



TOWARDS AN UNDERSTANDING OF THE CHINESE AGRICULTURE TECHNOLOGY DEMONSTRATION CENTRE(S) IN AFRICA

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Abstract:

This review article focuses on the Chinese built Agriculture Technology Demonstration Centers (ATDCs) in Africa as a model for delivering agriculture aid. The article attempts to answer several questions key among them are; How has the model fared in different contexts? What questions or themes did existing studies miss or partially cover and how can such questions be framed for us to; have a better understanding of the ATDC; or instead develop a framework for studying the ATDC model. The study makes use of a systematic scoping review as the guiding research methodology. The ATDC managed to diffuse agriculture technology to farmers in Africa, increased their incomes, diversified their livelihoods and more importantly provided an alternative model for the delivery of agriculture aid in a context where traditional aid delivery faces sustainability challenges. Conversely, the model faced hurdles such as ensuring the balancing act between aid and commerce which are in essence two polemical activities, limited cooperation from some related bodies in host countries and lack of exposure to the African terrain also resulted in the implementation of inappropriate technologies. In terms of existing studies, the gender question is rarely addressed; similarly, in terms of technology adoption, there has been a binary description of adoption-non-adoption, this bifurcation does not correctly capture ground level realities. Furthermore, existing studies are institutionalistic mainly in nature with much emphasis on how the ATDC is run and not how it impacts on communities that are the supposed beneficiaries. Overall, there is an urgent call to work towards a framework for understanding ATDCs.

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Keywords: agricultural technology demonstration center; smallholder farmers; Africa; China; agriculture aid

1. Setting the Context

"*Get Out There. Become Global players!*" this was a rallying call from the then leader of China Jiang Zemin in the year 1994 for Chinese companies to be involved in global trade (Jacques, Gabas and Riber, 2015). Chinese enterprises, large and small, public and private seeking new markets responded to this call (Scoones, Kojo, Favareto and Qi, 2015; Xu et al., 2016). This was not China's first involvement in international engagements. China- Africa relations began in 1415 (Brautigam, 1998). The China – Africa relations range from trade, investments to aid. Davies (2007) sums up the forms of Chinese engagements as the aid in grants that are in kind, not cash form (e.g., schools) interest-free loans of which some end up as debt cancellation and concessional loans that usually have low or no interest with repayment periods of up to twenty years. Since the beginning of the 21st century, China has also broadened her interest in African agriculture as reported by Buckley (2015), that China is increasingly getting involved in African agriculture. At the same time, it is also important to note that organizations such as Food and Agriculture Organization (FAO) and Swedish International Development Cooperation Agency (SIDA) are also involved in African agriculture to increase productivity and enhance food security. However, in Africa, China is widely recognized for its flexibility and pragmatism (Gernot, 2007).

China's involvement in African agriculture is attributed to the fact that China had successful agriculture development and views sharing its experiences with other industrializing and developing countries as its foreign strategy top priority (Sorenson, 2010; Buckley, 2015). Furthermore, there are chances that China can spur a green revolution in Africa (Brautigam, 1998). As a result, China is massively involved in African agriculture as demonstrated by the fact that as of 2016, it had constructed 221 agriculture project, farms, 23 Agricultural Technology Demonstration Centers (ATDCs), irrigation and water conservation, 442 infrastructure projects and 622 public facilities (Zhou and Xiong, 2017). To the Chinese government, aid forms a unique diplomatic tool (Jiang et al., 2016; Zhou, Xiong, 2017; Gill and Reilly, 2014; Naidu and Mbazima, 2008).

This review article is aimed at highlighting the key features of the ATDC model; explore how the model has fared in different contexts, why it has achieved so much in other contexts and fared poorly in other contexts, and finally, more importantly, this article aims at raising some questions and themes that current studies on the ATDC have missed or could have elaborated more on. This article focuses on the ATDC model from 2006 to 2018. The highlighting of the missing gaps is done realizing the need for more empirical studies on ATDC across time and space, and subsequently, this could lead future studies to develop a framework for understanding the ATDC as a model of development cooperation. While we appreciate that a period of twelve years may not be adequate to make nuanced historical studies of ATDCs, we hope it presents us with the

opportunity to reflect and appreciate what this model has meant for the delivery of agricultural aid to Africa.

In reality, Chinese involvement in Africa is complex than portrayed. There are state- business interactions and complex relationships involving many levels, e.g. province, central state agencies, market actors (Gu et al., 2016). The formation of FOCAC in the year 2002 set the platform for sustained collaboration between Africa and China. The white paper presented by Hu Jintao then Chinese leader in 2006 set the framework for the establishment of ATDCs (Jacques, Gabas and Ribier, 2015; Naidu, 2007; Christensen, 2010; Gernot, 2007; Kragelund, 2010; Naidu, Corkin and Herman, 2009).

The agreement for the construction of the first ATDC was made in March 2008 in Liberia (AidData, 2017). By 2018, there were 23 ATDCs constructed, though they were at different stages of their life cycle (Jiang et al., 2016). Before the establishment of the ATDC, China used to implement her aid activities through the central and provincial level government agencies and later State-Owned Enterprises (SOEs)(Jiang, 2016). On the other hand, traditional agencies/ Organization of Economic Co-operation and Development (OECD) implement their aid through recipient government line ministries or departments and mainly through civil society organization/NGOs (Government of Zambia, 2016).

The establishment of ATDCs is meant to ensure that technology is disseminated to African smallholder farmers so that they achieve increased agricultural productivity and food security. However, it is essential to note that political and economic debates affect the ATDC interventions, influence technology choices and who gets trained (Scoones, Kojo, Favareto and Qi, 2015). Furthermore, technology goes to Africa, not as ‘a thing’ⁱⁱhowever, bound with social history and political meaning and implication (Xu et al. 2016).

Agricultural Technology Demonstration Centers are set up to achieve five (5) key objectives: introduction and extension of new varieties, new technology, research, education and training (Qi et al., 2015). The ATDC showcases methods of production from China, provide a training center for agriculture personal, student and farmers, and conduct agriculture research including biotechnology (Mukwereza, 2013; Jiang et al., 2016). The ATDC model is aimed at furtherance of Chinese foreign strategy, increasing grain production, improve agriculture technology production and food security of most countries, improve marketing techniques for grains, wheat, maize, soya bean, enhance collaboration in seed technology, biotechnology, food security, plant protection animal health and vegetable (Jiang et al, 2016; Gill, Huang and Morrison, 2007). Majority of the materials and resources used by ATDCs are sourced from China (Mullins, May, Mohan and Power, 2010). According to Buckley (2015), the technology transferred by ATDC includes hard technologies (farm equipment) and soft technology (capacity building

ⁱⁱ Not as a Thing-is used to demonstrate that the technology that China transfers is laden with her domestic experiences and political and economic goals.

and skills transfer). The aid activity of the ATDC is often referred to as public interest functions (Jiang et al., 2016).

The ATDC model presents a new approach in terms of delivering agricultural aid in that commercial interests are mixed with aid interests resulting in what other scholars have termed '*new developmentalism*' (Scoones, Kojo, Favareto and Qi, 2015). In essence, there are '*blurred lines between aid and business*' (Lixia, Lu, Zhao, Mukwereza and Xiaoyun, 2015; Tang, Li, and Mukwereza, 2018). These blurred lines result in a very complicated situation as aid tasks such as technology demonstration are intertwined with administrative tasks such as reception for the Chinese government and also commercial interests (Tang, Lu, Zhao, Mukwereza and Xiaoyun, 2015). However, there is a lack of understanding of how the commercial-aid model works, and this creates "*misperception and tensions among the different actors*" (Tang, Li, and Mukwereza, 2018). There are also arguments that the Chinese companies have '*substantial autonomy*' (Gabas and Goulet, 2012). This situation makes it difficult for the host government to hold them accountable if they do not deliver on the aid component. The pursuance of commercial interests in the ATDC model is put across as a necessary force that will ensure continuity with the guiding idea that the commercial unit will generate the necessary resources for the delivery of the public functions. Under the ATDC model, it is argued that there will be subsidization of development outreach and enhancement of income generation opportunities (Brautigam, 2011). Zhou and Xiong (2017) argue that market factors will save projects from collapsing. Under the ATDC model there '*is a limited role for conventional aid agencies such as NGOs*' (Scoones, Kojo, Favareto and Qi, 2015).

The setting up of an ATDC involves multiple players; from the Chinese side, it involves the Ministry of Commerce and Ministry of Foreign Affairs (Jiang et al., 2016). As for the host side, it involves the ministry of agriculture and other related institutions such as universities (Government of China, 2010; 2016; Nalwimba, Qi and Mudimu forthcoming). After the construction of an ATDC, it is later transferred to be an asset of the host government (Jiang et al., 2016). Negotiations for the establishment of an ATDC are done at top levels of government with limited consultations of local experts (Jacques, Gabas and Ribier, 2015; Nalwimba, Qi and Mudimu forthcoming).

1.1 Study outline

This article is divided into seven sections. Section 2 contains an explanation of the methodological approach used in the study; section 3 is a discussion of the critical features of the ATDC Model; Section 4 provides a discussion of the achievements of the ATDC Model; Section 5 a discussion of the constraints surrounding the model; Section 6 highlights and contains a brief discussion of key themes and questions that existing studies have left unexplored; and Section 7 provides some concluding remarks to the study.

2. Methodological Reflections

This study uses the research synthesis approach as a guiding research methodology. The research synthesis is defined as a literature review that:

“Focus on empirical research findings and have the goal of integrating past research by drawing overall conclusions (generalizations) from many separate investigations that address identical or related hypotheses” (Cooper, 2017).

The goal of such an approach is to *“present the state of knowledge concerning the relation(s) of interest and to highlight important issues that research has left unresolved”* (Cooper, 1998; Cooper, 2017:49). This process is also known as systematic scoping (Oya, 2013). The research synthesis involves multiple stages that are aimed at reviewing relevant literature that can answer to the research question. In this study, the guiding questions are: What are the key features of an ATDC and how has the model fared in terms of delivering agricultural aid in Africa? After coming up with the research problem, the second stage was to collect the data. The data was collected from various bibliographical databases such as Google Scholar, EBSCO, Taylor and Francis, ProQuest and Web of Science (Oya, 2013). Also, the study also used to a limited extent ‘snowballing’ network sampling. Through the network sampling, sources were obtained from the reference list of reviewed articles. To reduce data biases, the data collection also included technical reports from various African governments, China's Ministry of Agriculture and Ministry of Commerce that is primarily involved in the ATDC Model and the African Union (FOCAC) that coordinates the cooperation between China and Africa (On review bias see Simbizi, Benet and Zeveberg, 2014). The materials included in the data collection included conferences papers, journals, newsletters, report, newspapers, thesis, electronically assessed or hardcopy, published and unpublished (Hart, 1988). The data was then screened for quality. The screening included an inclusion and exclusion mechanism that later necessitated a critical evaluation of the relevant literature on ATDCs (Ramdhani, Ramdhani, and Amin, 2014).

The inclusion criteria were based on the discussion of the ATDC functions, operations, constraints and achievements in Africa. After coming up with the final inclusion list, a critical abstract and full-text analysis was conducted. The data was analyzed based on themes and conceptualization that emerged from the literature. The review covered the period 2006 to 2018. The formation of the ATDC as a model was elaborated at the FOCAC summit of 2006. The review indicated that more of the literature existing on ATDC is in the form of working papers, technical reports and policy documents. Some of the existing journal articles are the ones that were developed from the working papers. The Figure below illustrates the process of research synthesis.

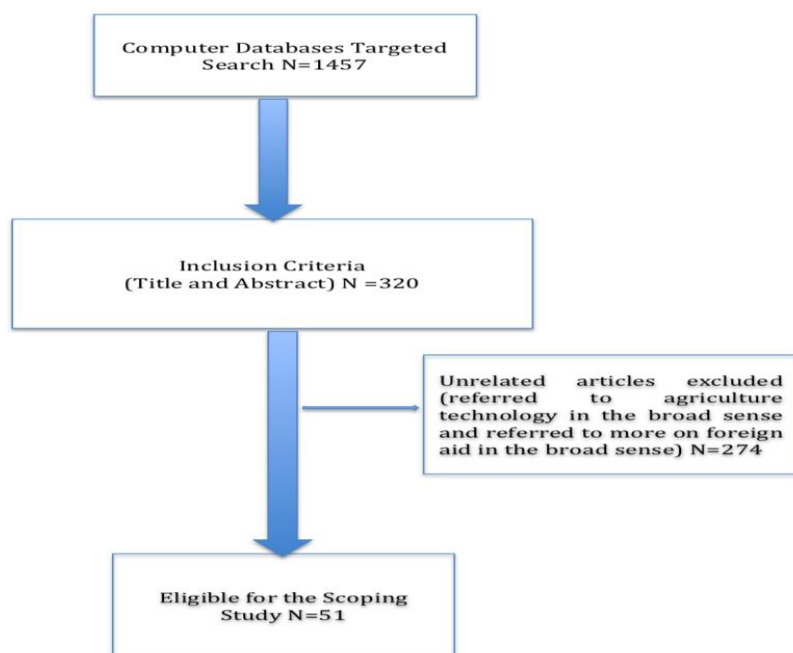


Figure 1: Systematic Review Diagram
(Source: Authors (2019))

3. Key features of the ATDC

In some cases, the Chinese government sets benchmarks on the number of farmers to be trained for example, in Zimbabwe the minimum number of personnel to be trained by the ATDC per year is 120 persons (Tang, Lu, Zhao, Mukwereza and Xiaoyun, 2015). In Zambia, the target was to train 300 personnel annually (Pia, 2013). As for the Chinese experts who work in the ATDC they have dual roles (Lixia, Lu, Zhao, Mukwereza and Xiaoyun, 2015). The duality of their roles is that at times they have to deliver aid and in other situations, they are business people pursuing commercial goals. The Chinese ATDC being a new model is based on trial and error experiences (Xu et al., 2016). This approach is based on the Chinese development philosophy of '*crossing the river by touching stones*.' The trial and error could be a result of the fact that Chinese enterprises are not well experienced in going global (Gu et al., 2016). Furthermore, the model is unique from the conventional aid delivery system (OECD approach) that relies on NGOs and other grassroots organizations to deliver aid. Based on these observations at inception there was limited clarity on how the model could progress.

In terms of how the ATDCs deliver their service, in Tanzania, the Chinese experts conducted regular farm visits and extension services (Makundi, 2017). Whereas in Zambia, Malawi and Zimbabwe farmers attended the training at the ATDC (Tang, Lu, Zhao, Mukwereza and Xiaoyun, 2015; Nalwimba, Qi and Mudimu forthcoming). As for monitoring and evaluation, Chinese ATDC managers do not engage in rigorous monitoring and evaluation; they label it western and a distraction to their goal of empowering farmers (Makundi, 2017).

The narrative and discourse accompanying the ATDC model are that it is based on cooperation, exchange, mutual, joint, together, strengthen and solidarity (Buckley, 2015; Nalwimba, Qi and Mudimu *forthcoming*). The model is viewed as a flagship for agricultural development cooperation a point in case is Mozambique where high profile visits by political elites necessitated the establishment of the ATDC and friendship farms (Gu et al., 2016). Resultantly, the launch of an ATDC is superintended by high profile delegations from a minister of agriculture, diplomats and even presidents (Nalwimba, Qi and Mudimu *forthcoming*). The ATDC model is also branded a Public Private Partnership [PPP] (Jiang et al., 2016). Though unlike the classical PPP model it only involves Chinese private companies in the running of the ATDC and none from the host country (Nalwimba, Qi and Mudimu *forthcoming*; Jiang et al., 2016). The ATDC has 3 phases, which include the Construction Phase, Technical Cooperation Phase, and Sustainability Phase. Figure 2 below highlights the phases of the ATDC Model.



Figure 2: Common Stages of the Agricultural Technology Demonstration Center

Source: Zhang Y, Liu Z, Li QR, and Jingyi Z (2016)

Table 1 below illustrates ATDCs in Africa and their locations.

Table 1: Agricultural Technology Demonstration Centers in Africa

No.	Country	Executing Agency	Area in Hectares	Areas of Cooperation
1	Zambia	Jilin Agricultural University	120	Grains (e.g., wheat, maize, soybean), vegetables, agricultural mechanization
2	Zimbabwe	Chinese Academy - Agricultural Mechanization Sciences	109	Agricultural mechanization and irrigation
3	South Africa	Chinese Academy -Fishery Sciences	0.47	Freshwater aquaculture
4	Mozambique		52	Grains (e.g., maize)
5	Uganda		0.3	Freshwater aquaculture
6	Tanzania	Chongqing Municipality Chongqing Academy of Agricultural Sciences	62	Grains (e.g.. Rice, maize, soybeans), vegetables, flowers, livestock (e.g., chickens).
7	Rwanda		22.6	Grains, mulberry, and silkworm

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		Fujian Agricultural and Forestry University		keeping, jun-cao cultivation, water conservancy.
8	Ethiopia	Guangxi Bagui Agricultural Science and Technology	52	Grains, vegetables and livestock (e.g., pigs, cows, and chicken)
9	Uganda	Huachang International Economic and Technical Corporation	0.3	Freshwater aquaculture
19	Sudan	Shandong Academy of Agricultural Sciences	65	Grains (Wheat, and maize), cotton, vegetables, water conservancy.
11	Republic of Congo	Shanxi province	59	Grains (e.g., maize,). Vegetables, livestock (e.g., chicken), fodder production and agricultural mechanization
12	Cameroon	Shanxi province	100	Rice
13	Liberia	Hunan Province Longping High-tech agriculture	32.6	Hybrid rice
14	Togo	Jiangxi Province Huachang International Economic and Technical Cooperation	10	Rice and Maize
15	Equatorial Guinea	Ganliang	-	No available data
16	Malawi	China Africa Cotton	-	No available data
17	Eritrea	Shanghai Foreign Economic and Technological Cooperation	-	No available data
18	Cote d'Ivoire	Liaoning International Company	-	No available data
19	Mauritania	Mudanjiang Yanlinzhuanyuan		No available data
20	Angola	Xinjiang Production and Construction Corps		No available data
21	Mali	Zijinhua		Research on crops and livestock, Agricultural technology and training
22	Central Africa Republic	TBC	TBC	Agricultural Technology Demonstration and Training
23	Democratic Republic of Congo	ZTE Energy	TBC	Agricultural Technology Demonstration and Training

Source: Authors' Construction based on Jiang et al. (2015)

4. Achievements

In Togo, the ATDC started with 80 ha of land for production and is in the process of increasing to 800ha (Jacques, Gabas and Ribier, 2015). Such improvements indicate that

it is possible for ATDC to increase their production. However, a question that remains is if the gains from the commercial expansion can also result in the delivery of more aid to the local farmers. This question among others is also explained in a section below. However, if one considers the fact that the model is premised on the fact that the expansion of the financial goals is envisaged to lead to the achievement of public goals; the Togolese achievement would be a remarkable feat. At the same, there are fears that land expansion and concentration by ATDCs could lead to tensions with local communities (Zhou and He, 2014:26). For example, there was a land conflict in Benin when the Cotonou ATDC was built on land allocated to the Benin Institute of Agricultural Research (Gabas and Goulet, 2012).

In Africa, there have been widespread perceptions of Chinese products being of inferior quality (Moyo, 2016). However, in Zimbabwe, the display and demonstration of modern farm equipment by the Chinese at the ATDC at Gwebi College, 40 km from the capital city Harare is slowly changing the local people's perception of Chinese technology (Mukwereza, 2013). In Mozambique, the ATDC successfully transferred technology as evidenced by the growth of its consultancy services (Jiang et al., 2016). However, it is essential to note that the majority of clients seeking consultancy services from Mozambique's ATDC are Chinese enterprises based in Mozambique. In a related case, the South African ATDC achieved fruitful cooperation with the host government. The South Africa government officials had direct participation in the ATDC activities and had an office at the ATDC (Jiang et al., 2016). The Zambian ATDC facilitated the transfer of mushroom technology that resulted in smallholder farmers diversifying their crop production and raised their incomes from mushroom, which is a high-value crop (Nalwimba, Qi and Mudimu forthcoming).

In Ethiopia, the Chinese experts manning the ATDC had various international experiences (Qi et al., 2015). This presented a chance for the local farmers to tap from this vast international knowledge of the Chinese experts. Besides, the Chinese staff at this ATDC had multi-functions that enabled them to cut costs (Sorensen, 2010). Moreover, the Chinese experts at the Ethiopian ATDC affirmed to do their best in order for the ATDC to succeed (Qi et al., 2015). The Chinese experts strengthened their rapport with the local community, and this influenced more farmers to participate in the ATDC activities (ibid).

One of the core functions of the ATDC is to test seed varieties and recommend them for uptake by local farmers. The ATDC in Mozambique managed to test local seeds and recommended them for uptake by local farmers and also, it managed to achieve the business introduction phase (Jiang et al., 2016). The ATDC prioritized provision of fundamental and practical farming skills to smallholder farmers (ibid). Prioritization of smallholder farmers is critical in contexts where the smallholder farmers are the majority and most resource-constrained (Nalwimba, Qi and Mudimu, 2017). A similar case in point is the Zambian ATDC that has managed to train over 1300 smallholder farmers since its inception in 2011 (Nalwimba, Qi and Mudimu

forthcoming). Other studies have also noted that the training provided to the Zambian farmers is 'valuable' (Curtis, Ngowi, Kharomo and Kuteya, 2016).

Similarly, in Tanzania, the ATDC managed to achieve high yields at its farm. The achievement of high yields provided a positive showcase to the local population on the achievability of high yields in Tanzania. As a result, more farmers joined the ATDC. Makundi (2017) notes that the 'High yield factor influenced farmers to join the ATDC.'

While the economic conditions in most African countries constrain the economic viability of some commercial interests; some ATDC has become more innovative as they try to raise capital to enable them to execute their public functions fully. In Ethiopia, the ATDC resorted to selling pork and poultry in order to raise money to support daily operations (Qi et al., 2015). Moreover, in South Africa, faced with stunted demands by the local population for its freshwater fish the ATDC resorted to selling the fish to the local Chinese population (Jiang et al., 2016). The importance of the ATDC to the African States is summed by Qi et al. (2015) in a study in Ethiopia, and they highlight that the local community remarked the ATDC is "our future."

5. Constraints

In as much as the ATDC is intended towards boosting agriculture production, there are some drawbacks. Qi et al. (2015) and Xu et al. (2016) argue that the political process in the implementation affects the achievement of policy goals. The ATDCs are formed at the highest level as such they are rarely monitored and evaluated for they are attached to high-level political goals. This may, in turn, hinder assessments of their performance. For example, in Ethiopia, the ATDC's performance was not evaluated by formal policies but by political pressure from the Chinese and Ethiopian government (Qi et al., 2015). Besides in some cases, there is limited participation by host government officials in the daily running of the ATDC due to various reasons ranging from exclusion and growth of institutional silos (*on institutional silos see* Nalwimba, Qi and Mudimu, 2017).

There are also some studies, which point out that the experts failed or declined to release hybrid technology to local experts (Jacques, Gabas and Ribier, 2015). For instance, in Mozambique, the government officials did not participate in the daily management of the ATDC (Jiang et al., 2016). As for the smallholder farmers in a related case in Tanzania, the local farmers were invited to visit the ATDC mostly for rice harvesting ceremonies (Makundi, 2017). Closely linked to this are the rise in resentment between the Chinese and other existing public agriculture centers for instance in Liberia local experts felt disrespected when it came to training (Jacques, Gabas and Ribier, 2015). Conversely, a training approach that involves local experts was a success in Zambia as the training session used relevant case studies the smallholder farmers could relate to (Nalwimba, Qi and Mudimu *forthcoming*).

There are allegations that there is limited transparency by Chinese firms involved in ATDC as firms respond to economic and political terms of their government (Raudino, 2016). As such, this complicates the task of monitoring the

activities of Chinese enterprises tasked with running the ATDC. Furthermore, Gill and Reilly (2014) argue that attempts to control or rein in Chinese firms involved with the ATDC through Chinese embassies in host countries are not always fruitful due to the profound influence of low ranking embassy officials in host countries.

The ATDC is a matrix of economic and aid goals. Makundi (2017) reported that in Tanzania there was a struggle to balance technology transfer and commercial goals. The struggle is exacerbated by the fact that there are no guidelines with regards to what percentage or efforts should be dedicated to aid or commercial activities. Furthermore, there are misunderstandings with regards to the role of the ATDC and other partners (host government and Chinese experts/ enterprises). For instance in Mozambique government officials only participated in bureaucratic roles such as visa processing, permits, and coordination of graduation ceremonies (Curtis, Ngowi, Kharomo and Kuteya, 2016). In Tanzania, some local farmers view the ATDC as a supplier for eggs and vegetables (Makundi, 2017). The lack of appreciation of each partner's roles causes some friction and is a hurdle to the achievement of the ATDC goals. However, at the same time the diversity of both China's agencies and local African institutions and people creates adaptive but variant cooperation approach that also evolves along with interaction intentionally or unintentionally.

One of the ATDC core functions is technology transfer. However, there are fears that the technology is not suitable for the current situation and training subjects are highly technical making it challenging to transfer the technology (Qi et al., 2015; Jacques, Gabas and Ribier, 2015; Buckley, 2015). Some scholars argue that the technology that China is transferring to Africa is inspired by her land constraints context and therefore not very appropriate to Africa where land is abundant (Jiang et al., 2016). Similarly, Chinese experts concerted that simple technology would be necessary before the application of advanced technology (Buckley, Rujian, Yanfei and Zidon, 2017). Xu et al. (2016) offer a plausible explanation for the inappropriate technology they argue that a Chinese enterprise demonstrates its competent product even when it is not appropriate to the local demands. This was also evidenced in Tanzania where the firm demonstrated sticky rice that was regarded as not famous among locals; the Chinese enterprise had vast experience in this rice type (Makundi, 2017). Also, the non-affordability of the latest technology has also hindered the adoption of the technology (Makundi, 2017; Nalwimba, Qi and Mudimu forthcoming). This situation is further complicated by the fact that there are limited government subsidies towards smallholder farmers and a general under-spending towards agriculture by the African states, actually in some instances way below the 10% of an annual budget mandated by the Maputo Declaration (AU, 2003; Chapoto, Chisanga, and Kabisa, 2017). Closely linked to the appropriateness of technology promoted by the ATDC is the limited adoption of the technology. The limited adoption of the technology has been exacerbated by other exogenous factors such as the high cost of fertilizers (AATF, 2010). The high cost of inputs resulted in low input usage decimating the adoption of High Yielding Varieties (HYV) that requires high input investment

(Makundi, 2017). In Madagascar, the local community reverted to the traditional seed because the hybrid rice seeds were unaffordable at \$4 per kilogram (Chen and Lendry, 2016). Furthermore, low adoption of new varieties is caused by limited support and coordination with host institutions that are required to license new varieties (AATF, 2010; Makundi, 2017; Nalwimba, Qi and Mudimu forthcoming).

For a farmer-training program to be progressive, there must be a robust communication mechanism. The ATDC is constrained in this regard. There is limited consultation with smallholder farmers and no formal feedback system (Jiang et al., 2016; Curtis, Ngowi, Kharomo and Kuteya, 2016). For instance in Zambia Co-operatives are one of the largest farmer organization groups, but these Co-operatives are not represented in the ATDC board (Curtis, Ngowi, Kharomo and Kuteya, 2016). The ATDC model is based on a trial and error mode as such, at times there is no formal training about aid delivery to the Chinese experts upon their deployment to Africa (Qi et al., 2015). This limited knowledge of aid and often weak debriefing of Chinese experts upon their deployment creates a mismatch of what they deliver and what is required in host communities. For instance, the ATDC model is based on farmers visiting the ATDC to get trained and to access services, yet in Africa, farmers are used to extension workers visiting their farms. Makundi (2017) noted that in the Tanzanian case, farmers do not like the approach used by the ATDC they prefer field schools (conducted on the farmer's premises).

Africa is characterized by a large number of smallholder farmers who account for 80% of food producers and with 80% of landholdings (FAO, 2012). Most African government agriculture policies are centered on the capacitation of smallholder farmers. On the contrary, some Chinese experts argue that the focus of agricultural aid must be on large-scale farmers (Buckley, Rujian, Yanfei and Zidon, 2017). This mismatch of Africa's contextual landscape presents challenges and results in the drafting of inappropriate initiatives for instance in Zambia, and the ATDC focuses more on mushroom farming training yet mushrooms constitute 1% of the dietary requirement (Curtis, Ngowi, Kharomo and Kuteya and 2016). Furthermore, the Zambian National Agricultural Policy stipulates that priority must be given cultivation of staples such as maize and wheat where Zambia has a comparative advantage (Government of Zambia, 2014). Other cases are the South African, where the Chinese firm embarked on freshwater fish training even though it is not a key component of local peoples' diets (Jiang et al., 2016). In Tanzania the development of rice while noble, rice is not a staple and therefore not a priority to the local people (Xu et al., 2015; Makundi, 2017). Thus, there are situations when the ATDC model was not in sync with some countries' national research systems and government policies (Alemu, Cook and Qi, 2015; Zhou and He, 2014). Such mismatches subsequently led to the drawing up of solutions that were not much appreciated by the supposed beneficiaries.

6. The Gaps in ATDC Research

While several studies have been conducted since the inception of the ATDC model, some questions are emerging, and some remain unanswered both at the theoretical and empirical levels. Below are some questions that are raised by this article with the hope that in the future a framework could be developed to improve our understanding of the ATDC. As Qi et al. (2015) noted in Ethiopia that the ATDC is 'our future' as such it is pertinent that we prepare for the future.

- i. Gender aspect of beneficiaries: The majority of studies on ATDC (Xu et al., 2015; Jiang et al., 2016) barely consider the gender dimensions in their analysis. Few studies mention or discuss the gender dimensions of the beneficiaries of the ATDC model (Curtis, Ngowi, Kharomo and Kuteya and 2016; Nalwimba, Qi and Mudimu forthcoming). Explaining the gender configuration could be useful to determine future training mix particularly in Africa where gender imbalance exists and where efforts are currently underway to mainstream gender in development activities since the 1995 Beijing Platform for Action.
- ii. Farmer participation and empowerment: there is a need to question the extent of farmer participation in the ATDC training program(s) formulation and decision-making. This will enable us to understand the extent to which the ATDC empowers local farmers. Most studies thus far dwell much on an institutional approach (Jiang et al, 2016; Xu et al, 2015; Qi et al, 2015; Tang, Lu, Zhao, Mukwereza and Xiaoyun, 2015) as they focus more on how the ATDC is run and not on how it interlinks with the farmers, the supposed beneficiaries. A compelling case is the Mozambique ATDC, Jiang et al. (2016) noted that the ATDC is now making a profit, but the Chinese experts said the local people could not operate the business sustainably. This raises a related question, how do we assess when the local people are empowered adequately to manage the ATDC successfully?
- iii. Technology relevancy and adoption: Existing studies have focused on a bifurcated analysis of technology relevance (Buckley, Rujian, Yanfei and Zidon, 2017). They have come up with the relevant not relevant dichotomy (Makundi, 2017) yet in reality, some aspects of the technology may be relevant while others are not. We suggest that it is plausible to have a graduated scale of relevancy so that there is surgical precision in the identification of the areas that need improvement. Similarly, adoption has been treated in a binary manner (Xu et al., 2015; Jiang et al., 2016). Ground level realities indicate that some farmers may adopt some parts of technology and not adopt some (Nalwimba, Qi and Mudimu forthcoming). Coming up with a graduated scale of adoption would enable us to measure the ground level realities, for example, lower level adoption, middle-level adoption and high-level adoption (Nalwimba forthcoming).

- iv. **Broader Political Economy:** Scoones, Kojo, Favareto, and Qi (2015) argue that political and economic debates affect intervention, influence technology and choices of who gets trained. Furthermore, Zhou and Xiong (2017) and Makundi (2017) remarked that national economies and national innovation progress have a bearing on technology adoption. It would be beneficial if more empirical studies interrogate to some extent the broader economic factors in which an ATDC is situated, this will enable us to come up with nuanced studies on the performance of the ATDC as an intervention in agricultural development.
- v. **Aid and Commerce-Balancing Act:** The ATDC model is a mixture of aid and commercial activities (Lixia, Lu, Zhao, Mukwereza and Xiaoyun, 2015; Xu et al., 2016). It will be prudent for studies to explore this balancing act, key questions would be: How does the ATDC balance aid and commercial goals? What percentage is aid? What percentage makes up commercial activities? Which one is dominant? For instance, in the Togo case (Jacques, Gabas and Ribier, 2015), the ATDC was expanding its landholding, but we are not made aware if this commercial expansion translates to the expansion of the aid function. In Zimbabwe Xu et al. (2016) noted that there are blurred lines between aid and business.
- vi. Furthermore, the Zimbabwean government noted that Chinese enterprises were not in Zimbabwe for profit making (ibid). So the critical question confronting us today is how and when do we draw the line between business and aid? In this quest, what are the indicators of a successful ATDC?

7. Conclusion

This article discussed the key features of the ATDC model from 2006 to 2018. It highlighted the achievements of the ATDC as a model of delivering agricultural aid to Africa. The ATDC model enabled farmers to access training on various crop cultivation methods, established itself as a possible tool in delivering aid using commercial interest as an engine. In countries such as Zambia, technology on mushroom cultivation was transferred to farmers, in Mozambique, the model prioritized peasant farmers training, and in Ethiopia, the model managed to transform itself and offer the farm-based extension to smallholder farmers. At the same, the model led to the display of modern technology that has enabled the fostering of a positive African perception of Chinese technology. Overall the model has boosted China - Africa relations as China invested about US\$6 million per ATDC and more importantly, the model has come in handy in a context where aid projects die a natural death due to resource constraints. However, at the same time, the ATDC model faced some hurdles such as transfer of inappropriate technology, limited cooperation from host countries and low adoption of the technology by farmers. The article also noted several research themes and questions that could be used in coming up with a framework for understanding ATDC. The article argued that the gender dimension is rarely incorporated into studies on ATDC;

analysis has been focused mainly on a bifurcated spectrum on technology relevancy and adoption. In reality, farmers may adopt some aspects of technology. Furthermore, the majority of studies have been institutionalistic, and future studies can focus on how the African farmers are empowered, how ATDC strikes a balance between delivering aid and business goals that are in reality two different activities and how the missing themes of gender, adoption graduation can be integrated into ATDC studies.

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