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The Impact of Chinese Investment on Skill Development and Technology Transfer in Zambia and Malawi's Cotton Sector

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ABSTRACT

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China-Africa Cotton (CAC) was one of the first Chinese cotton firms to enter the African market. This study analyzes China-Africa Cotton's operations in Zambia to investigate the impact on the technological development of the local cotton sector. Western multinational corporations, particularly American based Cargill, Zambian Dunavant, and the British Great Lakes Cotton Company in Malawi, once dominated the cotton market. As a new player in the arena, CAC has business models and a management style that differ from those of previous foreign investors in the region. In addition to detailed and in-depth analysis of CAC's unique qualities, the study also uses Cargill's operations in Zambia as a comparison. The comparative analysis is done through qualitative measures to illustrate the different mechanisms used for technology transfer between Chinese and Western firms. CAC's business model is not yet fixed, in fact evolving very quickly. Within six years, CAC grew from a sole ginnery with outreaching agents into a firm with tens of thousands of contracted outgrowers, and is now a comprehensive multinational business with an integrated value chain. CAC experimented with various possibilities to properly adapt to the local context, with the evolution of CAC's business model creating three distinct characteristics. First, CAC is open to adopting existing systems and practices in Africa and is willing to take advice from local managers. Second, CAC's business model is cautious about cost control and cost efficiency. Finally, being "frugal" on its own investment, CAC seeks financial resources from various external partners to help business and technology transfer.

INTRODUCTION

COTTON PLAYS AN IMPORTANT ROLE IN BOTH THE LOCAL economy and export industry for a number of African countries. Meanwhile, although China is a valuable cotton producer it also imports large quantities of African cotton. A growing number of Chinese investors are taking advantage of this mutual relationship to enter into the African commodity market, directly exporting and producing cotton. Has Chinese investment had an impact on skills development and technology transfer in Africa's cotton sector?

China-Africa Cotton (CAC) was the first company to enter the African market. This study analyzes China-Africa Cotton's operations in Zambia to investigate the impact on the technological development of the local cotton sector. Western multinational corporations, particularly American based Cargill, Zambian Dunavant, and the British Great Lakes Cotton Company in Malawi, once dominated the cotton market. As a new player in the arena, CAC has business models and a management style that differ from those of previous foreign investors in the region. In addition to detailed and in-depth analysis of CAC's unique qualities, the study also uses Cargill's operations in Zambia as a comparison. The comparative analysis is done through qualitative measures to illustrate the different mechanisms used for technology transfer between Chinese and Western firms. How does the new Chinese firm, CAC, compare to previous investors in training its employees and farmers? Does the Chinese approach work effectively in an African context?

Researchers have studied the impact of foreign firms on the Zambian cotton market as well as skill transfer among local farmers. Irene Brambilla and Guido G. Porto described how Zambia liberalized its cotton sector in the 1990s by privatizing the state-owned Lint Company of Zambia (Lintco), which used to wholly manage the input distribution process, cotton buying, credit loans, and technology extension. Several foreign firms, such as Dunavant (acquired by a South African Company, NWK, in 2013) and Clark (acquired by Cargill in 2006), arrived and developed outgrower schemes using Zambian farmers, usually providing farmers with seeds and fertilizer and then purchasing their cotton. Foreign investors' different business models significantly affected the productivity of cotton farmers, in both positive and negative ways.[1] Thomson Kalinda and Richard Bwalya found that foreign firms and donor funded extension programs were critical to productivity improvement in Zambia.[2] Philip Grabowskia, as well as Haggblade and Tembo and others, investigated the diffusion and adoption of conservation farming practices among Zambian farmers.[3] They found that cotton farmers have a higher rate of technology adoption than farmers growing other kinds of crops, even without incentives. They pointed out that extension efforts of multinational firms, like NWK and Cargill, promoted conservation farming.

However, the aforementioned studies have only focused on well-established American and South African firms. Little research has been done on new Asian players. The recent arrival of Chinese cotton investors to Zambia brings with it a new approach and business model providing opportunities for both countries to exchange experiences in cotton production. The impact of Chinese firms, like CAC, on the Zambian cotton market is worth close a closer look.

Through examination of the CAC case study in Zambia, and its comparison with Cargill, the author aims to gain a comprehensive understanding of CAC's business model and its training activities. In-depth qualitative and quantitative analysis was conducted to obtain insights into the effects and local perception of the technology transfer process between Chinese and Zambian counterparts. Additionally, CAC manages the agricultural technology (agri-tech) demonstration center in Malawi, which is a Chinese government funded aid project. The relationship between this aid project and CAC's business operations in Zambia and Malawi is examined as well to better understand the training, technology transfer, and overall industry building impacts of the center. This study can shed light on skill diffusion mechanisms used in Chinese aid projects as well as the complementarity between aid and business.

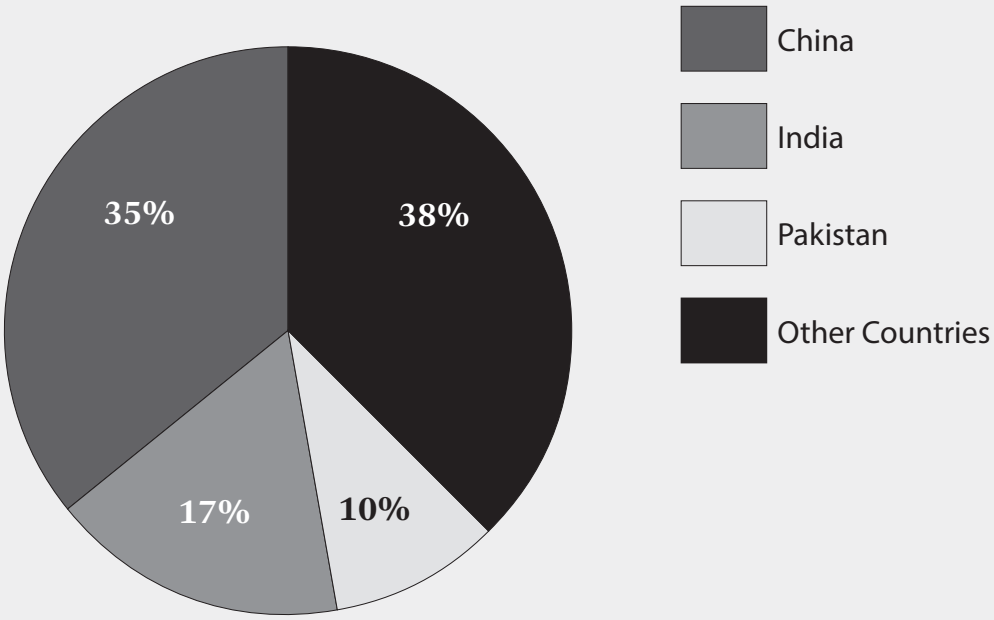
The research is mainly based on two field visits conducted in July and August 2013 to Zambia and August 2016 to both Zambia and Malawi. The researcher carried out semi-structured interviews with government officials, company managers, cotton associations, extension workers, research institutions, and other donor agencies. Additionally, a survey was conducted among CACs contracted farmers in the Eastern Province of Zambia. Input distribution and cotton production data was collected with the approval of CAC managers.

BACKGROUND

CHINA IS BOTH THE LARGEST CONSUMER AND IMPORTER of cotton in the world. Its immense textile industry requires millions of tons of cotton per year. Since 2002 the Chinese textile industry has sourced roughly 10 to 20% of its cotton from Africa (see Figures 1 and 2). In terms of cotton farming productivity, Zambia and its' neighbors lag far behind China and other world leaders (see Table 1). These productivity differences present opportunities for Chinese investment throughout the region. Now the oldest and largest Chinese player in Africa's cotton sector, CAC started to acquire cotton in the Chipata region of Zambia as early as 2003, expanding to Malawi, Mozambique, Zimbabwe, and Mali. As of 2016 CAC's operations have covered every thing from seed processing to ginning and oil extraction, providing work for thousands of local workers, and contracting with over 100,000 farmers throughout Southern Africa.[4]

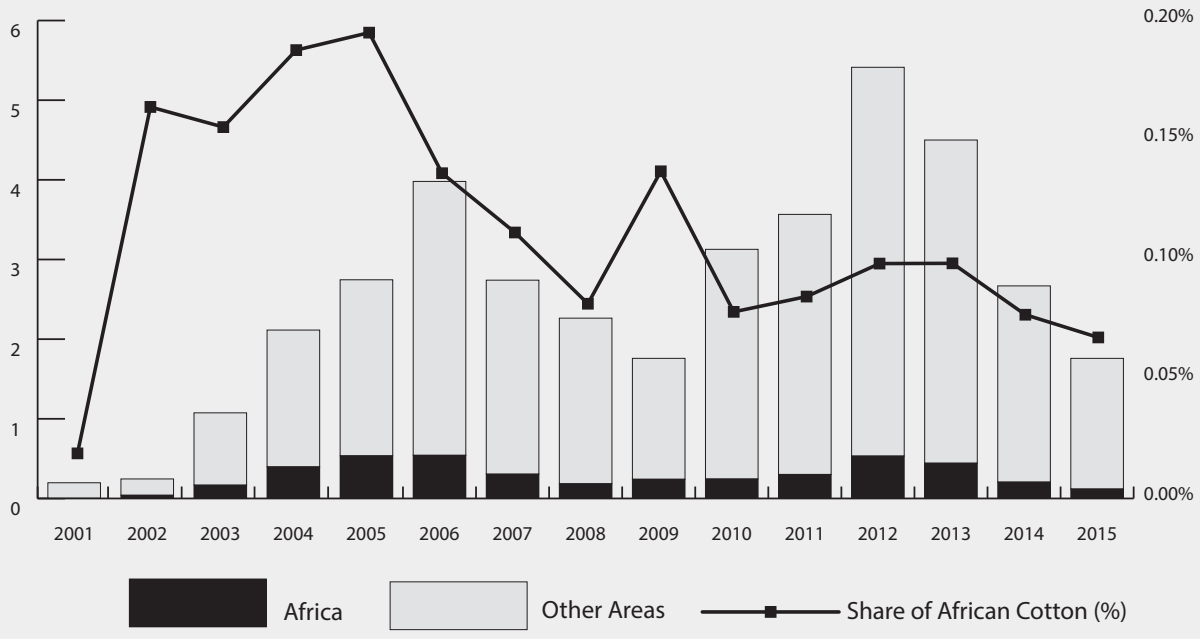
China's engagement in Zambia's cotton and textile industries can be traced back to the 1970s, when China offered interest-free loans and technical support, assisting Zambia to build a textile aid project in Mulungushi. After being shut down for a few years, the mill was restructured into a joint venture between the two governments in 1997. Mulungushi Textile's operations were mainly concerned with spinning, although the company also bought cotton through local agents to ensure sufficient cotton supplies for production.[5] Although Mulungushi finally closed down in January 2007, a former manager of Mulungushi Textile, Ju Wenbin, started the Chipata Cotton Company (CCC), which was later to become CAC or China-Africa Cotton.

Figure 1: Total Cotton Consumption by Country, MY 2001-2016



Source: ICAC World Cotton Database

Figure 2: China's Cotton Imports from Africa and its Share in China's Total Cotton Imports, 2001-2015 (in millions of tons)



Source: UN Comtrade database

Table 1: Cotton Yield by Country, 2016 Estimate (in kilograms/hectare)

Rank	Country	Yield (kg/ha)
1	Australia	1,887
2	Israel	1,769
3	China	1,614
4	Mexico	1,565
5	Turkey	1,537
6	Brazil	1,506
7	Venezuela	1,234
8	South Africa	1,089
58	Malawi	268
60	Zimbabwe	245
61	Mozambique	228
71	Zambia	207
72	Kenya	196
73	United Republic of Tanzania	174

Source: United States Department of Agriculture

OVERVIEW OF ZAMBIAN COTTON SECTOR

SIMILAR TO OTHER AFRICAN economies, Zambia's cotton sector was dominated by a state-operated marketing entity, Lintco, from 1977 to 1994. Lintco was a public agency with centralized power and resources, able to easily regulate the domestic cotton market. They were responsible for all links in the cotton production chain, offering material, technical, and financial services to farmers, while also enjoying fixed prices while purchasing products from them. But ultimately, due to low productivity of the Zambian cotton sector, the government was forced to launch market-oriented reforms and privatized Lintco in 1994. Two US firms, Lonrho Cotton and Clark Cotton, inherited Lintco's assets, resources, and its nation-wide market share.[6] Consequently, upon privatization the government largely reduced its involvement in the cotton sector.

In terms of operations, Lonrho and Clark managed production by initiating contract farming outgrower schemes in which they (the firm) contract farmers by giving them seeds and inputs (inputs include pesticide, fertilizer, herbicide, tools, etc.) throughout the entire farming process. Farmers then sell cotton to the firm after the harvest and deduct the costs of seeds and inputs from the income obtained.[7] The outgrower scheme appears to be derived from Lintco era production operations, because farmers' relatively low position in the cotton value-added chain has remained unchanged. Since farmers cannot afford production costs, they have to depend on private companies for necessary means of production and financial support.

The absence of governmental regulations helped create conditions for disorder to gradually grow as an increasing number of private firms and independent merchants entered the Zambian cotton market. Some firms were regarded as black sheep in the market, free-riding on the system by disregarding existing contracts and "side-buying" cotton from farmers that had already been provided inputs and perhaps extension

services by other firms. Without responsibilities or expenses such as credit loans, firms could present farmers with higher prices, which were so attractive that some farmers even preferred to default on existing loans held with their original contracting firm.[8] The market began to unravel into a vicious cycle in which both outgrower companies and faithful farmers suffered. As a result of the unbearable losses caused by defaults, one of the leading companies in the cotton sector, Lonrho, withdrew from the market in 1999, selling its property to Dunavant Zambia Limited.

As the new market leaders, Dunavant and Clark Cotton committed to resume market order by refining the existing outgrower schemes. Instead of using its own employees Dunavant decentralized the distribution of materials and credit loans to independent cotton growers, while Clark continued using the previous dispensation methods driven by their own personnel, although in an enlarged range of markets. The companies also developed a means of distinguishing the cotton grown by contracted outgrowers from cotton grown by those who had disturbed the previous market order.[9] All of these measures worked effectively, although comprehensive government regulations were still lacking during this era of other reforms. The Zambian cotton sector subsequently went through a period of alterations, when another market leader experienced reorganization as well. In May 2006, Clark Cotton in Zambia was sold to Cargill Cotton. As one of the world's largest and most experienced cotton trading companies, Cargill brought access to international cotton markets, out of reach for Clark's former parent company, Afgri.[10]

"The one-day training is not enough. There are always new farmers. Some may not know, some shift from maize to cotton newly. We need to explain crops' natural behabiors to the farmers and keep repeating."

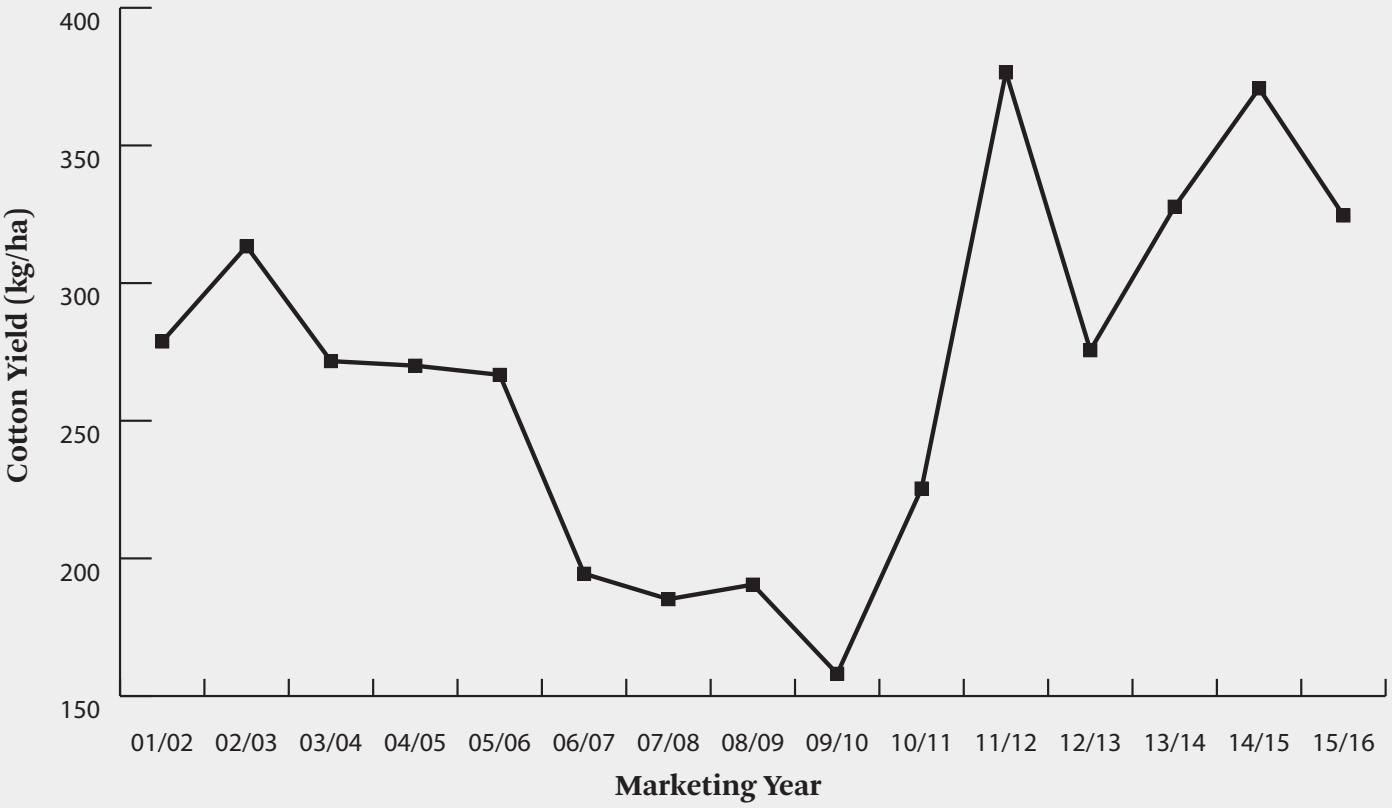
Other companies also responded to the market leaders' efforts. Partly due to the common goal of eliminating side-buying, nine of eleven ginning companies joined together to create the Cotton Ginners' Association (CGA).[11] The association was originally set up in 1999 as a forum for ginners to discuss common problems. Although CGA does not have an office or a permanent secretariat, the members occasionally meet at Dunavant or Cargill's headquarters to exchange information, coordinate activities, and lobby the government for selected solutions.[12] After the establishment of the Cotton Board in 2009, CGA became one of the nine voting members of the regulatory body.[13]

Between 2010-2016, approximately 250,000-300,000 smallholder farmers grew cotton per year, representing roughly one third of the Zambian farmer population.[14] The cultivation of cotton plants was especially centralized, with about 70% in the Eastern Province.[15] The cotton yield has fluctuated significantly over the past 15 marketing years (MY). Output stood at about 279 kilograms per hectare (kg/ha) in MY 2001/2002. After a slight increase, it consistently declined over the next 7 MYs, and fell to its lowest point to 258 kg/ha in 2009/2010. However, as a miraculously sharp rise took place, the yield peaked at over 376 kg/ha after only 2 years. (see Table 1 and Figure 3).

As of 2016, there were a total of nine registered ginneries in Zambia (see Table 2). Cargill, NWK, and Continental are the biggest players while CAC is one of the medium-sized ginneries. Grafax and Manjeet are from India and while Continental is originally from India it partners with Olam from Singapore. Alliance is from Kenya and Mumbwa Farmer Ginning and Pressing Company (MFGPC) was established by the Zambian

Cotton Farmers Association (CAZ) in 2011 and is supported by the Zambian government. The main purpose of MFGPC is to break the price monopoly of foreign ginners. It collects cotton from a limited number of association members and sells the lint to local textile mills.

Figure 3: Zambia's Cotton Yield in Kilograms/Hectare (kg/ha), Marketing Year (MY) 2001-2016



Source: ICAC World Cotton Database

CHINA-AFRICA-COTTON (CAC):

ALTHOUGH CAC WAS OFFICIALLY ESTABLISHED IN 2008, its history can be traced back to 2003. The founder, Ju Wenbin, became familiar with Zambia's cotton sector and sensed opportunities in it while he worked as a manager of the former Chinese aid project, Mulungushi Textiles. In 2003 he partnered with several investors to set up the Chipata Cotton Company in Zambia. The company grew at a modest pace until 2008 when a new shareholder, the Chinese Development Bank's equity investment fund known as the China-Africa Development Fund (CADF), brought in capital. It was with CADF's investment that the Chipata Cotton Company became China-Africa Cotton. CAC has become a heavyweight in Zambia, Malawi, Zimbabwe, and Mozambique and

Table 2: Registered Ginneries Operation Data - Zambia 2016

Company	Number of Farmers	Cotton Planted (in hectares)	Expected Production (in metric tons)
NWK	90,317	96,187	38,475
Continental	51,563	63,670	25,460
Alliance	39,019	40,506	16,202
Grafax Cotton	38,611	43,038	15,063
China Africa Cotton	37,055	31,805	12,086
AGDC Limited	29,360	24,520	9,808
Manjeet Cotton	21,074	19,714	7,886
MFGPC	856	1,113	389

Source: Zambia Cotton Board based on estimates self-reported by each ginnery. Therefore the statistics of this data are not completely reliable.

is now a joint venture between CADF, Qingdao Ruichang Cotton Industrial, and Qingdao Huifu Textile with a total investment of US$64,720,000.[16]

CAC began by only running ginning operations, without providing extension services directly to farmers, instead commissioning Indian agents to purchase cotton from the farmers on their behalf. As the firm scaled up in 2011, it took over cotton buying activities and started offering extension services to contracted farmers. CAC recruited several experienced Zambian managers, most of which were previous Cargill employees, to rapidly expand the cotton-buying network. The amount of cotton collected rose from 3,603 metric tons (MTs) in 2010 to 11,401 MTs in 2011 and 27,650 MTs in 2012 before the amount significantly decreased due to bad weather conditions and enhanced competition.[17] Unlike Cargill, NWK, and Continental, which operate nationwide, CAC only focuses its business in Zambia's Eastern Province.

In addition to the ginning business, CAC also operates cottonseed oil extraction plants and a cottonseed delinting workshop. The two cottonseed oil extraction plants are located in Chipata and Petauke. After the oil is extracted, cottonseed leftovers are

sold to farms as feed for animals and the cottonseed hulls are sold to a Chinese agricultural company in Lusaka as the basis for growing mushrooms. Locals may also buy hulls for household use, to fill their sofas for example. In order to improve the seed germination rate, in 2013 CAC set up a workshop to delint cottonseeds with dilute sulfuric acid. Although the delinted seeds originally were for CAC farmer use only, due to the seeds popularity other cotton firms now pay a fee to bring their seeds for delinting as well.

In spite of income source diversification through the oil extraction plants and the seed delinting workshop, lint exports still make up the majority (70-80%) of CAC's profits in Zambia.[18] Before 2014, all lint had to be exported to China, a lending condition by the China Development Bank. However, as China continuously limited the import of cotton and CAC proved to be a reliable borrower, the bank lifted constraints on export destinations. In recent years, most of the lint was exported to Southeast Asia and Bangladesh.

As production costs in China have risen sharply over the past decade, labor-intensive manufacturing enterprises have been relocating their production bases overseas. China's new policy of exporting excess industrial capacity includes government assistance offering loans and other incentives to encourage Chinese enterprises in these sectors to invest in other developing countries where production costs are cheaper.[19] In this context, CAC partnered with a textile mill in Tianjin to set up mills in African countries. CAC does not aim for merely one African mill, but aspires to build one mill in almost each country of its operation. In Zimbabwe, an MOU to construct an integrated textile mill, worth US$200 million, was signed during Xi Jingping's visit to the country in December 2015. In Malawi, CAC plans to invest in a mill and in Zambia, CAC has been actively negotiating with the government to revive the Mulungushi Textile Mill. CAC has also planned to enter Mali with investments in a ginnery and a spinning mill.[20]

CAC'S EXTENSION STRUCTURE AND TRAINING ACTIVITIES

THE MOST BASIC STRUCTURE TO DESCRIBE HOW CAC OPERATES in Zambia is the outgrower scheme. Western cotton firms developed the outgrower scheme based on Zambia's existing model inherited from Lintco and the reality of farmers' economic conditions, namely that farmers there have such limited financial resources that they cannot afford seeds and inputs upfront. CAC has essentially adopted the same system as Cargill, but applying its own characteristics.

The outgrower system is divided into four levels: company management, regional managers, route managers, and buyers and contact farmers. Shi Jingran, CAC's general manager for all Southern Africa, is based in Chipata. Under him, there is another Chinese manager in charge of the company in Zambia. There are several departments, including finance, import and export, cotton purchasing, (factory) production, and agriculture. The department that deals directly with cotton planting is the agriculture department, lead by its manager Robert Bwalya. Four regional managers, together with

four assistant regional managers, report to the agriculture department. Each region employs a handful of route managers, who visit and supervise 8-12 depots along their respective routes. Each depot is run by a buyer, usually a farmer in the village, who is commissioned to distribute cotton seeds, pesticides, and tools, assist the farmers to grow cotton, and purchase cotton after harvest. Each buyer needs to cover a radius of approximately 10 kilometers containing anywhere from 30 to 150 farmers. Because of bad traffic and communication in rural areas, two or three contact farmers are assigned to each buyer to spread messages to the farmers, provide advice for cotton growing, and send farmers' feedback to CAC.

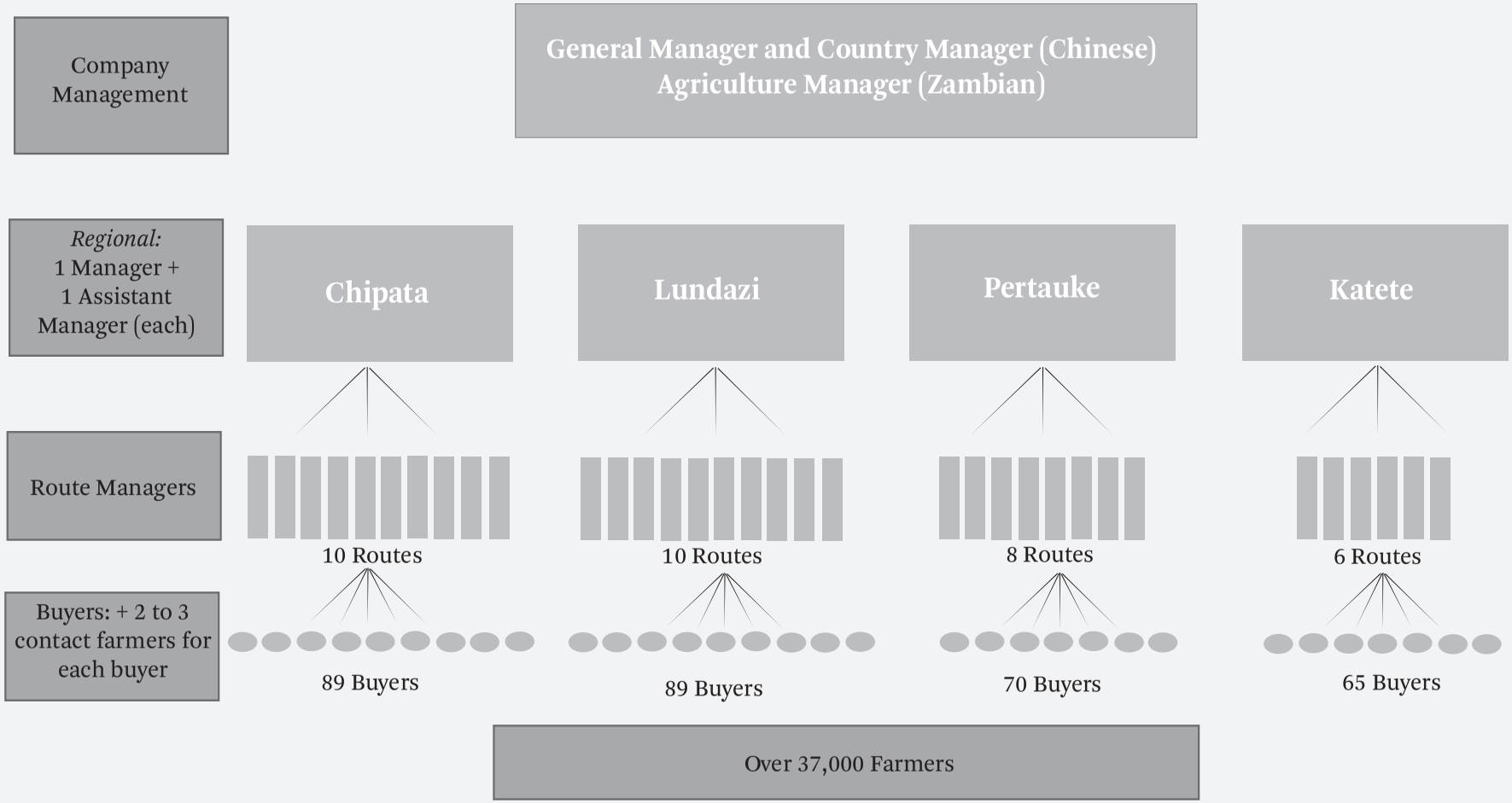
Besides the General Manager and the Country Manager, all players in the extension system are Zambians. Agriculture manager, Robert Bwalya, was a former regional manager for Cargill before he connected with Ju Wenbin in 2008 and moved to CAC to help set up the extension network in Malawi. In the second half of 2010, when CAC decided to take over cotton purchasing activities from the agents, Bwalya returned to the Chipata region. He persuaded several former colleagues from Cargill to join CAC, in addition to recruiting several other experienced managers to regional and assistant manager positions. It was these Zambian managers that set up the extension system, as it exists today, in large part due to their experiences in Cargill.

However, CAC has made three significant variations to the extension system, giving it distinct "Chinese characteristics". First, CAC does not pay buyers a high salary. At Cargill buyers earn an attractive salary, on average 2,700 ZMK/ US$270 per month, but are in charge of many more farmers, usually three times more than a CAC buyer within a similar sized area, and buy other commodities in addition to cotton. CAC originally paid a monthly wage ranging from 120-560 ZMK/ US$12-56 to its buyers, but stopped in 2015. In 2016, CAC renewed their payment program, but at only 100 ZMK per month. Consequently CAC buyers are not as motivated when compared to Cargill's buyers. The main business reason behind these lower payments is cost. Cargill is able to pay its buyers because it purchases maize, soybean, and sunflower seeds in addition to cotton while CAC only runs a cotton business whose revenue cannot sustain a buyer's higher full-time salary.

The second major difference is that CAC does not use independent cashiers. Instead, buyers carry cash to pay farmers directly. Although this increases the risk of embezzlement by the buyers, it does reduce costs by circumventing paying independent cashiers' wages. This approach gives CAC another advantage: farmers like to receive cash immediately. CAC was the first company in Zambia to pay in cash. While Cargill usually requires the farmers to collect money from a certain location one week after the transaction, CAC's policy of paying cash at the moment of trade has gained widespread popularity.

The last variance is that CAC does not operate a contracted farmers database. Instead, buyers record farmers' information, inputs, and purchases. Data controllers audit the figures from time to time, but do not have detailed information about individual farmers. This leaves the possibility for ghost farmers, namely falsely reported farmers, and increases the risk of embezzlement as well. Although CAC is

Figure 4: CAC Zambia's Extension System (as of 2016)



Source: Author's Field Research

planning to build a database in the future, construction remains a low priority. A database is used primarily to regulate electronic payments and Chinese management is hesitant to make changes to the current cash payment modality.

KNOWLEDGE DISSEMINATION

THREE THINGS MATTER IN COTTON GROWING: seed, inputs, and field management. The key is to nurture good seeds. Currently, the Zambia Cotton Development Trust (CDT) only has three varieties of seeds and they have no ability to develop new varieties. In Shi Jingran's view, the Agri-tech Demonstration Center run by CAC can help address this limitation by studying and developing new varieties.[21]

Jingran explained how CAC contributed to seed development in Zambia and Malawi through the creation of the cottonseed delinting workshop. As the only firm producing acid-delinted seeds, "we sell the seeds to NWK, Parrogate, Grafax and so on, we also sell to Great Lakes Cotton Company in Malawi, we break down the monopoly of Zimbabwean seed company Quton in Malawi…Seed sales hardly makes profit. Quton's seeds are priced between 1800-2600 Kwacha (Malawi), our seeds sell only for 900 Kwacha (Malawi). The purpose is to make the whole sector prosper."[22] At first, the acid-delinted seeds were distributed to contracted CAC farmers only. The seeds quickly became popular among local farmers because of its high germination rate and other cotton firms started bringing their seeds to CAC for delinting as well, in exchange for fee payment.

However, Chinese managers at CAC have not yet offered substantial field management training to local farmers or even to its own Zambian staff. Among the 12 Chinese employees at the Chipata headquarters, only one technician and the general manager were knowledgeable about cotton growing, and even they had not instructed the local staff using their knowledge. The main obstacle is the use of a different business model rather than a difference in techniques. Chinese trained staff have no experience in indirectly tutoring farmers who do not have control of their inputs, as is the case in Zambia. "The way of growing cotton in China was totally different [from in Zambia]. We have no idea of how to teach them [the Zambian farmers]."[23]

Zambian managers provide the content for current CAC trainings. In April and October of each year, every regional manager calls together all the buyers in his region for one to two days of training. The training in April puts emphasis on how to purchase cotton, write receipts, loan calculations, proper storage, transportation means, and so on. The training in October focuses more on how to distribute seeds, chemicals, and other inputs to the farmers as well as a lesson on field management. As CAC management has not been able to provide standardized training materials, regional and assistant managers individually choose their own. Some use training manuals acquired while working at Cargill, while some use books acquired from previous trainings that they attended, and yet others use materials they have collected online.

After receiving these trainings from the regional and assistant managers, buyers then convene farmers in their neighboring villages once a year in October or

The CDT covered the costs and inputs for the FFS during the training year, but the CAC will need to provide inputs if they want to continue. CAC's Chinese managers had not decided whether or not to continue this model in the next season, perhaps wanting to evaluate the cost and outcome of the experimental projects over a longer period before reaching a decision.

November. Although mainly for the purpose of seed distribution, farmers are also given training on seeding and field management. These trainings bring together a group of 30 to 40 farmers and last no more than half a day. Since the farmers walk long distances to attend these meetings, CAC has used various methods to attract attendance, like providing attendees with food or playing movies. For all contracted farmers, CAC provides a standard input package, including cottonseeds, pesticide, and fertilizer for wollen with the option for aphicide, weed killers, and other additional items. CAC regulates the amount of inputs per hectare and quantities may fluctuate from year to year according to production needs.

During the growing season from November to May, buyers visit the farmers from time to time for additional instruction. Regional and route managers give advice during their field visits as well. According to CAC's Agriculture Manager, "The 1-day training is not enough. There are always new farmers. Some may not know, some shift from maize to cotton newly. We need to explain crops' natural behaviors to the farmers and keep repeating."[24] A route manager added, "The farmers are little educated. They need to be reminded repeatedly how to weed, how to seed, how to use pesticide, when the crop is growing etc. The buyers need to check the farmers regularly, remind the farmers to visit the field regularly. They need to be educated. Buyers should not leave the farmers without checking."[25]

Buyers' instructions to farmers range from crop choice, the timing of seeding, and land preparation methods to the application of chemicals such as pesticides. One buyer reported, "When I see some farmers not doing good planting, I persuaded them to give up and stop using chemicals so that they won't have loans."[26] Another buyer considered their instruction to be critical in attracting farmers to CAC: "The reason for getting more farmers is... the buyer [referring to himself] understands the farmers' problems. I see field pests, I tell them to apply the right type of chemicals."[27] One old farmer said that the buyer taught him about spacing issues and the spraying of aphicide.[28] In general, it is because of the technical assistance illustrated in these anecdotes that villagers respect buyers.

Ginneries in Zambia often get assistance from other institutes, like the German aid agency (GIZ) and the Food and Agriculture Organization (FAO), to train their staff. CAC participated in a Farmer Field School (FFS) implemented by Zambia's Cotton Development Trust (CDT) and funded by the FAO. Starting in 2014, this FFS program trained 58 Zambian agricultural facilitators from seven companies. CAC sent five facilitators, including three assistant managers and two route managers, to take part in the training. Over the course of almost a year, all the facilitators attended two-week long training sessions every two months with most of the time spent in the field. Classroom courses were also offered. A Zimbabwean master trainer taught them about seed planting, post-harvest seeding, integrated production and pest management (IPPM), and methods to teach and engage farmers. Every trained facilitator then went on to conduct one to two FFS experimental projects back in their villages during the training year. According to the organizer of the CDT, Mutibo Chijikwa-Mushenywa, "CAC did not have extension before, they found the FFS very effective, seeing volume of

production up. CAC was the first to build oil extraction plant and the first to introduce acid-delinted seeds in Zambia. They are clever at business model, but do not invest in extension."[29] The CDT covered the costs and inputs for the FFS during the training year, but the CAC will need to provide inputs if they want to continue. CAC's Chinese managers had not decided whether or not to continue this model in the next season, perhaps wanting to evaluate the cost and outcome of the experimental projects over a longer period before reaching a decision.

"The school helps farmers look into business, help them think at the beginning of the season, not just seeing it from rear mirror. They should make informed decision to pursue profit. By pursuing profit, they can think about how to achieve high productivity. They can analyze the profit/loss, think why to use herbicide, hybrid maize. Before, they just try their luck and calculate from rear view perspective."

CAC's assistant regional manager, Edwin Mseteka, ran two FFS experimental projects last year in the Chipata region, and each of those projects had about 27 graduates. The FFS experiments lasted from October 2015 to May 2016. He conducted three field demonstrations as part of the projects, one using the old practice, one with IPPM, and the other mixing both methodologies. Although farmers did not have information about IPPM before, they have since learned that they can save more time and money on spraying pesticides by conducting inspections before proceeding with the application. Mseteka hopes to continue doing FFS next year. He believes support for farmers will produce more cotton and stimulate the industry to grow. In his view, FFS is one of the best training programs because it involves farmers' participation and emphasizes practical knowledge. Since Chinese managers see the benefits of trained buyers in other firms, they are also starting to think about training.[30] Before, some Chinese managers were said not to care about training, but only about cotton. However, Jingran describes training from a different perspective, "CAC is willing to actively participate in various kinds of training activities, but COMPACI [a GIZ-run training program] did not accept Chinese companies. We have those farmers who grow relatively well demonstrate to other farmers."

Apart from extension staff CAC also employs around 100 workers, 85 seasonal and 15 year round staff, in the factory in Chipata which includes three workshops: ginning, oil extraction, and miscellaneous (cottonseed hulls processing, iron sheets, etc.) Most of the year round staff have been working for CAC for over 10 years. They learned how to operate the machines by following Chinese technicians while the machines were being installed.[31] Some needed one to two years of training while others only needed two to four months to learn the operation. For the most part, Zambian workers can run the factory without help from their Chinese counterparts, unless serious problems happen, which are very rare. During the three-week period the author was present in the factory no such issues occurred. Additionally, CAC runs the only cotton oil extraction plant in Chipata using only three Chinese technicians, two to alternate around the clock production supervision and a third is an electrician.

TRAINING IN CHINA AND CHINESE AID PROGRAMS

SINCE 2009 CAC HAS SENT DOZENS OF ZAMBIANS, including both its employees and officials, in several groups to train in China. The CAC itself has only financed one of these groups, a trip in 2012 to reward employees after a particularly good harvest. Agriculture Manager Bwalya, a regional manager, two route managers, and a buyer

were selected. During the two-week trip they saw how GMO cotton was widely planted as well as the use of acid-delinted seeds in China. The other trainings in China were part of the Chinese government's Ministry of Commerce (MOFCOM) aid-funded training programs.

A more recent MOFCOM sponsored trip in 2015, lasted two weeks and included four Zambians from the Cotton Board, the CDT, the Zambian Cotton Farmers Association (CAZ), and a factory supervisor from CAC, respectively. The focus of this particular trip was cotton planting technology training and included participants from Ethiopia, Ghana, Nigeria, Malawi, Pakistan, Sri Lanka, and Sudan, for a total of 40 trainees. In Beijing, they took part in classroom training sessions and visited demonstration fields. In Shandong, they visited the cotton research center in Jinan to learn about seed development. They also visited textile institutions in Xi'an. Gerald Kachali, from CAZ, observed how plastic mulch was used to preserve and distribute moisture. He acknowledged that while Zambians were in need of said technology, the investment and mechanization required made the practice beyond their reach but admitted the importance of knowing what kind of technology could be used in the future.[32]

Another form of Chinese aid is investment in the creation, construction, and operation of the Agri-tech Demonstration Center in Selima, Malawi. When the Chinese government looked for an enterprise to realize this center, CAC became the ideal candidate and was assigned the task in October 2011. Construction was completed in 2015 and ownership handed over to the Malawian government. It is currently operated by CAC, and as of April 2016 headed by a Ph.D. in Agronomy. Seed development is planned as an important function of the center, not only to support CAC business, but also to help the center achieve long run financial sustainability. "The main problem for the center is sustainability", Mou Zhengang, the Director of Agri-tech Demonstration Center, admits. The proceeds from the crops grown on their 50 hectare of land will not be enough to fund the centers' activities. Seed development has the potential, through expansion into other vegetable seed types, to sell seeds to other nearby CAC branches for a profit.[33] The center operates a seed-delinting processor (owned by CAC) and is pursuing research on cottonseed varieties together with the local cotton research station in addition to the training it plans to offer to local farmers and technicians. However, at the time of the field research in 2016, the center had not fully implemented these training and research activities.

COMPARISON WITH CARGILL

AS COMPETITORS IN THE SAME REGION, CAC AND CARGILL have a great deal in common in terms of extension services, but also many strategic differences. A comparison between their extension and training systems reveal CAC's characteristics more clearly. As noted before, Cargill has been operating in Zambia longer than CAC and its business size is also much larger. Inherited from Lintco, Cargill operates hundreds of permanent stations for seed and input distribution as well as for

purchasing cotton and other crops in Zambia's East Province. Cargill has also contracted a large number of established cotton farmers who previously grew cotton for state-owned Lintco. According to Yang Yitong, manager at CAC Zambia, farmers trusted Lintco, particularly farmers with larger parcels of land (5 ha or more). Even after the privatization of Lintco many local farmers have remained loyal to the corporations, like Cargill, that took its place.

Each of Cargill's permanent stations has a full-time buyer, with more responsibilities than CAC's part-time buyers. Not only do they buy more crops, such as maize, soybean, and sunflower seeds, in addition to cotton, but they also cover more farmers than CAC buyers. In the Vubwi region, for instance, a CAC buyer deals with a maximum of 45 farmers while a Cargill buyer contacts upwards of 200 farmers. Since Cargill buyers earn a consistent monthly wage, reportedly 1800-2200 ZMK (USD 180-220) or two times more than the average wage in the region, they are very motivated. Each buyer has a motorbike and works with several more contact farmers who also have bicycles, all transportation being provided by Cargill. As for CAC, buyers usually only receive a year-end bonus and use bicycles instead of motorbikes, while contact farmers are responsible for their own means of transportation. In general, CAC buyers are not as devoted to their work as are Cargill's. Many local farmers apply for positions as buyers with Cargill, allowing Cargill to be highly selective when reviewing applicants' education and experience. This is a luxury CAC cannot afford. Some of CAC's buyers have only seven years of formal education compared to Cargill, which requires a minimum of 12 years education and sometimes even a diploma. CAC's regional management agrees that buying is a large problem for them.

"According to Dafulin Kaonga, Zambia Cotton Board CEO, "The change of investors from different countries just happen at the top. Operating people on the ground are moving around among companies, they keep the old practices. Thus new Asian investors do not appear very different from old ones."

Furthermore, Cargill provides its buyers with a weeklong seeding, planting, and pest management training at the beginning of the season, October to November, and a shorter training on harvesting, April to May. Meanwhile, CAC only provides a one-day training for buyers on planting and seeding and another one-day training on harvesting and loan recovery. Cargill also trains their managers in-house so they can learn the use of chemicals and agricultural practices in detail to then teach to farmers. While at CAC, technical issues are just briefly mentioned during the one-day trainings and lack follow-up.

During the 2015-16 season, Cargill purchased cotton, maize, soybean, and sunflower seeds. This not only helps Cargill attract more farmers to sell their products, but also makes it possible to instruct them on general crop management. Farmers are taught to rotate plantations of cotton, maize, soybean, and others in different land slots. They are also advised to plan the land size of each crop according to the market situation. Consequently, Cargill has a large influence on the size of cotton plantations. In Jingran's view, Cargill, as well as NWK, are able to run multiple crops because they have an extensive network of crop trade in neighboring countries.

Although cotton is still Cargill's anchor crop, farmer training has also evolved into a more integrated process. A main problem of the outgrower scheme is that farmers often cannot repay their loans after investing in technologies. To address this problem, Cargill has recently begun to promote the Farmer Business School. Emmanuel Mbewe,

"CAC did not have extension before, they found FFS very effective, seeing volume of production up. CAC was the first to build oil extraction plant and the first to introduce acid-delinted seeds in Zambia. They are clever at business model, but do not invest in extension."

Cargill's Project and Public Relations manager, explained how, "The school helps farmers look into business, help them think at the beginning of the season, not just seeing it from rear mirror. They should make informed decision to pursue profit. By pursuing profit, they can think about how to achieve high productivity. They can analyze the profit/loss, think why to use herbicide, hybrid maize. Before, they just try their luck and calculate from rear view perspective." By contrast, CAC addresses loan repayment problems in a more limited way, by de-incentivizing the use of and reducing access to expensive inputs such as weed killers and fertilizers.

Cargill joined the Competitive African Cotton Initiative (COMPACI) in 2009, a collaborative effort between the private sector, the Bill & Melinda Gates Foundation, and several German development organizations. Through this partnership, all the areas where Cargill sources cotton in Zambia are enrolled in the program, covering about 70,000 farmers. It works directly with smallholder farmers through more than 1,600 training schools, Cargill Cotton field schools, to enhance their skills and farm operations by instructing them in how to improve land preparation and soil management, plant crops at the right time, and use fertilizer and pesticide safely and efficiently.[34] Mbewe pointed out, "Cotton never stands alone-- it deals with the integration of food crops and can improve household food security." In 2011, Cargill became a verified Cotton Made in Africa (CMiA) partner, an Aid by Trade Foundation initiative and a partner of COMPACI, aiming to promote a brand for socially and environmentally sustainable cotton in retail outlets worldwide with the CMiA brand.[35]

Although Cargill has a company-wide farmer training policy, the training method is country-specific.[36] It often gets hybridized through COMPACI's international experience with countries like the Philippines and Ghana. COMPACI organizes exchange visits from Benin, Burkina Faso, Cameroon, Malawi, and Zambia. Every year there is a 200 participant COMPACI stakeholder conference in Zambia for the exchange of technological development and shared experiences. The cost of the whole program is shared between COMPACI and participating firms. Although Cargill does not disclose its exact investment, COMPACI spends approximately US$2 million per year in Zambia.[37]

However, Mbewe criticized the Farmer Field School sponsored by the Zambia CDT and FAO because it only lasted for two years and had no follow-up. Cargill does not know how much funding was spent in the FFS program either. By comparison, COMPACI works directly with Cargill and Cargill "can check why something is happening or not happening."[38] Cargill's training also uses an advanced level of technology. Its own Field School has already been teaching Integrated Pest Management (IPM). Therefore, when the FAO promotes IPPM, Cargill just needs to add planting to the IPM protocol. By comparison, CAC only takes part in one FFS training program, and is very inexperienced in this field.

Cargill has also established more than 800 Women's Clubs throughout the country to make sure women have access to training and extension services. "Since previously mostly male farmers came to the cotton schools, the women clubs are established for women to exchange and learn so that the firm can attract more farmers," explained

Rosalia Daka, Cargill's Gender Mainstreaming Officer. Although CAC does not have similar organizations it does try to attract farmers by playing movies, offering free meals, and holding other social activities.

DATA ANALYSIS AND SURVEY

This section aims to illustrate the patterns of CAC's technology diffusion and their effects through quantitative analysis. The correlation between land size, input, training, other factors and productivity will be examined and presented with data collected during field research. First, we observe the growth rate in terms of number of contracted farmers, the amount of cotton harvested, and the average yield per hectare for CAC and Cargill from 2010-2016. The statistics below do not show a consistent trend during this period.

From the table below, we can see that average yields per hectare have been fluctuating over the past seven years for both firms. Jingran considered drought to be a main reason for the drop in yield in recent years and pointed out that both firms are likely to underreport their actual yields. Likewise, Wolfgang Bertenbreiter, the GIZ director of the COMPACI program in Zambia, noted that yield improvement is difficult to measure in Zambia due to the lack of reliability of the figures reported by the firms. Mbewe attributed the decrease of contracted farmers to "world market price distortions". The price of cotton peaked in 2011, attracting a large number of farmers to grow cotton in 2011 and 2012. Yet, cotton prices were almost halved in 2012, disappointing many farmers with some retiring from the cotton industry entirely after the price plunge. The Zambian government has also utilized an incentive scheme to encourage work in other commodities like maize, creating fierce competition between various crops.

CAC lags behind Cargill in terms of overall size and productivity. Yitong, manager of CAC Zambia, believes the main reason for this is that more large farmers sell to Cargill, namely those with cotton growing areas of more than five hectares. Large farmers know cotton planting better and are unlikely to partake in side selling - breaking their contract to sell to other ginneries. In his words, "one large farmer matters more than ten small farmers." CAC has very few farmers growing more than five hectares of cotton. Among CAC's 1,675 contracted farmers across three regions, only 11 farmers met the criteria. However, this view does not seem to be supported by the data. Out of the 11 the author was able to interview three and obtain their yield data. Even among these three, productivity appears to diverge widely. One reason is that the farmers do not only grow for one firm-- these particular farmers sold cotton to two firms. Between 2015 and 2016, CAC delivered chemicals late so farmers had to get pesticides and other inputs from Grafax and Cargill. Consequently, they did not sell all of their cotton to CAC. In addition, side selling is also a common phenomenon. For example, some farmers only received a small amount of cottonseeds from a company, but after harvest sell much more cotton to the company in order to get slightly higher prices or other kinds of material rewards like food and utensils.

Table 3: Cotton production and productivity 2010-2016

	CAC			Cargill		
Year	No. of farmers	Purchased seed cotton (mt)	Avg. yield (kg/ha)	No. of Farmers	Purchased seed cotton (mt)	Avg. yield (kg/ha)
2010	N/A	N/A	N/A	36,487	19,140	443
2011	20,197	11,401	424	63,465	42,768	617
2012	64,413	27,650	450	95,005	78,311	655
2013	40,532	11,700	205	60,743	23,800	296
2014	43,000	9,055	259	54,000	21,987	466
2015	24,585	7,500	250	62,905	23,479	350
2016*	37,055	12,085	380	43,528	20,702	450

*2016 figures are estimated

The author conducted field research in six villages in the Chipata region to compare growing patterns and production outcomes between 492 CAC contracted farmers for 2015-16. The purpose was to understand which factors might influence technology transfer and productivity in cotton farming. First, there is an overview of the size and outcome of each village. The number of contracted farmers is based on the number of seeds distributed to the farmers with one bag of cottonseeds being roughly equivalent to one hectare of planted cotton. The author acknowledges the limitations to using this proportion given that it is likely not all farmers planted cotton in the instructed proportion. Village K2 was unusual because CAC closed down this depot the previous year due to strategic adjustments. It was reopened for the 2015-2016 planting year, but it takes time to regain farmers.

For various reasons, when looking at the productivity of these villages, not all contracted cotton was sold to CAC. Some farmers did not plant well while others harvested late, or had delays in delivering cotton to the buyer, and yet other cotton income was missed due to side selling to other firms. Some farmers complained that CAC did not distribute chemicals in time during the 2015/16 season and thus turned to other firms for supplies, causing yet more side selling. Due to climate and transportation variations, the harvest season can last from May to early September.

Table 4: Comparison of Cotton Produced by CAC's Large Farmers

Name	Region	Cotton Planting Area (ha)	Total Cotton Sold to CAC (kg)	Average Yield (kg/ha)
AAA	Lundazi	6	6,205	1,038
BBB	Lundazi	5	3,400	680
CCC	Chipata	5	948	190

Source: Author's interviews

Data was collected in the middle of August, when 80% of the cotton was estimated to be delivered. The following table counts the number of farmers within the surveyed villages who sold cotton to CAC as of August 2016 as well as their average yield. The proportion of contracted farmers who sold cotton to CAC (named effective farmers) varies largely among villages. This figure indicates the average yields of the farmers who finally sold cotton to CAC.

The reasons for diverging average yields are complicated. Some include uncontrollable factors like soil fertility and climate change. The factors that can be influenced by firms, according to Jingran, are cottonseed quality, field management, and inputs such as usage of chemicals. Since all of the contracted farmers use the same CAC provided seeds, this factor can be omitted in the analysis. The field management and the input amount depend on individual farmers, but the buyers of each village play an important role in influencing farmer behavior. For example, village M1's buyer considered himself to be contributing to the high average yields of the village, but it was also the village with the highest level of input investment per hectare. Both factors are possible reasons for M1's high productivity.

Table 5: Overview of size, outcome, and productivity

	Number of Contracted Farmers	Cotton Planting Area (ha)	Total Cotton Sold to CAC (kg)
Village C1	95	111	19,196
Village K1	114	171	33,510
Village M1	86	107	28,701
Villlage C2	62	117	13,744
Village K2	38	56	3,368
Village M2	97	149	31,981

Source: Author's calculations based on CAC data

As mentioned before, CAC has a standard input package for contracted farmers. In 2016 the package consisted

of the following for each hectare of plantation: one 8 kg bag of cottonseeds (45 ZMK); one 500 ml bottle of pesticide (45 ZMK); one bottle of fertilizer for wollen (20 ZMK); one bottle of aphicide (15 ZMK). Although aphicide is optional, over 80% of contracted farmers in the survey purchased it. Input packages are distributed to farmers through their corresponding buyers during the growing season. Both the costs of inputs and seeds are then deducted from the payout after the farmers have sold their cotton back to CAC. In addition to the standard package, farmers may request weed killers, sprayers, and ploughs according to their need.

Input cost difference is mainly due to the usage of optional inputs like aphicide, weed killers, and ploughs. Particularly, the researcher found that usage of weed killers made the biggest difference. Weed killers can save farmers the effort of cleaning weeds and allowing cotton to grow faster and larger. Yet it is relatively expensive, costing 75 ZMK for a 500 g package, which is just enough for half a hectare. In addition, the use of other optional inputs may also contribute to the yield increase. From Figure 5 we can see that there is a correlation between input per hectare and the average yield per hectare among the villages surveyed.

Table 6: Overview of Effective Farmers

	Number of Effective Farmers	Effective Farmers as Percentage of Total Contracted Farmers	Cotton Planting Area (ha)	Total Cotton Sold to CAC (kg)	Average Yield (kg/ha)
Village C1	62	65%	70	19,196	274.23
Village K1	82	72%	121	33,510	276.94
Village M1	44	51%	53	28,701	541.53
Villlage C2	23	37%	37	13,744	371.46
Village K2	10	26%	15	3,368	224.53
Village M2	63	65%	90	31,981	355.34

Source: Author's calculations based on CAC data

Other firms like Cargill provide fertilizers on loan, but CAC does not. Although fertilizers are commonly used in China and can significantly raise yields, they are expensive, with one hectare requiring over 2,000 ZMK worth of fertilizer. Chinese management is reluctant to give fertilizers to farmers out of concern for repayment

Table 7: Input Comparison

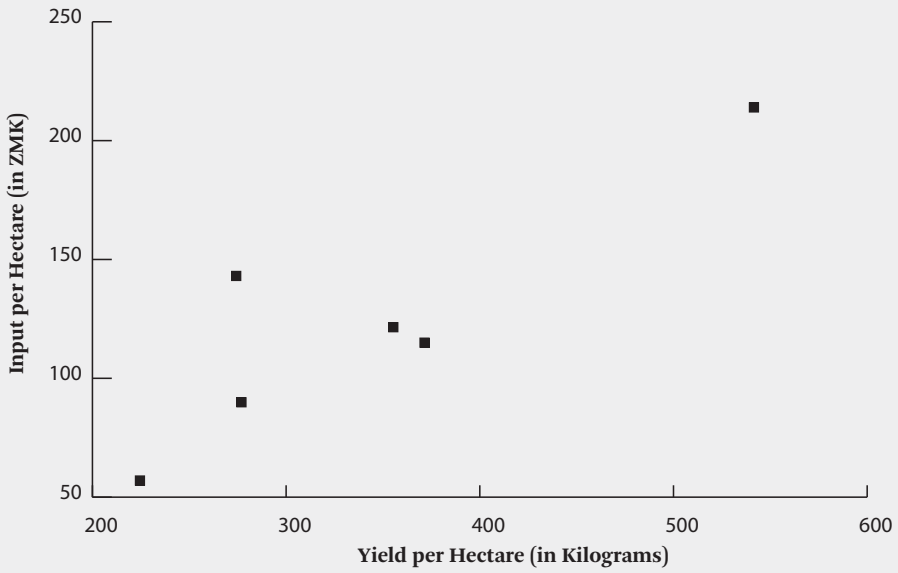
	Total Input Loan (ZMK)	Number of Effective Farmers	Cotton Planting Area (ha)	Input per Hectare (ZMK)
Village C1	10,015	62	70	143.07
Village K1	10,880	82	121	89.92
Village M1	11,340	44	53	213.96
Villlage C2	4,255	23	37	115.00
Village K2	855	10	15	57.00
Village M2	10,935	63	90	121.50

Source: Author's calculations based on CAC data

risks.[39] As such, CAC does not encourage the use of more inputs to raise productivity. A main concern is that increased productivity may be too expensive, making it harder for farmers to repay costlier loans. Even though Village M1 had the highest yields, the regional manager harshly criticized the buyer for giving out too many loans, as only 44% of the loans were recovered. According to another regional manager, farmers usually ask for more inputs than they really need because they can sell extra chemicals to other farmers and not pay back their loans to increase profit. This case shows how commercial consideration strongly influences the application of technology in farming practice and productivity. The technical constraint in Africa is not purely a matter of knowledge and equipment, but to a large extent linked to farmers' general economic difficulties.

In three villages, the researcher was able to distinguish new farmers contracted for the first time versus older farmers who had been contracted with CAC longer (see table below). Comparing their average yields, we cannot see a clear trend indicating a correlation between experience and productivity. While the old farmers in village C1 had a much higher yield than the new farmers, the situation was reversed in village K1. In village M1, old and new farmers had almost the same yields. A main reason for this is that new farmers are not necessarily first-time cotton growers. Quite a few of them moved from other firms to CAC, already having the necessary knowledge and experience. Therefore, their productivity is not always lower than that of old farmers. Moreover, the so-called old farmers did not show more commitment to the firm. For

Figure 5: Correlation between input and yield per hectare



Source: Author's Field Research

instance, in village M1, only 41.5% of contracted old farmers sold cotton to CAC and in village C1 and K1, the percentage of old farmers who sold cotton was 61.9% and 72.3%, respectively. By comparison, the rates of newly contracted farmers who sold cotton were 75%, 70%, and 66.7% in village C1, K1, and M1. Low commitment rates suggest that side selling may still be common among farmers and that farmers may frequently be moving between companies. The frequent change of contracted farmers discourages firms from investing in more training for the farmers.

CONCLUSION

In conclusion, the CAC case study has shed light on the complex role of a Chinese firm in the technology transfer process. CAC has a clear interest in promoting the productivity of local farmers, as profit directly correlates with how much cotton they export. However, CAC's approach to increase productivity is quite different from other multinational firms in Zambia as well as other firms in China. CAC did not appear to put an emphasis on extension training, as Cargill did. Thus it has left the impression on some Zambians that CAC is solely interested in making money, and not in training in using technology. In referring to Chinese managers, a CAC regional manager commented that they, "Did not want training, but only want cotton." Zambian governmental official likewise noted, "They are clever at business model, but do not invest in extension."[40]

However, interviews with Chinese managers reveal that they think about technology transfer in a different way. Seeing that Zambia has a completely different socio-economic context from China, Chinese managers decided to start with another element of productivity growth, seed quality. CAC became the first firm to successfully introduce acid-delinted seeds to Zambia and Malawi. CAC also brings cost-efficient

Table : Comparison between New and Old Contracted Farmers

	Total Number of Farmers (Cotton Planting Area in ha)	Number of Farmers who Sold Cotton (Cotton Planting Area in ha)	Total Cotton Sold to CAC (kg)	Average Yielld (kg/ha)
Village C1				
New Farmers	24 (28 ha)	18 (22 ha)	3,498	159
Old Farmers	71 (83 ha)	44 (48 ha)	17,253	359.44
Village K1				
New Farmers	20 (25 ha)	14 (16 ha)	6,246	390.38
Old Farmers	94 (146 ha)	68 (105 ha)	27,264	259.66
Village M1				
New Farmers	33 (43 ha)	22 (29 ha)	15,517	535.7
Old Farmers	53 (64 ha)	22 (24 ha)	13,184	549.3

Source: Author's calculations based on CAC data

chemicals to these countries. Currently, CAC is working alongside the agri-tech demonstration center on improving seed varieties. Given these contributions, CAC has indeed significantly impacted the technical improvement of local cotton sectors.

Table 8: Loan Recovery Rate

	Total Input Loan (ZMK**)	Input per Farmer	Total Loan Recoverd (ZMK**)	Loan Recovery Rate (%)
Village C1	14,045	122.13	11,306	81
Village K1	14,450	126.75	10,381	72
Village M1	20,605	239.59	9,065	44
Villlage C2	12,270	197.90	3,950	32
Village K2	2,970	78.16	1,250	42
Village M2	15,425	159.02	8,529	55

Source: Author's calculations based on CAC data

Another impact of CAC on the technical development of the cotton sector is its vertical integration of the value chain. In the direction of upstream integration, CAC runs seed processing and plans to establish a seed company based out of the agri-tech demonstration center. In the direction of downstream integration, CAC was the first company to build oil extraction plants in both Zambia and Malawi. These plants add value to the cotton sector. Moreover, CAC plans to set up textile mills in each country of operation, which will greatly elevate industrial capacity.

CAC's business model is not yet fixed, in fact evolving very quickly. Within six years, CAC has grown from a sole ginnery with outreaching agents into a firm with tens of thousands of contracted outgrowers, and is now a comprehensive multinational business with an integrated value chain. CAC experimented with various possibilities to properly adapt to the local context, with the evolution of CAC's business model creating three distinct characteristics.

First, CAC is open to adopting existing systems and practices in Africa and is willing to take advice from local managers. Without any similar experience in China, CAC built its own extension team by recruiting Zambian managers and buyers with Chinese management mainly monitoring and auditing the extension system as a whole. The division of labor is broken down according to comparative advantage. The Chinese are familiar with machinery and chemicals, are responsible for acquiring them, and are also knowledgeable about the export market. Meanwhile direct engagement with local farmers is lead by Zambian managers with decades of field experience. The main challenge in this division of labor is the connection between Chinese and Zambian managers. Being quite ignorant of farmers' planting practices, Chinese managers are not interested in farmers' training. Instead, they focus on the ratio between input and output. Although Zambian's can suggest changes in chemical usage or training schedules to management, they often find Chinese managers uninterested or slow to put recommendations in action.

The second characteristic of CAC's business model is that they are very cautious about cost control and cost efficiency. Starting as a small private business, CAC did not make large investments upfront. Even with an investment from the China-Africa Development Fund, its strategy remains unchanged. Unlike Cargill, CAC does not pay high wages to hundreds of buyers, but prefers to award buyers post-hoc bonuses to avoid risk. When CAC saw competition increase and limited production potential in Zambia, they quickly took measures to streamline its buyer team and cut inefficient departments. CAC does not provide expensive chemicals like fertilizers to the farmers, either. They makes full use of the materials they have, for instance, selling cottonseeds after extraction to farms as feed for animals and selling cottonseed hulls to a Chinese company for growing mushrooms. According to Jingran, CAC is in good financial condition and is one of the few profitable Chinese agricultural investments in Africa. He believes his firm had a higher profit margin than its multinational competitors like Cargill and NWK because of strict financial discipline. However, in the eyes of a Zambian manager, the firm can still improve the allocation of financial resources into

extension programs for better results. "Cheap is expensive. We should not cut route managers as the Chinese suggested, because business must have people to control it."[41]

Third, being "frugal" on its own investment, CAC seeks financial resources from various external partners to help business and technology transfer. The largest support comes from the Chinese government. The agri-tech demonstration center is set to play a strategic role in developing better cottonseeds and training technicians for CAC firms in the region. CAC has sent several groups of its own local employees as well as related African government officials to China through training programs offered by the Chinese government. Although the contents of the training programs turned out to not be very pertinent, the trip to China was perceived as a reward for the best performing employees and a helpful tool to enhance CAC's communication with local government. With CADF as a shareholder, CAC is also able to easily access loans from the China Development Bank. Its plans to establish textile mills are also linked to the government's capacity cooperation initiatives and financial support from the Chinese EXIM Bank and the China Development Bank.

Moreover, CAC has learned to gain support from international institutions and local governments. While it was not included in the COMPACI program, it actively participated in the Farmer Field School training organized by the Zambia CDT and funded by the FAO. CAC was also in discussions with UK Aid Direct to take part in its Malawi Oil Sector Transformation program.

Although CAC and other multinational firms have different business models and different approaches toward technology development, their impacts on technical improvement in the local cotton sector are interrelated. According to Dafulin Kaonga, Zambia Cotton Board CEO, "The change of investors from different countries just happen at the top. Operating people on the ground are moving around among companies, they keep the old practices. Thus new Asian investors do not appear very different from old ones."

A researcher on the Zambian cotton industry, Stephen Kabwe, has not found a significant difference in farmers' output between ginners either.[42] His explanation is that farmers keep moving around and no company can maintain farmers. This view is confirmed by the researcher's interview and data analysis above (see Table 8). The statistical difference of productivity between CAC and Cargill, indicated by Table 3, may be influenced by various other factors, such as input amounts, soil conditions, and experience. It cannot reflect different impacts foreign firms have on the productivity of the same farmers.

Cotton farmers perform better than non-cotton farmers in learning new technology and increasing productivity, because they receive instruction and assistance from private firms.[43] Non-cotton farmers rely on local government's technical extension efforts, which are not as efficient and rigorous as that of private firms. Various business models and training approaches used by the ginneries formed a synergism to promote technology development in the cotton sector.

However, the outgrower scheme has constraints in promoting technical development, no matter where the firms are from. Not only do the inputs used depend

on the firms' choices, but also the firm may intentionally discourage the use of certain expensive inputs to reduce risk. Consequently the technology taught in this model is primarily about "producing more with less" rather than greatly raising productivity. That means that cotton production in Zambia will not see significant changes within the next few years. Cotton will still serve as a complementary income for farmers with the farmers' economic liability gradually improving. It is unlikely Zambian farmers will reach a productivity level comparable to that of Chinese farmers under the outgrower model.

Some Zambian cotton farmers have already seen the problem of dependence on foreign investors and would like to establish their own enterprises to derive more economic benefits. To this end, the Zambian Cotton Farmers Association (CAZ) created the Mumbwa Farmer Ginning and Pressing Company (MFGPC) in 2011 to become the sole Zambian owned ginnery. The Zambian government has designated in total 14 million ZMK (US$1.4 million) in support as of August 2016. Among all the foreign ginneries, CAC was the most cooperative and supportive of the project. As MFGPC has not yet multiplied its own seeds, it had to buy seeds from other ginneries. Yet, most ginneries refused to sell them seeds and they were only able to buy cottonseeds from CAC and another Chinese ginnery, AGDC, in the 2015-16 season. "They are the only one which understands us," said Joseph Nkole, National Coordinator of CAZ. However, CAC managers did not consider MFGPC to be a promising project for local cotton development. They believe that the politically driven enterprise, which aims to break the buying price consensus of foreign ginneries, might instead interrupt the market. That is why most ginneries refused to cooperate and CAC only sold a limited amount of seeds to MFGPC as a courtesy.[44]

In the end, the transformation and technical development of the agricultural sector is a slow process. As a Zambian manager of CAC described teaching new tillage skills to replace traditional tillage: "it takes long to change people's mind. My grandma will still continue doing things in the traditional way. Only when the children grow up, they may change. Old men change gradually." While agricultural production customs may take generations to change, skill learning in factories usually takes place more quickly. Hence, CAC's plan to set up textile mills in Southern Africa may initiate a new wave of technology transfer on a much larger scale. Related large-scale industrial projects may dramatically alter the socio-economic structure of the region. The role of CAC in Zambia's technology development is yet to be defined further. ★

APPENDIX A

FINALLY, THE RESEARCHER DID A SURVEY AMONG 48 CAC CONTRACTED farmers who were randomly selected from various villages to evaluate their opinions about CAC's benefits and shortcomings. From the below results, we first see that an overwhelming majority of farmers liked CAC's cash payment method. Farmers need hard cash badly and a payment delay can cause them serious problems. Since 2013 Cargill, NWK, and Continental have introduced an electronic system whereby they transfer money to the buyer via mobile phone three to four days after acquiring the cotton and farmers then have go to the buyers' depot to collect money. It may take farmers several weeks to receive cash in hand. Since most farmers do not have phones themselves, the money cannot be sent to them directly. Such a system can reduce fund embezzlement and cheating in cotton buying, but the farmers do not like it. They need money immediately and do not want to walk a long way, often several hours in the mountains or jungle, for their payout. Moreover, as the government also does not pay cash directly to the farmers for maize purchase, many farmers depend on cash income from cotton sales to pay their children's school tuition fees. It is said that some farmers contracted to other firms also sell cotton to CAC through their relatives to get cash. Several other Asian cotton firms also pay in cash and, together with CAC, they are all able to attract a lot of farmers through their flexible payment system.

Table 10: Survey Results among CAC Contracted Farmers

Response	Percentage
Benefits	
Cash Payment	95.83%
Good Seeds	87.50%
Digital Scale	72.92%
Cheaper Inputs	68.75%
Good Chemicals	60.42%
Quick Delivery of Chemicals	37.50%
High Price for Buying Cotton	20.83%
Shortcomings	
Not Purchasing Other Crops	66.67%
Delay of Input Distribution	60.42%
Insufficient Technical Support	47.92%
Low Price for Buying Cotton	35.42%
Not Delivering Incentives	33.33%
Fragile Tools	29.17%
Limited Supply of Chemicals	25.00%

Source: Author's survey

Farmers widely acknowledged the advantage of CAC's delinted seeds, citing the ease with which they can be planted. A CAC regional manager estimated that in general delinted seeds have a germination rate of 85-95%, whereas only 65% of Cargill seeds germinate. Consequently, CAC contracted farmers only need an 8 kg bag of seeds for one hectare, while a Cargill farmer needs a 15 kg bag for the same acreage. In addition to seeds, other CAC inputs are also cheaper than those of Cargill. A standard Cargill package of inputs in 2016 cost 260 ZMK, more than double the cost of CAC's package, which cost 125 ZMK.

A more serious problem regarding chemicals is delayed

delivery. As mentioned earlier, some contracted farmers had to use chemicals from other firms in 2016 due to CAC's late distribution of chemicals. The agriculture manager explained that it was a regional problem, rather than a firm-wide issue. The growing season may vary in different regions, and the delivery of chemicals in some regions may thus be late, while in other regions it will be on time and some roads may become inaccessible after the rain. The route managers need to calculate that and send the inputs there earlier.

Confirming the agriculture manager's assertion, a few farmers do consider CAC to be delivering inputs more quickly than other firms. CAC is actually the only firm that has its own transportation team, made up of 20 large trucks. All of the other companies hire trucks from external service providers. Even CAC needs to hire additional trucks during the busy season, but its own transportation team gives effective support when there is a shortage in the truck supply. Apart from delivering chemicals, trucks can also bring cotton back to the ginnery in time.

Another highly appreciated benefit of working with CAC is that the firm uses digital scales. This is clear for the uneducated farmers to see. All other firms use old-style arrow scales. A buyer recalled an instance when a new farmer sold cotton to him and the digital scale showed 96kg. When they used the arrow scale of another firm to verify, it showed only 88 kg. This convinced many farmers in the village about the digital scale's advantage.

A third of the interviewees mentioned that CAC failed to keep its promise several times. For instance, CAC promised to award one iron sheet to every 500 kg cotton sold two years ago, but not all of the farmers received the iron sheets in the end. Another time, because of a sharp cotton price hike during the season, CAC announced that it would give additional money to some farmers who sold their cotton earlier as compensation. The farmers reported that they did not receive the money either. The former general manager of CAC Zambia, Mr. Ma, changed policies every year and some promises were not fulfilled. "Cargill is better organized, when they say something, they don't change. They run with the promise to stabilize loyalty [of the contracted farmers], for they have computed the promise. CAC is building the loyalty. But failure to fulfill the promise of giving iron sheets causes damage."

As for the purchasing price of cotton, there is no clear indication of an obvious strength or weakness of CAC. Every year, the ginners coordinate each other's purchasing price through the CGA. Hence, the price difference between ginners is relatively small.

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