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Science, Technology, and the Politics of Knowledge: The Case of China's Agricultural Technology Demonstration Centers in Africa

XIULI XU^a, XIAOYUN LI^a, GUBO QI^a, LIXIA TANG^a and LANGTON MUKWEREZA^{b,*}

^a *China Agricultural University, Beijing, PR China*

^b *Research for Development Trust, Harare, Zimbabwe*

Summary. — Agricultural Technology Demonstration Centre (ATDC) has been considered as an alternative model to pursue sustainability of Chinese foreign aid to African countries in the new era. This paper attempts to examine the ATDC scheme, particularly focus on the knowledge construction at macro level of design and the knowledge encounter at micro level of daily operation based on the case studies in Tanzania, Ethiopia, Zimbabwe, and Mozambique. Our study finds multiple facets of the ATDC, i.e., the cleavage between the macro-level of policy design and micro level of implementation realities; the interplay between knowledge and politics, and appearance of possible alternative development pathways stimulated by ATDCs in African countries. The paper argues that even though the ATDC is a technology-centered scheme, it is inevitably a social and political process in implementation, resulting in the discontinuity of the policy results. With a whole set of ideas and imaginaries being delivered, frustrated, and negotiated, the ATDC creates a very different vision to the established CG system, or the western bilateral aid programs. As an embodiment of a “traveling technocratic rationality”, the ATDCs are important sites for negotiations over knowledge and politics, and the meanings of aid, investment, and development, as part of the wider playing out of China's engagement in Africa.

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Key words — aid, knowledge, encounter, technology, China, Africa

1. INTRODUCTION

China's increasing engagement in Africa has been widely commented on (Alden, 2013; Alden & Large, 2010; Brautigam, 2009, 2011; Kragelund, 2008; Monson, 2009; Reilly, 2012; Tan-Mullins, Mohan, & Power, 2010). Agriculture is a significant part of China's aid and investment program, with this sector highlighted as a priority (The State Council of China & Trade Cooperation, 2013). A central feature of China's agricultural engagement has been to undertake the transfer of technology, particularly through the 23 Agricultural Technology Demonstration Centers (ATDCs) across Africa. The ATDC has been developed as a new model of China's official agricultural technology aid to African countries since 2006. A central feature is to combine a business operation with the aid-funded project to ensure financial sustainability after the three-year technical cooperation period.

This paper focuses on the experience of these Centers as a lens through which to look at Chinese agricultural cooperation in Africa. Unlike other studies on China's agricultural cooperation that have focused on China's strategic objectives (Bautigam & Zhang, 2013; Hairong & Sautman, 2010; Ukaejiofo, 2014), this paper emphasizes the actual practice of implementation, and the dilemmas, challenges, and negotiations involved. The paper examines how certain narratives and perceptions of development and technology transfer are constructed, and how these emerge from a particular historical context in China. The paper also delves into the day-to-day experiences of project implementation, through the experiences—and what Long (2001, p. 243) terms “interface encounters”—of Chinese experts, their African counterparts and farmers involved in demonstration and training activities.

By switching from broad policy assessments to encounters, practices, and negotiations of knowledge (Lewis & Mosse, 2006a; Mosse, 2005), the paper contextualizes the politics of Chinese development cooperation, highlighting the dilemmas and pitfalls confronted. The paper is based on empirical data

collected in Tanzania, Ethiopia, Zimbabwe, and Mozambique, involving extended stays in the Centers and close ethnographic observation of their operations during 2013–14.

The article begins by reviewing China's agricultural science and technology (S&T) regime; and then reviews how an S&T-centered ideology and the corresponding modalities have been embedded into the historical evolution of China's agricultural aid to African countries. We present narratives surrounding the construction of the ATDCs, and also reveal the politics of technology transfer in ATDC operations. We then empirically analyze three aspects of the knowledge encounter between Chinese and African. The paper examines how and why the Chinese perceptions of agriculture and technology, demonstration and extension, as well as aid and development, are understood, practiced, and negotiated with African colleagues during the daily operation of ATDCs. We conclude by highlighting the implications of our observations for Chinese technology transfer in Africa.

2. THE AGRICULTURAL S&T REGIME IN CHINA

China has a long history of promoting agricultural development through technical extension based on small farmers'

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“trial-and-error” experiences. Agricultural technology has been central to China’s empire and nation building. “Farmer” was considered second only to “scholar” within the traditional Chinese social hierarchy, ever since the Spring and Autumn and Warring States Period (770—220 B.C.). Since the Han Dynasty (202—220 B.C.), hunger has been recognized as a cause of political turbulence, and the motto “food is the paramount necessity of the people” (*min yi shi wei tian* 民以食为天) has been taken as one of the major principles for governance (Wu & Zheng, 2004, p.79).

The first modern agricultural experimental farm was initiated in 1906. Soon afterward, each province set up its agricultural experiment farms for demonstrating and extending advanced “research-based” technologies (Yue, 1989, p. 425). Both Sun Yat-sen, the founder of the republic, and later Mao Zedong, paid high attention to food security through modern agricultural technology and firmly concluded that the fundamental reality of China is “a large population with relatively little (arable) land” (*ren duo di shao* 人多地少). The most promising solution should therefore be to rely on modern technology. The “Eight-Word Agricultural Constitution” (*nongye bazi xianfa* 农业八字宪法) was hence promoted by Mao via a strong central and command planning system (Jiang, 2013; Xu, 2004, p. 28).

An ideology of technocratic rationality, centered on technology-driven modernization has been central to China’s policy stance from the beginning of the twentieth century, despite regime changes. It was reinforced at the end of the 1970s in Deng’s era with the introduction of the private sector to diversify the public-financed S&T system. Reversing the bias against intellectuals during the Cultural Revolution period (1966–76), Deng Xiaoping enhanced the social and political status of intellectuals to pave the way for market-oriented reforms and a knowledge-based economy. He emphasized the key importance of S&T in pursuing agricultural development and national economic productivity: “the development of agriculture relies firstly on policy, and secondly on S&T. . . , but the solutions ultimately rely on science” (Deng, 1982, p. 17).

Accordingly, China has invested vigorously in an agricultural research and extension system, resulting in the biggest research system in the world in terms of staff members (Huang & Hu, 2004). It is highly concentrated on the high-productivity enhancement of staple-food varieties, including hybrid rice and farming instruments (Zhu, 1997).

China’s agricultural development can thus be seen as a process of expanding technocratic rationality. The success of China’s agriculture, often symbolized by feeding more than 20% of world population with less than 10% of the world’s arable land and a quarter of its per-capita water availability (Huang & Hu, 2004), is perceived as the result of technology change by both politicians and the public.

This dominant approach emphasizes the central role of state-backed science, technology, and innovation in promoting productivity enhancement and thus economic growth. Technical solutions are deemed to be the ideal entry point to stimulate a national development agenda, supported by a state-led apparatus, which is central to nation building and developing a common national identity. Today China’s S&T system—in agriculture as in other areas—is part of an increasingly diversified and dynamic system, especially following the introduction of market-oriented reforms. Given this rich and complex history, a key question is how this technocratic rationality, with its deeply embedded history and strong political associations, travel to Africa via China-Africa agricultural cooperation?

3. HISTORICAL EVOLUTION OF CHINA’S AGRICULTURAL AID TO AFRICA

China’s agricultural aid to Africa was initiated at the end of the 1950s, and intensified during the 1970s and 1980s due to diplomatic competition with Taiwan (Amanor & Chichava, 2016; Brautigam & Tang, 2009). The Chinese government realized the critical role played by agricultural technical aid in reviving China-African friendship, particularly in those countries that had received Taiwanese aid, as well as increasing global impacts more broadly (Jiang, 2013).

In 1971, China started to expand its aid in Africa to 18 countries and dispatched agricultural experts (Tang & Li, 2014). The technical aid aimed to help African countries to achieve “self-reliance” (*duli zizhu* 独立自主) and solve food insecurity problems. The “Eight-Word Agricultural Constitution” and collective farming, “*Dazhai* (大寨)”, both salient in domestic China during the 1950 to 1970s, were extended to African countries. Some African leaders visited *Dazhai* in China and adopted the model in their own countries; the most famous case being Julius Nyerere’s promotion of the Ujamaa Movement in Tanzania from the Arusha Declaration of 1967. In this period, close relationships were struck between China and newly independent socialist countries in Africa, such as Tanzania, as well as liberation movements fighting colonial rule. However, during the 1980s, the quality of Chinese experts became a problem, as selection was based on political criteria, such as their family and individual political background. This was later reversed, and the Chinese government started to emphasize technical expertise and training (Tugendhat & Alemu, 2016).

During the 1980s and 1990s, China’s agricultural aid to African countries stressed the technical and economic dimensions of the aid program and an emphasis on technocratic-centered operations emerged, although set within wider diplomatic and commercial objectives (Amanor & Chichava, 2016; Gu, Zhang, Vaz, & Mukwereza, 2016). This involved decentralizing and rationalizing the aid-governance structure, introducing feasibility studies and project management methodologies, inviting African co-funding, particularly for local operations, and promoting the participation of China’s companies and finance institutions. These refined aid modalities highlighting technical transfer supported by an apprentice system and the rehabilitation of dozens of former aid projects with joint ventures and contracts.

In the 2000s, this technocratic perspective on agricultural aid and development was pushed further with the initiation of the ATDC (Agricultural Training and Development Center) program. This was announced at the 2006 Beijing summit of FOCAC (Forum on China-Africa Cooperation) as a flagship program. Li, Tang, Xu, Qi, and Wang (2013) argue that the low productivity of African agriculture, particularly of its smallholders, explains the paradox of abundant land available coexisting with food insecurity in Africa. Technology transfer should therefore be the key element of China-Africa agricultural cooperation, they argue.

This point is echoed both in China’s key policy documents, such as “China’s Policy Paper on Africa (2006)”, as well as follow-up action papers of FOCAC, and African policy documents linked to the launch of the African Union’s Comprehensive African Agricultural Development program (CAADP) in 2003. It is also reflected in other international development programs, such as Alliance for a Green Revolution in Africa (AGRA) and the Millennium Villages program (Nziguheba *et al.*, 2010).

Building on a long history, a technocratic rationality has therefore been entrenched in China's agricultural aid to African countries. It prioritizes productivity improvement and economic development via technological solutions, highlights the leading role of the state in the national development agenda, and adopts an approach of close state-business linkage for development sustainability. In other words, China's aid policies and practices not only deliver specific particular technologies to Africa, but traveling with them as part of the aid encounter, Chinese development cooperation fosters the transfer of a wider technocratic development ideology, deeply rooted in Chinese historical experience. Technologies therefore travel from China to Africa not just as "things", but they are bound up with social, historical, and political meanings and implications. This reflects the ideological and political dimensions of technology transfer agricultural development cooperation. Technologies, initially constructed in particular Chinese settings, travel with these contexts, and so adopt a particular "rationality", that is at once technical, social, cultural and political, and embedded in historical experiences.

Yet, as with Western aid programs, the "technical fix" solution has encountered many challenges during the process (Scoones, Devereux, & Haddad, 2005). "Good practices" offering high productivity are not sustained when Chinese experts withdraw (Yun, 2000). Technologies that have worked well in China do not seem to offer the same benefits when transferred to Africa. The local contexts in Africa provide a continuous challenge to simple technology transfer models. Yet, the blame for failure is often attributed to other factors; for instance, unaccommodating African farmers. Wei (2011, p. 226), for example, comments: "The African farmers need a revolution on their mindset to accept Chinese technologies".

This paper probes this process and asks how historically-informed ideologies, and particular knowledge and power relations, construct the intervention, both in terms of macro-design and overarching policy, as well as in the micro-level forms of knowledge encounters that guide the intervention. In this way, we read the ATDC experience as the playing out of historically-constituted "traveling technocratic rationalities". As we show, when such rationalities arrive in particular places—four countries in Africa in this study—they take on diverse forms, and play out in different ways, dependent on the actors involved and on the encounters that emerge.

While a singular powerful view of Chinese aid exists, rooted in an historical narrative and a commitment to technological transformation, this can result in incongruous outcomes, as agency, power, knowledge negotiation, brokerage, and interpretation come into play. In important respects, this parallels experiences of Western aid programs (cf. Biggs, 1998; Lewis & Mosse, 2006a; Mosse, 2005; Mosse, 2011; Uphoff, 1992).

4. ATDC ORIGINS: THE "GOING OUT STRATEGY AND THE POLITICS OF TECHNOLOGY TRANSFER

ATDCs have been constructed in 23 African countries so far. The operation is basically divided into three stages. First, one to two years of infrastructure construction; second, three years of technical cooperation, followed by a third stage that is aimed at moving the operation to a sustainable financial footing, whereby costs are covered by the business operations of the Center. Although details vary in different countries, the most prominent feature is that the mandate is given to a company to run the Center. The Chinese government provides financial support for the infrastructure construction and the

technical cooperation element, with a total investment of US \$5–6 million for each Center. The companies contracted to run the Centers are expected to develop a sustainable model for their operation by the end of the three years of government support, in order to continue to provide the public goods of training, demonstration, and extension.

Chinese policy makers believe this business-based management model can serve as an effective instrument for pursuing aid sustainability (Gabas & Goulet, 2013; Gabas & Tang, 2014). Wei (2011, pp. 227 and 232), the former vice minister of the Ministry of Commerce (MOC), and an architect of the ATDC design, commented:

"Is existing international aid able to solve the food insecurity problem in Africa? According to my 36 years of observation based on China-Africa economic and trade cooperation work, I would conclude "Absolutely Not!"... Alternatively, I am assuming the ATDC is the best model to deliver Chinese agricultural technology to stimulate the local development... First the state can provide aid funds to support the center for several years, then the company should operate with autonomy via individual business or joint ventures. The seeds, fertilizer, as well as experts, can be supported in some way for some certain years until the center reaches long, stable and sustainable development."

In this way, "the government sets the stage, and the enterprises play the drama" (*zhengfu datai, qiye changxi* 政府搭台, 企业唱戏) (Wei, 2002). The business-based management model originated from two historical sources. During the 1980 and 1990s, there were some successful cases where market mechanisms were mixed with aid, such as the Mali Sugar Farm, Guinea Koba Farm, and Zambia Friendship Farm. As flagships of the Chinese aid legacy in Africa, their physical maintenance, with both Chinese and host country contributions, continues until today. This provided confidence that productive aid projects had their best chance of sustainability if Chinese partners with a profit motive were firmly involved as owners or leaseholders (Brautigam & Tang, 2009).

Second, China's market-oriented reform of its research and extension system aimed to promote the needs of small farmers and agricultural enterprises by distributing public support funds via competitive grants and focused research programs. The policy also encouraged researchers and extensionists to commercialize their research products and extension services, particularly for those easily translated into business opportunities such as seeds, fertilizer, and machinery, allowing them to retain profits and reinvest as a major source of revenue for their follow-up activities. Institutes-cum-enterprises (Huang & Hu, 2004) burgeoned and paved the way for the design and operation of ATDCs.

The state-business relations at the heart of the ATDCs' design is linked to China's "going out" strategy (Gu *et al.*, 2016). This was firstly coined by Deng in the 1980s mainly for promoting trade to earn foreign currency. It was not until the end of the 1990s that it was formally announced as one of the main national strategies, with the slogan of "fully utilizing both domestic and international markets and resources" (*chongfen liyong liangge shichang he liangzhong ziyuan* 充分利用两个市场和两种资源) (Chen, 2009).

Despite the achievements in raising domestic production in agriculture, food security was again becoming an area of great concern for China. The "going out" strategy thus encourages Chinese firms, including agricultural parastatals and state-owned companies, to invest abroad to increase global food supply, contributing to global markets, and thus ultimately improving Chinese food security capacities (Alden, 2013; Morton, 2012). According to one senior Chinese consultant who led the feasibility studies of ATDCs in seven African

countries, the criteria for establishment included a set of comprehensive considerations including regional advantage, foundations of agricultural technology development, agricultural resource endowments, and political stability (Chinese Academy of Social Sciences (CASS), 2013).

Internally, the choice of companies to run ATDCs involves multiple negotiations and a balance between the central government and provincial governments. At the central level, the MOC, in partnership with the Ministry of Agriculture (MOA), led the process of design, implementation, monitoring and evaluation, along with expertise support from affiliated think tanks.

As a nationally significant scheme, the promotion of ATDCs receives high-profile political attention. A national agricultural “going out” leading group was established led by the MOC and the MOA, with members from nine key ministries, commissions, bureaus, administrations and banks (Wei, 2011, pp. 237–238). At the local level, with an expectation of constructing an overseas platform for broader cooperation, each selected province has a strong motivation to encourage its leading enterprises (*longtou qiye* 龙头企业) to pioneer their businesses overseas, in addition to committing to the training, demonstration, and extension aid services required by the ATDC.

Following the guidelines for bidding delivered from the central level, the qualified companies submit their application to the province and finally are approved by the MOC and the MOA. To date there are a total of 21 undertaking units from 19 provinces working in 23 African countries. The ATDCs in Benin and South Africa are operated by the same state-owned enterprise; and those in Mali and Malawi are operated by one private enterprise. Among them, two are agricultural universities, two are agricultural research institutes, and 17 are enterprises, among which eight are state-owned companies and nine are private.

The ATDC is presented as an innovative model for China-Africa agricultural cooperation. The Center is focused on local agricultural development via technology demonstration and transfer, with land ownership in the hands of local technical cooperation partners. It is very far from the “land grab” of much media commentary. However, even though the ATDC is a technology-centered scheme, it is inevitably political. Both political interests and technical expertise interplay during the ATDC commissioning process. In China, the establishment of ATDCs involves negotiation between central and provincial governments, and between the state and different enterprises and institutes.

5. KNOWLEDGE ENCOUNTERS: ATDCS IN OPERATION

How do these broader politics play out on the ground? Policies and plans are always reshaped by different and unexpected factors, including the agency of different actors, their diverse logics, as well as quite particular forces and individual chemistries that play out during implementation (Mitchell, 2002). Messy practices are inevitable. In understanding development as practice, we always have to inquire the phenomenon of “disjuncture comes first”, or “the illusion of order” (Lewis & Mosse, 2006b).

During the field study period, the ATDCs were in their second phase of state-supported technical cooperation and were planning for longer-term, business-based sustainability. We stayed in the ATDCs with the Chinese team, following their

daily routines and observing training, planning, field trials, demonstrations and other activities. Such observations were complemented by interviews with Chinese team members and their African partners, exploring different themes. Table 1 provides a profile of the four ATDCs that we have studied.

Physically, the ATDC in each country is a compound combining both living and working spaces, normally including living rooms for Chinese staff, an office building, meeting rooms, close to which is sometimes located the dormitory for local trainees, and the demonstration area. The internal decoration and design of the building follow the Chinese style, often reflecting the character of the counterpart province in China. For example, in Tanzania, the ATDC was termed “made in ChongQing” (Yao & Wen, 2011). In Ethiopia, the office, training and living space were designed and constructed by a Chinese company from its counterpart province, Guangxi, mostly with materials imported from China.

The ATDCs in Zimbabwe and Mozambique follow the same character. Sizes range from 52 ha to 120 ha, with the major part for on-farm experiments and demonstration of crop varieties from China, sometimes with comparison with local varieties. Some cash crops, such as mushrooms, beans or other vegetables, and fodder varieties are also experimented with and demonstrated. Chinese agricultural machinery is displayed and applied in some pilot farms, representing examples of what ATDC managers described frequently as “China’s advanced agricultural technologies” and “modern agriculture”.

The ATDC is also a social and political space for China-African relations and development cooperation. Most are close to the capital city, making it convenient for political visits, study tours, and presentations. Presidents and responsible ministers along with Chinese ambassadors were often present at the “hand-over” ceremony to exhibit the high profile of the project. Senior officials on both sides frequently visit the Centers, with such visits widely reported in the public media or announced in intergovernmental gatherings. Various stakeholders, including African counterparts such as the MOA and the Ministry of Science and Technology (MOST), as well as the Ministry of Education (MOE), along with their local partners, Chinese companies in Africa, international development organization, researchers and students, extensionists and farmers, all visit the Centers.

Across our cases, the local Chinese operational team consists of five to 13 staff who are recruited for the project by the company or enterprise managing the Center. They come from different agricultural research and extension institutes, universities, companies, state farms, or government subsidiaries within the counterpart province. The internal governance of the team is rather loose and dynamic, though their positions are prescribed as production, sales, logistics for the business, on the one hand, and training, demonstration and extension for the aid program, on the other. The team leader in Ethiopia commented, “I am representative of Bagui just temporarily and will go back to the Department of Agriculture after the end of this cooperation phase.”¹

The team is coordinated by a man (they were all men, and there were very few women experts across the cases, see Table 1), with a senior title and experience in farm management, business operation, or aid management. He is normally in his 40s or 50s. The other team members are dominated by men with ages ranging from 20s to 50s. The majority of the team members cannot speak fluent English or French, or any African local language prior to the work. Therefore, most Centers recruit translators from China who are also, in the meantime, responsible for sales or local coordination.

Table 1. *Profile of four case ATDCs*

Country	Counterpart province in China	Undertaking unit (parent company)	Technologies on demonstration	Distance to capital (km)	Area (ha)	Local Chinese team leader and members	Local partners/ coordinator
Tanzania	Chongqing	An agricultural high-tech company, focusing particularly on seeds (<i>Zhongyi zhongye</i>)	Rice, maize, vegetables, layer feeding, machinery	240	62	The team leader is a senior professor of agronomy in his late 50s with ten years of overseas business experiences. The team consists of five to nine members, with ages ranging from 30s and 40s. Only one is female, who is the wife of one member, newly arrived in early 2014. They are mainly from Chongqing Agricultural Research Institute, and related companies and extension subsidiary. It is the first time for most of them to be abroad	The coordinator is the MOA at ministry level. The local partner is Chollima Research Institute, which is near the ATDC
Ethiopia	Guangxi	An agricultural high-tech company with comprehensive business (<i>Bagui</i>)	Maize, wheat, vegetables, fodder, mushroom, animal husbandry	86	52	The previous team leader used to work as a manager of an agricultural extension center. His successor (in his 40s), used to work in the provincial aid office, and has overseas experience and good English. There are around 14 staff who are all male and came to Ethiopia alone, without their families, with ages ranging from 20s to 50s. Most of them sign a contract of one year and a half and have a month's holiday at the end of the contract if they do not want to continue. Two of them used to work abroad. The team includes experts and translators	The MOA at central government level. Ginchi Ward government is the local coordinator. The ATDC has some informal exchange with Ambo Research Institute nearby
Zimbabwe	Anhui	An agricultural high-tech company, focused particularly on machinery sales (<i>Menoble</i>)	Agricultural machinery, potato, maize, wheat, bean	27	109	The team leader is a retired manager of a state-owned farm in China. He cannot speak English. There are around six to 10 members in the team. Only one woman. They used to work on state-owned farms as technicians or administrators, such as drivers or in the kitchens. Four of them can speak fluent English. The ages of the team members range from 20s to 50s	The MOA at the central government level. The local partner is Gwebi Agricultural College nearby
Mozambique	Hubei	Hubei nongken (Lianfeng Company)	Rice, maize, cotton, vegetables	28	52	The team leader used to work at a state-owned farm. He cannot speak English. It is his first time abroad. The team has six to 13 members, with only one woman, for cooking. Most of the others used to work on farms, and are in their 30s. A young staff member was recruited as translator and local coordinator	The MOST currently at central government level. Locally the Center collaborates with Umbeluzi Research Institute nearby

Normally, each member of the team is multi-functional to save costs and pursue the dual functions of both business and aid. For most of them, it is actually the first time to go abroad. They have worked as farm managers, workers, drivers, and experts on particular areas of agronomy, such as maize, rice, vegetables, horticulture, or livestock in China.

In an alien setting without their families accompanying them, they are often isolated from the local population, and working with a small group of other Chinese. Social life revolves around communal eating and cooking, as well as drinking. Some ATDCs have facilities such as table tennis tables (in Mozambique) and a swimming pool (in Zimbabwe).

Most of the time is spent at the Center, with occasional visits to local towns. The Internet is the main route to communication with their families in China. In discussions, many staff focus on their next home leave, which is usually offered once, lasting for a month every year. This social isolation and distance from home and family can result in tensions and depression. Sometimes, however, it also generates inspiration and ambition to contribute to local agricultural transformation. This engagement with local agricultural challenges is inevitably shaped by their backgrounds and perceptions of Africa, as we discuss in the next section.

6. CLASHING TECHNOCRATIC RATIONALITIES: NEGOTIATING TECHNOLOGY TRANSFER AT AFRICAN ATDCS

The above context shapes the encounters that influence how technology is transferred or how trainings and demonstrations are received. In the following sections, we outline how these “knowledge encounters” (cf. Scoones, Cabral, & Tugendhat, 2013) play out, drawing on examples from across the cases. We examine in turn different perceptions of agriculture and technology, extension and demonstration, and aid and development.

(a) *Agriculture and technology*

We start at the ATDC in Morogoro, Tanzania. Here a training for local farmers was proceeding on 18 March 2013. The topic was high-productivity Chinese hybrid rice. It was the second training session on this topic for this group of farmers. Rice is a high priority for the ATDC. The training was supposed to be presented by Mr. L, who was the rice expert in the team. However, due to language barriers, the training was instead presented by Mr. C, the team leader and the only one in the team who can speak fluent English. The English presentation was then translated by Mr. M, the Tanzanian coordinator from nearby the research institute, into Swahili for trainee farmers.

The training first introduced the importance of rice production, then compared the sharp productivity gap between Tanzania and China, with the former reaching a maximum of three tons per hectare, while the latter rises up to 6–12.5 tons per hectare. “The most important thing for agricultural development is high productivity (*gaochan* 高产)”, strongly emphasized Mr. C.

After presenting a set of comparison pictures, vividly showing the gap from the demonstration plot within the ATDC, he continued to explain, “Once you have Chinese hybrid rice varieties, you can certainly improve your outputs and income.” Then he started carefully to elaborate the technical procedures of rice cultivation from seeding to harvest. The lecture lasted for almost 2 h. The high productivity of rice was repeatedly stressed through the pictures of hybrid rice heavy

with yield and the broad green paddy fields in the demonstration area. The pride of the Chinese experts when comparing pilot results was very evident. This was China’s “technocratic rationality” on show in the fields of Tanzania.

However, this rationality was not as smoothly accepted by the Tanzanians as the Chinese experts expected. Mr. M, the local technical cooperation partner, commented “For rice, fragrance matters, rather than high productivity. Previously, we had many rice varieties with high productivity [from IRRI], but they all proved difficult to be extended to farmers.”² His point was echoed by Ms. M from the Tanzanian MOA, “Technically, Chinese rice varieties are really excellent. However, the rice is not so good as the local variety. . . Actually rice is not only perceived to be a kind of staple food, it has a special meaning in local ceremonies. Normally rice is consumed by middle-upper classes of Tanzania as it has a higher price. For ordinary people, maize is their first staple food, and rice can only be used in some holidays and festivals.”³ Such views were reinforced in discussions with farmers. Crops and food are deeply culturally embedded, associated with particular classes, and linked to particular ceremonies. This is very different to how rice is seen in China.

When this feedback was shared with the Chinese team, it was rejected. Mr. L, the rice expert, who said that this was just an excuse by the Tanzanian government to refuse Chinese hybrid rice. This was blamed by Mr. C, the team leader, on the government’s “franchise” policy and on the failure of the government to subsidize farmers. Mr. L concluded, “Now I realize that it is a mission impossible to extend the hybrid rice varieties here”.⁴ But the Chinese team leader was more optimistic: “We are trying our best to promote the process. It takes time.”⁵

Given the importance of maize in food security, why was rice emphasized in the training and demonstration? Mr. C explained: “Rice varieties are the core competitive products of our research companies. Since we are here to do the demonstration, we need to demonstrate the most advantageous varieties we have at hand. We actually do not have much technical advantage on maize production.”⁶ The logic behind the technology selection is clear: hybrid rice is the product that they hope to present and to sell, and the business venture of the ATDC is highly dependent on a market demand being created.

In our studies in Ethiopia, Mozambique, and Zimbabwe, this dilemma was also faced. Local officials appreciated the potential of China’s “advanced technologies,” even though they have low possibility for extension in an African context for the time being. An Ethiopian MOA official commented: “It is the future of Ethiopian agriculture, scale-production with infrastructure and mechanization, and we can’t stop at a backward production situation”⁷. In Mozambique the productivity of Chinese rice, breaking the records of the Portuguese, created a strong vision of “food self-reliance” for the government and farmers. However, the challenges remained of poor infrastructure, shortage of labor inputs, as well as inability of local farmers to buy the modern and expensive technologies. In Zimbabwe, for example, the Chinese team found that local farmers could not afford the large-scale machinery, which is their technical competitiveness and market opportunity, making them question the longer term commercial viability of their operation.

Obviously, a vision of modernization is shared by both Chinese and African officials, yet the practicality of its realization is challenged. A particular vision of agricultural development is projected by Chinese officials. Yet this is colored by commercial imperatives, and the need to make a profit from commercial sales of technology by the third phase of ATDC operation. This means that much effort is spent on creating

market demand, and sometimes inappropriate technologies are piloted and pushed, whether non-fragrant hybrid rice or large-scale machinery.

(b) *Extension and demonstration*

Demonstration and extension are the core functions of all of the ATDCs. However, what does demonstration and extension mean, and how should it be implemented on the ground? The understanding of Chinese and African partners differs. From the Chinese experts' perspective, the job of demonstration means that they need to do on-station comparison studies and pilot research, normally within the compound of ATDC, to present how Chinese technology will perform in an African context. It is a highly political task that is not simply about the demonstration of technology, but also the presentation of China's development miracles in Africa. Therefore, they try their best to create an enabling environment for technology performance to achieve the best results.

In the case of Ethiopia, it took almost a year for the team to find a proper place for the construction of the ATDC. They needed four wells to be dug with additional budget to ensure an irrigation system. Water, as one key element of "*Eight Word Agriculture Constitution*" (*nongye bazi xianfa* 农业八字宪法), is vital for demonstration from a Chinese perspective, although most Ethiopians have no irrigation capacity. In Tanzania, the team struggled to secure access to irrigation water. They tried various approaches, such as convening meetings with Tanzanian partners and reporting to Chinese senior officials during their visits. Mr. C, the team leader, commented, "Without an irrigation system, we cannot utilize the 50 ha of demonstration area. So we have to do the demonstration where we can provide the water."⁸

However, African partners' perspectives of the demonstration and extension function of the ATDCs presented another story. In Mozambique, a local researcher commented on the ATDC: "It is just a building. We have not yet seen much demonstration. They need to work closely with farmers outside the wall. The ATDC is presenting good results with irrigation systems and big-scale farming machines. However, local small farmers do not have these facilities."⁹ In Zimbabwe, local MOA officials and partners shared a similar complaint: "They should not forget why they are here; not for business, but for providing public services. To identify local farmers' needs and working with them are important."¹⁰ The Tanzanian coordinator also commented: "I think they are still doing research there. But we should remember this center is not a research center, but a demonstration center. The technologies should be extended outside the Center."¹¹

Yet Chinese experts thought that, once they completed the job of demonstration, local government or technological partners should lead the process of extension to farmers if they agree on the excellence of the technologies. In Ethiopia, Chinese experts at the ATDC complained about the low efficiency and under-performance of the extension department in mobilizing resources to promote the technologies introduced by the ATDC: "They always offer high praise to our technologies, but when we talk about how to extend it to farmers, there are always no follow ups at all. There are no co-managers from Ethiopia coming here, even though they said there should be someone here. I do not know why it was delayed again and again."¹²

As the end of the three-year, government-financed period approaches, the pressure is rising to find markets for the products, as well as to follow the adjusted guidelines of China's MOC and MOA to extend technologies to local farmers.

Chinese experts in turn have tried to explore ways to interact with local farmers. However, during the on-farm interaction process, Chinese experts have revealed their clashing perceptions of Africa on the ground. Mr. Q in Tanzania shared a similar shock during the extension process: "China has established relatively strong synergies among government, researchers, extensionists, and pilot farmers. But here I found things are different. First, an on-farm pilot is normally carried out by farmers themselves in China. But here I need to do it all by myself. Second, the extension work should be done along with local extensionists, but the local R&D system is very poor in terms of its effectiveness of disseminating technologies to farmers. Thirdly, the government has neither strong mobilization capacity nor substantial subsidy capacity to promote farmers in taking new technologies in big scale as we do in China."¹³ Similar comments were also made in Ethiopia, Mozambique, and Zimbabwe.

Technologies get transferred within wider and interacting systems of policy, extension, government support, and so on, and these cannot be just assumed to be similar. Across the four ATDC cases, the most frequently mentioned barrier for local participation is the *per diem* system, and the expectation that government officials and even farmers get paid by the Center. Prevalent across Africa, and fueled by aid programs, this practice with strong precedents was not considered in the planning and implementation of ATDCs. In China, good performance is promoted by strong state coordination, with the expectation of compliance with government-led projects. In African government programs, where mobilization capacity is poor with weak motivation and low pay, such compliance often fails.

(c) *Aid and development*

It is not only differing perceptions of agriculture and technology, as well as of demonstration and extension, that affect the way the ATDCs have been operating, but also more fundamental contrasts in the way that aid and development as a whole is imagined. As already noted, the ATDCs have a dual identity, as both an aid modality to transfer Chinese agricultural technologies to African countries and a platform to promote Chinese agribusinesses "going out".

In China there is a blurred boundary between aid and business projects (Gu *et al.*, 2016; Tang *et al.*, 2015; Xu & Xu, 2011). There is no special training for aid workers nor any aid think tanks to nurture and strengthen the aid industry in China. In other words, aid policy and practice so far have been more experience-driven, based on trial and error. Within such a context, it is not surprising to find that the ATDC's daily operations reflect a mix of these imperatives, with symbols and practices of "aid" mixed with "business".

The identities of the Chinese team are shaped by the activities they undertake, and reflect the tension between the commercial drive for profit and the aid mission of public service provision, such as training, demonstration, and extension. The conflicts among these diversified demands and expectations can result in challenges for ATDC operations on the ground. The Chinese team is concerned variously with technology appropriateness, market development, costs of operation, promoting Chinese diplomatic relations, cooperation with the host government, interacting with local farmers, and so on. All these professional roles, alongside the daily challenges of project management, have created high pressure on Chinese experts at the ATDCs.

For example, the daily routines of Mr. W in a week in Zimbabwe are very diverse.¹⁴ In one week they included

transporting potatoes to a local company, tackling the Wifi problem, and picking up visitors at the airport on Monday; making labels for on-station pilots in the office, supervising local women selecting potatoes on the farm, discussing the collaborative proposal with another Chinese company, shopping for coppers, discussing potential investment opportunities outside the door of the supermarket on Tuesday; painting the labels made the day before, cleaning up the apparatus store, checking the financial books, calculating the labor costs of the occasional workers, and preparing a training Power-Point on Wednesday; supervising local women selecting potatoes, putting labels out in the plots, checking financial books, going shopping, and sorting out the potato pilot results on Thursday; and arranging workers cleaning the Center, preparing the introduction material of the Center and acting a translator during the team leader's visit to the Minister of Agriculture in Zimbabwe on Friday. It is no surprise that he commented that his job was hard.

Additionally, the ATDCs are governed and supervised by Chinese government bodies from the central level, notably the MOA and the MOC, but also they are responsible to provincial governments, as well as to their parent companies. All have different priorities. The various meetings, directions, and official documents (such as management guidelines, indicators for monitoring and evaluation, and so on) can give conflicting messages. Mr. X in Zimbabwe commented: "Our Center is a very complicated institution. First, we have to fulfill the aid tasks of training and demonstration from the Chinese government; second, we need to make a profit to sustain the Center and meet the needs from parent companies in China; third, we are also required to serve the Zimbabwe government."¹⁵

The complexity of the tasks, and the apparent lack of commitment from local counterparts, can lead to frustration: "I do not feel comfortable to do the aid work here. It seems the local partners do not care at all. Who on earth needs the aid scheme? We or they?", commented Mr. X, a Chinese expert from Mozambique.¹⁶ A former head of one of the case study ATDCs reputedly retreated to his dormitory for several months before being returned to China by the company, so difficult did he find the situation. Mr. X in Zimbabwe also struggled: "I met some aid workers from the US. They worked with farmers directly, and they look very professional and know clearly what they are doing. . . however, I am stuck dealing with the minutiae of our daily lives and the farm operations. If I don't go to buy vegetables from the local market, we have no food for lunch. This is our reality."¹⁷

African counterparts have long experience of working with aid projects, of course, and assume that the Chinese interventions will be the same as those they are acquainted with. A Tanzanian government official commented: "I have rich experiences of collaborating with JICA [Japanese cooperation] staff who are particularly good at making detailed plans. They also provide support for *per diems* for participation. But here at the ATDC, they just tell you that there will be a training, then nothing else. That is probably because they are from a company."¹⁸ A Zimbabwe MOA official also commented: "They should have training planning, rather than commercial production. If they came here for planting potato, maize and soybean and only want to manage a thousand-hectare farm, they were totally wrong."¹⁹

The clash of different perceptions concerning aid and development between Chinese experts and African counterparts is central to the negotiation of the implementation of ATDCs across the four cases. Such encounters and negotiations around objectives, priorities, payments, and styles of working have of course happened before, with other aid projects, whether from Japan, Europe, or the US. But the Chinese experience in Africa is relatively new, and especially the particular form it has taken in the ATDCs, in particular the blurring of commerce and aid, presents new challenges for all involved.

7. CONCLUSION

This paper identifies three key elements of technocratic rationality that penetrate China's internal agricultural S&T governance regime, which has taken shape particularly in the last three decades of development. The approach to development focuses on technology transfer centered on productivity-enhancement, and supported by strong state-led development processes and state-business interactions. By reviewing the history of China-Africa agricultural cooperation, we observe how this technocratic rationality has been gradually entrenched in China's agricultural aid to African countries.

The emergence of the ATDC model in Africa consummates this particular form of traveling technocratic rationality. In this paper we reveal the ATDCs' origins to highlight the politics and power embedded in the knowledge construction behind the scheme design. This justifies the aid-business nexus in the conceptualization of the ATDCs and highlights their intensely political nature.

Our examination of ATDC performance of knowledge practices in four countries indicates how China's traveling technocratic rationality is delivered, frustrated and negotiated in the interaction between Chinese experts and their African counterparts. Negotiations must take place about the meanings and implications of agriculture and technology, demonstration and extension, as well as aid and development. The Chinese experts' perception is not always accepted, and this results in challenges for the operation of the ATDCs.

ATDCs are thus social and political arenas for multiple interactions. They are more than just technology centers, but carry with them a whole set of ideas and perspectives about what agriculture is for and what development means; of what the role of the state should be in technological development and extension, as well as of how business and development can work together. This is a very different vision from the established international systems for agricultural research and development (as represented by the Consultative Group for International Agricultural Research and its centers), or the Western bilateral aid programs, promoted in these same countries.

As a platform for a whole array of activities, the Centers provide an important symbol of Chinese development experience and perceptions. As a future model for agricultural development, these first phases of the ATDCs have been an important learning experience, but there will be challenges to achieve full commercialization and a business platform that can fund aid activities. Accomplishing this planned evolution will present a real test for this particular development model.

NOTES

1. ATDC team leader, Ginchi Ward, Ethiopia, July 15, 2014.
2. Local coordinator in Chollima Research Institute, Dakawa, Tanzania, March 19, 2013.
3. Local aid official, Dar es Salaam Tanzania, March 12, 2013.
4. ATDC team member, Mr. L, Dakawa, Tanzania, March 20, 2013; July 20, 2014.
5. ATDC team leader, Dakawa, Tanzania, July 20, 2014.
6. ATDC team leader, Dakawa Tanzania, March 20, 2013.
7. ATDC team leader, Ginchi Ward, Ethiopia, April 5, 2013.
8. ATDC team leader, Dakawa Tanzania, March 21, 2013; July 15, 2014.
9. Local researcher, Umbeluzi Research Institute, Mozambique, July 15, 2013.
10. Local official from the Ministry of Agriculture, Harare, Zimbabwe, March 20, 2013.
11. ATDC team leader, Dakawa Tanzania, July 25, 2014.
12. Chinese experts in Ethiopia, Ginchi Ward, Ethiopia, September 28, 2014.
13. ATDC team member, Dakawa Tanzania, July 21, 2014.
14. ATDC team member, Harare, Zimbabwe, March 15, 2013.
15. ATDC team member, interview referencing, April 20, 2014.
16. ATDC team member, Maputo, Mozambique, August 10, 2014.
17. ATDC team member, Harare, Zimbabwe, April 15, 2014.
18. Local coordinator, Dakawa Tanzania, March 21, 2013.
19. Local official from the Ministry of Agriculture, Harare, Zimbabwe, March 20, 2013.

REFERENCES

- Alden, C. (2013). China and the long march into African Agriculture. *Cahiers Agricultures*, 1, 16–21.
- Alden, C., & Large, D. (2010). China's exceptionalism and the challenges of delivering difference in Africa. *Journal of Contemporary China*, 68, 21–38.
- Amanor, K.S., & Chichava, S. (2016). South–south cooperation, agribusiness, and African agricultural development: Brazil and China in Ghana Mozambique. *World Development*, 81, 13–23.
- Bautigam & Zhang (2013). Green dreams: Myth and reality in China's agricultural investment in Africa. *Third World Quarterly*, 9, 1676–1696.
- Biggs, S. (1998). Beyond methodologies: Coalition-building for participatory technology development. *World Development*, 2, 239–248.
- Brautigam, D. (2009). *The dragons gift. The real story of China in Africa*. Oxford, UK: Oxford Univ. Press.
- Brautigam, D. (2011). Aid 'with Chinese characteristics': Chinese foreign aid and development finance meet the OECD-DAC Aid Regime. *Journal of International Development*, 23, 752–764.
- Brautigam & Tang (2009). China's Engagement in African Agriculture: Down to the Countryside. *The China Quarterly*, 199, 686–706.
- Chen, Y. (2009). The formation and the implications of Jiang Zemin's "Going Out" strategy. *Literature of Chinese Communist Party*, 1, 63–69.
- Chinese Academy of Social Sciences (CASS) (2013). *Prof. Jiang Heping carried out feasibility field study to ATDC in Mali in conquering difficulties* <http://www.iae.org.cn/html/153/2012/20120310165441500234752/20120310165441500234752_1.html> Accessed on 12.01.15 [May 27, 2012].
- Deng X. (1982) *In the First Decade, Prepare for the Second*, Deng Xiaoping's Collection Volume III, p. 17.
- Gabas, J.J., & Goulet, F. (2013). *South-South cooperation and new agricultural development aid actors in western and southern Africa: China and Brazil, case studies* <<http://www.afd.fr/webdav/site/afd/shared/PUBLICATIONS/RECHERCHE/Scientifiques/Documents-de-travail/134-document-travail.pdf>> Accessed on 01.11.15 [Paris: AFD, p. 27. (Document de travail: AFD, 134)].
- Gabas, J. J., & Tang, X. (2014). *Chinese agricultural cooperation in sub-Saharan Africa: Challenging preconceptions*. Montpellier: CIRAD, p. 4. (Perspective: Cirad, 26). <http://www.cirad.fr/en/content/download/8740/96379/version/2/file/Perspective26_Gabas-Tang_ENG.pdf> Accessed on 01.11.15.
- Gu, J., Zhang, C., Vaz, A., & Mukwereza, L. (2016). Chinese state capitalism? Rethinking the role of the state and business in Chinese development cooperation in Africa. *World Development*, 81, 24–34.
- Hairong, Y., & Sautman, B. (2010). Chinese farms in Zambia: From socialist to agro-imperialist engagement?. *African and Asian Studies*, 9, 307–333.
- Huang, J., & Hu, R. (2004). China's agricultural research system and reforms: Challenges and implications to the developing countries. *Asian Journal of Agriculture and Development*, 1, 1–17.
- Jiang, H. (2013). Agricultural technological aid to Africa (1971–1983): Case studies on the modalities and impacts. *Foreign Affairs Review*, 31–49.
- Kragelund, P. (2008). The return of Non-DAC donors to Africa: New prospects for African development. *Development Policy Review*, 26, 555–584.
- Lewis, D., & Mosse, D. (Eds.) (2006a). *Development brokers and translators: The ethnography of aid and agencies*. Bloomfield: Kumarian Press, p. 5.
- Lewis, D., & Mosse, D. (2006b). Encountering order and disjuncture: Contemporary anthropological perspectives on the organization of development. *Oxford Development Studies*, 34, 1–13.
- Li, X., Tang, L., Xu, X., Qi, G., & Wang, H. (2013). What can Africa learn from China's experience in agricultural development?. *IDS Bulletin*, 44, 31–41.
- Long, N. (2001). *Development sociology: Actor perspectives*. Routledge, p. 243.
- Mitchell, T. (2002). *Rule of experts: Egypt, techno-politics, modernity*. Berkeley: University of California Press, p. 51.
- Monson, J. (2009). *Africa's freedom railway: How a Chinese development project changed lives and livelihoods in Tanzania*. Bloomington & Indianapolis: Indiana University Press.
- Morton, K. (2012). *Learning by doing: China's role in the global governance of food security*. RCCPB working paper 30.
- Mosse, D. (2005). *Cultivating development: An ethnography of aid policy and practice*. London: Pluto Press, pp. 6–10.

- Mosse, D. (2011). *Adventures in aidland: The anthropology of professionals in international development*. New York, Oxford: Berghahn Books, p. 199.
- Nziguheba, G. et al. (2010). The African green revolution: Results from the millennium villages project. *Advances in Agronomy*, 19, 75–115.
- Reilly, J. (2012). A norm-taker or a norm-maker? Chinese aid in Southeast Asia. *Journal of Contemporary China*, 21, 71–91.
- Scoones, I., Cabral, L., & Tugendhat, H. (2013). New development centers: China and Brazil in African agriculture. *IDS Bulletin*, 44, 1–19.
- Scoones, I., Devereux, S., & Haddad, L. (2005). Introduction: New directions for African agriculture. *IDS Bulletin*, 36, 1–12.
- Tang, L., & Li, X. (2014). The management pattern of China's agricultural assistance to Africa: Evolution and results. *China International Studies*, 6, 29–40.
- Tang, Li, & Langton. (2015). *Blurring the lines between aid and business: ethnographic study of the Chinese agricultural technology demonstration center in Zimbabwe*. IDS working paper.
- Tan-Mullins, M., Mohan, G., & Power, M. (2010). Redefining 'Aid' in the China-Africa context. *Development and Change*, 41, 857–881.
- The State Council of China, *White Paper on China-Africa Economic and Trade Cooperation*. (2013): Agriculture is one of the top-priority areas, <http://www.china.com.cn/news/world/2013-08/29/content_29860758.htm> Accessed on 16.12.14 [Aug 29, 2013].
- Tugendhat, H., & Alemu, D. (2016). Chinese agricultural training courses for African officials: Between power and partnerships. *World Development*, 81, 71–81.
- Ukaejiofo, R. (2014). *China-Africa agricultural cooperation: Mutual benefits or self-interest?* Working Paper. Center for Chinese Studies. Stellenbosch University.
- Uphoff, N. (1992). *Learning from Gal Oya: Possibilities for participatory development and post-Newtonian social science*. Ithaca and London: Cornell University Press, pp. 448.
- Wei, J. (2002). *Africa, top option for China's agricultural investment*. Xinhua News Agency, [September 28, 2002] Accessed on 15.12.14.
- Wei, J. (2011). *My life in Africa: Affection and perception*. China Commerce and Trade Press, pp. 226, 227, 232, 237–238.
- Wu, L., & Zheng, Y. (2004). *The solutions to the challenges of China's Sannong (rural areas farmers and villages)*. China Economy Press, pp. 79.
- Xu, X. (2004). *A research on the pro-poor agricultural technology policy in China* Ph.D. dissertation. China Agricultural University, p. 28.
- Xu, X., & Xu, L. (2011). Reshaping the international development discourse? The modalities of China-Africa agricultural cooperation and its implications. *Journal of China Agricultural University (Social Sciences Edition)*, 4, 26–33.
- Yao, Y., & Wen, S. (2011). *The ATDC made in Chongqing is successfully turned over to Tanzania*. <http://cqrpaper.cqnews.net/cqrb/html/2011-05/26/content_1368390.htm> Accessed on 05.01.15 [May 26, 2011].
- Yue, C. (1989). *China agricultural economic history*. Beijing China Renmin University Press, p. 425.
- Yun, W. (2000). China's agricultural aid to Africa from the perspective of international development assistance. *West Asia and Africa*, 2, 17–23.
- Zhu, X. (1997). *The contribution of R&D to agricultural growth in China: Methodologies and applications*. Beijing: China's Agricultural Press, p. 135.

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