than the minimum necessary. Both theories integrate the three sustainability pillars of economic, social, and environmental dimensions.

There has been recognition that corporate environmental management across the supply chain has used a reactive approach, such as pollution control and risk management, but is in need of a more proactive approach towards sustainable practices, such as product life-cycle management and industrial ecology (Liu, Yang, Qu, Wang, Shishime, & Bao, 2011). In response, many in the textile and apparel industries are changing the conversation from pollution control to pollution prevention by identifying the multiple levels of environmental impacts across the supply chain and across the life-cycle of products (de Brito, Carbone, & Blanquart, 2008). Many of the challenges facing apparel supply chains are due to the difficulty to trace products back through the value chain from garment to fiber. It can be difficult to understand the environmental impacts of a product if you cannot identify current practices. For example, there can be large variances in the environmental impact of fibers based upon processes and capabilities (Chen & Burns, 2006).

One of the fibers gaining much attention for its environmental impact is cotton; currently the world’s second most widely used textile fiber (International Cotton Advisory Committee, 2013). Cotton cultivation occurs in about 80 countries
worldwide, representing an economically important crop. The majority of cotton (90%) is grown on small farms, less than 2 hectares in size, providing critical income to smallholder farmers, mostly in developing countries (Better Cotton Initiative, 2013). Unfortunately, poor infrastructure and irrigation, improper use of chemicals, and poor farming practices can lead to numerous environmental and social safety issues. Oversight of cotton farming practices is difficult due to the complexity of the cotton supply chain and the geographically large rural areas where cotton farms exist. Furthermore, it is difficult to trace textile products back to the fiber source because cotton lint is often pooled together from numerous farms (sometimes even from multiple countries) before spinning into yarn. The global cotton supply chain is a complex web from cotton lint-yarn-textile that often crosses national boundaries before sewn into garments, making it virtually impossible to trace back to the source. This research follows a small sample of a cotton supply chain from the farm forward to identify practices within each node of the supply chain that impact the environmental, social and economic sustainability. Although there is strong interest in developing a more sustainable industry, there has yet to be a comprehensive or systematic approach that directly addresses the changes necessary at each level of the supply chain when looking at the chain as an integrated system. This study follows a cotton apparel supply chain to explore the practices within each node that support sustainability and across the supply chain to gain a broader perspective on sustainable apparel supply chains.

While the apparel industry does not yet have a comprehensive approach for developing sustainable supply chains, there are theories that can be applied to designing products, processes, and systems that are environmentally and socially
responsible. This research will include the theory of the triple top line and how to address factors that contribute to a sustainable cotton supply chain by addressing environmental, social, and economic factors within each node of the supply chain.

**Operational Definitions**

The term sustainability was first defined in 1987 by the United Nations in regard to development and the need to reduce resource use in industry, in order to have the same level of resources available in the future (United Nation’s World Commission on Environment & Development, 1987). In 1994, John Elkington coined the term ‘triple bottom line’ as the framework for the private sector to engage in a business strategy that incorporates the factors of ‘Planet, People, and Profit’ for the goal of becoming sustainable (Elkington, 1998). Sustainable supply chain management was defined by Carter and Rogers (2008, p. 360) as “the integration of environmental, social, and economic criteria that allow an organization to achieve long-term economic viability.” McDonough and Braungart (2002) adopted the triple bottom line into a design model they called the triple top line. For the purpose of this study, the theory of triple top line will reflect the factors of the environment, social, and economic costs associated with the apparel industry. Sustainability will reflect the consideration of these three pillars as a long-term goal for the apparel industry.

**Problem Statement**

As apparel companies become more engaged in their efforts to create and manage sustainable supply chains they will need a framework to identify what sustainable practices are in a balanced approach for environment, social and economic factors. Apparel supply chains are a complex web of businesses each dealing with
various impact areas (environmental and social) while trying to remain competitive. This system makes it difficult to integrate sustainable practices across the supply chain when it is difficult to communicate below the first tier of suppliers. There are no standards or guidelines for apparel companies to reference that apply to the entire supply chain, much less how to integrate sustainable practices throughout the supply chain as a management practice or a strategy for developing sustainable apparel supply chains. There are standards, certifications and assessments that support social and/or environmentally responsible practices at different nodes of the supply chain but none take a holistic approach to the supply chain. This study will address the research question: Is there a way to identify practices within a supply chain that support the principles of sustainability and does that further support the overall sustainability of the supply chain as a whole? The purpose of this study was to observe current management practices at each node within a small apparel supply chain that support the theory of the triple top line and can be applied to strategies for developing more sustainable apparel supply chains. The researcher chose to work with an organization that is working towards developing a sustainable cotton textile and apparel supply chain in South Africa.

The objectives of this research are to (1) determine if a cotton apparel supply chain in South Africa is sustainable, (2) identify current practices in the supply chain that apply to the triple top line theory, (3) identify areas of good sustainable practices or areas to improve practices, and (4) make recommendations to improve sustainable practices as a strategy for developing more sustainable cotton apparel supply chain. In order to help identify what are considered good sustainable practices the research applies the triple top line model developed by McDonough and Braungart (2002). The
triple top line model can be applied to designing sustainable products, processes, or systems. Since environmental impacts can vary widely across the supply chain, the research cross references with international environmental standards developed for different nodes of the supply chain (i.e. cotton cultivation, textile and apparel manufacturing) used in the apparel industry. Although there have been applications of sustainable practices for various components of the apparel supply chain, there has yet to be any studies that follow a supply chain from fiber to retail and compare practices within the supply chain and across the supply chain. This research uses a qualitative case study approach that applies the triple bottom line theory to practices in a subset of a cotton apparel supply chain, in order to make recommendations for development of a more sustainable apparel supply chain. A detailed discussion of the research methods will be addressed in chapter 3.

**Justification and Limitations of the Study**

Current standards and assessments used by the apparel industry alone are not sufficient for applying to the supply chain as a whole because they do not incorporate all three pillars of the triple bottom line, but rather tend to focus on either the social or environmental practices separately. These assessments also do not take into consideration how economic factors may be beneficial or limiting to the ability of businesses to engage in sustainable practices. In order to identify sustainable practices within a node of the apparel supply chain this research cross-references internationally recognized standards and assessments that address environmental management systems practiced by the businesses, appropriate to each node. This gives the research a reference point of environmental management practices that are recognized as the most important areas of concern.
While organic cotton farming practices may be considered less environmentally harmful than conventional cotton farming (and thus more sustainable) the organic cotton market represents a relatively small niche market (Illge & Pruess, 2012; Sathe & Crooke, 2010). There were no organic cotton farms in South Africa available for this study, nor would they represent the magnitude of cotton production necessary to address a cotton apparel supply chain found entirely in country. This research interviewed cotton farmers who apply modern farming techniques that are mindful of chemical, water, and land use practices. However, none of the farms visited are certified by an outside authority for cotton cultivation practices. There are standards for organic cotton farming and standards for reducing high-impact farming, but both require payment to become certified. Currently, there is no globally recognized definition for sustainable cotton cultivation.

This research does not conduct full assessments for environmental and social practices but rather explores the business decisions and reasoning for current practices and identifies how these may or may not support the theory of the triple bottom line. Thus the research uses the current management systems practiced by each node to address the long-term environmental, social, and economic sustainability of the supply chain as a whole.

Access to the multiple actors involved in a cotton supply chain are limited due to distances between nodes in a supply chain and/or access to archival documentation required for this study. For the purpose of this study, the researcher chose to work with a cotton apparel supply chain in South Africa that is under development to create an integrated sustainable supply chain. The national government of South Africa has recently developed a directive to revitalize the apparel and textile industries in an
effort to create new job opportunities and improve the economy (Republic of South Africa Department of Trade and Industry, Industrial Policy Action Plan, 2013/14). In 2014, under the support of the government a national cluster was formed for the development of a sustainable apparel and textile industry, including multiple stakeholders. A small-scale pilot cotton apparel supply chain, from farm to retail, within South Africa was under development at the time of this study. Although the supply chain was not yet integrated, in that the products each node produced were not being purchased up the supply chain, the farmers and firms chosen for this study had agreed to participate in the pilot study. Therefore, the opportunity to engage with the actors across a cotton supply chain prior to the integration of the supply chain was ideal for the purpose of this study. It allowed for observation of management practices that are currently being employed to identify which practices support the theory of the triple bottom line and how the findings might be applied to the development of a future integrated apparel supply chain.
This study uses the theory of the triple bottom line and the design theory developed by William McDonough and Michael Braungart (2002). A review of these theories and applications toward designing sustainable products, processes, and systems contributes to understanding applications of sustainability. In order to fully understand the complexity of how to integrate sustainability factors in apparel supply chains, a review of current research will explore the economic, social, and environmental impacts of the apparel and textile industry. Being that the apparel and textile industry is a buyer driven system, theories addressing sustainability in the supply chain management literature is explored. The chapter concludes with a review of challenges facing apparel firms when attempting to develop and maintain sustainable cotton supply chains. Understanding the challenges facing apparel supply chains and management of those supply chains lends understanding of the goals for sustainable apparel supply chain development.

From Triple Bottom Line to Triple Top Line

When thinking about sustainability of the textile and apparel industry, the environment is a major component to sustaining our ability to continuously have the resources needed to make new products. Therefore, the various environmental impacts the apparel industry can have are important to consider. But equally important are the impacts on people and the ability of the industry to maintain a global business.
Elkington’s (1998) theory of the triple bottom line was developed as a framework for corporations to include environmental and social aspects into their business strategy, alongside economic prosperity. Since businesses are often in need of utilizing resources in order to provide products and services, they are an important component to the development of a sustainable society. The term triple bottom line (TBL) has been popularized as a core principle of sustainability; in that the ability to sustain our current way of living is to maintain resources in a manner that retains resources for future use. Hence, degradation of current resources, such as excessive use of water or materials, creation of waste and pollution of resources, is not sustainable. Often environmental sustainability is considered of direct concern since the degradation of the environment directly impacts social well-being. Elkington (1998) argues there is a need to balance environmental and social sustainability into business strategy in order to obtain true sustainability. Social sustainability is to incorporate a business strategy taking into account both internal (i.e. employees) and external communities. The principles for social sustainability are to uphold equality and diversity, maintain a good quality of life, promote connectedness within the community and to the larger global community, and provide a democratic process with governance systems that are fair and transparent (Elkington, 1998). Elkington’s TBL strategy offers a basis for corporations to engage in environmental and socially-oriented management programs to address sustainability.

While the concept of sustainability has been widely accepted by businesses there remains a lack of understanding of how to measure the relative contributions each pillar has to business performance. There are few examples of how to apply sustainability due to the complex nature each pillar may have depending upon the type
of activities the business or industry may be engaged in (Sneddon, Howarth, & Nogaard, 2006). With little guidance and few examples businesses must balance the pressure of addressing environmental and social performance of operations while remaining economically competitive (Wu & Pagell, 2011). There is little industry wide data on how the triple bottom line can be integrated into a business strategy. However, a recent survey of 519 manufacturing plants in 19 countries found internal environmental programs (within the organization) had a positive impact on all three pillars of the triple bottom line and internal social programs had a positive impact on social and environmental but not economic performance (Gimenez, Sierra, & Rodon, 2012). This research found the adoption of environmental and social programs by manufacturers has, in general, a positive impact on the TBL. However, this research was a broad study on adoption of programs, not specifically what the programs entailed. Depending upon activities, environmental and social programs could vary widely across industries and businesses.

McDonough and Braungart (2002) developed a green design theory, called cradle-to-cradle, which incorporates designing products that are not only benign to the environment but rather can be beneficial to nature and human well-being, while also having economic value. The authors identify 3 main tenets to their design theory that can be applied to designing products, processes, and systems in a sustainable manner. The three tenets of the cradle to cradle design theory are 1) waste equals food, 2) use current solar income, and 3) celebrate diversity (McDonough, Braungart, Anastas, & Zimmerman, 2003). First, the authors explain the creation of waste from products and processes should be mindful of their disposal and that waste should be equal to food. In this manner, waste equals food represents the ability to distinguish materials into
either a biodegradable nutrient that can be composted to create food in the form of soil, or technical nutrients which a valuable high energy resources, such as petroleum-based synthetics, that should be captured and recycled back into high value products. Technical nutrients are recyclable and biological nutrients are compostable. However, the authors discuss the blending of the nutrients together create ‘monstrous hybrids’ that are neither recyclable nor biodegradable and thus lose their value. Second, the authors suggest using renewable sources for energy, such as wind or solar, rather than using depleting resources to produce electricity. Dependency on energy sources from depleting resources, such as fossil fuels, is simply not sustainable. Solar income is abundant and the technology to capture energy from solar is evolving. Third, the authors discuss the value of celebrating diversity in not only biodiversity but also to include the human dimension in the way businesses operate. Sustainability should be local with the ability to use local materials in a manner that does not cause harm and allows for resources to be available to the local community. The authors suggest local material and energy flows should be catered to the appropriateness of the region such as use of renewable energy sources, use of materials that are local to the environment, and not utilizing materials that are not appropriate to the local environment such as growing crops that are water intensive in arable regions.

The authors discuss the need to move away from only being more efficient at using resources, such as energy and water, towards being ‘eco-effective’ which actually enhances the environment for which we operate in (McDonough & Braungart, 2002). For example, manufacturing processes that filter water would provide a service to the environment and local community. As well as adapting the roofs of building to be ‘living roofs’ that provide habitat and reduce the energy used to maintain a
building’s temperature (McDonough & Braungart, 2002; McDonough et al., 2003). These examples apply a different mindset to how businesses may consider enhancing their surrounding environment through their processes rather than simply being efficient at using resources. Even with increased efficiency of energy, water, and raw materials use, manufacturing of products are still contributing to the depleting of resources. The cradle-to-cradle design theory of waste equals food, use current solar income, and celebrate diversity is geared for firms to add value to designing products and services that are beneficial to the environment and considerate of the human dimension.

The authors suggest a differentiation from the triple bottom line ideology (due to a trend with companies using the concept solely for risk mitigation purposes) and offer their own Triple Top Line (TTL) ideology. The TTL refers to designing products and processes that are beneficial from the beginning, rather than retroactively. Similar to the triple bottom line philosophy, the authors provide a comprehensive model for identifying environmental, social (they also distinguish environmental as ecology and social as equity), and economic value but also how these factors can overlap, categorizing 9 components into the model. These 9 components, or principles, include the three main pillars ecology, equity, and economy, as well as their overlap such as ecology/equity or ecology/economy creating two additional principles per pillar. The authors argue the future of sustainability will require a design perspective to consider all 9 principles in their model. The textile and apparel industries are heavily influenced by the three pillars being that economy, equity, and ecology each have unique and often complex impacts. When considering the application of using the triple top line
model to design sustainable apparel supply chains, it is important to also understand how each pillar affects today’s textile and apparel industries.

Economy Impacts

The textile and apparel industries are an important economic sector worth over $700 billion in global trade in 2012 (World Trade Organization [WTO], 2013). These industries are an important component to economic development in developing countries because they create job opportunities and income in poverty stricken regions and can bolster a country’s economy through exports and foreign investment (Keane & Velde, 2008). These industries are labor-intensive and developing countries with low labor costs position themselves to have a competitive advantage for producing labor-intensive products, which are sold to wealthier countries that can afford to import labor-intensive products (Thornhill, 1988; Porter, 1990). In 2012, 58% of apparel and textiles produced were imported by the United States and EU countries (WTO, 2013). Because these western countries are the major importers of these products, they tend to retain the higher skilled jobs in the industry, such as design and product development, and then dictate product needs to the manufacturers in the developing countries. In this manner, the countries that are able to retain low production costs relative to others are more competitive and are rewarded with continued contracts from western buyers. Countries like India and Bangladesh were able to receive a competitive advantage from low labor costs causing consistent export growth in the clothing industry from 1995-2003 (Kathuria, 2013). However, having a large and willing labor force is not the only resource necessary for a healthy industry. Currently in Bangladesh, the garment industry is worth $20 billion annually and the small country is the second largest garment exporter in the world (Bradsher, 2013).
However, despite the economic success of the garment industry for Bangladesh it has been coupled with insufficient infrastructure, poor enforcement of labor rights, and inadequate safety measures for garment workers, causing over 2,000 deaths in the past decade (Taplin, 2014). Although the textile and apparel industries have a long history of unsafe and unhealthy work conditions (English, 2013), changes in retail business strategy to produce faster turn-over of products has increased pressure on suppliers, leading to neglect of basic labor and safety standards (Taplin, 2014). In the last decade, this shift towards ‘fast fashion’ has created a growing market segment in the apparel industry. Many western brands/retailers are using a global sourcing strategy that is highly flexible with shorter lead times and low production costs, in order to gain competitive advantage (Fukunishi, Goto, & Yamagata, 2013). However, there is growing concern this strategy is fueling a race-to-the-bottom mentality among producers that in order to remain competitive they must keep costs low and pushes orders out quickly, regardless of the consequences to the workers well-being.

Not only is the textile and apparel industries labor intensive, they also require a high use of environmental resources for materials and manufacturing of products. Cost of materials and efficiency in producing these products directly impacts a firm’s ability to remain competitive. Further, the resource based view theorizes a firm’s long-term competitive advantage is highly dependent upon valuable resources, not easily replicated by competitors, along with the firm’s capabilities. Hart (1995) noted the resource based view was not sufficient because the increasing constraints on ecological resources were not being taken into consideration. Hart argued that the rapid increase in global population, consumption of fossil fuels and industrial production is multiplying the environmental impacts associated with these activities,
creating constraints on ecological resources. Therefore, Hart suggested a natural-resource-based view of the firm would be needed to include pollution prevention, product stewardship, and sustainable development in order to sustain long-term competitive advantage.

Porter and Kramer (2011) theorized that good business strategy integrating social and environmental components creates shared value, in that it creates economic value as well as addressing societal needs. A study by Schmitt and Renken (2012) identified successful businesses of German fair trade and organic apparel companies increased value in economic, social, and environmental factors across their supply chains. The results of the study confirm Porter and Kramer’s theory that development of shared value across the supply chain can be a good business strategy for companies. Furthermore, a value chain analysis comparison between organic and conventional cotton supply chains in India found added value (USD) at each stage of the supply chain from farming (+.06), ginning (+.29), spinning (+.34), knitting (+.15), dyeing and finishing (+.26), garment stitching (+.27) and specialty retailing (+27.10), showing the inclusion of organic to fetch a premium price at every stage of the supply chain (Rieple & Singh, 2010). While these studies support the adoption of sustainable practices for environmental and social factors can add value to the firm, both fair trade and organic apparel has remained a niche market.

Equity Impacts

The United Nations Global Compact (www.unglobalcompact.org) and the International Labour Organization (www.iло.org) have developed a set of guiding principles for international human rights and labor standards, as a framework for the minimum necessary for businesses to uphold in every country. However, these are not
policing organizations and it is expected national governments should maintain the integrity of these principles through legal enforcement (Burtless, 2001). Yet the globalization of the apparel industry has caused many developing countries to take unfair advantage of an impoverished workforce, leading to many violations in workers’ rights and creating a vicious circle that keep product prices low through low production costs (Dickson, Loker, & Eckman, 2009). While these nations may see an increase in trade for apparel products, it can be at the cost of poor social responsibility. Being a labor intensive product, the apparel industry has always sought out new production opportunities utilizing low wages to reduce costs. After World War II, the U.S. began to move garment manufacturing to offshore production for cheap labor (Bonacich & Appelbaum, 2003), making textiles and apparel an important trade commodity. The textile and apparel industry has become a global production network crisscrossing national boundaries, regulated by international trade agreements. However, as Aaronson (2009) discusses in her review of Hafner-Burton’s work on whether trade agreements have a positive impact on human rights or not, international trade agreements dictated by the World Trade Organization do not regulate human rights as a component of trade policy. Furthermore, trade agreements utilized by the U.S. and the European Union (EU) which specifically include human rights clauses are rarely enforced since these countries are unlikely to enact any trade sanctions against violating countries (Aaronson, 2009). The evidence suggests trade policies have had little impact on ensuring socially responsible behavior, by either party. As trade policy alone has not been sufficient as a governance tool for upholding socially responsible behavior in the apparel industry, apparel companies have sought out other means to address this governance gap.
Corporate social responsibility (CSR) is a term used to define a company’s efforts to comply with legal and ethical standards in the manner of how it conducts business. In the past CSR represented a set of self-regulated guidelines to monitor business activities. Yet as apparel companies became increasingly aware of poor labor standards by suppliers, the concern for the company’s ethical standards were at risk. In the early 1990s apparel companies began to adopt corporate codes of conduct; a contract which outlined a set of labor standards a supplier must adhere to in order to maintain business with the apparel firm (Frenkel & Scott, 2002; Lim & Phillips, 2007; Zadek, 2004). The adoption of codes of conduct by the apparel industry was popular in the 1990s and early 2000s but quickly gave rise to a need to monitor compliance with external verification (Dickson, Locker, & Eckman, 2009). Simply adopting a code of conduct did not necessarily create a direct improvement in socially responsible behavior and several monitoring agencies arose to address issues with compliance. However, monitoring of compliance alone has had only a moderating effect on improving the social responsibility of suppliers in the apparel and footwear industry (Barrientos & Smith, 2006; Locke, Qin, & Brause, 2007).

Ecology Impacts

The textile and apparel industries involve a complex global supply chain that has impacts on the environment. The shift of textile and garment manufacturing to developing countries has raised concerns since manufacturing processes create high amounts of pollution, environmental degradation and resource use (Fiskel, 1996). Across the supply chain, each node can have differing environmental impacts based upon the resources and activities the node engages in to produce its product. An
apparel product from beginning to end (fiber production to consumer use and disposal) can have a wide array of environmental impacts.

**Fiber Production**

Fibers are the base materials used to create the yarns, which are woven or knit together to create textiles. Fibers can come from either natural, renewable sources (e.g. plant-based like cotton or animal-based like wool) or petroleum-based depleting sources (e.g. polyester). In a review of the environmental impacts of producing a series of fibers such as natural (cotton and wool), regenerated (rayon and lyocell), and synthetic (nylon and polyester), not a single one was found to be ‘nonpolluting to obtain, process, and fabricate’ (Chen & Burns, 2006, p. 249). Each fiber has differing and unique environmental impacts which can influence the overall environmental performance, across the life cycle of an apparel product (Orzada & Moore, 2008). For example, polyester fiber production uses high amounts of energy while cotton production uses high amounts of water compared to polyester (BioRegional Development Group, 2005). While these fibers are not interchangeable, comparing between them offers insight into some of the environmental challenges associated with fiber production. Where synthetic fibers are petroleum based dependent upon non-renewable fossil fuels as the base materials, natural fibers produced in agriculture need more water and can cause land degradation. Water and land use impacts of bio-based textile fibers for viscose (wood-based) and cotton production can have negative impacts in areas that are already water stressed and transformation of land for cotton cultivation has a negative impact on biodiversity (Sandin, Peters, & Svanstrom, 2013). Cotton fiber is the second most widely used fiber in the world and represents an important global commodity with over 24 million tons of cotton produced in 2013/14.
(www.icac.org). Although cotton is a renewable and natural resource, cultivating the crop can have several environmental impacts such as water use, land degradation, and chemical use.

Cotton is ideal for semi-arid and arid regions because it is drought tolerant, but it is sensitive to water stress at certain times of its growth cycle and over 73% of cotton produced is from irrigated farms, making cotton a high water use crop (International Trade Centre, 2011). Overuse of irrigation can reduce freshwater availability and cause salination of soil, as is the case of the Aral Sea. Since 1960, the Uzbekistan government has diverted two main tributaries that feed into the Aral Sea in order to irrigate state owned agricultural land, largely to grow cotton and rice. Fifty years later, the Aral Sea has shrunk by 90% (United Nations Environment Programme, 2002) mostly due to inefficient irrigation canals (losing 60% of water before reaching farms). Water footprint assessments (which incorporate the volume of water used to produce goods or services consumed within a location) for cotton based products have found water use at the cultivation stage to have the highest consumption (Chico, Aldaya, & Garrido, 2013). Chapaign, Hoeskstra, Savenije and Gautam (2006) found the global water footprint for the consumption of cotton products was more dependent upon freshwater than rain fed water and 44% of global water for cotton production was for fibers being exported. Because cotton is a global trade commodity, the impacts of water and land use on producing countries can be impacted by the global consumption of cotton.

Long-term use of chemical inputs in agriculture has caused negative impacts on the environment, flora and fauna, and biodiversity (Pimentel & Greiner, 1997). Pesticides used on farms have been shown to have short-term and long-term impacts
on workers’ health and have even caused deaths (Wilson, 2000). Furthermore, even though many pesticides were found to be very effective at eradicating pests on cotton crops and improving productivity, over-time the pests became resistant and outbreaks became worse (Pimentel et al., 1992, Wilson & Tisdell, 2001). In response to growing evidence of environmental and health hazards associated with industrial chemicals, including many pesticides, the United Nations developed the Stockholm Convention on Persistent Organic Pollutants (POPs) in 2004, as an international treaty to ban production and use of toxic compounds. Alongside the Stockholm Convention was the Rotterdam Convention of Prior-Informed consent, an international treaty aimed at guiding information and proper labelling of materials being imported, including pesticides. While the Stockholm Convention has been useful in identifying and preventing use of the worst offenders for pesticides in agriculture, chemical use in cotton cultivation is still common.

Conventional cotton farming represents less than 3% of global agriculture but represents 16% of the world’s pesticide use, more than any other single crop (Environmental Justice Foundation, 2007). The developing countries provide 75% of the world’s cotton supply (Environmental Justice Foundation, 2007) making chemical use practices of great concern for environmental and social well-being. Pesticide use on cotton crops is of concern in developing countries that may have insufficient regulation of chemical use in the agricultural industry (International Cotton Advisory Committee, 2010). Due to growing concern of the impacts of chemicals in agriculture, great strides have been made to alter cotton cultivation practices. Integrated pest management practices use a procedure of scouting for pest outbreaks, evaluation of outbreak, followed by pesticide treatment at the outbreak only. Previous methods
applied pesticides to the entire crop. Studies have shown training smallholder farmers on integrated pest management practices reduces the frequency and amount of pesticides used while retaining a healthy production of cotton (Khan & Iqbal, 2005; Khan, Iqbal, & Ahmad, 2007). Training and education on pesticide use in rural communities is important because education and access to information may be limited, leading to an increase risk for workers and smallholder farmers who may not understand proper use and safety precautions when using chemicals. A survey of female farm workers in South Africa found the majority of the women had not received safety or application training of pesticides and the majority were not observing standard safety protocols (Naidoo et al., 2010). However, women who had received training were significantly more informed and likely to observe safety protocols.

A growing number of regions are adopting the use of genetically modified cotton seed that is resistant to the cotton bollworm (CBW), Helicoverpa armigera, as a bio-based control for pest management. The cotton seed is genetically engineered with insect resistant proteins from the bacterium Bacillus thuringiensis (Bt). Adoption of Bt cotton over a 10 year period in China found positive impacts of reduced insecticide use, an increase of beneficial insects, and a decrease in aphid pests (Lu, Wu, Jiang, Guo, & Desneux, 2012). Alongside genetically engineering crops with Bt to be insect resistant, herbicide-resistant genes are also being applied so that the entire crop can be sprayed with an herbicide which will kill weeds but not harm the crop plant itself. Bt crops (cotton, corn, soybeans, etc.) are resistant to glyphosate herbicide (also known as Roundup Ready ®). However, in the U.S. over a 16 year period since the introduction of these crops, some weeds have developed a resistance to glyphosate
leading to an increase in use of the herbicide. While insecticide use has decreased, due
to increased herbicide use the overall use of pesticides (includes insecticides,
herbicides, fungicides) in the U.S. has increased by an estimated 7%, or 183 million
kgs (Benbrook, 2012). While biotechnology may help to reduce the insecticide use, it
is important to consider long-term dynamics of genetically engineered crops.

While there are several environmental impacts areas associated with cotton
cultivation, cotton ginning is a relatively low impact area in comparison. Cotton
cultivation is only the first step in cotton fiber production. The ginning of cotton
separates the fiber from the seed and plant debris using a mechanical process. Cotton
gins use minimal amounts of water (Sandin, Peters, & Svanstorm, 2013) but are high
users of electrical energy. However, production processes and advancements in
equipment has led to a significant decrease in energy consumption over time in the
U.S. (Funk, Hardin, Hughes, & Boykin, 2013), one of the world’s largest cotton fiber
producers.

Textile Production

The textile industry in the U.S. has shown a marked decline in production since
the 1980’s when many new environmental regulations for pollution controls were set
in place (Moore & Ausley, 2004) and dramatic increases in imports occurred due to
the inclusion of free trade agreements (i.e. NAFTA) and the phasing out of the Multi-
Fibre Agreement (Gereffi & Frederick, 2010). Most of the textile industry has since
moved to developing countries. Often these countries do not have sufficient oversight
of environmental regulations leading to problems with pollution and inefficient
resource use. The textile industry can be categorized into two main areas for dry and
wet processing. Dry processes include spinning of fibers into yarn and the process of
weaving and knitting yarn into fabrics. Whereas wet processing uses water based processes on fabric such as dyeing. The spinning of yarn and weaving/knitting of fabric are mechanical based production processes that are energy intensive. High energy use in manufacturing correlates with higher greenhouse gas emissions, a contributing factor to climate change. Efficiency measures and equipment upgrades in textile production can significantly reduce energy consumption, greenhouse gas emissions, and lower costs for textile mills (Ozturk, 2005; Palamutcu, 2010; Hasanbeigi & Price, 2012). However, the majority of environmental impacts are due to wet processing (dyeing, washing, printing, finishes) which uses a lot of chemical inputs, energy and water use, and creates high levels of wastewater discharge (Ren, 2000; Moore & Ausley, 2004; Orzada & Moore, 2008). Because of these impact areas associated with textile production, there is concern about whether developing countries have the capabilities to handle potentially hazardous environmental impacts.

China has become the largest exporter of textiles with over 50,000 textiles mills in the country (Natural Resources Defense Council, 2010); they are also the largest consumer of textile chemicals accounting for 42% of global consumption (United Nations Environment Programme, 2012). Although there are measures in place restricting the use of harmful chemicals by both governmental regulations and western brand’s code of conduct contracts, there continues to be difficulty with enforcement of pollution control measures in developing countries like China. Investigative reports conducted by Greenpeace International have identified textile manufacturing regions in China are polluting the Yangtze and Pearl River Deltas, with a number of chemicals hazardous to human health and the environment (Greenpeace International, 2010). Researchers have begun to explore chemical substitutions
(Ozturk, Yetis, Dilek, & Demirer 2009; Ferrero, Periolatto, Rovero, & Giangetti, 2011) and production methods to reduce chemical consumption in the textile industry (Hoque & Clark, 2013). Recently researchers applied sustainable production applications to a textile mill in Turkey and found significant reductions in water use, wastewater generation, energy use, greenhouse gas emissions, and salt use (commonly used in large quantities during the dye process) and investment was recovered in 1.5 months (Alkaya & Demirer, 2013). Because of the high resource use and waste creation associated with the textile industry, it can be expected researchers will continue to explore alternative production methods to address the various environmental impact areas.

**Life-Cycle of an Apparel Product**

Beyond the resources needed to create apparel products there are also environmental impacts from the manufacturing and consumption of products. The manufacturing of consumer commodities use high amounts of energy, water, and chemical use, and create air emissions that can consequently contribute to climate change (Rebitzer et al., 2004). However, across a product’s life cycle the majority of energy and water use occurs during the laundering of apparel by the consumer (Allwood, Laursen, deRodriquez, & Bocken, 2006). Furthermore, product development and design teams may not be aware of the environmental impacts their choices for fiber, color, and finishes have on the product’s end-of-life impacts at disposal (Kozlowski, Bardecki, & Searcy, 2012). Research on incorporating sustainability in the apparel industry are seen at multiple levels from product development and design (Gam, Cao, Farr, & Heine, 2008; Curwen, Park, & Sarkar, 2012; Kozlowski et al., 2012), production and manufacturing (Tsai, 2010; Zabaniotou
& Andreou, 2010; Niinimaki & Hassi, 2011), as well as consumer use and disposal (Allwood et al., 2006; Chen & Burns, 2006). While these studies have contributed to elements at different stages of a product’s life-cycle, there is a gap in the literature linking the multiple levels of sustainability across the entire production supply chain of apparel products. Kozlowski et al. (2012) offer a framework for utilizing the main themes of a life-cycle analysis (LCA) and stakeholder analysis approach for product design teams to consider sustainable choices in the design process. While this offers insight on design choices that may improve the environmental performance of a product, it does not address environmental impacts across the supply chain.

Sustainable product development is not the same as sustainable production processes. For example, Kozlowski et al. (2012) apply the main themes of a LCA to make suggestions of design choices that can impact the manufacturing of the product. However, the design considerations suggested by the authors, such as “selection of appropriate materials such as organic and recycled and that enable manufacturing to optimize utilization” (Kozlowski et al., 2012, p. 30), may be broad in their application to an apparel supply chain when considering the many different ways manufacturing might optimize utilization of a material. While the designer’s choice of material does have impacts (for example choosing organic cotton impacts agriculture), what the impacts are at the manufacturing stage is difficult to generalize since different production processes may be utilized at different facilities, based upon capabilities.

While product design, consumer use and post-consumer disposal of apparel and textile products have significant environmental impacts, this study focuses on the environmental impacts associated with the production processes of a cotton apparel supply chain. However, it is important to understand the research exploring the life-
cycle of products when considering the various environmental impact areas associated with the apparel and textile industries.

**Challenges in Supply Chain Management**

One of the greatest challenges facing apparel companies today is with whom does the responsibility of poor environmental and social standards within the supply chain lie when actions by the suppliers extend beyond the direct control of a focal company. Corbett and Kleindorfer (2001) discussed the firm’s role is changing towards being stewards for mitigating the environmental impacts of their products and services. The authors suggest firms need to be incorporating a bigger picture to include suppliers and customers in an ‘extended supply chain analysis.’ The authors noted a changing landscape in the 1990s with shifts in public expectations and an increase in environmental regulations needing consideration beyond direct impacts, but rather across the entire value chain. Dickson, Waters, and Lopez-Gydosh (2012) found stakeholders in the apparel industry (non-governmental organizations and an industry association) had clear expectations and a sense of urgency of the environmental performance apparel brands and retailers should be instituting throughout their supply chains. The authors suggested supply chain management practices to address these concerns including increased collaboration across the supply chain. However, one of the challenges facing apparel supply chains is the governance of suppliers by the focal company (i.e. brand/retailer) to adhere to their standards for social and environmental performance. Focal companies are further challenged with managing their supply chains beyond the first tier suppliers that may subcontract and source themselves from a vast network with no transparency (Hurley & Miller, 2006). However, supply chain transparency (i.e. full disclosure of operations) has been shown
to increase socially responsible behavior by managers across the supply chain (Awaysheh & Klassen, 2010). Traditionally, supply chain management by the focal company was defined by parameters of procurement of commodities and distribution efforts to maximize customer value (Handfield, 2011). While supply chain management does assume some level of influence over operations in the supply chain in order to make the focal company more competitive, this does not take into account the workplace standards or environmental performance across the supply chain.

Carter and Rogers (2008) introduced the concept of applying sustainability, “the integration of environmental, social, and economic criteria that allow an organization to achieve long-term economic viability,” into a framework for supply chain management (Carter & Rogers, 2008, p. 360). This idea was further explored in a literature review by Seuring and Muller (2008) synthesizing the topics of research, from 1994-2007, related to sustainable supply chain management to identify drivers and strategies. They discovered most research was focused on environmental factors and social aspects and integration of all three dimensions of sustainability to be rare. Seuring and Muller also found the main reasons cited as barriers to implementing sustainable supply chains were 1) higher costs, 2) complexity of the supply chain, and 3) insufficient communication across the supply chain. Although Gereffi (2005) argues the apparel industry being a buyer-driven model gives leading firms high leverage and the majority of the power, it has not followed through with sustainability initiatives where there are numerous cases of poor compliance with codes of conduct by suppliers. Kogg and Mont (2012) found power of the focal company had little influence on the success of implementing sustainable supply chain management practices for various apparel firms in Sweden. The authors noted some of the smaller
firms (with significantly less power) had greater success with sustainable supply chain management than their larger counterparts. Gereffi and Frederick (2010) discussed a more recent trend for leading apparel firms in their sourcing strategies were to mitigate risks associated with social and environmental responsibility across the supply chain by diversifying suppliers, while at the same time developing more long-term relationships with them, and reducing the size and scope of the entire supply chain. Although these studies offer guidance for focal companies to utilize sustainable supply chain management practices that incorporate social and environmental factors, the realities of cost, complexity, and communication are reasonable real-world problems facing companies.

The ability to ensure an organic cotton supply chain raises several challenges for apparel companies, mainly due to a lack of available supply and quality standards. A study evaluating the strategies for sustainable organic cotton for a mass market merchant (H&M) found challenges facing the retailer to be 1) demand for organic cotton was greater than supply, 2) cross-pollination from genetically modified cotton was a disruption for organic cotton, and 3) inconsistent standards for labeling organic cotton made it difficult to assure quality to their customers (Illge & Pruess, 2012). The study also identified the strategies for organic cotton for a small niche retailer in Germany differed, in that the company had to play an active role in increasing organic cotton production and education of organic cotton farming practices. Two case studies of apparel companies’ organic cotton supply chain development in Peru found similar challenges for both Swedish-based Verner Frang AB (Kogg, 2003) and U.S.-based Eileen Fisher (Curwen, Park, & Sarkar, 2012) that required a high level of direct involvement by the brands to ensure quality and consistent supply. Both of these
studies emphasized the lack of guidance at implementing a strategy for sustainable supply chain management that caused many unforeseen hurdles in the process. The conversion of conventional farms to organic cotton farms takes time and commitment from both farmers and the buyers, which has been a challenge for the expansion of the organic cotton market. Sathe and Crooke (2010) reviewed the expansion of the organic cotton market for apparel companies when the brand Patagonia decided to convert to organic cotton in the mid-1990s the main limiting factor was a lack of supply. However, the market for organic cotton expanded once larger mass-market retailers Walmart and Nike also adopted organic cotton into their product categories. These studies illustrate how brands face significant challenges when trying to adopt organic cotton and create a reliable supply chain. Also, the lack of supply for organic cotton has led apparel companies to seek out new sources of cotton that are cultivated in a less environmentally harmful manner. Although organic cotton fiber does fetch a higher market value than conventional cotton, converting to organic cotton takes several years and the farming practices tend to be more labor-intensive and can have higher costs for inputs making it difficult for smallholder farmers.

**Cotton Industry Standards & Assessments**

In the last decade there has been a surge of cotton initiatives aimed at reducing the environmental impact of the global cotton agricultural sector. In 2010, the Better Cotton Initiative (BCI) began working with smallholder farmers in Brazil, Mali, Pakistan and India offering training and services based on a set of standards to reduce the environmental impacts and provide decent work. The organization’s philosophy is centered on continuous improvements of farming practices that reduce the amount of chemical use, water use, and uphold general well-being of farmers by connecting them
to education and skills sharing, while also linking their ‘better cotton’ to the retail market. The Better Cotton Initiative represents a multi-stakeholder not-for-profit organization, with several multinational apparel corporations as members that agree to purchase ‘better cotton’. In their self-published annual report for 2011-2012 cotton season BCI reported compliance of their standards averaged 72% with over 90,000 farmers producing ‘better cotton’ (Better Cotton Initiative Annual Report, 2011). In India, BCI reported significant reductions in pesticide use (average -40%), water use (average -20%) and an average increase in yield (+20%).

Cotton made in Africa (CmiA), founded in 2005, also works with smallholder farmers in six developing countries in Africa (not including South Africa) with a set of standards to reduce environmental impacts and improve working conditions. Similar to BCI, CmiA also uses a set of standards, verification of standards being met, and certification of cotton that is then sold to retailers. A recent (2013) agreement between the two organizations allows CmiA certified cotton to be sold to BCI members as ‘better cotton’ since the standards are similar. Textile Exchange, founded in 2002, also works with smallholder farmers in developing countries focusing on organic cotton cultivation standards, verification, and certification.

While there are several global initiatives focused on smallholder cotton cultivation, commercial cultivation practices have fewer multi-stakeholder initiatives. In 2013 the formation of Cotton LEADS, an Australian and U.S. cotton farmers organization, is based on current commercial practices that promote reductions in water use from irrigation, integrated pest management to reduce pesticide use, and soil preservation efforts to promote land conservation. It is a collaborative platform for commercial farmers to share knowledge, technological innovations and resources, but
also provides traceability of their cotton. While these cotton initiatives do work across various standards and countries, they all share similar terminology of continuous improvements in farming practices in an effort to become less environmentally harmful. Therefore, this research will cross-reference current cotton farming practices with the standards set forth by the current leading global initiative, Better Cotton Initiative, to identify practices that support sustainable cotton farming in South Africa. The guidelines of standards set by BCI are used in the development of the research interview questions used to obtain data for this study.

**Cotton Value Chain in South Africa**

According to the Republic of South Africa’s (RSA) Department of Agriculture, Forestry & Fisheries, the country has seen a dramatic decline in domestic cotton production due to a lack of competitiveness compared to cotton imports from neighboring southern African countries and cheap textile imports from the East (RSA Dept. of Agriculture, Forestry & Fisheries, 2011 report). Currently, South Africa produces below domestic demand while neighboring countries are able to produce above demand. Between 2006/07 and 2010/11 seasons, the country showed a 72% decline in cotton production, mostly represented by smallholder farmers switching to more reliable cash crops such as maize and sunflower. The Department of Agriculture, Forestry & Fisheries identifies three main factors for the decline: 1) cotton is no longer considered to be a viable crop compared to other crops, 2) cotton prices are not increasing at the same rate as other crops, and 3) low international prices for cotton, in general. International price for cotton has been volatile in recent years with a price differentiation of 140 cents per pound in 2010/11 season and an 77.5 cents per pound the prior year, an 80% higher price year to year (International Cotton Advisory
Committee, Cotton Supply and Demand Report, 2011). Rapid price fluctuations of cotton are dependent upon changes in supply, demand, and economic recession. In the 2011/12 season, South Africa produced 14,377 tons of cotton of which 80% was exported while local cotton spinners imported 93% of their cotton, mainly from neighboring countries with lower prices for cotton due to lower wages (International Cotton Advisory Committee, 2012). Local textile and apparel sectors saw declines in production volume between 2010 and 2011 by 11-13%, leading to a decrease in employment by 4%. At the same time, value of textile exports increased by 25% and value of imports of textiles increased by 23%, with China as the main source (International Cotton Advisory Committee, 2012). The majority of cotton lint cultivated in South Africa is exported to Asia while at the same time local spinners are importing cotton from neighboring countries (RSA Department of Agriculture, Forestry & Fisheries, 2012). The cotton value chain of South Africa is a somewhat fragmented system with local cotton being exported and all other cotton demand needs, from lint to textiles, are being imported.

South Africa’s apparel industry represented a collection of firms that were interdependent upon each other, from fiber to garment production. Post Multi-Fibre Agreement phase-out, the entire industry contracted leading to factory closures and a significant loss of agricultural production of cotton. However, the retail industry has taken advantage of low cost apparel products from Asia and while the domestic apparel production industry had a decline the retail sector grew, replacing many of the jobs lost (Biacuana, 2009). South Africa represents an emerging economy with a growing middle class, which lends support to a strong retail sector (South Africa Info, 2007). While South Africa’s economy has been gaining strength, many neighboring
countries are still considered to be developing nations with low wages contributing to their competitiveness of cotton prices (International Cotton Advisory Committee, 2012). Southern Africa has a large natural resource of arable land suitable for growing natural fibers, such as cotton, for the apparel industry. Cotton production in southern Africa totaled over 300,000 tons in 2010, produced by 863,000 farmers (Bennett, Salm, & Greenburg, 2011). Economic incentives are placed on sourcing within the Southern African Development Community (SADC), a group of 15 countries that have free trade agreements including South Africa. Major cotton producing SADC countries include Tanzania, Malawi, Zambia, Mozambique and Zimbabwe, all of which produce more than local consumption (Cotton South Africa, Core Statistics Report, 2013). In South Africa, on average each year 70% of cotton is of Grade A quality. In 2012/13, 6,977 hectares of cotton was planted in South Africa, significantly less than the 22,574 hectares planted ten years earlier (Cotton SA Core Statistics, 2013).
Chapter 3

METHODS

Conceptual Framework

The purpose of this study was to observe current management practices at each node within a small apparel supply chain that support the theory of the triple top line and can be applied to strategies for developing more sustainable apparel supply chains. The triple top line (TTL) model offers a framework for identifying the three pillars of sustainability, including environment, social, and economic factors, as well as the interplay of these factors where they overlap. By expanding beyond the main three themes of economy, ecology, and equity to include overlap areas, allows for a greater depth of understanding how these pillars of sustainability influence or even drive adoption of the others. This study used the TTL model to identify sustainable practices at each stage of the supply chain to develop a better understanding of the shared value these practices may have within the supply chain. The research objectives of applying the principles of the triple top line to a sustainable apparel supply chain are to: 1) identify if the current cotton supply chain was sustainable, 2) identify current practices at each node that apply to the TTL model, 3) identify areas of good sustainable practices and areas that are weak or gaps in sustainable practices, and 4) make recommendations that support weak areas identified by the TTL model as a strategy for developing future sustainable supply chains.
Methods

In order to follow a cotton apparel supply chain from farm to retail, the research identified four main branches:

- Cotton fiber production: both cultivation and ginning of cotton in South Africa
- Textile production including yarn spinning, knitting or weaving, and dye/finishing
- Apparel manufacturing within South Africa
- A South African retailer using locally produced cotton products

This research is a case study of a cotton apparel supply chain in South Africa. The research traces the nodes of a cotton apparel supply chain across the four main branches. Each node represents a business actively engaged in the cotton and apparel supply chain within South Africa but does not represent an integrated supply chain in that the linkages between the businesses are not direct. However, the participants of this study were selected based upon efforts by our host, a cotton merchant based in southern Africa, to develop an integrated cotton apparel supply chain with these participants in the near future. A case study approach allows for deeper understanding of the challenges and opportunities facing each of the actors that may influence the potential success of integrating a supply chain. Qualitative data were collected on the farm and firm-level managerial practices that influence sustainability at each stage of the cotton supply chain. The researcher conducted in-depth interviews of actors across the supply chain and cross-reference with archival documentation provided by each node such as management programs and industry reports.
Instrument Development

The interview questions were developed by the researcher based upon the three themes of the triple top line for economy, equity, and ecology. McDonough and Braungart’s TTL model for identifying sustainability principles is similar to a triangle where the three pillars of sustainability bear equal weight at each corner (note the authors use the terms ecology for environment and equity for social dimensions) as well as have overlap between these corners. The overlap of the pillars represent the relationship between the pillars can have and the relative importance the pillars can impact each other. Refer to Figure 1 for an example of the TTL model and 9 components.

Figure 1  Triple top line model adapted from Cradle to Cradle (2002 p. 150).
Therefore each ‘corner’ represents one pillar, such as the economy/economy corner represents the purely capitalistic component of business with the greatest economic value. A research question pertinent to this segment would be ‘is your product or service profitable?’ The other components such as economy/ecology may question ‘does sustainable cotton production cost more than conventional practices’ or economy/equity ‘does our business provide decent work?’ (questions adapted from McDonough and Braungart, 2002, pp. 151-153). While these questions address the cost associated with different business activities and the interplay with other factors, the purely economy/economy factor addresses profitability. In this example we see how the interplay of the sustainability pillars (ecology, equity, and economy) are important considerations to the overall sustainability of the business. The model allows the researcher to identify gaps or weak areas in sustainable factors that can impact the overall sustainability of the node and the entire supply chain. The researcher created the research questions to address the three main sustainability themes and potential impacts appropriate for that node.

Economy questions represent the ability to maintain a viable business such as costs, income, profitability, productivity and financing. Equity questions represent the ability of the business to have a positive impact on workers and the community such as offering employment and trainings, as well as safety and health considerations. Ecology questions are more difficult to generalize since each node of the supply chain can have very different environmental impacts arise from their operations. For example, agricultural impacts associated with cotton cultivation have a greater focus on biological systems such as soil, biodiversity, and water use. These impacts differ from the environmental impacts of textile manufacturing which use high amounts of
water, energy and chemicals, which again differ from the impacts associated with
garment manufacturing which does not have chemical inputs. In this case, the
researcher cross-referenced with internationally recognized standards/assessments
used in the apparel industry that are specific for the three nodes of cotton cultivation,
textile manufacturing and apparel manufacturing. While there are currently no known
guidelines or standards for sustainable supply chain practices as a whole, there are
initiatives that address the environmental practices at differing nodes such as farming,
textile production, and apparel production.

This research addressed the environmental themes in standards set by three
different global initiatives aimed at reducing the environmental impact of each of the
previously mentioned branches. Questions about cotton cultivation practices were
based on the Better Cotton Initiative (BCI) standards for production criteria. “How do
you protect your crop from pests” was developed as an open-ended question based
upon the integrated pest management practices found in the BCI standards. The Global
Organic Textile Standard (GOTS) is a multi-stakeholder initiative that defines a set of
standards for maintaining the integrity of organic textile production, from fiber
through textile, including chemicals used for dyes and finishes. Although this research
is not utilizing organic cotton fiber these standards are useful for identifying the
environmental management considerations for sustainable textile production. The
Higg Index is a self-assessment tool developed by the Sustainable Apparel Coalition, a
global multi-stakeholder initiative, to address the environmental impact of apparel
production at multiple levels for facility, brand, and product. This research cross-
referenced with the facility module of the Higg Index to identify environmental
management themes associated with apparel manufacturing. Each of these initiatives
has identified a set of criteria for production principles that directly apply to these branches of the supply chain. The researcher cross-referenced with these to identify parameters of environmental management practices for each node. A summary of the environmental management themes associated with each of these standards can be referenced in Appendix C.

Consideration of concerns from a retailer/brand’s perspective on sustainable supply chain development is an important component to this research, being that the apparel industry is a buyer driven system (Gereffi, 2005). Additional research questions for a local retailer were created to understand the challenges facing supply chain management below the first tier suppliers. Interview questions focused on the retailer’s perspective about the current state of South Africa’s cotton industry, challenges facing the local clothing and textiles industry, current sourcing strategy for cotton and cotton based products, expectations for claims of a sustainable cotton apparel supply chain, and willingness to be involved in an integrated cotton supply chain within South Africa.

The researcher conducted two interviews beyond the direct linkages of the cotton apparel supply chain to include a regional cotton merchant and a non-governmental cotton organization. These interviews allowed for greater depth of understanding as to the regional context of the South African cotton industry. Interview questions for the cotton merchant were developed to establish an understanding of the role of cotton merchants in South Africa. Interview questions for the merchant also included questions related to flow of goods for the cotton supply chain, local infrastructure, national and international prices of cotton and their subsequent impacts on the competitiveness of South African cotton, and impacts of
government policy on the cotton industry. Interview questions for the non-governmental organization related to the role of the association in the cotton industry, quality of cotton in South Africa, history of the cotton industry in South Africa, current challenges and future opportunities for the cotton industry in South Africa. While the focus of the research is to identify the sustainable practices within a cotton supply chain, external forces may heavily influence the success or decline of the cotton industry which may directly impact the ability of a sustainable supply chain to function. Therefore, contextual interviews were deemed an important source of information. The interview questions were designed to engage the interviewee in an open discussion about sustainability topics related to economic viability, environmental management practices and socially-oriented practices by the organization. Interview questions were open-ended and follow up questions would be posited for clarification sake. Therefore, coding across the entire interview is deemed appropriate for analysis. Below is a review of the coding guide for the 9 TTL sustainability principles.

Ethical consideration was given to development of interview questions and approved by the Internal Review Board (IRB) at the University of Delaware prior to conducting research. The study followed IRB standards and received exempt status due to the noninvasive nature of the interview questions (refers to Appendix A for IRB approval form and consent narrative). Interview participants were explained the purpose and goals of the research and gave verbal consent to being interviewed prior to starting the interview. Participants were made aware they could choose to not answer a question they did not feel comfortable being asked or could request to end
the interview at any time. None of the participants chose to skip any questions or interrupted the interview for any reason during this study.

Interview schedules for each node are available in Appendix B. Additional interviews were conducted with a cotton merchant and a local non-governmental organization representing the cotton industry to provide contextual understanding as to the current state of the cotton industry in South Africa. Interviews of actors across the supply chain were conducted with two smallholder farms, one commercial farm, two ginning operations, one spinning operation, one textile production operation, one apparel production operation, and one retailer, totaling 11 interviews. Refer to Table 1 for a summary of interviews. Interviews with participants were conducted in-person with farmers, managers of ginning and spinning operations, textile mills, apparel manufacturer, and a local retailer in South Africa in January, 2014. All interviewees conducted in English and no interpretation from the local language was necessary. Interviews were semi-structured with questions developed for each node but the interviewee was allowed to discuss any topic and speak for as long as they wanted. Interviews were audio recorded and transcribed verbatim for the purpose of accuracy when coding data. Interview data were supported with observational data collected at site visits and archival documentation obtained either directly from the businesses or through desktop research. The researcher used the triangulation method for qualitative research (Yin, 2009) obtaining multiple sources of data and cross-referencing for accuracy.
Table 1  Interviews conducted in South Africa

<table>
<thead>
<tr>
<th>Supply Chain Node:</th>
<th>Interviewee's Role:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallholder farm</td>
<td>Two farmers and an extension officer</td>
</tr>
<tr>
<td>Commercial farm</td>
<td>One farmer</td>
</tr>
<tr>
<td>Cotton gin</td>
<td>Manager</td>
</tr>
<tr>
<td>Smallholder farm</td>
<td>Two farmers, two extension officers, and</td>
</tr>
<tr>
<td></td>
<td>representative from a farmer organization</td>
</tr>
<tr>
<td>Cotton gin</td>
<td>Two managers</td>
</tr>
<tr>
<td>Spinning facility</td>
<td>Manager</td>
</tr>
<tr>
<td>Textile mill</td>
<td>Two managers</td>
</tr>
<tr>
<td>Apparel manufacturer</td>
<td>Manager</td>
</tr>
<tr>
<td>Retailer</td>
<td>Four managers from different departments</td>
</tr>
<tr>
<td>Merchant</td>
<td>Manager</td>
</tr>
<tr>
<td>Non-profit organization</td>
<td>Manager</td>
</tr>
</tbody>
</table>

Data Analysis

Interview data was coded using a deductive analysis based upon the TTL model for sustainable practices. Coding for the 9 components occurred across the entire interview, not just in direct relationship to the questions posited. In this manner, if the interviewee relayed information about a current practice that adhered to one of the sustainability principles it would be coded as such, even if out of context with the direct question. For example, one of the initial interview questions was to ask the interviewee their role in the business. The purpose of this question was to gain an understanding of the interviewee’s relative position within the organization. However, as one interviewee began to explain his role as chairman of a local farmer’s association he also told the interviewer he felt as part of his role promoting cotton as a drought tolerant plant was important. In this case, the information of cotton being promoted as a drought tolerant plant represented a good sustainable practice in that it promotes good ecology appropriate for the local environment.
The researcher coded the data based upon the 9 components of the TTL model; the data was analyzed using a coding protocol (Appendix D) and the constant comparative methodology as developed by Glaser and Strauss (1967). The constant comparative method is an approach to cross-referencing codes within and across the interviews to retain accuracy and consistency when coding. The data was coded only once for one of the 9 components. Coding was conducted within the transcript documents with detailed notes as to why the highlighted statement was coded accordingly. Coding accuracy was validated by the researcher’s advisor for a subset of the interviews.

The goal of this data analysis approach, using the TTL model, is to identify specific sustainability factors within a node of the supply chain and across the entire supply chain. These data were coded using deductive coding techniques for the TTL model’s 9 components. Examples of the general questions or statements relevant to each code are outlined in Table 2. The researcher coded each interview for each node of the supply chain. The data from the deductive coding were analyzed in two manners: 1) data were analyzed for the three main pillars of sustainable themes (economy, equity, and ecology) within a node and across the entire supply chain by pooling all nodes, and 2) data were analyzed for all 9 components. Due to relatively small data sets within a node the researcher pooled all nodes across the entire supply chain for analysis of the 9 components.
Table 2  Triple top line tool as deductive coding guide*.

<table>
<thead>
<tr>
<th>Economy/economy</th>
<th>Is the business profitable/viable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economy/ecology</td>
<td>Business decisions that impact ecology.</td>
</tr>
<tr>
<td>Economy/equity</td>
<td>Business decisions that improve equity.</td>
</tr>
<tr>
<td>Equity/equity</td>
<td>Does the business provide an environment where people are treating each other with respect?</td>
</tr>
<tr>
<td>Equity/ecology</td>
<td>Practices that benefit workers and the environment.</td>
</tr>
<tr>
<td>Equity/economy</td>
<td>Financial decisions that are made for the benefit of workers or the community.</td>
</tr>
<tr>
<td>Ecology/ecology</td>
<td>Practices which are either beneficial or benign to the environment.</td>
</tr>
<tr>
<td>Ecology/equity</td>
<td>Practices that reduce environmental impact and are beneficial to workers and the community.</td>
</tr>
<tr>
<td>Ecology/economy</td>
<td>Practices that reduce environmental impact and make the business more competitive.</td>
</tr>
</tbody>
</table>

*Adapted from McDonough and Braungart, Cradle to Cradle, 2002.

Since the data were coded for the 9 components, in order to assess the three sustainability themes, the data were weighted rather than simply pooling within a main theme. Because the TTL model allows for greater understanding of the interplay and overlap between sustainability pillars each code is not treated in equal proportion to each other, but rather how the pillars may contribute some aspect towards each other. For example, economy/economy relates to the financial viability of the business and a decision made solely based upon cost without any consideration to other factors is common. However, economy decisions that also contribute positively toward ecology or equity may lend a greater understanding to how business decisions can positively impact sustainability. Therefore, if we want to have a greater understanding as to the overlap between business decisions that also impact ecology and equity, the relative contribution should be considered. Simply pooling the 9 codes into the three
sustainability themes risks losing the relative contributions, therefore giving a weight to the contribution is reasonable. The codes are weighted in thirds based upon the three possible themes per segment. Table 3 summarizes the weighting scheme from a subset of the data collected for clarity. In the example below, an economy/equity weighted code relates to the majority of the business decision is for the sake of economic viability (2/3) but also impacts equity (1/3). While 2 examples of economy/equity were coded in the interview, the value of equity is given a weight relative to economy, leading to 1 data point recorded for economy and 1 data point recorded for equity. The weighted data points were then summed for the three sustainability themes for each node. The weighted data was also pooled across all of the nodes for an analysis of the three sustainability themes found for the entire supply chain. Because there were multiple site visits for the farm (two smallholder and one commercial) and gin (two gins) nodes but only a single site visit for the textile, apparel and retail, the average was calculated per node for analysis across the supply chain.
Table 3  TTL codes weighted into the three sustainability themes: economy (econ), equity (eqty) and ecology (eco).

<table>
<thead>
<tr>
<th>Node</th>
<th>TTL</th>
<th>No. of codes</th>
<th>econ weight</th>
<th>eqty weight</th>
<th>eco weight</th>
<th>econ</th>
<th>eqty</th>
<th>eco</th>
</tr>
</thead>
<tbody>
<tr>
<td>smallholder farm</td>
<td>econ/econ</td>
<td>6</td>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>smallholder farm</td>
<td>econ/eco</td>
<td>3</td>
<td>66.7%</td>
<td>0</td>
<td>33.3%</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>smallholder farm</td>
<td>econ/eqty</td>
<td>2</td>
<td>66.7%</td>
<td>33.3%</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>smallholder farm</td>
<td>eqty/eqty</td>
<td>1</td>
<td>0</td>
<td>66.7%</td>
<td>33.3%</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>smallholder farm</td>
<td>eqty/eco</td>
<td>1</td>
<td>0</td>
<td>66.7%</td>
<td>33.3%</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>smallholder farm</td>
<td>eqty/econ</td>
<td>1</td>
<td>33.3%</td>
<td>66.7%</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>smallholder farm</td>
<td>eco/eco</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>smallholder farm</td>
<td>eco/eqty</td>
<td>4</td>
<td>0</td>
<td>33.3%</td>
<td>66.7%</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>smallholder farm</td>
<td>eco/econ</td>
<td>0</td>
<td>33.3%</td>
<td>0</td>
<td>66.7%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td><strong>10</strong></td>
<td></td>
<td></td>
<td><strong>4</strong></td>
<td></td>
<td></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>

The second method of analysis was for all 9 codes across the entire supply chain. These codes were not weighted or adjusted in any manner. The purpose of this data analysis was to gain understanding as to the most common areas for sustainable practices across the supply chain and to identify areas that are weak or gaps found in sustainable practices. This method allows for greater understanding to the strengths and weaknesses that may need to be leveraged for the success of a future supply chain and the ability of the supply chain to address sustainability factors.

The research was conducted on a cotton supply chain that was about to embark on a pilot project for an integrated cotton apparel supply chain within South Africa. A secondary qualitative data technique that uses an inductive approach to analyzing the data was applied. The purpose of this approach is to develop an explanation-building process for the development of a phenomenon or change in behavior observed (Yin, 2009). In this case study the causal links to reasons for why participants were
engaging in the pilot supply chain and how they regarded integration across the supply chain. Integration across the pilot supply chain requires participants to agree to purchase cotton products from farm to retail. At the time of the field data collection the nodes of the supply chain were not yet integrated. However, reasons for participating in the pilot supply chain may reveal practices not found from deductive coding that are relevant to the sustainability of the supply chain. Understanding the motivations and perspectives on the pilot supply chain are important to developing a greater understanding on why a change in behavior towards integration is happening.

Archival Documentation of Farming Practices

The purpose of this research is to identify sustainable practices within and across a cotton apparel supply chain. Because the supply chain begins with the cultivation of cotton fiber it is important to understand the current farming practices employed in South Africa. Fiber production can have a wide array of environmental impacts based upon farming practices and cotton cultivation practices can vary region to region. Since site visits were limited to only two agricultural areas, due to time constraints, it was important to gain a broader perspective on the general cotton cultivation practices commonly employed in South Africa, beyond the two regions visited. The researcher referenced documentation on the cotton farming practices in South Africa from Cotton SA Core Statistics 2013 report, pamphlets and training materials utilized by Cotton SA. Cotton SA is the country’s premier organization that represents the interests of the national cotton industry and produces annual reports on the state of the industry. Currently, all cotton production in South Africa uses genetically modified cultivars (Cotton SA, 2013).
Chapter 4

RESULTS

Contextual Interviews

Interviews were conducted with a merchant and a non-profit organization that represent stakeholders in the cotton industry, while not necessarily involved directly in the supply chain. These interviews give a greater understanding of the context of the current cotton industry in South Africa (SA).

The volatility of international prices for cotton has had a dramatic impact on cotton production in SA because farmers did not know what they could anticipate for their crop at the time of planting. Compared to other crops that had more stable prices and thus farmers could rely upon better financial planning. This led to a rapid decrease in cotton production and contraction of the amount of cotton available in SA.

Infrastructure for the flow of cotton does exist in SA, in many areas they will likely require technological and/or equipment upgrades where players in the supply chain have long since closed their doors and liquidated. This is true not only for gins, but spinning and textiles as well. Cotton merchants require large quantities of consistent grades of cotton to meet the demands of local spinners. In general, SA cotton grade is fairly consistent with ‘better white colour grades,’ middle-staple length, and above average fiber strength. Although production in SA has declined the consumption of cotton has exceeded local production. Currently, the majority of cotton lint used by SA spinners is imported from the SADC region. SA needs to expand its cotton production while also retaining high quality standards and using
modern farming techniques to maintain consistency. In order to convince farmers to cultivate cotton again there needs to be mechanisms in place that can give them a fair and guaranteed price for cotton.

The government wants to create millions of jobs in SA. I think cotton can make a big contribution to that. Government is really, very serious to get cotton back to the levels it used to be and build the industry again.

Cotton farmers face inherent risks due to loss of yield from lack of rainfall or extreme weather conditions which can damage crops. Smallholder farmers were particularly vulnerable to the financial risk because they are unlikely to have an economic buffer if their crop fails. Also, smallholder farmers do not own the land they farm because it is tribal land. Therefore they do not have access to commodity financing. The cost of seed and other inputs for cotton cultivation have been rising. However, due to the deflation of the SA currency ZAR (1 USD=10.41 ZAR at time of this publication) could be a contributing factor.

Supply Chain Interviews

This research visited three sites within two of the major cotton production regions in South Africa. Site visits included a large commercial irrigation area and a nearby dryland (i.e. no irrigation available) smallholder farm area. The third site was one of the largest smallholder cotton regions (all dryland) located at a different agricultural area. Within the two major cotton production regions we also visited the regional cotton gins. A government representative of the Department of Agriculture, known as the extension officer, is assigned to each major production region. This person is responsible for organizing trainings, communicating with farmers, consulting farmers, and providing any government funded services to the farmers. An extension
officer was present at all three of the cotton farmer interviews. Interviews were conducted as a discussion among all participants but the questions were directed at the farmers. Sometimes the extension officer would clarify a statement, but they did not respond to questions directly and did allow the farmers to answer questions on their own. The farmers appeared to be comfortable with the extension officers.

Smallholder Farms

Two sites were visited for interviews with smallholder farmers at two different regions. All three pillars of sustainability themes were found to be strongly associated with each site, yet differed in frequency of mention with economy being the most common of the three. Being that the farmer is in the business of selling a nature-based commodity this makes sense. Codes were pooled for both smallholder farm interviews. Economic factors were the most often mentioned totaling 21 codes across both interviews. Ecology was the second most often mentioned factor with 11 codes across both interviews. Equity was only slightly less often mentioned with 9 codes found across both interviews.

Economy Factors

Economy factors such as profitability, costs, selling the cotton, and commodity financing (as confirmed from the interview with the NGO representative) were the most common discussed among farmers. Farmers in both regions are usually profitable growing cotton; however the yield and gross profits differed by region. In the first region visited, farmers averaged a yield of 800-1,000 kg seed cotton per hectare and grossed 1,000 ZAR/hectare. While in the second region the average yield is 800-1,500 kg seed cotton per hectare and grossed 4,000 ZAR/hectare. At both sites
the farmers mentioned the yield is dependent upon rainfall which can cause a wide range in yield year-to-year. The differences in yield between the two sites are likely due to differences based upon ecological factors between the regions, such as soil quality and rainfall. The differences in profitability between the two sites are likely due to economic factors such as quality and grade of the cotton which can fetch a higher market value and the international cotton price at the time of harvest season.

Costs of inputs are associated with Bt cotton seed, Roundup® herbicide, insecticide, and fertilizer for the first region visited. The second region visited did not use fertilizers. Diesel for tractors is also an expense and some farmers will rent tractors or contract out the services of a farmer who owns a tractor. Other expenses include labor at harvest season, grading fees, and ginning fees. These are not considered to be the largest expenses by the farmers. Farmers at both sites noted the rising cost of seed, herbicide, and diesel as main concerns associated with expenses, “The price of seed is going up. Not a huge difference but it goes up about 10% each year.”

The interviewees expressed similar economic challenges at both sites: a lack of commodity financing available to them, the volatility of international cotton pricing, and rising costs for seed and herbicide, both of which are provided by the sole supplier Monsanto. At both sites the farmers expressed an interest in expanding cotton cultivation in the region to include more farms and increase their own farm sizes. The farmers felt there was an economic opportunity with growth potential if the economic challenges could be accommodated, particularly getting a fixed price for the cotton. The farmers stated it was difficult to convince other farmers to grow cotton if they do not know what the price will be until harvest time. The farmers associated the economic opportunities of growing cotton will have a positive impact on the
community. They related an increase in cotton production can create more jobs for their community.

With financial support I would like to grow over 200 hectares and to help the people. Farming implements would be much needed before you can go to bigger farming. With only one small tractor, you could not finish planting such a large area in time. We don’t have enough tractors right now. I would like to get a bigger machine to expand. I would also like to have an irrigation system.

**Equity Factors**

Common themes for equity were the creation of jobs through seasonal work at harvest season, training and safety associated with chemical spraying, and the communication networks among farmers and collaboration with gins. All of the farmers hire locals for harvesting the cotton by hand. They are paid per kg of picked cotton and usually work 2-3 months. The farmers noted this provided much needed income to locals with few job opportunities in the rural areas. Farmers at both sites noted they wanted to be able to have bigger farms to hire more locals and create more jobs in the community.

All of the farmers interviewed have attended government sponsored trainings on integrated pest management techniques, chemical safety training, and discussed they provided protective clothing to workers or used themselves when applying chemicals. These training programs are government funded but conducted by the non-governmental agency, Cotton SA. At the first region the farmer who owned a tractor used a boom-sprayer to apply chemicals and needed to wear a mask and gloves. The second site visited the farmers noted the region had few tractors and the majority of farmers used knapsacks (handheld device which can be used by a single person) to apply chemicals. They are trained and assisted in their integrated pest management
practices by extension officers who also help farmers with calibration of the knapsacks and proper mixing of chemicals.

Communication and collaboration among the farmers in both regions was discussed. At the first site visited one of the farmers had been mentored by Cotton SA and commercial farmers in the region. He now mentors other smallholder farmers in his region on cotton cultivation techniques. He also owns a tractor and will work with the local farmers to get their land prepared for planting. He noted if they cannot pay him he will do it for free and they can pay him if they make a profit at the end of harvest season. The farmer also noted he wanted to see more farmers planting cotton and wished to mentor more students and to have those students mentor others in the area. At the second region, a representative of the farmer organization was present and spoke of the network for communication they have developed for the region. Because there can be great distances between farms, being a rural area, and many farmers do not own vehicles, it is important to have a way for farmers to communicate with each other and to share knowledge. Farmers join a local organization that will provide services such as information sharing and pool resources to purchase inputs together in order to reduce costs. These organizations will inform farmers of training services.

Ecology Factors

Farming practices, such as use of Bt cotton, the amount of chemical inputs, integrated pest management practices, and land preparation were similar across site visits. The most common cultivar is Monsanto’s Genuity, a type of Bt cotton seed which contain two modified genes, one for resistance to the bollworm pest and the other resistant to the herbicide Roundup®, also developed and sold by Monsanto. The Roundup® resistant gene allows farmers to spray the herbicide over the cotton without
damaging it. Therefore, common practice is to spray the entire cotton crop 1-2 times with herbicide to inhibit weeds, allowing for a higher cotton yield. The farmers only spray a second time if they observe an outbreak or if the type of weeds is particularly pernicious. The farmers use 2 liters of Roundup® per hectare. Use of herbicides reduces the need for tilling of soil between the rows of cotton and improves soil stability and health.

The only farming practice that differed was use of fertilizers at the first region of farms and no fertilizers used at the second region visited. The farms visited at the first site use cotton in a crop rotation practice to maintain soil health. Total fertilizer use is 200 kg per hectare, 100 kg for preparation and 100 kg top-dressing. At the second site visited, smallholder farmers do not use any fertilizers in their farming practices, nor do they practice crop rotation.

At both sites the farmers noted they preferred using the Bt cotton because it was resistant to the cotton bollworm and they no longer had to spray the entire crop with insecticide. The use of Bt cotton is seen as a big advantage.

I no longer have to worry about the bollworm because with the Bt cotton it is resistant. What I have to watch out for is aphids and jassids which I control with Mospilan using the boom-sprayer…When you scout and you find 2-3 times spray will be enough, only on the area with the outbreak.

The smallholder farmers at both sites use an integrated pest management system which includes regular scouting for pest outbreaks, identification of type and severity of pest outbreak, and spot spraying of pesticide only on infected area. Common pests include aphids, jassids, and stainers. Insecticides used by the smallholder farmers visited were Mospilan and Alpha-thrin, depending upon the type of insect outbreak. Insecticide use only occurs 1-2 times per season; amount of
insecticide used is equivalent to 1 liter per hectare if an entire hectare needed spraying, which is not likely. Farmers noted they are trained to keep chemicals stored in a safe location away from people that is locked.

Commercial Cotton Farm

Responses by the commercial farmer were similar in regard to sustainability themes frequency and influences on practices. Economy factors were also the strongest influences on practices with 12 codes, followed by Ecology with 6 codes recorded and Equity factors with 5 codes recorded.

*Economy Factors*

Farming practices differed between smallholder farms and the commercial farm in that the later had water rights and irrigation, state-of-the-art equipment for land preparation, chemical spraying, and harvesting. This allowed the farmer to use precision farming practices that uses satellite imagery and remote sensing data to identify differences within a crop that can relay information such as pest outbreak areas or differences in soil quality. The information can be used to make precise adjustments to specific sites within a field, which result in much higher yields. The commercial farmer average yield was 4,600 kg seed cotton per hectare.

Although the farmer stated he usually receives a profit from selling cotton, he noted this is not always the case due to the inherent nature of crops failing due to extreme weather conditions, such as hail. The commercial farmer stated rising costs for diesel, labor, seed, and water were all negative impacts on remaining competitive. However, he also stated his ability to remain competitive was his ability to use the best technology and precision farming practices. The commercial farmer identified
economic opportunities for other farmers with expanding production of cotton in South Africa. In particular, the farmer mentioned concern for high unemployment in South Africa and felt the jobs created with cotton would help alleviate poverty.

Cotton gives the minimum amount of money [investment] to get the maximum amount of work [job creation]. They say 40% of our people are unemployed and if it’s going on, and on, and on, you will have a revolution. That’s my biggest concern. People who don’t have a job have nothing to lose.

Equity Factors

Education and training in agriculture were relevant themes. The commercial farmer was concerned for the future of farming in the region due to a lack of young people coming into the farming industry. He was currently paying for an employee to attend an agriculture school. He also collaborates and mentors smallholder farmers in the region; one of them was interviewed previously who now mentors others. The smallholder farmer and the commercial farmer will share knowledge and even resources. The commercial farmer loaned a tractor to the smallholder farmer when he needed help with planting. The commercial farmer is also one of the co-owners of the local cotton gin and feels it is his role to promote and support the expansion of cotton production in South Africa. In the previous harvest season, the commercial farmer employed 90 workers to come and handpick 40 hectares of his total 200 hectares of cotton. Although he had the means to harvest all of his cotton by machine at a lower cost, he felt compelled to give work to the locals.

It is mainly to give the unemployed people work. It’s not that I have to, and it’s not beneficial to me, but it is good for them. It is mostly women; otherwise there is nothing for them to make money.
Ecology Factors

Farming practices included use of Bt cotton coupled with use of Roundup® herbicide, use of fertilizers based upon soil analysis, integrated pest management practices, minimum tillage techniques, and crop rotation. The commercial farm was located in an irrigation area and the farmer used the irrigation on a regular basis. The water use was monitored and only used when necessary, but the farmer did not explain in detail under what criteria irrigation was used.

The commercial farmer used technology along with his integrated pest management practices. Commercial farms in the irrigation area use satellite imagery data to identify areas for scouting, the technology is capable of transferring outbreak information to the tractor and automatically adjusting the amount of pesticide spray specific to the outbreak area and severity. The farmer also used modern farming equipment for land preparation and planting of cotton seed, as well as for harvesting. The farmer noted using the precision farming techniques allowed him to be very precise in application of chemicals in order to use the minimum necessary while also getting the best yield. Chemicals used included pesticides, herbicides, and defoliants.

Contrast between Smallholder and Commercial Farms

Similarities in farming practices between smallholder farms and the commercial farm included use of Bt cotton seed coupled with Roundup® herbicide and integrated pest management practices. Differences in farming practices included use of fertilizers, harvesting techniques, equipment, and irrigation.

Practices to maintain soil health varied across sites. At the commercial and smallholder farms at the first site visited, the soil is analyzed prior to preparation for planting. Based upon deficiencies identified in the analyses fertilizers will be added to
soil, on average 100 kg per hectare. Later in the growing season, after the cotton plants have emerged, a second round of fertilizer top-dressing (nitrogen addition) is applied, on average 100 kg per hectare.

A wide range of farming equipment was observed at the farms. The commercial farms had state-of-the art equipment used for precision farming practices for land preparation, planting, spraying and harvesting. Smallholder farms had a few farmers with their own tractors for land preparation and spraying purposes. Often the smallholder farmers who owned tractors would be contracted out by other smallholder farmers in the area. Otherwise, donkey or oxen-plowing was used for land preparation. One smallholder farm site observed, prepped by oxen-plow, was uneven and the cotton plants were of various heights. Without a smooth soil bed the cotton plants will produce less of a yield. The commercial farms had equipment for mechanical harvesting which requires the crop to be sprayed with defoliant chemicals in order for the leaves to fall off before harvest. Otherwise, the leaves will negatively impact the quality of the cotton by adding too much plant debris in the cotton seed. Mechanical harvesting is faster and cheaper than handpicking. However, handpicking is a common practice at smallholder farms that do not have access to mechanical harvesters. Handpicked cotton does not require use of defoliants and tends to have a higher quality of cotton due to minimal plant debris getting mixed in.

Only one site had water rights with irrigation available, being a major agricultural farming region. The commercial farmer purchased water from the government and monitored water use. The smallholder farming sites were on dryland and had no access to irrigation. They are rain fed farms.
All of the farmers visited noted similarities in economic risks associated with cotton farming such as rising cost of inputs, volatile cotton prices, and weather. Differences in economic factors were related to access to financing between smallholder and commercial farmers. In the irrigated region, farmers owned the land with water rights attached. This allows them access to commodity financing in order to purchase technology and/or equipment. These farms use technologically advanced farming equipment with precision farming techniques that give them significantly higher yields. In contrast, the smallholder farmers do not directly own the land because it is tribal lands. The farm is passed along generation to generation. However, if the farmer chooses to leave the land or to no longer plant on the land the tribal chief may give the land to another. Because the farmers do not hold the title to the land they lack access to commodity financing. The smallholder farmers tend to be dependent upon government grants and/or resource support. Smallholder farms use minimal equipment and tend to be more labor-intensive for farming, such as handpicking for harvesting of the cotton.

Cotton Gins

Interviews were held at two cotton gins, both owned by farmer co-operatives for the function of servicing their agricultural regions. One gin was servicing both an irrigated and dryland farms within the first region visited and the other was servicing the second region visited which was all dryland farming. Although they serviced different regions they operated under similar circumstances using similar techniques. The interviewees across both gins had similar themes for Economy, Equity, and Ecology with the frequency of mention being 28, 8, and 4, respectively.
**Economy Factors**

The gins operate after the harvest season and separate the cotton fiber from the seed and trash content. The goal of the gin is to preserve the natural quality of the fiber, bundle the fiber into 200 kg bales, and coordinate the sale of each bale with cotton merchants based upon the grade of the cotton and current international cotton price.

For both gins, economic challenges noted related to the difficulty for servicing farmers without a fixed price for cotton, the rising cost of energy impacting their ability to operate, and difficulty getting spare parts for the gin which need to be imported or parts must be machined locally. The cotton gins are not viewed as separate entities or businesses from the farms. They are inextricably linked and the trend toward farmer owned gins is to provide the ginning service to the farmer to add value to the cultivation of cotton. The business strategy for both gin operations is to operate at a very small profit margin, just enough to provide for any capital needs the gin itself may need. The goal is to provide the best price possible to the cotton farmer, not to run a highly profitable gin. Gin operators expressed the desire to increase production of cotton will be a benefit to the gin for lowering operating costs as well as providing additional income to the local community through job creation. One gin owner stated for every hectare of cotton under cultivation 1.5 jobs will be created.

The second gin was previously run by a private company that went bankrupt in 2006. At that time the gin was under liquidation until 2010 when the government agreed to purchase the gin for the benefit of the local farming region. During the liquidation period, farming of cotton dropped dramatically because the cotton had to be shipped to the gin in the first region 600 km away, greatly increasing the cost for
ginning the seed cotton. Instead farmers moved to growing other crops such as maize or vegetables but these are not drought tolerant crops.

   It was really a disaster for the farmers. It had a big impact, the closing down of the gin, on the farmers. Because this area is very hot. The rainfall for this area in the past was about 700-800ml, sometimes 900ml. But now, it is around 300-400ml which is very bad for farmers to plant any crop...But the rest of the land here is dryland and you cannot plant any food crops here. You can only grow cotton here. 90% of the land here is dry and you can only plant cotton.

**Equity Factors**

   Equity factors were linked to job creation and income generation for rural communities. The gins operate seasonally during the harvest season and service the local region. The first gin visited had been operating longer and had seasonal workers. The second gin was not yet fully operational but had conducted a small-scale run of cotton seed. The second gin expected to be able to service the local cotton region in the 2014/15 season and anticipated hiring seasonal workers for the gin. Both gin managers noted employees are provided with protective masks because fine cotton fibers in the air can cause lung irritation, as well as hearing protection since the machinery is very loud. As one gin manager explained the “cleaning process takes place by sucking up the cotton, it is very dusty. Employees wear masks, goggles, and ear plugs.”

   The gins also provide services to the local farmers such as coordinating training services and communicating among farmers. Training services can reduce farmer’s exposure to chemicals and sharing of knowledge about farming practices can improve the productivity of the farm which provides more income for the farmer. Trainings and knowledge sharing about practices to maintain the highest quality of the
cotton fiber can impact the price the farmer receives for his cotton. Often, extension officers will coordinate and collaborate with the gin to provide services to the farmers. The gins represent a central place for storage of seed and chemicals that will then be distributed to the farmers as needed.

Ecology Factors

The ginning process is a mechanical separation of cotton seed from the lint, there are no chemical inputs and minimum water is used to maintain moisture content. The main environmental impact comes from the high energy use, which gin operators noted to be the highest cost for operating the gins. At the first gin visited, when asked if energy is the largest operating expense the manager responded:

Yes, if you look at the electricity we are running between 300,000-350,000 rand per month. Very high, and it’s also high voltage coming through, it’s a 1000 watt.

Both gins have virtually no waste as they use the seed for additional revenue streams, such as cattle feed. The little waste the gins do create is biodegradable and has no negative impact on the environment. This is in line with McDonough and Brangaurt’s (2002) waste equals food philosophy representing a truly sustainable practice. At the first gin they even have a method for using the low quality fibers that are usually considered solid waste, left over from the ginning process. A process the newly acquired gin may also consider for reducing solid waste at their facility.

Moute is considered gin waste, in the past it was thrown away. We are in the process where we will clean it and now we are selling it for seed grade cotton. Some spinners can still spin it, it is a lower quality but it gets blended with the higher grades and it can bring the cost of the textile down. Another use is when there is an oil spill they will use it to soak up the oil. Also, it is used to make mops or other textiles. Hardly any waste.
Spinning Facility

Sustainability themes found Economy factors were coded 16 times, followed by Equity with 3 and Ecology with 2 codes recorded.

*Economy Factors*

The spinning operation visited was purchasing its cotton needs from the SADC region but not from South Africa because the volumes of consistent grades were not sufficient. The majority of cotton is sourced from the southern Africa region on a quarterly basis. Similarly, 90% of the cotton yarns are sold locally with only 10% being exported. The spinning operation provided a variety of yarns to the textile industry for knitting, weaving, and toweling, roughly in 1/3 proportion each. The cotton blending based upon cotton grade is an important component to the quality of yarn specific to the textile sectors. The manager notes “…we have to be careful, the same yarns can go into toweling and weaving but with the knitting we have to be very careful with the blend. It is a key function in terms of your quality.”

The spinning facility has two types of spinning equipment capable of maintaining quality standards. The investment in open-end spinning requires less labor to operate and has better capabilities such as being able to spin multiple yarn types at once. The manager felt the equipment and processes at the facility were sufficient for local yarn requirements.

We have two main ways of producing yarn. One is called open-end and the other is ring spun. Open-end spinning technology is absolutely state-of-the-art. Our ring spinning, some of the machines were bought in 2007, others were bought in 1997. But from what they are capable of doing, there is no reason why we should change them. We are in the process of expanding our capacity by 20% and expanding in certain areas. From a technological point of view, we do not have a disadvantage.
The spinning manager felt the capabilities of the yarn production were comparable to the global market but noted other external factors were creating challenges for the business such as the volatile nature of international prices for cotton negatively impacting the purchasing strategy for the business. The manager expressed the importance of expanding production with an increase of volume, to decrease operating expenses, would contribute significantly to competiveness. The interviewee expressed a desire to see an expansion of local cotton production and local cotton procurement with an integrated supply chain in South Africa.

*Equity Factors*

The manager of the spinning facility noted they were fully staffed and operating at full capacity but would like to increase the number of operating days per year from 338 to 350 days. The firm offers trainings on safety and skills improvement for workers. The manager was passionate about providing educational services and skills development to his employees.

> We are in the process of designing the technical training courses. We don’t need to teach them about anything else but what happens in there. Just how do you do your job better? I think that will probably be a 2-3 year program.

The facility also has an on-site clinic that offers free exams and provides counseling services. The firm also conducts regular exams on workers for hearing and lung function because of the high levels of dust and noise in the facility. The employees are provided with ear and eye protection, and masks. It was observed many workers would wear scarves instead of the company provided masks, likely due to comfort reasons. All of the workers observed had ear and eye protection on and most wore gloves.
Ecology Factors

The spinning of cotton fibers is a mechanical operation, requiring no chemical inputs and minimal water use in the process. Very little waste is generated in the process. The main ecological impact comes from being a high energy use operation which is also a major expense and concern for the business. The interviewee related the energy expense as a major economy factor for them since energy costs have raised dramatically.

We buy our energy from the government. In the last 4 years, our energy costs have gone up. We were paying about $6 million rand per year; it went up to $20 million rand in 4 years. It’s a massive increase.

The manager also noted the facility had recently begun to measure its greenhouse gas emissions. An important first step towards reducing impacts is being able to measure them in order to implement a target goal for reducing those impacts. Dust and noise levels within the facility are monitored in an effort to reduce the environmental exposure to workers. Another environmental impact area discussed by the manager was the transportation of products which are shipped via diesel trucks.

Textile Manufacturer

Sustainability themes found from the interview of the textile mill differed from other nodes in the supply chain. While Economy codes were still the most common recorded at 18, Equity followed closely behind with 12 codes recorded and 7 Ecology codes were recorded.
Economy Factors

The textile mill is a specialty niche textile producer of mostly synthetic fibers but also includes cotton blends with synthetics. The company sells 85% of products locally and 15% are exported. The textile mill is highly adaptable to size runs of products and is fully equipped with an integrated dye house. The mill is running at full capacity but has the opportunity to expand production by extending from 2 shifts to 3 shifts.

The economic challenges noted by the managers were associated with the rising cost of water being a major input of the operation, loss of local business relationships from the globalization of the industry, and general global positioning for transportation costs of importing and exporting. Economic opportunities impacting business strategy were to re-establish relationships with local businesses to create niche textiles catered to retailers, taking advantage of a recent government local procurement act by expanding their product line to meet those needs, and continued upgrading of equipment to improve efficiency of resource use, such as water and energy.

Equity Factors

Equity impacts were associated with efforts by the company on training services for not only skills upgrading of employees, but also included providing access to educational services through a library and courses.

…we send our guys on courses to the university. They teach each other when they return. We find that even when they come with the proper degrees, they are not properly trained.

The company was involved in a community based paid internship program that gave locals skills in the textile manufacturing sector. The company also developed
community projects that provided income opportunities to local sewers by selling scrap fabric at a very low cost. Social services were provided with an onsite clinic. The interviewees also noted several examples of efforts and management practices that were geared towards breaking down racial and class barriers. Examples included facilities upgrade of toilets and the canteen for the benefit of the employees; as well as an annual ‘braai’, where the managers cooked and served the employees. Choices are made to reduce chemical exposure to employees and maintain the well-being of the workers. In particular not using sulfur in the dye process was discussed as well as limiting exposure to chemicals they know to be potentially harmful.

Silicones are generally not nice chemicals because they are generally in solvent form…which isn’t good for our guys. One of the things that we do is to mix our solvent with a human friendly compound and we conduct blood tests on our guys… Unfortunately in SA there is no legal limit, but we know it’s a bad thing, so we try to monitor it and reduce exposure.

Ecology Factors

Environmental management practices at the textile facility were focused on solid waste, chemicals, water use, energy use, and wastewater treatment, all important impact areas associated with textile production. The facility had an extremely low solid waste program with very little being send to the landfill. Mangers identified waste streams as an area of importance to the business. The company separates 17 waste streams and works with a local third party recycling company to repurpose as much as they can, often generating an additional revenue stream. Textile waste was included in the waste streams and the separation by fiber type was observed. However, it was not clear as to whether the textile waste for synthetics was being recycled back into yarn or repurposed into another product. Cotton and synthetic fiber blends cannot
be recycled since the fibers cannot be separated from each other and are likely being recycled into another product category.

The textile facility has a dye-house and uses cold-batch reactive dye techniques in order to reduce the amount of hydrolyzed dye found in the spent liquor. The company chooses not to do vat or sulfur dyeing. The company only sources chemicals from companies that adhere to Europe’s REACH standards for environmentally acceptable chemicals. This reduces their exposure to risk associated with chemical inputs and outputs generated by their operation.

….not all dye stuffs is a carcinogen, sometimes the intermediaries are carcinogens, but we are not master chemists, we don’t know, but we would rather deal with Europe that has all the legislation in place so we know what we are getting is environmentally sound. If we re-export that stuff back to another country and there are any problems with the chemicals, it is REACH certified and we go to our supplier and say look this is your problem, not ours.

The textile manufacturer does not do any printing treatments but does use finishes and coatings on certain products. Finishes include fluorocarbons and hydrophilics and coatings include polyurethanes and silicones. Other chemical treatments may include softeners, fatty acids, and waxes. All of these chemicals are REACH certified.

Efforts to reduce environmental impacts were closely linked to increasing efficiency for the sake of reducing production costs. Such as investing in equipment upgrades to increase boiler efficiency and reduce energy consumption. The efficiency upgrades of the boilers are estimated to reduce the monthly electricity cost by $4,000 USD per month for the business and are more efficient at producing energy.

When we burn the coal for our boilers rather than buying the same amount of electricity it reduces the amount of coal used by 50% because you are not losing all of the friction and energy down the line.
Our electrical energy in SA is in many cases more expensive than overseas.

The facility manager identified three streams of water for the facility being municipal water that is treated onsite, sewage water that is sent to a municipal sewage treatment plant, and storm water. Although the mill could send their effluent to the local municipality to clean, the company chose to invest in their own on-site effluent treatment plant.

Our water can be sent back to the catchment area down the road and the local municipal can’t tell us if the water is good or bad. They don’t have the resources or funding to have a laboratory to check the water. We run our own effluent treatment plant here.

The manager described efforts to reclaim water and reuse when appropriate by adding two outflows on equipment that uses water. If the water can be reused for another batch of product it will be reclaimed and reused leaving one pipe. If the water cannot be reused it will leave the second pipe and be treated as wastewater at the on-site effluent treatment. The water that is treated from the on-site effluent treatment is not clean enough to be reused in the boilers or in the dye processes because there are still suspended particles in the water. The facility would need to invest in filtration equipment in order to repurpose the effluent water. The manager has also considered capturing storm water from the roof, filtering it and using it as sewage water for the bathrooms. However, this would also require an investment in piping and filtration system before it could be enacted. The manager believes with financial flexibility in investments for projects such as these he could make the facility a closed-loop water production system with zero-discharge.
Apparel Manufacturer

Similar to the textile mill, sustainability themes still ranked highest among Economy factors with 23 codes, Equity at 16 codes and Ecology factors with 3 codes recorded. The apparel manufacturer is owned by a larger corporation. The manufacturer specializes in school wear, which they have been manufacturing for over 40 years. The manufacturer employs 1,500 people and produces 8 million garments per year.

Economy Factors

The apparel manufacturer is part of a larger corporate structure giving them an economic buffer in that they are not subject to the seasonality of their production and can take advantage of sufficient cash flow provided by their parent company. The manufacturer has four factories housed in a single building which causes space constraints for growth. At the time of the site visit, the manufacturer was in the process of renovating and upgrading each of the factories. While demand has increased for the manufacturer, due to space constraints they must add an entire pipeline from cutting to sewing to packaging, in order to be 100% balanced. The manufacturer noted they cannot simply add more sewing machines to increase production. This creates an economic challenge to the company to be able to build and supply additional factories. However, the manufacturer was under a four-year expansion plan to renovate the current factories and then add an additional shift in order to increase production. The manager identified economic challenges to be the investment needed to upgrade equipment and the facilities to be more energy efficient. Although energy is not one of the biggest expenses overall for the operation, the manager did mention the rising cost of energy was a concern. “It has increased about
300%... Costs have gone up dramatically which obviously makes us less competitive.” Economic opportunities noted were the ability to take advantage of a new national local procurement act that would allow the company to expand into work-wear for government employees. Thus the expansion of production would be through increasing sales in the local market.

**Equity Factors**

The interviewee was openly concerned for the well-being of the workforce living in the surrounding area with high poverty rates, heavy violence, and high rates of drug and alcohol addiction. The interviewee identified the challenges of living in this area was strongly associated with high levels of absenteeism and low work productivity in the past. To counteract these issues the manufacturer put into place several social services such as on-site clinic, utilities bill pay, and medicine delivery. Nearly 80% of the workforce in the factories is women, often mothers.

We’ve got a department in our employee wellness plan that brings people in so employees can pay their maintenance money [utilities] in-house. Any service anybody can think of we’ve got onsite for them. We’ve got a suggestions scheme as well. If they come to us and say I need to get my chronic medicine from 15km away, we’ve got a driver that goes and picks up medicine for employees.

The manufacturer offers skills trainings to anyone in the community who wants to learn the different jobs. They are paid as an apprentice and receive a certificate upon completion. It is the hope of the company to maintain the skills available to the apparel manufacturing industry and not have this knowledge lost. The company has also worked towards changing the culture within the organization with efforts to increase respect between management and employees. The company upgraded facilities such as the toilets and canteen. In the past there were separate
facilities for managers and workers, today they are the same. The company also engaged in communication training and leadership training for supervisors. Since enacting these changes the turnover rates have dropped to near zero for the company.

Ecology Factors

The manager identified three main environmental impact areas for the facility to be textile waste generated from the cutting rooms, high energy use, and waste from packaging materials. Previously, the textile waste was used by a third party manufacturer to make underfelt but the company no longer exists. The manufacturer currently produces two tons of textile waste per week creating a solid waste problem for the facility. The textile waste (poly/cotton and poly/viscose fabrics) is sent to the landfill.

We are so far from green its shocking. The material waste from cutting currently all goes to the landfill. Previously it use to go to corporate manufacturers that used it for underfelt, they don’t do that anymore. We are battling to find someone to take it, to do something with it.

The interviewee noted there were challenges for the company to reduce energy use because of the age of the building and the building houses multiple departments, besides just the factories, so they cannot monitor where the energy is being used. The company has considered investing in solar panels but found the technology was not sufficient to run the amount of electricity needed for their operation. “We are still heavy users of electricity. We do not have access to any renewable energy sources.” Current efforts are underway to reduce energy use with the factory renovations, such as replacing lighting and upgrading the boilers to be more efficient.

The company does work with a recycling company to address materials waste from packaging. The facility pays 28-32,000 ZAR per month for solid waste disposal
and recycling. The textile waste is a considerable expense for the company. The poly/cotton blend of fibers cannot be separated from each other which reduces the ability to be either biodegradable (i.e. cotton) or recyclable (i.e. polyester). In this case, choice of materials impacts the solid waste and disposal aspect of the facility. However, the manager discussed the reasons for choosing poly/cotton are due to price, durability, and comfort. She would be willing to consider other materials if they could meet the same requirements.

Our average customer earns $800 rand per week…The problems we have with just cotton currently, is that it doesn’t dry quickly and it creases. The finishes you would need to add to make it easy care, add cost. Our customers often don’t have a washing machine; they might wash in the river with rocks. They don’t have irons, they don’t have electricity. They don’t have 5 shirts, they have 1 shirt.

Retailer

The retailer for this study represented one of the largest in South Africa with both apparel and housewares divisions. Sustainability themes were similar to the textile and apparel nodes with Economy factors coded 11, Equity coded 8, and Ecology coded 4. The interview questions developed for the retailer were not about current practices at the retail level but rather about the retailer’s role at the end of the supply chain and perspective on the cotton supply chain and the apparel and textile industry capabilities in South Africa. The retailer’s role as the buyer is important to the overall sustainability of the supply chain.

Economy Factors

The retailer sources apparel and textile products for cotton, mostly in blends with other fibers. Some products are made with SADC cotton such as towels and t-
shirts, although the managers noted they source cotton and cotton blended products outside the SADC region as well due to price. The retailer noted they know the location where the cotton is knitted or woven but cannot say where the cotton fiber comes from because there is no way to trace it. The majority of sourced products and fabrics with cotton are imported. The company is currently involved in a new integrated supply chain pilot study agreeing to source a certain amount of South Africa cotton and place into a product category. The managers noted the main economic challenge of using South Africa cotton and being competitive in the retail market comes down to pricing. The retailer makes strategic sourcing decisions based upon quality and price. The interviewees felt local procurement of cotton will need to fit the company’s current business strategy. However, they felt the expansion of local procurement would be good for the country because it would create jobs. They saw their role in the integrated cotton supply chain project to be integral in supporting the local economy.

We believe there is great opportunity and it is our responsibility as a leading retailer to be involved and to revitalize the industry which is almost non-existent at this point.

While the economic opportunity to revitalize the local industry was deemed important, the challenges facing the industry were linked to a lack of investment in modern technology in manufacturing and lack of skills in the manufacturing sectors. The managers discussed that during the decline period of the industry after the Multi-Fibre agreements were phased out there was no succession of educating the next generation on apparel and textile manufacturing, much less upgrading skills on modern techniques. “It was a very healthy industry but also quite contained and introverted. But I think one of the biggest challenges we face now is that of
continuity.” The interviewees felt a revitalization of the local apparel supply chain would be beneficial to their business by shortening lead times for delivery. However, they noted since the contraction of the industry there has been a loss of necessary skills.

The skills on the apparel side like printing on t-shirts, those are the kinds of suppliers we have in South Africa, but not on the highly technical side. Our suppliers have become importers and are not thinking like exporters anymore.

Equity Factors

The company had recently conducted a feasibility study to investigate the opportunities of sourcing South Africa cotton. Specifically, the company was interested in tracing the supply chain all the way down to the farm level. The feasibility team found it challenging to build relationships along the supply chain because it ‘broke the traditional rules’ for the retailer to work with them directly. Eventually, the team visited a gin and local cotton farmers.

It was amazing to us because even though you deal with the final product, you don’t get to experience the entire process. I think that is what we learned is we need to be more connected with what happens down the supply chain.

The managers were passionate about the impacts expanding cotton production and revitalizing the apparel and textile industry in South Africa would have on people. Specifically, they felt the need to create more jobs and to help alleviate poverty were of utmost concern. Followed by the opportunities for skills and training in the manufacturing sector.

Many are not going to go off to university so we need to create jobs for them with manufacturing. We see our role as a retailer how we can engage with all levels down the value chain.
The retailer identified communicating with the consumer about African cotton was an important role for them to play. Consumer support was considered an important component to the revitalization of the local industry which would contribute to job creation. The managers noted their customer was not likely to be very aware of where the cotton in their products comes from. Yet the local consumer is likely to support African grown cotton products, as a sense of regional pride. Consumers in South Africa are not particularly concerned about the environmental impacts of the apparel and textile industry. The managers noted they themselves would be interested in seeing a certification of cotton, such as Better Cotton Imitative, but did not believe it added any value to the cotton product. One manager felt the South Africa consumer is not going to be swayed to pay more for certified cotton. The managers noted in general consumers in South Africa are more concerned about social problems than environmental.

Ecology Factors

While the interviewees were optimistic about the equity impacts expanding cotton production in South Africa could have, they were more cautious as to the environmental impacts it would have. In particular, it was noted the government was promoting agriculture to grow food and whether South Africa had enough water for large irrigation for cotton might not be best. The interviewees noted many of the farms from the SADC region and within South Africa are rain fed which they felt was good for the ecology. The interviewees noted the national regulations for manufacturing were sufficient for environmental protections.

In South Africa we have so many social and economic issues it tends to be our main focus, perhaps a bit more than environmental. In South Africa, we already have in place quite good environmental regulations
and there is already a lot of work being done from government for cleaner production. So it isn’t as big of a concern as it is in other countries.

The managers discussed in recent years there was a macro-trend to want to know where things come from in many industries. They also found investors were beginning to ask about tracing raw materials back to their source and what percentage of products can be traced back to sustainable sources. These trends in the industry led the retailer to embark on the feasibility study for sourcing South Africa cotton but also to the realization cotton is difficult to trace back to its source. The retailer could not find out how much South Africa cotton compared to SADC cotton was in the mix for their locally procured products. Without the ability to trace the cotton back to the farm, the retailer was unable to know if the product category was from a sustainable source or not, even within the region. Because of this, the retailer felt having traceability of the cotton all the way down to the farm level was very important because it gave transparency to the supply chain. The managers felt transparency would allow for the retailer to address problems across the supply chain.

What we have learned from our experiences over the last year is we think about things differently and are as cost-conscious as we have ever been, but we can be far more effective and we can actually take other people on the journey with us. So transparency is what has transformed us and how we think.

The managers noted the ability of the retailer to engage all levels down the supply chain would allow for greater collaboration. The managers cited working with supply chain partners to share knowledge and resources to accomplish sustainability goals such as reduce waste would be a major benefit. The managers also noted the importance of developing greater understanding across the supply chain. When the interviewees went to meet with smallholder cotton farmers, the farmers wanted them
to buy all of their cotton. The retailer had to explain to the farmers they do not buy raw cotton. Similarly, the interviewees learned about the economic challenges the smallholder cotton farmers were faced. The ability to communicate allowed for a new level of understanding for both parties at opposite ends of the supply chain.

**Summary of Triple Top Line Codes**

The data was first analyzed within each node by weighting the 9 codes of the TTL tool for the three sustainability themes. Figure 2 summarizes the three sustainability themes for each node in the supply chain, the average is used for farms and gins since they represent more than one site visit. Although these data do allow for interpretation of practices within the supply chain, due to the design of the interview process we cannot directly compare between nodes. The number of codes per interview does not take into account the verbosity level (i.e. interviewees who talk more often have more codes), the interviews were not set on a time limit and some are longer than others, and some interviews had multiple participants while others were a single participant. Therefore the frequency of codes found across the nodes is not comparable, only within the node. The codes found within the node lend understanding as to the relative importance given by the interviewee of current management practices and how these practices apply to the three pillars of sustainability.

Although farms did not have the most Ecology codes found, farms did show proportionally higher Ecology to Economy ratio (6 and 11 respectively), than the rest of the supply chain. Likely due to the fact farms are in the business of a nature-based commodity and are therefore more engaged in Ecology in their daily business decisions. The textile mill showed the largest number of Ecology codes of the group.
which reflects the relatively disproportionate environmental impacts associated with the processing of textiles; therefore it would require a more active engagement as part of the operation. Gins and the spinning facility had proportionally higher differences between Economy codes to the other two. Both of these types of operations have relatively low environmental impacts but are more directly impacted by the local demand and changes therein, contributing to more economy factors being discussed. The apparel manufacturer had the largest number of Equity codes, with the textile mill following closely behind. Each of these operations had a large workforce (250 and 1,500, respectively) where social dimensions can directly impact productivity. The retailer had the most balanced and proportionally similar codes of the group. Likely due to the fact the retailer is positioned at the end of the supply chain and the interview questions were not related to their retail operations, but rather their influence at the end point of the supply chain. Therefore, the retailer represents more of perspective-based view of the sustainability of the cotton apparel supply chain. The other nodes were questioned on current practices, reflecting sustainability within the supply chain. Since the retailer is an important influencer over the supply chain, it is important to understand their perspective on the cotton supply chain and which sustainability themes emerge.
The data were also analyzed for the three sustainability themes for the entire supply chain and the weighted data was pooled for the six nodes (using the average farm and gin data). Across the entire supply chain, sustainability themes coded using the TTL model found Economy to represent 56%, followed by Equity representing 29%, and lastly Ecology representing 15% of codes (based upon weighted categories). Being that each site visit was an independent business it makes sense the data would be skewed towards the economic concerns. The economy pillar represents the business’ ability to be viable and capable of operating long-term. The ability to sustain a viable business contributes to the economic stability of the community by providing jobs and income. The equity pillar is the closest of the three to being 1/3 of the total codes. Interestingly, the ecology pillar is the smallest of the coded data set, even though the interview questions were dominated by more environmental management practice questions. These data suggest that the three pillars were not found to be in
equal proportion to each other, nor were they related to the frequency and types of interview questions asked.

The data were further analyzed for all 9 codes which were pooled for all 9 supply chain interviews due to small sample sizes within each node (refer to Table 4). Across the cotton supply chain economy/economy was the most common of all; followed behind in almost equal proportion was economy/equity and economy/ecology. Equity/economy followed behind the economy themes, these were most often represented in cases when the business invested in facility upgrades or on-site social services that were for the benefit of the workers. Common examples of economy/economy come from factors which impact the business’ viability such as costs, profitability, changes in local demand, and access to financing. These factors were not always in a positive association and recorded negative associations were most often found in the economy dimension. For example, smallholder farmers noted lack of access to commodity financing made it difficult for them to afford the necessary inputs needed at the right time. Farming can be high risk due to sudden changes in weather which can greatly impact the yield, which in turn impacts the profitability of the business. For both farmers, gins, and the spinning facility, the volatility of international cotton prices put them at economic risk because price fluctuations made financial planning difficult. For many of the manufacturers, rising cost of energy and water was a negative impact on their ability to remain competitive.

Economy/ecology codes most commonly found were investments in equipment or processes which improved efficiency and reduced energy, water, and/or chemical use. A negative association was found at the commercial farm where it is common practice to use machine picking for harvesting the cotton because it is more
efficient and economical for large farms. However defoliants are sprayed on the plants prior to harvest, which has a negative impact on the environment. Negative associations in manufacturing were related to rising costs of energy and water, for which they are dependent upon government municipalities to provide. The most common themes found for economy/equity was efforts to provide training and social services in the workplace that helped improve productivity. The only negative association found was at the apparel manufacturer since the business has reduced its workforce by 25% over the last 7 years.

Equity/economy themes commonly found included investments in facility improvements that improved the morale of the workforce, education and trainings, and onsite social services such as health clinics. Investments into these services for the benefit of the workforce also benefitted the businesses by improving productivity and lowering turn-over rates. Equity/equity themes reflected efforts to promote mutual respect among everyone. Efforts such as these were found in management practices that improved communication, practices that promoted fairness of treatment among workers, and providing mentorship.

The weakest areas identified with the TTL model were equity/ecology, ecology/ecology, ecology/equity, and ecology/economy. Equity/ecology was found mostly at the farm level due to the handpicking of cotton creating seasonal jobs, but also avoids the need for defoliant chemicals to be applied which is beneficial to the environment. The textile mill chooses not to use sulfur dyeing because it is harmful to workers, which adheres to equity/ecology because it reduces exposure of harmful chemicals for the benefit of workers, but is also a benefit to the environment. Ecology/ecology was found at the farm level and once at the retail node but it was in
direct reference to dryland cotton farming being good for the environment because it was rain fed. Farming practices that support natural cycles such as crop rotation, and not using inputs such as fertilizers and water, were included. As well as farming practices that support biodiversity such as integrated pest management and spot spraying pest outbreaks allows for beneficial insects to remain in the fields. Examples of ecology/ ecology for manufacturing might include the generation of compost from waste or the processing of water through their facility that is cleaner than the water was at the input (McDonough & Braungart, 2002). Both of these examples represent applications of improving the surrounding environment with beneficial services. However, none such examples came up in the interviews. Only one negative association was recorded at the apparel manufacturer for not having a current practice to deal with the textile waste generated, which was also creating an economic burden on them.
Table 4  All 9 sustainability themes across supply chain.

<table>
<thead>
<tr>
<th>Code</th>
<th>Coding guide</th>
<th>No. code</th>
<th>Neg. assoc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economy/economy</td>
<td>Is the business profitable/viable?</td>
<td>63</td>
<td>12 neg</td>
</tr>
<tr>
<td>Economy/ecology</td>
<td>Business decisions that impact ecology.</td>
<td>42</td>
<td>5 neg</td>
</tr>
<tr>
<td>Economy/equity</td>
<td>Business decisions that improve equity.</td>
<td>40</td>
<td>1 neg</td>
</tr>
<tr>
<td>Equity/economy</td>
<td>Financial decisions that are made for the benefit of workers or the community.</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Equity/equity</td>
<td>Does the business provide an environment where people are treating each other with respect?</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Ecology/economy</td>
<td>Practices that reduce environmental impact and make the business more competitive.</td>
<td>10</td>
<td>1 neg</td>
</tr>
<tr>
<td>Ecology/ecology</td>
<td>Practices which are either beneficial or benign to the environment.</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Ecology/equity</td>
<td>Practices that reduce environmental impact and are beneficial to workers and the community.</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Equity/ecology</td>
<td>Practices that benefit workers and the environment.</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

A secondary data analysis technique of inductive coding was applied to the supply chain interviews and found themes related to communication, collaboration, and transparency across the supply chain. These were deemed as evidence for why the participants were engaging in the pilot integrated supply chain project. The only evidence of current communication and collaboration of the participants interviewed was between the farmers and cotton gins. In recent years, all of the cotton gins in South Africa have been adopted by cotton farmers as co-operatively owned and operated. Previously, cotton gins operated as separate entities. Yet as the cotton industry contracted in South Africa, many gins ran into financial difficulties. Some were purchased by regional farmers, as was the case for both gins visited. The farmer-owned gins provide a hub of communication for the farmers and provide several services such as bulk purchasing of inputs, distribution services to farmers, as well as
ginning services. The gin which serviced commercial farmers was able to label each bale with a code corresponding to the farm from which the cotton lint came from. The manager of the gin servicing the commercial farm discussed the ability to label each bale was for the purpose of being able to trace the cotton back to the source and provide transparency. The other gin services only smallholder farms and in order to have enough lint for a 200 kg bale the gin needs to pool similar grades of cotton from multiple farms together. Labeling of bales and traceability were not discussed at the second gin visited.

The textile facility expressed an interest in restoring communication with local retailers and establishing a collaboration to design specific niche products for local retailers. The interviewee noted the textile facility had good relationships with local businesses both upstream and downstream during the Multi-Fibre agreement period. However, since then the industry has become increasingly fragmented, the company lost most of its local business. Reestablishing communication was deemed a big incentive for them to participate in the pilot supply chain.

The retailer specifically addressed communication, collaboration, and transparency as important factors for why they chose to participate in the pilot supply chain project. The retailer currently does not use much locally procured South Africa cotton but does source some from the SADC region. The managers from the retailer were strongly motivated by their experiences of tracing the supply chain back to the farm and sitting down with local farmers to engage with them. The interviewees felt passionately about wanting to pursue partnerships across the supply chain and to build capacity for sustainable practices throughout the industry. While at the same time the interviewees were very pragmatic about the need to maintain competitiveness in their
business strategy. The goals of participating in the pilot integrated supply chain are to develop transparency and collaboration across the supply chain for the development of more sustainable production processes of local cotton products.
Chapter 5
DISCUSSION AND CONCLUSIONS

The results of this study identifies the three pillars of sustainability (economy, equity, and ecology) are not found to be of equal proportion to each other but rather economy factors are the greatest influencer of the other two. Similarly, Wu and Pagell (2011) found most organizations do not emphasize the three pillars in equal proportion to each other but rather will conduct trade-offs among them in order to accomplish a specific goal for sustainable practices. The interviewees of this study discussed the managerial practices of the business and the impacts these practices have on workers, the community, the environment, and ultimately the ability of the business to be competitive. Management practices at the farm and firm level often have overlap and sometimes trade-offs among the three sustainability pillars. Applying the TTL model allowed for deeper understanding of the overlap between the three pillars of sustainability and revealed the economy dimension strongly influences the other two dimensions.

External economic factors such as loss of local demand, has had a negative impact on the lower section of the supply chain resulting in a decline in cotton production and facilities not operating at full production levels at the gins, spinning, and textile nodes. The apparel and retail nodes were less impacted but were importing the majority of their supply needs. The companies visited for this study had agreed to participate in a pilot integrated cotton apparel supply chain. The participants felt the revitalization of the clothing and textiles industries and expansion of cotton back to
previous levels would be good for the economy and for their respective businesses. While this study was able to identify areas of good practices using the TTL model, it also found areas to improve practices. Since the economy dimension does influence the other two, it is important to consider how the overlap of dimensions can be leveraged to improve the sustainability practices at each branch of the cotton supply chain in South Africa.

**Economy → Equity**

McDonough and Braungart (2002) discussed the importance of considering the social dimension of business actions as a consideration of fairness and respect. Being that South Africa is a young democracy and a post-apartheid society, considerations for fairness and respect at the firm level are reasonable. This study found evidence of fairness and respect at the sites visited were linked to efforts to breakdown racial and social barriers. All of the sites visited discussed efforts of training and mentorship to be key social programs at the business. Farmers were engaged in training and educating other local farmers about cotton cultivation techniques such as proper use of pesticide equipment and safety considerations. At the manufacturing sites social programs also included on-site social services, such as health clinics, as well as improvement in communication and relationship building between management and staff. The efforts to improve upon breaking down racial and social barriers were deemed highly important to the managers interviewed. Locke and Romis (2010) found human resource management style at an apparel manufacturing site that had improved engagement with employees and improved communication skills had a happier workforce and better productivity than a similar apparel manufacturing site. Across the entire supply chain, evidence of investment by the firm was consistent with the
desire to improve workplace standards and worker well-being, which the managers stated increased the business’ productivity.

At the cotton cultivation nodes for farms and gins, the ability to expand cotton production was considered to have an important and positive impact on the local community due to an increase in jobs and income in rural areas. Similarly, across the manufacturing sites visited the ability to maintain operations and opportunities to expand production were viewed as positive impacts on job creation and income for the local community. While job creation is an important contribution to the social dimension within South Africa, rapid job creation by the apparel industry is sometimes also associated with poor social responsibility at the facility level (Taplin, 2014).

**Economy→Ecology**

Decisions made to invest in infrastructure, equipment, and processes at the textile mill were efforts to remain competitive by lowering the cost of production. The business strategy to increase efficiency of energy and water use is in line with Hart’s (1995) natural resource based view (NRBV). The NRBV was developed to take into account the dependency of businesses on natural resources that are becoming more constrained as ecological systems become more stressed, due to environmental damage and rising global population. The three strategies for the NRBV include pollution prevention, product stewardship, and sustainable development associated with a firm’s growth of business. Examples of pollution prevention practices were found with energy efficiency measures to reduce emissions from manufacturing, treatment of effluent, and working with third party recycling companies for waste. Sustainable development at the firm level was observed with investment in equipment upgrades that reduced resource use by being more energy and water efficient.
Evidence of product stewardship was found to some degree at the textile facility that works with a third party for recycling of textile fabric waste and the company will take back some used products and reuse as second-hand products. Aspects that support the NRBV as a business strategy to create a competitive advantage were found with consideration of resource use and investment in capabilities such as equipment upgrades.

Porter and Kramer (2011) theorized investing in sustainable practices can add shared value to the business and address societal issues such as the availability of resources. An investment made to increase efficiency reduces the quantity of energy and water used to produce the same products. The business decision creates shared value by reducing cost per unit while also reducing the strain on natural resources. Porter and Kramer (2011) further the concept of shared value can be applied beyond the company level to include the supply chain and supportive industries. Similar to the NRBV, the concept of shared value is based upon efficient and considerate use of resources can foster economic value to the company. However, Porter and Kramer (2011) also note the importance of development of capabilities across the supply chain and supportive industries, such as technology and process innovation that reduces resource use. This study found evidence at the firm level for investment in energy efficiency measures reduces the cost per unit of manufactured product creates shared value. Also, the farmer co-operatives purchasing gins adds value for the farmer by reducing the cost of cotton production. Supportive recycling industry was available to the textile mill for recycling of textile waste. However, the apparel manufacturer was struggling to find an industry partner to take their textile waste.
All of the manufacturers visited, including the gins, noted a concern over being able to remain competitive over the long-term with the rapidly rising cost of energy in South Africa. The businesses were concerned about the ability to have the funds for investment in upgrades when they are also in need of buffering themselves from the rising costs of energy. While the businesses had invested in efficiency measures, they all noted future areas of improvement could be addressed. In this case, while economy factors had the greatest influence on the ecology dimension, it was a double-edged sword as to whether the financial flexibility would be available for investment in sustainable practices. Seuring and Muller (2008) found in a review of supply chain management literature one of the main barriers to integrating environmental and social performance cited by a firm, was the costs associated. While firms may need to conduct a trade-off of short term economic investment in improving sustainable practices (Wu & Pagell, 2010) this study found investment in improving workplace standards and reducing resource use improved productivity and reduced cost per unit, making the business more competitive. Similarly, at the farm level a financial investment in the more expensive Bt cotton seed was motivated by the economic benefit of greater productivity and higher yields of cotton. Yet the use of Bt cotton also significantly reduced the amount and frequency of insecticide use, which is beneficial to the well-being of both the environment and people. The farmers were very happy to use less insecticide and noted it was a big improvement over past practices.

This study found evidence of business strategy to integrate sustainable practices improves the competitiveness of the business. Both the natural resource based view theory (Hart, 1995) and the theory of shared value (Porter & Kramer,
2011) were supported by the current practices observed at the firm level. As efforts are underway to revitalize the apparel and textile industries in South Africa, applying business strategy that takes sustainable practices into account will likely create a competitive advantage to the industries as a whole.

**Recommendations to Improve Sustainable Practices within Supply Chain**

The purpose of this study was to identify current practices across a cotton supply chain in South Africa that support the theory of the triple top line and can be applied to strategies for developing a more sustainable apparel supply chain. Table 5 is a summary of practices which support sustainability for each of the three pillars and areas where practices could be improved. Based upon data collected, cross-referencing of the industry standards and understanding of the literature, several recommendations of improved practices are discussed for each branch of the supply chain. This discussion identifies a subset of themes for improved practices but does not address every single one recommended in Table 5.

Cotton Cultivation

Cotton farming practices were cross-referenced with the standards set by the Better Cotton Initiative (BCI) for smallholder farms. This study conducted site visits and interviews across the supply chain in January, 2014 about midway through the cotton growing season. Because of this direct observation of workers and working conditions were not available since it was not harvest season. Therefore, the researcher was not able to get a sense of whether or not seasonal workplace standards at the farm and gin levels support decent work standards, as laid out by BCI standards (Appendix C). The farmers mentioned chemical safety training and wearing protective clothing
when applying chemicals. However, based upon the recent findings by Naidoo et al. (2010) of female farm workers in South Africa having lack of education on chemical applications may signal a potential gap. In order to address these concerns it is recommended to 1) verify decent work conditions as described in BCI’s standards and 2) gain an understanding as to the level of knowledge and training among cotton farm workers for chemical applications. Both can be accomplished by conducting a survey of a subset of workers during the harvest season at multiple locations. If gaps are found, expansion of training and education among the cotton farming community can be addressed.

Farming practices of smallholder farms were in line with the standards set by BCI. Paying the fees associated with becoming BCI certified does not seem to add value to the farmer’s operation, particularly when financial flexibility is a difficulty for the farmer. Rieple and Singh (2010) found organic cotton fiber added financial value at each node of the supply chain compared to conventional cotton fiber because organic cotton products receive a premium price in the market. Studies have shown the supply for organic cotton products are not meeting the demand for large multinational retailers like H&M (Illge & Pruess, 2012). As apparel companies continue to adopt more organic cotton products into their product categories, the demand for organic cotton fiber is likely to continue to grow. Although the farmers are currently satisfied with the use of Bt cotton because it reduces the purchase and use of chemicals and increases yield, whether genetically modified cotton will continue to be economically and ecologically sustainable is unknown. Currently there is conflicting research on the long-term impact of Bt cotton. A study of Bt cotton in China over a 10 year period found significantly reduced insecticide use (Lu et al., 2012) while an
evaluation of chemical use with Bt cotton in the United States found an increase in chemical use over 16 years (Benbrook, 2012). Clearly, more long term research is needed to determine whether or not use of Bt cotton can be sustainable. It is recommended a longitudinal study on the impacts of Bt cotton has should begin. The study should set up long term data tracking and documentation of inputs, yield, and economic viability. Due to the increased economic value of organic cotton fiber and the inability to determine if use of Bt cotton is sustainable it is recommended an expansion of cotton farming should consider a region for organic fiber production. Illge and Pruess (2012) found H&M’s organic cotton supply was compromised by cross-contamination with GMO cotton. Organic standards do not allow for use of GMO cotton. Therefore, it would be best to consider the development of an organic fiber production region that can be buffered from the GMO cotton regions. A longitudinal study to compare an organic cotton fiber region with a Bt cotton fiber region would lend greater understanding to which practices support sustainable cotton production.

Chico et al. (2013) showed the water footprint for cotton products had the highest water usage during cultivation. However, the research was based upon irrigated cotton farming. In South Africa, both irrigated and non-irrigated cotton is being grown. Irrigated cotton at the commercial farm visited for this study had 3x higher yield per hectare than the rain fed smallholder farms. Also, the smallholder farmers noted the average rainfall in their respective regions was lower than in the past. While at the same time the commercial farmer noted the rising cost of water was a concern for him. South Africa’s water policies for irrigation and availability of freshwater for consumption are likely to be issues of contention as water stressed
environments in arid regions will continue to find constraint on resources (Chapaign et al., 2006). Sandin et al. (2013) found cotton cultivation in environments which are already water stressed to have a negative impact on both water and land use. In South Africa, the retraction of cotton cultivation is not linked to abandonment of agricultural lands but rather farmers (particularly smallholder farmers) chose to grow different crops that had more stable prices (Cotton SA, 2013). Expansion of cotton cultivation in South Africa, particularly in dryland farming areas, is not likely to have the same negative environmental impacts. However, efforts to continue to develop farming practices that are less dependent upon external water sources are likely to be more sustainable. It is recommended research on the water footprint of cotton cultivation in South Africa be conducted and a long term water use plan be developed.

At the cotton gins, as production of cotton expands the capabilities of the gins to process cotton fiber efficiently will be important to adding economic value. One of the gins had invested in keeping on hand spare parts because there are no local parts dealers in South Africa. Therefore, if the gin has parts in stock it greatly reduces the financial risk associated with the gin stopping during the harvest season to wait for parts. The second gin had only recently been reopened and the equipment was older, needing more frequent repair. Investing in equipment upgrades and maintaining a parts inventory is recommended. Verification of work standards during the ginning season based upon BCI standards is recommended. As well as developing an energy use reduction plan for the facility with measurable goals and evaluation as outlined by the Higg Index 1.0 assessment tool.
Textile Production

Both the spinning and textile firms were not at full production and noted increasing production would improve their businesses competitiveness. Both operations noted a lack of local demand was limiting their ability to increase production. The apparel manufacturer noted the reason they import their cotton blend fabrics is due to quality and price comparison. The apparel manufacturer noted if a local supplier could provide the quantity, quality, and price the company would buy local. Therefore, it is recommended the spinning and textile operations collaborate with the apparel manufacturers on research and development of fabrics that can meet local demand.

This research cross-referenced the spinning and textile operations with the Higg Index 1.0 assessment tool and the Global Organic Textile Standard (GOTS). If organic cotton fiber production were to be expanded in South Africa, based upon the findings of Rieple and Singh (2010), value would be added to both operations. It would be recommended the operation managers cross-reference with the GOTS to ensure integrity issues are met for processing of organic products. Particularly in reference to differences in chemicals and processes that may diverge from their current practices. Since both operations require high energy use it is recommended these businesses reference the Higg Index 1.0 and adopt an energy reduction plan.

The textile mill was the largest user of water at the firm level across the supply chain due to the nature of the production process. The facility had actively engaged in various ways to address water use. The textile mill manager noted if funds were available he believed he could make the mill a zero-discharge for water by investing in closed-loop production processes. Alkaya and Demirer (2013) applied changes to several aspects of the production process at a textile mill in Turkey, including
renovations of equipment and reuse of water in the wet processing. They found the investment in upgrades to the process not only significantly reduced resource use, but also saved the mill inputs costs. The Higg Index 1.0 assessment of water use can be a useful tool in analyzing and developing a water use reduction plan. The textile facility currently has many practices that promote reusing water when possible, a practice that is also promoted in the Higg Index 1.0. It is recommended investing in closed-loop production processes would add shared value to the company and reduce resource use.

Apparel Manufacturer

As noted earlier the apparel manufacturer imports their fabric needs but would purchase from a local supplier if it met the same criteria. Purchasing locally produced fabric would negate the transportation and fees from importing and contribute to reducing the cost of inputs. Before this practice could be implemented it is again recommended the apparel manufacturer work with local textile producers to develop a fabric that can meet the criteria. De Brito et al. (2008) found innovation in fashion supply chains required the development of partnerships across the supply chain but also to include external organizations with unique expertise. In this case, expertise from a third party may be beneficial to understanding the root causes for the differences between textiles produced locally and those being imported.

The apparel manufacturer’s main environmental impact areas were energy use and textile waste from cutting being sent to the landfill. An improved practice for energy use is to develop and implement an energy reduction plan as outline in the Higg Index 1.0 assessment tool. Kozlowski et al. (2012) suggested apparel designers should consider the life cycle of an apparel product and consider choices such as fiber choice has on the environment. Similarly, the textile waste created from the cutting
room has the same environmental impact in that fabric blends of natural and synthetic fibers are difficult to deal with. The apparel manufacturer uses poly/cotton blend fabrics because the quality and price meet the needs of the consumer. Unfortunately, the fibers cannot be separated and the textile waste and the products themselves cannot be recycled or biodegrade. The Higg Index 1.0 assessment includes a section on end of life impacts of products and evaluates the environmental performance of products based upon a life cycle approach. It is recommended the apparel manufacturer take a life cycle analysis approach for their products and practice principles of design for end of life consideration.

Retailer

The retailer was engaged in purchasing regionally produced cotton products for some product categories and expressed an interest in expanding their sourcing strategy to include more locally grown cotton. Highly flexible sourcing strategies can give retailers a competitive advantage (Fukunishi et al., 2012) but can also increase their exposure to risk if the practices within the supply chain are not environmentally or socially responsible. Gereffi and Frederick (2010) found leading apparel firms were adjusting their sourcing strategies by reducing the size of their supply chain and to be more engaged with their suppliers. While Kogg and Mont (2012) found smaller apparel firms were more successful at managing sustainable practices within their supply chains. These studies suggest greater cooperation across the supply chain to support sustainability may have greater success with a smaller supply chain. Therefore, it is recommended the retailer practice a sourcing strategy using the local cotton supply chain and to engage with the nodes to improve flexibility of the supply chain. By increasing collaboration with supply chain partners the ability to share
knowledge and promote the development of innovation in the supply chain would be beneficial to both parties.

Illge and Pruess (2012) evaluated the ability of multinational retailer H&M to manage their organic cotton supply chain and found lack of supply to be a limiting factor. Adoption of organic cotton products by a ‘fast fashion’ retail chain and discount retailer WalMart (Sathe & Crooke, 2010) suggests the ability for organic cotton products to reach a wide audience that is cost-conscious should be considered a potential new area for all retailers. Organic cotton may soon ascend out of the niche market and be more widely supported by consumers. Rieple and Singh (2010) found the largest added value across the organic cotton supply chain was at the retail stage. Therefore, it is recommended the retailer include purchasing of organic cotton products.
<table>
<thead>
<tr>
<th>Node</th>
<th>Economy</th>
<th>Equity</th>
<th>Ecology</th>
</tr>
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</table>
| Farms  | **Good practices:** cooperative purchasing of inputs such as seed and chemicals with other farmers, contracting out tractor services to local farmers  

*Improved practices:* conversion to organic farming inputs will add value to the fiber sold | **Good practices:** harvesting by handpicking creates jobs, training and protective clothing provided to reduce chemical exposure to workers, organizations representing smallholder farmers interests  

*Improved practices:* verification of work conditions for decent work standards during harvest season | **Good practices:** use of Bt cotton reduces pesticide use, integrated pest management, soil analysis prior to fertilization treatment, crop rotation, rain-fed cultivation or minimum irrigation use  

*Improved practices:* chemical substitutions and/or organic farming practices that negate chemical use, promote biodiversity, protection against soil runoff |
| Gins   | **Good practices:** provide services to farmers, bulk purchasing of inputs, selling waste generated  

*Improved practices:* invest in upgraded equipment to improve efficiency | **Good practices:** training and information sharing with farmers, provides seasonal work, provides protective clothing to workers  

*Improved practices:* verification of work conditions for decent work standards during harvest season | **Good practices:** sorting and selling of waste, all material inputs are biodegradable  

*Improved practices:* measure and track energy use, develop an energy reduction plan, set target reduction goals, use of renewable energy sources |
| Yarn Spinning | **Good practices:** source majority of cotton from Southern Africa, products are sold locally  

*Improved practices:* increase production to run facility full time and reduce cost per widget | **Good practices:** skills training, health and safety services on-site  

*Improved practices:* increase shifts to provide more income opportunity to workers | **Good practices:** material inputs are biodegradable, measuring energy use, plan to reduce energy use with target goals  

*Improved practices:* use of renewable energy sources |
| Textile | **Good practices:** niche product categories and highly flexible | **Good practices:** skills training, education services, health and safety services, | **Good practices:** Recycling efforts, reuse of water when possible, chemicals |
production, investment in efficient production reduces overhead costs

**Improved practices:** develop more products to meet local demand, include organic cotton into product mix

| Apparel       | Good practices: efficient production lines, consistency in quality of product, investment in upgrades to improve efficiency of operations  
**Improved practices:** purchasing of inputs from local suppliers such as cotton fabric blends | Good practices: skills training, health and safety services, on-site social services, communication training, upgrading worker facilities  
**Improved practices:** increase shifts to provide more income opportunity to workers and create jobs | Good practices: upgrades in energy efficiency, recycling efforts  
**Improved practices:** measure and track energy use, develop an energy reduction plan, set target reduction goals, use of renewable energy, design products with end of life in mind, identify a use for textile waste

| Retail        | Good practices: purchasing of Southern Africa cotton for some product categories  
**Improved practices:** sourcing strategy to use local supply chain | Good practices: skills training, promote regional pride of locally grown cotton  
**Improved practices:** collaboration with supply chain partners | Good practices: purchase preference for dryland cotton  
**Improved practices:** purchase preference for SA organic cotton

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**Applying Cradle to Cradle Theory to Business Practices**

This research used McDonough and Braungart’s triple top line model to identify current practices at each node of the supply chain from farm to retail that applied to the 9 principles of sustainability within the tool. While the research was able to identify good sustainability practices and areas to improve sustainability practices it does not qualify the performance of these practices. It merely points to the
current status of practices which impact environmental and social performance based upon the interviewee’s engagement in operations that influence sustainability. The triple top line model was developed as a design tool to take into consideration the activities of a business and how they can be used to enhance environmental, social, and economic viability.

This study found economic factors to be the driving theme for sustainable practices that impact equity and ecology in the cotton supply chain in South Africa. Being that each node across the supply chain are independent businesses, it is reasonable to expect decisions that impact the competitiveness of the business to be more prevalent than the other two sustainability themes. Sustainability practices were most often linked to efficiency of resource use which has been shown to be a good business strategy for improving the competitiveness of the business. Although these are good practices, it is not the same principle as enhancing the environmental performance through business activities. For example, McDonough and Braungaurt (2002) worked with a textile mill to develop processes and products that were not only environmentally benign, but actually beneficial. The water that left the textile mill was cleaner than the water that came into the mill and the products which the mill produced were fully biodegradable and could be used for compost. In this case, the textile mill had utilized new innovative processes that enhanced the environmental performance, not merely reduced the environmental impact. In this manner, if South Africa’s apparel and textile sector are seeking new strategies to engage in sustainable practices one question manufacturers should consider is ‘how can the facility support the local ecology?’ and ‘does the operations of this facility enhance the social well-being of the larger community?’
The cradle-to-cradle design theory suggests firms incorporate waste equals food, use current solar income, and celebrate diversity into their business practices in order to be sustainable (McDonough & Braungart, 2002; McDonough et al., 2003). Across the cotton supply chain in South Africa there were examples of practices that already implemented these tenets and others where applying the tenets could be beneficial. An example found in the cotton supply chain of waste equals food was the selling of the cotton seed waste as cattle feed. The authors suggest careful consideration of how materials can be disposed of as either a biological nutrient, as in the cotton seed being used to feed cattle, or as a technical nutrient such as the textile facility separates and recycles their synthetic fiber waste. The solid waste generated at the apparel manufacturing facility inhibited the waste equals food component of the business. Particularly since the textile waste generated was a poly/cotton fiber blend representing a hybrid that is no longer biodegradable or recyclable. In this case, choice of materials at the firm level impact the ability to deal with solid waste generated. Collaboration with industry partnerships to deal with waste generation can be important to a firm’s sustainability practices. The lack of local industry partnership was creating a solid waste problem for the apparel manufacturer. Research and development of textile recycling capabilities should be employed to foster innovation in practices that can lead to resolution of how to dispose of fiber blend fabrics in a sustainable manner.

While efficiency for reducing energy use was a common theme across the supply chain, all of the firms were dependent upon coal-based electricity. Both the textile facility and the apparel manufacturer had researched the ability to use solar energy but both found the technology was not sufficient to suit the energy needs of the
business. The investment in renewable energy sources and the advancements in technology are likely to be important factors for firms in the future as external factors associated with rising cost of energy are likely to continue in South Africa. Research and development into renewable energy sources and advancement of technology to meet the criteria of manufacturers would be an important area of consideration for sustainable development of the apparel and textile industries in South Africa.

In this study, an example of celebrating diversity was found with cotton cultivation practices that supported growing a crop suited to an arid environment. Dryland farming practices observed supported natural cycles being rain fed, using minimal chemical treatments and practices that support soil health such as crop rotation or omitting use of fertilizers. Also, considerations at the manufacturing level included a desire to expand use of locally produced materials such as locally sourced cotton. Another example was collaboration with local industry partners to recycle multiple waste streams at the textile facility. Celebrating diversity in the cradle-to-cradle design theory relates to the importance of incorporating a local dimension to sustainability (McDonough & Braungart, 2002; McDonough et al., 2003). That by considering the impacts of a business on the local environment and community leads the firm to want to be sustainable. Mostly because the use of local materials and replenishment of those materials must be in balance in order to have a long-term sustainable business. Similarly, having a long-term sustainable business requires sustaining the well-being of workers and the community. The willingness to participate in a local integrated cotton supply chain within South Africa supports this philosophy.
Recommendations of Sustainable Supply Chain Development

All in all, the sites visited across a small cotton apparel supply chain in SA represented fairly good sustainability practices for support of equity and ecology. Although there were areas for improvement identified, management practices at the firm level were considerate of social and environmental dimensions. Considering sustainable practices at the firm level is important but also is considering how to integrate sustainability across the supply chain. This study interviewed participant prior to engaging in a pilot integrated supply chain. As an emerging theme in this study the willingness to participate in an integrated supply chain were related to opportunities to revitalize the local industry and improve local demand would have a positive impact on the job creation in SA. However, some participants did note several challenges to integration were linked to lack of skills, technology, and ability to be competitive with price. The research identified three core components that could be applied to a strategy for designing a more sustainable apparel supply chain: 1) identify economic challenges and opportunities, 2) create communication and collaboration across the supply chain, and 3) support of continuous improvements of sustainable practices.

Identifying Economic Challenges & Opportunities

Being in South Africa created a unique set of economic challenges identified by the supply chain participants. First, the global positioning of South Africa makes transportation costs for importing and exporting higher in comparison to other countries. Secondly, the economy of South Africa has had unstable inflation rates that impact the cost of purchasing various inputs. Lastly, since the phase-out of the Multi-Fibre agreements in the mid-1990s the local clothing and textile industry did not
remain competitive on the global market, creating a fragmented supply chain that no longer functions as a localized industry. Because of this, the nodes in the supply chain no longer communicate across the supply chain but rather work independently as importers/exporters in the larger industry. This has greatly reduced local demand for cotton and cotton products, leading to economic instability at the beginning of the supply chain (farmers, gins, and spinners) that are more dependent upon local demand. While the first two economic challenges facing the supply chain are out of the direct control of the businesses, the ability to bolster the local demand can be developed for the purpose of creating economic opportunity. Each node from farm through manufacturing noted an economic opportunity by expanding their business operations would create additional jobs in their community.

Addressing financial constraints and providing financial incentives is the best strategy for improving sustainable practices within and across the cotton apparel supply chain in South Africa. Increasing local demand of local cotton products is a main goal for the development of the national cluster for revitalizing the apparel and textile industry. Creating an integrated cotton supply chain, with agreements to purchase cotton products between local businesses, allows for a fixed price on cotton which will allow for the lower end of the supply chain (farmers, gins, and spinners) to develop better financial planning. Increasing local demand over time for South African cotton products would increase production across the supply chain visited. Financial support for investment in upgrades either through access to financing or external funding sources would provide financial flexibility for upgrades in equipment and/or processes that support sustainable practices. Furthermore, financial incentives to promote research and development of innovation of sustainable technology and
processes for each node would further improve upon the sustainability of the supply chain as a whole.

Communication & Collaboration across the Supply Chain

Due to the fragmentation of the local apparel and textile industry, there has been little communication between the nodes visited for this study. Direct communication was only seen between farmers and farmer-owned gins. The retailer ‘broke the rules’ by following the cotton supply chain all the way to the farms. Yet this experience transformed their view of the local industry and created an emotional connection to the local supply chain. The retailer felt it was their role to support efforts to revitalize the local apparel and textile industry. They have committed themselves to be the end point of a pilot study to create an integrated cotton supply chain within South Africa. In this case, the ability to communicate across the supply chain is an important step for a strategy to develop a sustainable supply chain. Furthermore, the ability to identify potential supply chain partners can only arise out of knowing who the actors are. Seuring and Muller (2008) found the main reasons firms cited barriers in integrating sustainability into their supply chain management practices were due to cost, complexity, and difficulty in communication across the supply chain. Many apparel firms have large supply chains that can be spread out across the globe, adding to the complexity. However, difficulty in communication may also stem from cultural and language differences between parties. Gereffi and Frederick (2010) found apparel firms were adjusting their sourcing strategies to reduce the size of the supply chains which would also reduce the complexity and may also improve the ability to communicate. One of the benefits of the retailer working with the pilot integrated supply chain in South Africa is the ability to communicate directly with supply chain
partners in the same language and culture. Kogg and Mont (2012) discovered smaller apparel firms in Sweden had greater success at implementing sustainable supply chain management practices than larger firms. By reducing the complexity of the supply chain and working within a single region, the ability to communicate across the supply chain could be beneficial to sustainable supply chain development.

Several studies have suggested an increase in communication and collaboration between buyers and suppliers, rather than relying on monitoring/assessment alone, would be beneficial to addressing socially responsible behaviors in apparel factories (Frenkel & Scott, 2002; Lim & Phillips, 2008; Locke & Romis, 2010). Park and Dickson (2008) found communication between buyers/sellers about labor issues to be a common behavior, but fewer partnerships were effective at developing long-term relationships with successful conflict resolution. The authors suggest although apparel firms were frequently communicating with supply chain partners about labor issues the ability to resolve these issues requires greater collaboration between the two parties.

In South Africa, ownership of cotton gins has become farmer owned cooperatives that operate for the benefit of the cotton production region. The gins have become a central hub for communication and collaboration among the farmers which also adds significant economic value to the farmer’s cotton crop. The gin is capable of purchasing larger quantities of inputs for the farmers, thus reducing the input costs per farm. In this case, we found collaboration to have a positive impact on the competitiveness for cotton farming. Gimenez, Sierra, and Rodon (2012) found supply chain collaboration had a positive effect on the triple bottom line for assembly manufacturers surveyed from 19 countries. Development of collaborative projects
have also been shown to have a positive influence on manufacturing performance, that in turn positively impact sustainability factors (Carter & Rogers, 2008; Klassen & Vachon, 2008). The South African retailer identified collaboration across the supply chain could lead to several benefits such as reduced waste, improvements in product quality, and shortening of lead times; each contributing to the competitiveness of the retail business. Similarly, the textile mill identified collaboration with retailers could allow the company to develop products catered specifically to the retailer. This type of collaboration could allow both parties to identify goals for products to be developed in a sustainable manner. Rather than developing products and seeing if they are successful in the marketplace. Collaboration could greatly reduce redundancy in production that can lead to over-production, increased costs and unnecessary waste generation. Engaging organizations in a proactive strategy of collaboration can lead to capacity building and innovation of sustainable practices (Klewitz & Hansen, 2014).

Support for Continuous Improvement

The ability to develop sustainable apparel and textile supply chains will require new strategies that actively improve environmental and social performance at the firm level, as well as across the supply chain. Since sustainability is difficult to define due to the complexity of issues and the challenges which are unique to the nodes within the supply chain, gaining a broader perspective and actively seeking new strategies will be important for apparel supply chains (de Brito et al., 2008). Furthermore, stakeholders have the expectation that apparel supply chains should be actively pursuing measurable improvements in sustainability across the supply chain by collaborating with supply chain partners, building capacity, and striving for continuous improvement in sustainable performance (Dickson, Waters, & Lopez-
Dydosh, 2012). Wu, Ding, and Chen (2012) found Taiwan’s leading apparel and textile firms were aggressive in their approach toward environmentally sustainable technology and found both internal and external resources (such as collaboration with supply chain partners) were driving innovation through improvement in capabilities.

There are no guidelines or set of standards to identify sustainable cotton apparel supply chains, much less a definition for sustainable cotton. This is likely due to the difficulty of quantifying how much of a resource can be utilized before it is considered renewed and for how long. For example, how much water, soil, seed, and chemicals can be used to sustain cotton production on a piece of land over generations, is not yet understood. This study applied the theory of the triple top line to identify practices that support the sustainability themes of economy, equity and ecology. While the results showed economy factors were the drivers for equity and ecology, the later was found to represent the smallest segment overall. South Africa does have adequate environmental legislation and regulation (www.environment.gov.za/legislation/actsregulations), as well as nationally funded initiatives that promote cleaner production in the country (ncpc.csir.co.za). However, the textile mill noted a potential sustainability gap in the capabilities of local municipalities to test and clean effluent and the apparel manufacturer was struggling to find someone to partner with to recycle or reuse the textile waste. Currently there is no technology available to recycle fabric using blends of fibers, such as polyester/cotton, because the fibers cannot be separated from each other. Alone synthetic fibers can be recycled and natural fibers can biodegrade but without the ability to separate them neither process can be used, creating a solid waste problem. Each of these nodes had self-identified sustainability gaps and had either made
improvements or were seeking solutions to improve upon the gaps. Similarly, the cotton farmers had identified use of Bt cotton was an improvement because it greatly reduced pesticide use. While the current farming practices for cotton farming are still using chemical inputs, which may not be sustainable, the current practices are greatly improved over past practices for pesticide use. The ability to define sustainability may not necessarily be clearly identified with specific parameters, but it does appear to be a process rather than an end product. In this manner, it stands to reason the path towards environmental improvements across the cotton supply chain in South Africa should consider a process of continuous improvement.

This study found a strong desire by participants to develop an integrated cotton supply chain within South Africa. Development of a local cotton supply chain was deemed important because it would create economic opportunity across the supply chain. In particular, job creation was considered the greatest benefit across the supply chain. The participants also identified benefits that were unique to their node, as seen in Figure 3. As discussed earlier, the economy dimension has a positive influencing effect on adoption of sustainable practices for social and environmental practices at the farm and firm level. However, a lack of financial stability due to a loss of local demand and fragmentation of the supply chain can also be a limiting factor. Research findings support adding economic value across the supply chain through improvements in local demand will further support sustainable practices within each node. It is important to consider economic incentives to promote continuous improvement in sustainable practices across the supply chain. Progress in supply chain communication and collaboration are likely to support a process of continuous improvement in the environmental impacts of the supply chain as a whole. Yet it is
also important to promote sustainable practices, rather than relying on the assumption businesses that have greater financial fluidity will automatically invest in sustainable practices. Instead, financial supports in the form of programs that incentivize businesses to adopt improved practices and promote continuous improvements are more likely to succeed.
Conclusions

The first objective of this research was to identify if the pilot cotton supply chain in South Africa was sustainable. While the participants were clearly eager and had strong feelings towards wanting to see a revitalization of cotton production and the apparel and textile industries in South Africa, no clear definition or expectation of what qualifies a sustainable cotton supply chain emerged. The cradle-to-cradle design theory and the triple top line model allowed identification of practices at the farm and firm level that support the pillars of sustainability. Yet working independently on
sustainability at the firm level may not be enough to create a sustainable supply chain. This study found whether or not the current supply chain was sustainable, was inconclusive. There is not enough evidence of the long-term effects of farming practices for cotton cultivation used in South Africa, for either smallholder or commercial farms. Evidence of sustainable practices to reduce use of resources was found, but there was not sufficient data to tell if the resources were being replenished at comparable rates of use. Furthermore, although industry standards and assessments were used to identify beneficial environmental management practices these do not qualify whether engagement in these practices alone create a sustainable supply chain. The ability to sustain a business, a supply chain, and an industry are likely to require frequent evaluation of resource use, pollution prevention practices, waste generation and disposal practices, and social well-being.

The second objective of the research was to identify current practices in the supply chain that apply to the triple top line theory. The TTL model takes into account the overlap of the three pillars to lend a greater understanding across the entire supply chain how the themes of sustainability influence each other. The triple top line model identified across the supply chain economic factors were the drivers for adoption of sustainable practices suggesting leveraging economic support within the supply chain will ultimately influence the sustainability of the supply chain as a whole.

The third objective of this study was to identify areas of good sustainable practices or areas to improve practices as seen in Table 5. Applying the TTL model was beneficial to identifying the current management practices at the farm and firm level across the cotton supply chain. This study found farms and firms were engaged
in good sustainable practices that supported environmental and social performance while contributing to the competitiveness of the business.

The final objective of this research was to make recommendations to improve sustainable practices at each node of the supply chain and to make recommendations based upon the theoretical concepts of sustainability for the entire supply chain. The ecology dimension was found to be the weakest pillar of the sustainability themes. The study was able to make practical environmental management recommendations based upon the GOTS and Higg Index 1.0 assessment tools. The study found the farming practices already adhered to the BCI standard, therefore the next step towards enhancing more sustainable practices would be to adopt organic farming practices. Areas to improve practices can be leveraged through the value added from the practices towards business performance. Lastly, the research also identified three strategies to be applied to addressing development of an integrated supply chain that wants to be more sustainable. First, identifying economic challenges and addressing them can create opportunities for investment in sustainable practices. Second, improving communication and collaboration across the supply chain can add value to sustainable practices. Third, supporting a process of continuous improvement of sustainable practices across the supply chain will fuel innovation.

This study contributes to the greater body of knowledge as to the perspectives at each node of a cotton apparel supply chain on environmental and social performance and how these actors view the current status of the supply chain within South Africa. The study enhances the understanding as to why the participants at each node in the supply chain are willing to participate in the pilot project to create a local integrated cotton supply chain.
Research Limitations and Future Research

This research found evidence of good sustainable practices and areas to improve upon practices at each node of the supply chain, making the ability declare whether the supply chain was sustainable or not inconclusive. The concept of sustainability refers to the long-term viability of business operations and their subsequent effects on the environmental and social well-being. This research was conducted on a cotton supply chain at one point in time and evaluated the current practices at that time. It did not compare past practices with current practices, except that adoption of Bt cotton has reduced chemical use at the farms. This research was conducted on a small subset of farms and firms within South Africa and does not represent the general practices of the apparel and textile industries.

The interviewees at each of the sites visited were participants in a recently developed initiative that would create an integrated cotton textiles and apparel supply chain within South Africa. Further research on the impacts of farming practices, such as use of Bt cotton seed, and identification of which practices may be sustained over long-term is needed. Research to identify a baseline of indicators for sustainable practices that directly apply to each node and could be benchmarked on an annual basis would allow for a long-term study on sustainable supply chain development. Development of a sustainable supply chain to improve local demand could be a new model for supply chain management and development strategies for not only the apparel industry, but other industries as well.
REFERENCES


International Cotton Advisory Committee (2010). An Interpretative Summary of the Study on: Pesticide use in cotton in Australia, Brazil, India, Turkey and the USA. Washington, D.C.


Appendix A

IRB REVIEW AND CONSENT FORM

University of Delaware

Consent Script-Managers

**Title of Project**: Identifying environmentally sustainable and socially responsible business practices across a cotton apparel supply chain in South Africa.

**Principal Investigator(s)**: Leslie Siron and Crescent Scudder (graduate students)

**Other Investigators**: Drs. Marsha Dickson and Huantian Cao (advisors)

You are being asked to participate in a research study. This form tells you about the study including its purpose, what you will do if you decide to participate, and any risks and benefits of being in the study. Please read the information below and ask the research team questions about anything we have not made clear before you decide whether to participate. Your participation is voluntary and you can decide not to be interviewed or stop the interview at any time without getting into trouble. You can choose to skip any question you feel uncomfortable answering... After we read you this form and if you agree to answer questions, you will need to verbally say yes; meaning that you are aware of why we are asking you questions as a part of our study and you are voluntarily taking part in this study.
WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of this study is to understand the current status of workers and environmental management practices in the cotton apparel supply chain in South Africa. In other words, we are interested in seeing how the cotton industry and its business practices affect people and the environment in South Africa. This study will help us researchers to understand what the working conditions and environmental impacts are in the supply chain from farm to retail. It will also allow us to help make suggestions on how the supply chain can become more environmental and socially sustainable in the future. This research is for Leslie Siron’s and Crescent Scudder’s masters theses.

You are being asked to take part in this study because your company is part of a supply chain that is being developed that focuses on improving social conditions of workers, economic competitiveness of companies, and reducing negative impacts on the environment. It is important to us to understand the manager’s perspective on the current impacts your company has on workers, business, and the environment. This can provide a measure from which future success of the apparel supply chain can be determined. In total we will interview around 11 managers that work for companies throughout the supply chain. In addition we will interview about 22-33 workers.

WHAT WILL YOU BE ASKED TO DO?

We will ask you several questions about the jobs workers have at your company, environmental practices, and the economic success of your company. We would appreciate your honest answers to these questions. The more honest the answer the better we can understand and provide input. There are no right or wrong answers. Your answers will be kept private and nobody will know your answers except for our
research team. The interview should not be longer than an hour. We will tape record our conversation, if that’s ok with you, to make sure we don’t miss anything that you say.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

All questions are basic questions that are not meant to make you feel uncomfortable, but to get a better understanding of the current situation of your company regarding the jobs provided to workers, the environmental concerns and practices, and the company’s economic success. There should be no risks involved with answering these questions. Your name nor your company’s name will be recorded or used. Nobody will be able to know who said what.

WHAT ARE THE POTENTIAL BENEFITS?

There are no direct benefits to you as a result of participating. We are working to help make the cotton and apparel industry in South Africa more competitive. By helping us we can learn about the real situation in the supply chain and what might be done to improve jobs offered to workers, reduce negative impacts on the environment, and improve your company’s business success. Because your company/farm is part of a pilot supply chain being put together by the retailer Mr. Price and Organimark, there could possibly be improvements in your company.

HOW WILL CONFIDENTIALITY BE MAINTAINED?

No individual or company names will be recorded in this research. We will use a audio recorder for these interviews to make sure that we do not miss anything that you say. We will type what we talked about word-for-word and save that with a password on the computer. Nobody will have access to the computer document except for us and our research advisors/teachers. All recordings and copies will be locked up
in a file cabinet and nobody will have access to them except for us. There are rules from our school that we have to keep this interview information for three years. After that it will be destroyed and erased.

Generalizations will be made across many workers and companies therefore no information will be published that highlights a single individual or company by name. If quotes are used in a paper, we will not include your name only job position and type of facility.

This research may be used in the future to see if there have been improvements in the jobs offered, environmental impacts, and economic success for the companies involved in this pilot supply chain.

Your research records may be viewed by the University of Delaware Institutional Review Board, but the confidentiality of your records will be protected to the extent permitted by law.

WILL THERE BE ANY COSTS RELATED TO THE RESEARCH?

There will be no costs for the participants of this study.

WILL THERE BE ANY COMPENSATION FOR PARTICIPATION?

There will be no compensation for the participants.

DO YOU HAVE TO TAKE PART IN THIS STUDY?

Taking part in this research study is entirely voluntary. You do not have to participate in this research. If you choose to take part, you have the right to stop at any time or you can choose to not answer a question and skip to the next. If you decide not to participate or if you decide to stop taking part in the research at a later date, there will be no penalty. Your refusal will not influence current or future relationships with the University of Delaware, OrganiMark, or the Sustainable Cotton Cluster.
WHO SHOULD YOU CALL IF YOU HAVE QUESTIONS OR CONCERNS?

If you have any questions about this study, please contact one of the Principal Investigator, Leslie Siron at lsiron@udel.edu, (+1 720 341 2385) or Crescent Scudder at crescent@udel.edu, (+1 928 699 5116).

If you have any questions or concerns about your rights as a research participant, you may contact the University of Delaware Institutional Review Board at 302-831-2137.

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will put a copy of this correspondence on file in our office. Please remember to notify us if you make any substantial changes to the project.

If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.
Appendix B

INTERVIEW SCHEDULES

Interview Schedule-Farmers

Site: Interviewee: Date: Audio file:

How long have you been farming here?
   a. Always cotton?

Where do you get your cotton seed?
   a. Why do you buy cotton seed?

How do you protect your crop from pests?
   a. What insects help your crop?
   b. What insects are bad for your crop?
   c. When do you use pesticides?
   d. How often and how much are they applied?
   e. Do you have to wear special clothing? Please explain why you wear or do not wear.

How do you protect your crop from weeds?
   a. What herbicides do you use?
   b. When do you use them?
   c. How often and how much are they applied?
   d. Do you have to wear special clothing? Please explain why you wear or do not wear.

How do you harvest the cotton?
   a. If by machines, do you need to use defoliants?
   b. If by human, when do you collect the cotton?
   c. How many employees do you need to harvest?

How do you store your chemicals?

How did you learn how to use the chemicals?
How do you water your cotton crop?
   a. Where does the water come from?
   b. Do you have to pay for the water? If yes, approximately how much do you pay every month (or year?)
   c. Do you monitor how much water is used?
How do you maintain soil moisture?

What do you do if there is a drought?

What else do you grow?

How do you keep the soil fertile?
   a. Do you get flooding here?
   b. Does it hurt your crop? Please explain or comment.
Do you use any machines for farming? What do you use?

About how big is your yield?
   a. How has it changed over the last five years?

About how much is your profit?

Can you tell me about selling your cotton?
   a. Who buys it?
   b. How much do you get for it?
   c. Do you get the same price each year?

Can you tell me what most of your expenses for growing cotton are?
   a. Are costs going up?

What changes would you like to see for your farm?
   a. Where do you see your cotton farm in the future?
   b. Do you want to grow more cotton? Why?

Interview Schedule-Cotton Gin

Site: Interviewee: Date: Audio file:

How long has the ginnery been here?

Where does the majority of your cotton come from?
How do you process lint?

a. Do you add any chemicals? If yes, what chemicals do you add or use?
b. Tell me about what employees are required to wear when working?

What machinery do you use?

a. Are the machines older or new?
b. Are the machines as reliable as they use to be?
c. Is there any machinery you would like to have if available?

What might be some environmental impacts the ginnery might cause?

a. How do you manage environmental impacts the ginnery might cause?

What are your main costs for your ginning operation? Energy, water use, employees, etc.

a. Where do you get your energy?
b. Approximately how much did you pay for energy in 2013?
c. Have costs been rising?
d. What are the biggest changes in cost recently?

How has business been lately?

a. Tell me about changes in business over the last five years?
b. How does the price of cotton affect your business?
c. Who buys your cotton?

What can cause production to increase or decrease?

a. How has production changed over the last five years?

How much cotton can you process at full capacity?

How many employees do you need when running at full capacity?

a. How many do you have now?

How do you train employees how to use the machinery?

a. Is safety training included?
b. Tell me about what is covered in safety training?
c. What is provided to employees by the company for safety? i.e. masks, gloves, etc.

What would you like to change for the ginnery in the future?
Interview Schedule-Spinners

Site: Interviewee: Date: Audio file:

How long has the spinning facility been here?

Where does the majority of the cotton you spin come from?
  a. Does the cotton get blended together?

Where does the majority of your yarn go to?
  a. Do you sell all of your yarn to South African textile mills?

How do you process cotton into yarn?
  a. Do you add any chemicals? If yes, what chemicals do you add or use?
  b. Tell me about what employees are required to wear when working?

What machinery do you use?
  a. Are the machines older or new?
  b. Are the machines as reliable as they use to be?
  c. Is there any machinery you would like to have if available?

What might be some environmental impacts the spinning facility might cause?
  a. How do you manage environmental impacts the spinning facility might cause?

What are your main costs for your spinning operation? Energy, water use, employees, etc.
  a. Where do you get your energy?
  b. Approximately how much did you pay for energy in 2013?
  c. Have costs been rising?
  d. What are the biggest changes in cost recently?

How has business been lately?
  a. Are you producing as much as you use to?
  b. Would you like to process and sell more cotton?
  c. Who buys your cotton?
d. Tell me about the price for cotton over the last five years? Does it affect your business?
What can cause production to increase or decrease?
  a. How has production changed over the last five years?
How much cotton can you process at full capacity?
How many employees do you need when running at full capacity?
  a. How many do you have now?
How do you train employees how to use the machinery?
  a. Is safety training included?
  b. Tell me about what is covered in safety training?
  c. What is provided to employees by the company for safety? i.e. masks, gloves, etc.
What would you like to change for the spinning facility in the future

Interview Schedule-Textile Production (Knitting/Weaving/Dying/Finishing)

Site: Interviewee: Date: Audio file:

How long has this facility been operating?

What type of textiles do you offer?

How much cotton do you use compared to other fibers?

How do you process cotton yarn before dyeing?
  a. Tell me about chemical additives you use; such as use of sizing agents, bleaches, ammonia or mercerization treatments, detergents or others?
  b. Can we get a list of pre-treatment chemicals you use on a regular basis?

What is your process for dyeing yarn?
  a. Do you use a variety of dyes?
  b. What types do you prefer?
  c. Are there dyes you won’t use? Why not?
Do you work with specific suppliers for dyes?

Can we get a list of the dyes you use on a regular basis?

Do you use printing treatments?
a. What do you use for printing?
b. Can we get a list of the printing agents you use?

Do you use finishing treatments?

a. What do you use for finishes?
b. Can we get a list of your finishes?

What might be some of the environmental impacts your facility may cause?

a. How do you manage the facility’s environmental impacts?
b. Do you have a written environmental management program? What does the program cover?

How do you manage your energy and water use?

a. Do you measure your energy and water consumption?
b. Do you have a plan for reducing energy and/or water use? Can you tell me about your plan?

What are your main sources for waste?

a. How do you manage waste?
b. Where does the waste go?

How do you deal with waste water? Do you treat the waste water onsite?

a. What do you measure?
b. How often do you measure?

What would you prioritize as the most important environmental management practices for your facility?

What would help you improve your environmental management program?

Where do your greatest expenses come from? (Energy, water, employees, etc.)

a. Where do you get your energy?
b. Approximately how much did you pay for energy in 2013?
c. Have costs been rising?
d. Tell me how the cost of producing textiles has changed over the last five years?

Has demand for cotton from your customers changed in recent years?

a. Where does your cotton yarn come from?
b. Would you prefer to use more South African cotton if available?
c. Tell me how the price of cotton can affect your production and business?
How has business been lately?

- Tell me about changes in business over the last five years?
- Who buys your cotton textiles?

What can cause production to increase or decrease?

- How has production levels changed over the last five years?

Approximately what is your profit each year?

How many employees do you need when running at full capacity?

- How many do you have now?

How do you train employees how to use the machinery?

- Is safety training included?
- Tell me about what is covered in safety training?
- What is provided to employees by the company for safety? i.e. masks, gloves, etc.

What would you like to change for the textile facility in the future?

**Interview Schedule - Apparel Production**

Site:  
Interviewee:  
Date:  
Audio file:

How long has this facility been operating?

What type of services do you offer?

Do you work with textiles other than cotton?

How much cotton do you use compared to other textiles?

What might be some of the environmental impacts your facility may cause?

- How do you manage the facility’s environmental impacts?
- Do you have a written environmental management program? What does the program cover?

What are your main sources of waste?

- What do you do with the waste?

How do you deal with solid waste?

- What do you measure?
b. How often do you measure?

How does your facility use water?

How do you deal with waste water?

   a. What do you measure?
   b. How often do you measure?

What would you prioritize as the most important environmental management practices for your facility?

What would help you improve your environmental management program?

Where do your greatest expenses come from? (Energy, water, employees, etc.)

   a. Where do you get your energy?
   b. Approximately how much did you pay for energy in 2013?
   c. Have costs been rising?
   d. Tell me how the cost of producing apparel has changed over the last five years?

Has demand for cotton apparel from your customers changed in recent years?

   a. Where does your cotton fabric come from?
   b. Would you prefer to use more South African cotton if available?
   c. Tell me how the price of cotton can affect your production and business?

What can cause production to increase or decrease?

   a. How has production levels changed over the last five years?

Where do your textiles come from?

   a. Would you prefer to use more South African (SA) textiles if available?
   b. Tell me how the cost of cotton can affect your business?

How has business been lately?

   a. Tell me about changes in business over the last five years?
   b. Who buys your cotton apparel?

Approximately what is your profit each year?

How many employees do you need when running at full capacity?

   a. How many do you have now?

How do you train employees how to use the machinery?
a. Is safety training included?
b. Tell me about what is covered in safety training?
c. What is provided to employees by the company for safety? i.e. masks, gloves, etc.

What would you like to change for the apparel facility in the future?

Interview Schedule-Retailer

Site: Interviewee: Date: Audio file:

Tell me about how South Africa’s cotton industry impacts you?

What do you think are some of the greatest challenges facing South Africa’s textile and apparel industry?

Where do you buy the majority of your cotton products from?

- Do South African cotton products cost more? If yes, approximately how much more?
- Do your customers care where the cotton is grown? Please explain.
- Do your customers care if it is grown organically or sustainably? Please explain or give examples.

Tell me about your company’s involvement in the Sustainable Cotton Cluster?

What would be your expectations of a sustainable cotton supply chain?

- How do you verify the sustainability claims of cotton products?
- What are the main challenges in ensuring a sustainable cotton supply?
- What would be required for a sustainable supply chain claim to be validated?

What would you like to change for your business in the future?

Interview Schedule-Cotton Merchant:

Site: Interviewee: Date: Audio file:

Tell me about your company’s involvement in the cotton industry in South Africa?

What is the role of merchants in the cotton supply chain?

  a. How do they determine the price for cotton?
  b. Do merchants dictate how much cotton farmers should grow? Please explain.

Can you explain to me the flow of goods for the cotton supply chain?
a. What are some of the main challenges for the flow of goods? How does the infrastructure in South Africa (SA) impact the cotton supply chain?

   a. Such as storage facilities and transportation?
   b. Tell me about how sources for energy (nuclear, coal, gas, renewable, etc.) in SA affect the cotton supply chain?
   c. Tell me about how sources for water in SA affect the cotton supply chain?
   d. Where could there be improvements?

How does government policy impact the cotton industry in South Africa?

   a. Are there forms of financial assistance?
   What would you like to change for your business in the future?

Interview Schedule-NGO

What is your NGOs involvement in the cotton industry?

Do you have any programs that specifically address social responsibility?

Do you feel that there are any areas of poor social responsibility?

Are there any areas of environmental impact areas you think new farmers need to know about?

If farmers could be paid at a proper time would you be supportive of farmers growing organic cotton?

Do you have a definition for sustainably grown cotton?

Do you ever feel any top-down pressures on environmental measures? Like do the spinners ever ask what chemicals are being used?

What would be your predications for the future of the cotton industry in SA?

Do you have an estimate as to how short the supply of cotton is?

Observational Data Schedule

A) Machinery: what is it used for, is it functioning, older or newer
B) Employees: how many are observed, what are they wearing, any protective clothing, masks or eye protection, any signs in facility related to safety, is it loud and are they wearing ear protection
C) Water and Energy: sources for water and what is it used for, sources for energy and what type
D) Waste: visible signs for disposal, health and safety signs for disposal of waste, storage of waste, disposal methods, wastewater system and general state, effluent testing equipment, recycling streams
E) Chemicals: any chemicals observed, storage of chemicals and general cleanliness, labels on chemicals, protective clothing/masks/eyewear easily accessible, visible signs for health and safety with chemicals, eye wash stations
<table>
<thead>
<tr>
<th>Better Cotton Initiative Production Principles &amp; Criteria 2.0</th>
<th>Global Organic Textile Standard Version 3.0</th>
<th>Higg Index 1.0 Facility Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm/Fiber:</td>
<td>Textile Production</td>
<td>Apparel Production</td>
</tr>
<tr>
<td>Integrated pest management:</td>
<td>Material composition</td>
<td>Environmental management program</td>
</tr>
<tr>
<td>growing a healthy crop:</td>
<td>natural fiber certified organic</td>
<td>is there a program in place</td>
</tr>
<tr>
<td>prevention of pest build up</td>
<td>natural fiber certified 'in conversion' organic</td>
<td>is there someone assigned to the program</td>
</tr>
<tr>
<td>preserve and enhance beneficial insect populations</td>
<td>product must contain at least 95% organic fibers</td>
<td>does the site have necessary permits related to environmental compliance</td>
</tr>
<tr>
<td>regular observation of crops health:</td>
<td>mixed content products must have at least 70% organic fibers</td>
<td>does the program have a continuous improvement plan</td>
</tr>
<tr>
<td>management of resistance</td>
<td>Prohibited substances</td>
<td>are employees being trained about the program</td>
</tr>
<tr>
<td>reduced use of pesticides</td>
<td>aromatic solvents</td>
<td>is the program reviewed on a regular basis</td>
</tr>
<tr>
<td>prohibited use of pesticides listed in Stockholm Convention</td>
<td>chlorophenols (including their salts and esters)</td>
<td>does the program have target goals for reducing environmental impacts</td>
</tr>
<tr>
<td>phasing out of pesticides in the categories: WHO class I, listed in the Rotterdam Convention, and endosulfan</td>
<td>complexing agents and surfactants (APEOs, EDTA, DTPA, NTA, LAS, α-MES)</td>
<td>does the program with suppliers or subcontractors</td>
</tr>
<tr>
<td>Water management</td>
<td>fluorocarbons (such as PFOS and PFOA)</td>
<td>is info about the program made available to stakeholders</td>
</tr>
<tr>
<td>rain-fed cultivation</td>
<td>formaldehyde and other</td>
<td>is the program monitored</td>
</tr>
<tr>
<td><strong>practices minimum irrigation only as needed</strong></td>
<td>short-chain aldehydes and/or certified by a third party verifier</td>
<td>Energy use and greenhouse gas emissions (GHG)</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td><strong>water extraction does not cause adverse impacts</strong></td>
<td>genetically modified organisms and their derivatives (including enzymes)</td>
<td>site measures and tracks energy use</td>
</tr>
<tr>
<td><strong>Soil management</strong></td>
<td>halogenated solvents</td>
<td>site has had a third party conduct an energy audit</td>
</tr>
<tr>
<td><strong>maintain and enhance structure and fertility</strong></td>
<td>heavy metals (some exceptions for dyes and pigments)</td>
<td>site has target goals and procedures for reducing energy use</td>
</tr>
<tr>
<td><strong>nutrients applied on basis of crop needs only</strong></td>
<td>inputs with functional nanoparticles</td>
<td>site has measured reductions in energy use</td>
</tr>
<tr>
<td><strong>optimize timing, placement, and quantity of fertilizer</strong></td>
<td>inputs with halogen containing compounds</td>
<td>site has target goals and procedures for reducing GHGs</td>
</tr>
<tr>
<td><strong>minimize erosion</strong></td>
<td>organotin compounds (DBT, MBT, TBT, DOT, TPhT)</td>
<td>Water use</td>
</tr>
<tr>
<td><strong>protection against runoff to bodies of water</strong></td>
<td>plasticizers (PAH, phthalates, Bisphenol A)</td>
<td>site monitors and periodically measures water use from all sources</td>
</tr>
<tr>
<td><strong>Conservation and biodiversity</strong></td>
<td>inputs assigned to specific risk phrases related to health hazards</td>
<td>site has target goals and procedures for reducing water use</td>
</tr>
<tr>
<td><strong>enhance biodiversity on and surrounding farm</strong></td>
<td>inputs assigned to specific risk phrases related to environmental hazards</td>
<td>site has documented changes in reduced water use</td>
</tr>
<tr>
<td><strong>adhere to national legislation on agricultural land use</strong></td>
<td>*assessment basis for chemical inputs is the MSDS</td>
<td>Wastewater/effluent</td>
</tr>
<tr>
<td><strong>Fiber quality</strong></td>
<td>Separation and identification</td>
<td>site measures wastewater at least annually</td>
</tr>
<tr>
<td><strong>practices that maximize quality of cotton</strong></td>
<td>across the processing chain organic fibers must be kept separated from other fibers</td>
<td>all wastewater is being treated with on-site, off-site or both</td>
</tr>
<tr>
<td><strong>practices that minimize trash, contamination, or damage of fiber</strong></td>
<td>all organic materials must be clearly labelled and identified at each stage of</td>
<td>site has target goals and procedures for improving wastewater</td>
</tr>
<tr>
<td>Promotes decent work</td>
<td>Spinning</td>
<td>quality</td>
</tr>
<tr>
<td>----------------------</td>
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</tr>
<tr>
<td>processing chain</td>
<td>site has demonstrated evidence for improving wastewater quality</td>
<td></td>
</tr>
<tr>
<td>quality</td>
<td>Emissions to air (dependent upon operation)</td>
<td></td>
</tr>
<tr>
<td>smallholders have a right to establish organizations representing their interests</td>
<td>additives that meet the substances criteria are allowed</td>
<td>site maintains a list of emissions to air substances</td>
</tr>
<tr>
<td>access to potable and washing water is provided</td>
<td>paraffin products used must be refined with a value for residual oil of 0.5%</td>
<td>site regularly monitors and tests air emissions</td>
</tr>
<tr>
<td>no forced or compulsory labor</td>
<td>Sizing and weaving/knitting</td>
<td>site has target goals and procedures for reducing air emissions</td>
</tr>
<tr>
<td>no child labor, exceptions in the case of family smallholdings</td>
<td>sizing agents include starch, starch derivatives or other natural substances and CMC</td>
<td>site has measured reductions in air emissions</td>
</tr>
<tr>
<td>no discrimination based upon individual characteristics or group membership</td>
<td>polyvinylalcohol and polyacrylate may be used no more than 25% of total sizing in combo with natural substances</td>
<td>Waste management</td>
</tr>
<tr>
<td>freedom of association and collective bargaining</td>
<td>knitting/weaving oils must not contain heavy metals</td>
<td></td>
</tr>
<tr>
<td>health and safety standards</td>
<td>Pre-treatment stages, wet processing</td>
<td>site segregates hazardous and non-hazardous waste</td>
</tr>
<tr>
<td>wages paid in timely manner</td>
<td>ammonia treatment is prohibited</td>
<td>site has trained employees on proper handling of hazardous waste</td>
</tr>
<tr>
<td>wages meet national legislation for pay rates</td>
<td>bleaches on basis of oxygen are allowed (peroxides, ozone)</td>
<td>site measures and records all waste streams</td>
</tr>
<tr>
<td>overtime work is voluntary and remunerated</td>
<td>washing detergents must contain no phosphates</td>
<td>site has target goals and procedures for reducing hazardous waste creation</td>
</tr>
<tr>
<td>no physical punishment or harassment of workers</td>
<td>desizing using enzymes must not be from GMO sources</td>
<td>site has documented changes in reduced hazardous waste creation</td>
</tr>
<tr>
<td>transparent and clear policy for disciplinary measures</td>
<td>mercerization with alkaline must be recycled</td>
<td>Pollution prevention</td>
</tr>
<tr>
<td>optical brighteners must meet chemical input criteria</td>
<td>site has a detailed inventory of all</td>
<td></td>
</tr>
<tr>
<td><strong>Dyeing</strong></td>
<td>all relevant personnel are trained in how to properly handle, store or transport hazardous materials</td>
<td></td>
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<td>---------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>natural dyes, synthetic dyes, and auxiliaries must meet chemical input criteria</td>
<td>site conducts practice drills on pollution incidents</td>
<td></td>
</tr>
<tr>
<td>azo dyes that release carcinogenic arylamin compounds are prohibited</td>
<td>site has targeted goals and procedures for reducing risks associated with hazardous materials</td>
<td></td>
</tr>
<tr>
<td>dyes classified as allergenic are prohibited</td>
<td>site has demonstrated evidence for reducing risks</td>
<td></td>
</tr>
<tr>
<td>dyes containing heavy metals are prohibited (exception is iron)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Printing</strong></td>
<td></td>
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<tr>
<td>dyes, pigments and auxiliaries must meet chemical input criteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ammonia is allowed as required buffer in pigment printing pastes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>prohibited are discharge printing methods using aromatic solvents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>prohibited are plastisol printing methods using phthalates and PVC</td>
<td></td>
<td></td>
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<tr>
<td>same criteria for use of dyes as above</td>
<td></td>
<td></td>
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<tr>
<td><strong>Finishing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>natural and synthetic inputs must meet chemical input criteria</td>
<td></td>
<td></td>
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<tr>
<td>prohibited are synthetic inputs for anti-microbial finishing, coating, etc.</td>
<td></td>
<td></td>
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<tr>
<td>prohibited are garment finishing methods that are harmful to workers</td>
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<tr>
<td>Environmental Management</td>
<td></td>
<td></td>
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<tr>
<td>operator must have a written environmental policy</td>
<td></td>
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<tr>
<td>person responsible to program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>data on energy and water consumption per kg of textile output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>target goals and procedures to reduce energy and water consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>the monitoring of waste and discharges</td>
<td></td>
<td></td>
</tr>
<tr>
<td>procedures to follow in case of waste or pollution incidents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>staff training on conservation of water and energy, chemical use and disposal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>program for improvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>full records are kept of use of chemicals, energy, water consumption, waste water treatment and sludge disposal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>waste water treatment is measured and monitored temp, pH, sediment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wastewater treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>all discharge from wet processing sites must be treated before reaching surface waters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wet processing site must adhere to local and national legal requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>treated wastewater must have a COD content of less</td>
<td></td>
<td></td>
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<tr>
<td>than 20g/kg textile output</td>
<td></td>
<td></td>
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<td>--------------------------</td>
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</tr>
<tr>
<td>treated wastewater must have a pH between 6-9 and temp below 40C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wastewater analysis must be performed and documented periodically</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix D

CODING PROTOCOL

Interview Coding Protocol:
- Follow deductive coding guide
- Only code current practices
- Only code what the interviewee chooses to share
- Note in margins reason for selecting the code
- Use constant comparative method as designated by Glaser & Strauss (1967)
- Validate coding with a secondary reviewer

Triple Top Line tool as deductive coding guide

Economic/overall:
Is the business profitable/viable
- Can the business continue operations in the near future
- Is the business able to keep current workforce employed full-time
- Is the business operating at full capacity
- Does the business have the capacity to expand
- Has the business expanded in the last 5-10 years
- Do costs and/or inputs fluctuate wildly impacting competitiveness
- Access to financing

Economic/ecology:
Business decisions that impact ecology
- Reduced energy use
- Reduced water use
- Reduced chemical use
- Reduced waste creation
- Equipment upgrades that increases efficiency

Economic/equity:
Business decisions that improve equity
- Adhering to federal laws that protect workers’ rights
• Upholding to collective bargaining agreements such as wage increases
• Creating new job positions, expanding workforce
• Skills training that improve productivity
• Relationships with other local businesses
• Hiring locals for harvest season
• Providing health & safety services (i.e. protective clothing, training)
• Investing in equipment or processes that makes work easier for employees

**Equity/equity:**
Does the business provide an environment where people are treating each other with respect
• Efforts made to breakdown racial and/or class barriers
• Management practices that support communication
• Grievance mechanisms
• Disciplinary mechanisms
• Opportunity for advancement within the organization
• Mentorship programs

**Equity/ecology:**
Practices that benefit workers and the environment
• Reduced exposure to chemicals for workers (i.e. less spraying of chemicals)
• Restricting chemicals that are harmful to people, less exposure in the environment
• Handpicking cotton creates seasonal jobs, low ecology impact

**Equity/economic:**
Business decisions that are made for the benefit of workers or the community
• Facility improvements such as canteens and toilets
• Trainings (i.e. skills improvements)
• Social services such as on-site clinics
• Government sponsored training and/or services that are free

**Ecology/ecology:**
Practices which are either beneficial or benign to the environment
• Farming practices that do not require inputs such as fertilizers or water
• Practices that support natural cycles (i.e. crop rotation, soil health)
• Practices that support biodiversity
• Growing crops suited to the local environment
• Manufacturing processes that cleans water
- Closed-loop production processes
- Facility enhances local environment

**Ecology/equity:**
Practices that reduce environmental impact and are beneficial to workers and the community
- Chemical use training
- Proper equipment for application of chemicals
- Waste treatment
- Effluent treatment
- Reduction of waste sent to landfill (i.e. recycling efforts)

**Ecology/economic:**
Practices that reduce environmental impact and make the business more competitive
- Use of renewable energy sources
- Use of reclaimed or recycled water
- Use of ‘green chemicals’ compared to conventional chemicals
- Recycling or repurposing waste into an additional product or revenue stream