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Agents of Technology Localization in East Africa: Case Studies of Social Enterprises in Tanzania

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Abstract Technology localization refers to activities that seek to make particular technologies locally functional and locally embedded in order to overcome resistance to their adoption. These activities can be described as diffusion, institutional support, and technical adaptation. In developing societies that face experiences of resistance to technological change, several organizational agents could serve as agents of localization. This paper showcases a number of social enterprises in East Africa – particularly in Tanzania – that are involved in localizing technologies for sustainable energy and agricultural mechanization. Field data were collected between December 2014 and September 2015. Staff, clients and partners of the social enterprises were interviewed. In addition, field observations and a scan of accessible reports and documents of social enterprises and their partner organizations took place. The cases demonstrate technology localization activities and assess the effectiveness of these social enterprises as agents of localization. The study concluded that, given appropriate tools and context, such as engaging early adopters of innovation and staying attuned to feedback from local communities, social enterprises can be effective agents of technology localization.

Keywords: Technology localization; technological change; social enterprises; Tanzania; diffusion of innovations

Introduction

This paper introduces the concept of technology localization through several case studies from Tanzania. The three activities of technology localization are: diffusion of technologies to communities, provision of institutional support for chosen technological solutions, and adaptation of technologies to local conditions. Agents of technology localization conceive and introduce new technological solutions for communities. The paper examines the work of technology-oriented social enterprises (SEs) in rural regions of Tanzania as agents of localization. The study asked whether the case SEs demonstrated ongoing engagement in the activities of diffusion, support and adaptation, whether they demonstrated competence in engaging those who have been called ‘early adopters’ of innovations in the diffusion process, and whether their clients showed relative satisfaction with the technological change that they

experienced. In this introduction we go through the theoretical and empirical work from the existing literature, in development studies and technological change, based on which the concept of technology localization was constructed. Following the introduction, we describe the research methodology and cases, then the findings of the study, followed by conclusions.

Dichotomies and priorities: resistance to change

Technological development requires different stimulants and interventions depending on the social and cultural context. In Africa, agriculture had had slow rates of adoption of new technologies and minimal increases in productivity (Jones, 2009). Researchers have pointed to subjective and social challenges facing agricultural technology adoption in Africa, such as farmers' negative perceptions of technological changes, or cultural barriers to accepting them (Adesina and Baido-Forson, 1995; Rauniyar and Goode, 1992; Simalenga, 1999; Stamp, 1990). Dercon and Christiaensen (2011) demonstrate that besides subjective resistance there are also risks that farmers consider such as crude cost–benefit analyses and a multitude of household priorities, which lead many of them to avoid adopting new technologies. The story of Africa and agriculture resonates, in varying degrees, with other developing regions such as Southeast Asia and Latin America (Adeel et al., 2008; Binswanger, 1986; Martinez-Torres et al., 2010). In contrast, information and communication technologies (ICTs) have in a relatively short period of time experienced rapid adoption in developing societies around the world, including Africa, in the sectors of healthcare, tourism, small and medium-sized enterprises, and in education (Lekoko and Semali, 2012; Nasir et al., 2011; Rensburg et al., 2008; UNDP, 2001). Between the two extremes of modern agricultural technologies and ICTs there are varieties of other technology types with various levels of adoption, such as water and sanitation (Adeel et al., 2008; Fidiel, 2005) and alternative energy (Williams et al., 2011).

Technological development processes often find themselves entangled in conflicts between old and new (or traditional and modern) technological paradigms. Traditional technologies are often the creation of technology users themselves (Gamser, 1988; Visvanathan, 2004), while modern technologies are often the creation of engineers and scientists in modern societies who are often not the technology users. In developing societies traditional and modern technologies coexist and sometimes compete. This divide between the two paradigms may result in delays in adopting new technologies even if they are objectively more effective. With traditional technologies and techniques the technology is integrated, or embedded, into local social institutions (e.g. knowledge systems, customs and behavioural patterns, socioeconomic divisions of labour, cultural notions, etc.). This technological embeddedness can explain part of the challenge of technological change in developing societies (North, 1990; Hodgson, 2004). For example, while agricultural mechanization in Africa needs to find a way to either replace or coexist with traditional agricultural technologies that

are already embedded in local institutions, ICTs do not have to deal with that complexity. ICTs do not face similar resistance to adoption, compared to agricultural mechanization, partly because they are not replacing any technology that is already locally embedded.

The difficulty of replacing an existing technology that performs the same function could be a reason for the slow adoption rate of new agricultural technologies. Existing social institutions can be significant barriers in technological change. Local institutional constraints on technology diffusion have been documented (Adeel et al., 2008; Dengu et al., 2006; Eisler, 2002; Rogers, 2003). However, when cases of technological change are reasonably successful (Al-Ghafri, 2008; Fidiel, 2005; Gulrajani, 2006; Lekoko and Semali, 2012) there is little highlight on how local institutions contributed to making technology adoption a success.

Additionally, technology adoption stories may express themselves differently according to the technology type and a society's priorities. Binswanger (1986) focuses on agricultural mechanization and draws lessons about the multiple factors that influence transitions toward agricultural mechanization in different parts of the world (such as the US, Japan, Pakistan and Brazil). Some of those lessons apply to more than agricultural mechanization, such as how the economy of land and labour endowments affects the priorities and pace of the process of shifting to agricultural mechanization. Another lesson is on the relation between machinery design and capital costs: 'Machinery design adjusts to high capital costs by lack of convenience features, simplicity, and reduced durability' (p. 36). While the cost of energy is a very important factor in machinery use, the costs of capital and maintenance tend to be usually larger and more critical. This observation may explain why countries with least developed infrastructure tend to produce simpler, and less durable, engineered machinery – i.e. to compensate for the huge capital costs resulting from weak infrastructure to support industrialization (Zanello et al., 2016). Another lesson supports the argument of the decentralized nature of technology innovation. Technological innovation often takes place, Binswanger (1986) argues, 'in the early phase of [agricultural] machinery invention, subinvention[1] and adaptation are done almost exclusively by small manufacturers or workshops, working closely with farmers. Public sector research has contributed little to machinery development, but more to education' (p. 50). In agreement with Rosenberg (1972), Binswanger adds that 'Inventive work on a particular operation often precedes by decades the widespread use of machinery. It reaches a peak during the initial adoption cycle, when derivative invention,

1 By 'subinvention' Binswanger seems to refer to inventions that modify or change only parts of the machine or unit rather than the whole machine. For example, the invention of the automatic transmission in automobiles, in the 1950s, was a subinvention in the sense that it did not change the automobile or the function of the transmission itself in it, but rather invented a new part that substituted an older one within the same machine. It is similar to how Rosenberg (1982) distinguishes between inventions and innovations. Other similar terms to subinventions: upgrades, derivative inventions, or secondary inventions.

refinements, and adaptation to different environments are required.' (p. 51). These observations, or drawn lessons, suggest that a country's context informs technological change patterns, as different patterns call for different development priority areas.

Therefore, social resistance to technological change and local factors may explain why some technology types suffer persistent low levels of adoption over time in developing societies.

Overcoming resistance: technology localization

Technology localization is an interventionist approach to respond to incidents of persistent resistance to change regarding particular technology types. It refers to activities that seek to make chosen technologies locally functional and locally embedded. Localization is comprised of three main activities:

(1) Diffusion; which refers to activities of persuading targeted groups, through communication and promotion, to adopt new technological innovations.
(2) Institutional support activities; which refer to policy advocacy, resource mobilization (e.g. finance and credit systems), and logistical and training assistance for putting such technologies into operation.
(3) Technical adaptation activities; which include additional, incremental, technical modifications to available technologies in ways that add value and increase their usability in given contexts.

We argue that overcoming resistance to change requires diffusion efforts, institutional support, and sometimes technical modifications of available technologies. The three processes mutually reinforce each other.

Innovations tend to emerge from firms, laboratories, and specialized teams/associations (such as artisans and technicians), and even from smaller teams or individuals inside these entities. After innovative solutions are conceived and realized in an early embodiment (as initial prototypes or processes) comes diffusion, which is 'the process by which an innovation is communicated through certain channels over time among the members of a social system … The diffusion process typically involves both mass media and interpersonal communication channels.' (Rogers et al., 2009, p.418). Diffusion processes can take long or short terms, depending on various conditions (Noble, 1984; Kroszner, 1987; Rosenberg, 1972; 1982). Diffusion is thus one element in localization.

Institutional support addresses the need for advocacy, resources, training and logistics as a technology gradually permeates society and becomes integrated/embedded. For example, for a technology to be locally embedded there have to be some members of the local community competent in operating and maintaining it, and there has to be a common understanding of its function and benefits. This is achieved by encouraging a conducive local policy environment that acknowledges the new

technology, regulates it, and facilitates its diffusion and adaptation with resources for training and supply.

Technical adaptation addresses the required alterations to technologies adopted from other societies to make them more compatible, in functional and sustainable terms, with the new local context. For example, an agricultural machine may need some modification to make it function more effectively on a different soil type from where it was imported. It may also require some replacing of parts with locally available materials that will make it more affordable to maintain locally (Adeel et al., 2008; Dengu et al., 2006).

Table 1 summarizes the concept of technology localization, with the definition of its activities, examples for what they may look like in action, and who are the likely actors/agents in society to carryout the activities.

Agents of localization: social enterprises in Africa

Social enterprises (SEs) are considered part of 'the third sector', which includes NGOs, civil society organizations, as well as many cooperatives. The entire array of SEs that are growing in number and form in developing societies should draw keen interest from analysts of technological change. A social enterprise has been defined as 'a business with primarily social objectives whose surpluses are principally reinvested for that purpose in the business or in the community, rather than being driven by the need to maximize profit for shareholders and owners.' (UK Department of Trade and Industry, 2002, p.7). It has also been defined as 'a social initiative that addresses social needs or catalyzes social transformation. The creation of social value is the primary objective of the venture, while economic value creation represents a necessary but not sufficient condition' (Mair and Schoen, 2007, p.55). SEs cross the conventional boundaries between private sector and the voluntary or philanthropic sector, along with carrying some 'public sector principles' of democratic/participatory management and equitable redistribution, for the sake of social and/or environmental well-being (Ridley-Duff and Bull, 2015).

SEs include some cooperative models, credit unions, micro-finance banks, fair trade businesses, some business incubators, NGOs with a focus on economic activities, businesses with profit-sharing schemes with their communities, and other organizations with similar approaches (Alter, 2007; Haugh, 2012; Zahra et al., 2009). As shown, they refer to a host of business models, some of which are new while some are older than the term itself (Alter, 2007; Desta, 2010). SEs appeared and proliferated in Western Europe and Northern America, in the last decades, with the aim of filling a gap in the socioeconomic fabric which neither the public sector, nor the private sector, nor conventional NGOs quite fill. They have attracted attention as a relatively new channel for expressing and realizing innovative responses to socioeconomic challenges of local communities.

Recently, SE models in developing societies have come to overtake some traditional NGO work with respect to technology diffusion (e.g. Amm, 2009;

	Diffusion	Institutional support	Technical adaptation
Refers to …	Persuading targeted groups, through communication and promotion, to adopt new technological innovations.	Policy advocacy, resource mobilization (e.g. finance and credit systems), and logistical and training assistance for putting such technologies into operation.	Additional, incremental, technical modifications to available technologies in ways that add value and increase their usability in given contexts.
Sample activities	• Use of mass media channels to communicate new technological solutions and highlight challenges to stir ideas • Promotion of innovative solutions through pilots, affordable commercial schemes, etc. • by example: adopting new technologies as others see you use them and benefit from them.	• Resource allocation for R&D; education • Policy advocacy, pushing for incentives and constraints to help localization activities.	• Technology incubators and innovation centres • Community-based appropriate technology initiatives • Provision of counselling and access to R&D information resources to organizations and communal initiatives. • Participatory technology development.
Likely actors/ agents	Individuals (early adopters), commercial entities, NGOs, extension services, etc.	Community-based associations, NGOs, Think tanks, etc.	Individuals (innovators and technicians), R&D teams (in college projects, research institutes, private workshops and commercial industries), etc.

Table 1: Activities of technology localization (Activities that seek to make chosen technologies locally functional and locally embedded, in order to overcome local resistance to their adoption).

Rensburg et al., 2008). Although the SE literature has been growing globally over at least two decades (Granados et al., 2011), the study of the success of SEs as agents of technological change has only begun to be explored (Buell and Mayne, 2011; van der Horst, 2008; Williams et al., 2011). Due to their orientation towards both social and commercial value we may expect that SEs would be found active in contexts where there are social barriers to technological innovation because innovative technologies that create social value may not be commercially successful. There may need to be some social imperatives, beyond profit-making, that encourage organizations to engage in technology localization, and that is a central feature of SEs. On the other hand, many localization activities appear to require flexibility in approach as well as timely responses and seizure of opportunities which is a dynamism that the bureaucratic machinery of the public sector may not be able to accommodate.

Research methodology and cases

The study asked whether social enterprises were effective agents of technology localization in Tanzania. To answer the question, the field study collected data through case studies of technology-oriented SEs. Priority was given to rural and agricultural contexts.

The rationale for choosing Tanzania for fieldwork included the country's history of special attention to rural development and technological autonomy (COSTECH, nd.; Nyerere, 1968), a currently changing enabling environment for non-state actors (United Republic of Tanzania, 2015; 2016), and the familiarity of the authors with Tanzania (Sheikheldin, 2015; 2016). Due to limited time and resources Tanzania was the only country where fieldwork was undertaken. However, a fair number of the SEs that participated in this research had branches and/or business activities in other East African countries, which allowed them to give some information and perspective beyond Tanzania.

A qualitative comparative historical case study methodology was adopted with limited use of quantitative data. The cases were SEs for which historical and contemporary data were available. Data were collected via key informant interviews, literature scanning and field observations to construct narratives of how each social enterprise performed in the area of technology localization and what were the highlights and critical factors of its story. The narratives constructed were then used to compare their experiences and respond to the research questions accordingly. Three sub-questions were devised to make the data respond to. The first was: did the case SEs demonstrate activities that fulfil the definition of technology localization? After that was established, we asked two more sub-questions to verify why were SEs effective (or not) in their localization: did they engage local early adopters of innovation (who in turn accelerated diffusion), and were the technology adopters themselves overall satisfied with the localization efforts and outcomes?

The literature on diffusion of innovations suggests that early adopters often happen to be persons of leadership in their community (Brint et al., 2011; Huh and Kim, 2008;

Daberkow and McBride, 1998; Rogers, 2003). Using their influence and communication networks in their communities, they introduce others to the technologies they adopted, and persuade some of them to adopt, thereby accelerating diffusion. Early adopters are typically viewed as economically successful but not exceptionally wealthy in the eyes of the community. They have sufficient resources to take risks and try new products or services beyond the basic necessities for the average household of the community. They also often adopt more than one form of technology that was uncommon in their community (Daberkow and McBride 1998; Ram and Jung, 1994; Rogers, 2003).

The field study sought to recruit cases of business ventures with a primary social or environmental objective, i.e. social enterprises (as defined earlier).[2] Each case's fulfilment of this definition was assessed by looking at what they do and their model or structure. Their activities included providing a critical, under-met service to communities; providing technology education or training; or innovating and/or promoting new products or systems. Their model or structure was either a private enterprise, cooperative (or social firm), NGO with revenue-generating branch/activity, or a public-private partnership initiative (such as a revenue-generating technology training centre). Table 2 identifies the cases with general information about each one: GCS Tanzania Ltd., Kakute Projects Co. Ltd., Biogas Construction Enterprises (BCEs) (Tanzanian Domestic Biogas Programme – TDBP), Dorgo Agro-Enterprises, Twende, and Rafkisoft. A total of 108 interviews were conducted with personnel of participant organizations, users/adopters of their technologies, and partners in their projects, using interview guidelines (varied versions for social enterprise staff, technology users/adopters, and/or partners of social enterprise).

The guidelines designed some of its questions based on Rogers' (2003) criteria of innovations that achieve good rates of adoption, and criteria for recognizing early adopters of innovations. Other questions were designed to gather intelligence about the perspectives of respondents to how the social enterprises conducted their work and what critiques they had about that. The average time of each interview was 40 minutes. Interviews took place between December 2014 and August 2015. Each interview was given a code instead of a name, for confidentiality. Data analysis sorted the data using themes

2 The cases did not include known/conventional cooperatives in Tanzania or East Africa, although definitions of SEs tend to include cooperatives. The assumption that we made for the field study was that cooperatives are too big in age, proliferation and influence to be included in a field study of social enterprises. That is so particularly because social enterprises (save cooperatives) are generally still a recent phenomenon in developing societies, contested in theory and yet immature in practice. Cooperatives, on the other hand, are quite established in Tanzania and East Africa, and have been so for decades (Coulson, 1982). The assumption we made was consistent with the observation that we never heard anyone in Tanzania – native or foreigner – refer to cooperatives among the Tanzanian social enterprises. That may very well be the case in the rest of East Africa, and at even the global scale, since cooperatives are significantly older in origin than all other forms of social enterprise.

of inquiry, variables of categorization (for persons and organizations, to identify early adopters), categories (such as technology type or model of diffusion) and spreadsheets (for grouping likert-scale answers). Two software programs were used for organizing and coding data: one is the qualitative data analysis software, Nvivo (v.10 for PC) which was used to code data according to research participants (interviewees and organizations) and according to themes. The other software program used is MS Excel.

The cases that participated in the study represent a fair sample of the SEs in Tanzania that were involved in rural technology localization activities. Thus, we argue that what was learned from them can represent fair generalizations about such organizations in Tanzania. We surveyed all the SEs in Tanzania that he came to know about through various sources (e.g. networks of development actors in Tanzania that responded to us, networks and contacts of informant organizations, internet search, asking other researchers in Tanzania with whom we were acquainted, etc.). We confirmed that the number of SEs in Tanzania working in technology diffusion activities is limited (close to 30 at the time) and that most of them have offices or headquarters in Arusha.[3] Among those we narrowed down the list of viable candidates (per criteria of selection) to about 15 or 16 potential participants, contacted most of them, and eventually ended with 6 consenting participants (Table 2).

The study received ethics approval from two entities, respectively: the Research Ethics Board (REB) of the University of Guelph, and the Tanzania Commission for Science and Technology (COSTECH), n.d.

Research findings

The first sub-question regarding the effectiveness of SEs as agents of technological change was to determine whether SEs demonstrate involvement in the three activities of technology localization – diffusion, institutional support, and technical adaptation. Below are the general findings regarding each activity.

Diffusion

The cases that were clearly involved in diffusion were GCS, Kakute and TDBP. GCS innovated a nationwide diffusion network that it called the rafiki network. *Rafiki* in Swahili means 'friend', and the network is based on a group of independent sales representatives and distributors who are trained by GCS in handling and marketing their products. Each individual representative/distributor is called a *rafiki*. Most *rafikis* are both users of GCS merchandize – mainly solar PV lanterns, some solar cookstoves, and a few manual maize shellers – as well as local entrepreneurs who distribute these technologies locally. They are also free agents who made the voluntary choice of partnering

3 Arusha, Tanzania has a large scene of development organizations, international, regional and local. Authors knew of this beforehand and chose Arusha as base because of it.

Organization	Size*	Established since …	Technologies diffused	Organization/Business Model
GCS Tanzania Ltd.	30–40 employees (excluding the Rafiki Network, which has about 100 active individuals); multiple regions in Tanzania and Kenya; 3 offices in 3 regions, including inventory container, workshop; at least 4 vehicles; over 50,000 households served between 2011 and 2014.	2009	Solar lantern products (one brand, different products, imported); Energy-efficient cookstoves; Maize-shellers (manual and bike-mounted); and others	Private company, Sells sustainable energy products and post-harvest small agricultural tools. Some products are in-house designed, others traded from other producers.
KAKUTE Projects Co. Ltd.	~10 employees (used to be more, about double, a few years ago); Northern Zone (3 regions); one main office on relatively big premises well-maintained, with warehouse and hosting other companies (incubatees and partners); one vehicle.	1995	Solar Lantern Family Line; Solar PV panel small systems; jatropha-based personal care products; and other products Also technology services: technical consultancies, training, incubating, renewable energy school programme teaching, etc.	Company Limited by Guarantee. Introduces and innovates technology solutions for sustainable energy and agricultural production. Activities include technology-business incubation, consultancies, direct marketing and sales, training provision, etc.

(*Continued*)

Table 2: (*Continued*).

Organization	Size*	Established since …	Technologies diffused	Organization/Business Model
Biogas Construction Enterprises (BCEs) (Tanzanian Domestic Biogas Programme – TDBP)	TDBP has ~25 employees, nationwide programme with multiple offices and vehicles; main office hosted by CAMARTEC; BCEs are multiple and nationwide, with each having between 4 and 20 employees and some with small offices; so far over 12,000 biogas digesters constructed all over Tanzania.	2009	Biogas digesters construction and maintenance, with gas pipe connections for cooking and lighting.	Nationwide initiative with the aim of creating a viable commercial sector for biogas technology in Tanzania. Provides training, subsidies, coordination of businesses and community stakeholders, and establishing local biogas construction enterprises.
Dorgo Agro-Enterprise	3–4 employees; one small office and small workshop (yet with access to bigger workshops when needed); technically serves nationwide but still currently mostly confined to Northern Zone. ~20 products (agro-machinery) sold so far.	2012	Agro-machinery products, variety of mechanized and manual products.	Local micro enterprise that designs and builds various agricultural machineries and tools. Involved in community training and volunteer engineering services. Does direct sales and marketing, and renting of machinery
Twende (or AISE-Twende)	5–10 employees; one office and workshop; one vehicle; no estimates of sales over years but not many, as most work is not commercial yet. Formed by the 2014 merger of two organizations: Twende and AISE.	2007	Solar water heaters, agro-machinery, drip-irrigation kits, and others.	

(*Continued*)

Table 2: (*Continued*).

Organization	Size*	Established since …	Technologies diffused	Organization/Business Model
Also technological and innovation services: hosting and coaching innovation projects, school classes for appropriate technology, etc.	NGO with appropriate technology design and training orientation. Mostly works in training and coaching provision (paid for by NGOs instead of direct users/ adopters) as well as a few direct sales.			
RafikiSoft	2 co-founders (no employees); no office (virtual office); so far one main customer (GCS Tanzania Ltd.), few consultancies and prospects	2014	ICT: RafikiNet: ERP (Enterprise Response Planning) or a business management platform	Software company that provides ITC solutions to social enterprises dealing with wide networks of rural distributors/ agents. Provides direct service contracts

Table 2: Research case studies (social enterprises).

with GCS locally because of the potential they saw for the technology products after trying them as users. We interviewed 16 *rafikis* from various parts of Tanzania, and they revealed GCS' comprehensive approach to diffusing their products.

The diffusion process followed by GCS proceeds along the following line: GCS field officers seek out and recruit *rafikis*, through persuasion, marketing and selection, then the *rafikis* use similar diffusion techniques to market and sell GCS products to their communities. This approach has been called 'microfranchising' (Lehr, 2008). According to GCS staff, in 2015 the *rafikis* in the network were about 120 individuals spread across Tanzania (and a few in Kenya). GCS products sold by *rafikis* are commonly solar-charged lanterns of various sizes (small, medium, and large) with additional features such as outlets for mobile phone charging – including USB charging outlets for smart mobile phones – as well as multiple-lantern systems with a battery that can charge more than one mobile device. Other products include small, energy-efficient cookstoves and a bicycle-attached small maize sheller. Typically, GCS field officers make first contacts with the targeted communities by introducing themselves to the district officers and village councils of those communities, or to community-based organizations like churches or SACCOs (Small Saving and Credit Cooperatives). After that they secure an occasion allowing them to introduce themselves to the general membership of the community, as well as introduce their products and announce their interest in finding local partners in the community to be *rafikis*.

If the work of marketing the products, the company's brand, and the microfranchising idea succeeds, a number of community members will express interest in becoming *rafikis*. How the *rafikis* perform afterwards – after selection and training – determines whether they become active *rafikis* or eventually phase out of the network.[4]

On the other hand, Kakute engages in diffusing multiple technology products that are not necessarily their own commodities (i.e. the sales revenues do not go to Kakute directly). For example, the social enterprise Mobisol began as an incubatee start-up with Kakute and rapidly grew to a relatively big company of solar PV home systems with a significant market share in the off-grid energy subsector in Tanzania (and East Africa). Their PV systems were initially diffused by Kakute, as it incubated Mobisol and championed the diffusion of its products to Tanzanian rural and peri-urban communities. Based on interviews with Kakute staff, the SE used its knowledge of local communities' needs, institutions and networks to diffuse such new technological solutions/products, as it did in various projects. Another group of technology users associated with Kakute was a church group running a small hospital in a rural community in a rural district of Arusha region. That hospital is run by the local Catholic Church team, consisting of the parish priest (also the hospital director) and the church nuns, with additional physicians and nurses. The entire hospital premises and equipment

4 The description of the rafiki network here is according to how it functioned up to the conclusion of the field research activities. The network underwent changes afterwards, but were not reflected in the data collected from the field.

were run by a solar PV array with a large battery system, forming a solar generator with the capacity of ~10 Kilowatts. This system was installed by a German NGO through the facilitation of Kakute. As the parish priest tells the story (not verbatim):

> My initial contact with Kakute came through my need for energy in the hospital. We had a small generator and were still developing, so we needed something more … I wrote a proposal for TANESCO and REA.[5] I was looking for a way and a place to submit the proposal, so I met director of Kakute, whom I knew. He introduced me to an engineer from REA, and they both connected me to a German organization which then supplied us with the solar system for the hospital.

Soon afterwards, Kakute's director and the parish priest became interested in bringing solar home systems to the village households, since the village was still off the grid. Kakute teamed up again with the church and introduced the community to the home solar PV systems that are offered by Kakute's partner (and former incubate), Mobisol. Through Kakute's diffusion they succeeded in introducing these home systems to over 200 households in surrounding area.

As for the Tanzanian Domestic Biogas Programme (TDBP), their diffusion efforts consist of promoting biogas usage nationwide and particularly to rural and agricultural communities. TDBP conducts a variety of activities (TDBP, 2009) that include reaching out to regional governments, village committees and farmer associations, as well as promoting biogas via national media, particularly radio. Additionally, TDBP partners with community and faith-based organizations to promote biogas among their memberships. Additionally, it encourages masons and interested entrepreneurs to establish and register Biogas Construction Enterprises (BCEs), to be come certified contractors for building biogas digesters in their respective regions and nationwide. BCEs vary in their own diffusion activities, since each one is generally an independent business.

Two BCE cases are worth highlighting. The first is BCE is from Ngaramtoni (district in Arusha region). It consisted of four certified masons who registered a company as co-owners and run it like a small cooperative. This BCE has been in operation since 2009 when the first set of masons were certified and has constructed about 200 biogas digesters up to June 2015. By TDBP standards in Tanzania, this BCE is one of the successful operations with potential for growth. Yet it is not currently thriving commercially. This BCE is generally positive about its future in the biogas sector, provided that the sector will continue to grow in Tanzania. It diffuses through community networking and the word-of-mouth reputation building (peer to peer diffusion). The second BCE is based in Mwanza, in the Lake Zone, has constructed over 450 biogas digesters since 2012. According to its manger, this BCE has a few co-owners and about 15 masons employed in total, in addition to 6 mobilizers and an advisor for strategic planning and accounting. This BCE extended its marketing approach to the point

5 Tanzania Electric Supply Company Ltd. (TANESCO), and Rural Energy Agency (REA).

of producing video advertisements, putting them in DVDs, and paying local travel bus companies to play them on their screens while on the road.

Another social enterprise, Dorgo, focuses on diffusing their technologies through sales and partnership projects with agricultural R&D institutes. Dorgo meets and consults with small-scale farmers about their technological needs and suggests what Dorgo can offer in terms of products and training. Some of the work that Dorgo does on promotion is free of charge and some is direct sales or technical consultancies.

Institutional support

Two case SEs were visibly involved in institutional support activities: TDBP and Kakute. These activities included advocacy, resource mobilization and logistical and training assistance. For TDBP, its work on institutional support comes with its position as a nationwide initiative that has a commitment to both the public sector and large international donor agencies. TDBP works with national and regional governments to furnish an enabling environment for adopting biogas at a large scale and encouraging Biogas Construction Enterprises (BCEs), which are the social enterprise component of TDBP. It advocates and disseminates subsidies for BCEs based on their work, helps them register their businesses, and holds demonstrations and workshops for farmers and village residents about the benefits of biogas. It also lobbies regional governments to build pilot projects of biogas digesters in selected villages and public facilities (e.g. schools or hospitals). Additionally, TDBP works on resource mobilization to support BCEs and train and certify biogas masons. As described by the national programme coordinator, for carrying out the construction activities TDBP provides training and certification for masons who, after training and testing, can become independent contractors providing the service of constructing certified biogas digesters for clients. These certified masons are responsible for constructing digesters up to standards and reporting their work to TDBP testing teams (for approval of quality) that guarantee clients good quality digesters and follow-up when needed. The masons and their BCEs are also entitled to some subsidy schemes to support their work and reduce the cost to the clients (thus making more clients interested).

All in all, it is quite evident that the possibility of creating a viable commercial sector for biogas in Tanzania rests on the success of BCEs. They are the ultimate fruit of TDBP and it seems that the future of biogas in Tanzania will be as sustainable as BCEs will be. The small cooperative model that some BCEs adopt is a unique social enterprise experiment. As explained by the national programme coordinator, most BCE masons start by building their own biogas digester at their home, and so they are intimately connected to their product (i.e. both users and diffusers of the technology).

As for Kakute's, its institutional support activities begin with its involvement with TAREA (Tanzania Renewable Energy Association) to represent the growing renewable energy actors in the national policy arena. Kakute hosts the TAREA Northern Zone office, and its director is also TAREA's chairperson for the Northern Zone. TAREA

currently includes commercial businesses, SEs, NGOs and initiatives that seek to promote a supportive policy and infrastructure for renewable energy technologies in Tanzania in general. Their work involves lobbying the government and working with REA (Rural Energy Agency) to support and promote renewable energy solutions and foster a larger commercial sector for them, as a method of bringing energy to many parts of Tanzania. Overall, the cases provide examples of all institutional support activities: policy advocacy, resource mobilization, and logistical and training assistance.

Technical adaptation

Dorgo, GCS, Twende, Kakute and RafikiSoft demonstrated technical adaptation activities in their histories. Twende, for instance, works mostly with designing and building appropriate technology solutions to local challenges. Some involve adapting an idea of a machine or product and simplifying it for local affordability and utility. For example, a simple drip-irrigation kit, a small solar water heater, and bicycle-attached tools that use the pedalling mechanism, such as juice blenders. GCS, on the other hand, was more involved in technical adaptation in its earlier years than it is now. In the beginning it designed, produced and promoted simple maize shellers and bicycle-mounted maize shellers. The bicycle-mounted maize sheller made a good name for GCS but GCS decided to discontinue selling the product, with the explanation that it was working on improving its quality so that they may introduce a better version in the future. No specific numbers were given but a rough estimate of 200–300 of the these maize shellers were sold before discontinuation. As for RafikiSoft, its flagship product was an ICT programme and phone application that aids the *rafiki* network. This ICT product was modified to suit the needs of a network of distributors in a developing country.

Kakute received national awards in the late 1990s for its work on innovating and diffusing a number of agricultural technologies, including building a personal care products' industry from jatropha seeds (VCD Training, 2005; Kakute Ltd., 2007). Jatropha is a plant that is abundant in Tanzania, and Kakute was a leader in using it for making oils and shower soaps as well as generating biofuel. Kakute's approach was to help build a local value chain for an industry that supports local farmers and manufacturers while also creating a local and regional market for natural personal care products. Later on, Kakute supported its former incubatee, Mobisol, to adapt solar home systems to make products suitable and affordable for Tanzanian households in rural and peri-urban areas.

Dorgo was the most serious case of technical adaptation. Founded and headed by an agricultural engineer who has a talent for design, Dorgo started as a company that sells its own designs of agro-machinery products, modified to suit local Tanzanian conditions. Overall, Dorgo produced a variety of agricultural machines: 5 multi-crop and multi-operation machine (operated by a power tiller), a tractor-operated maize sheller, 3 forage choppers, 4 'mini maize shellers' (motorized with small engines), and 7 Cinva-ram Machines (soil cement block-making machines). Dorgo's power-

tiller operated multi-crop processor (POMP) machine received an international award for innovation for development. It uses power from an imported power-tiller machine (powered by a generator) to make an attachment that uses the same generator, and the mobility of the power-tiller, to perform other functions, such as cutting grass and shelling and threshing crops (maize, rice, sorghum, etc.). The design was robust and efficient for smallholder farmers.

Additionally, Dorgo engages in innovation projects to improve and disseminate some traditional technologies and best practices in agriculture and agro-processing learned from various local communities. For example, Dorgo was involved in fabricating and modifying 45 low-land weeders, 10 oil-press machines, and doing some repair works for customers. Other projects combine improved local tools and modern techniques. As the head of Dorgo explained, his knowledge and experience as a Tanzanian agricultural engineer allowed him to recognize how some existing local tools and techniques in agriculture are worthy of support and transfer from one region to another, or one community to another, as well as improving upon them instead of seeking to replace them with new machinery.

As for the case of TDBP and the BCEs, their entire business was based on a biogas digester design that was modified locally by engineers from CAMAREC (Centre for Agricultural Mechanization and Rural Technology) to suit Tanzanian conditions. They developed a simple yet efficient design that uses local building materials and a clear blueprint.

Overall, the cases demonstrated involvement in the variety of technology localization activities: diffusion, institutional support, and technical adaptation and success in generating adoption of a wide range of technologies. What factors might explain this success?

Engaging early adopters

We also asked whether the success of SEs in localization was related to their efforts in engaging individuals with the characteristics of early adopters of innovations. The clients of the SEs were asked how early and how in relation to the rest of their community or area, they adopted the technology in question. They were also asked if they held leadership or influential roles in their communities, and how they use those roles. Finally, they were asked about their general experience with the product and communicating its value to other community members, as well as their relation with the SE and how they valued that relation. The field data collected used criteria of early adopters from the diffusion of innovations literature (mentioned in the methodology section of this paper) to identify SE clients who demonstrated such characteristics.

Findings indicated that clients of SEs who were among the first adopters of their products and services also demonstrated qualities of early adopters. For example, they held positions of community leadership, i.e. played a leading role in village council, farmers' association, women association, church or mosque, commerce,

etc. Additionally, a number of adopters that were interviewed initially for their adoption of agro-processing machinery turned out to be also early adopters of biogas digesters and solar PV energy home systems, or vice-versa. A number of such interviewees described their future plans for adopting or improving more technologies – not necessarily provided by the case SEs – that would aid their livelihoods.

In the case of GCS, as shown earlier, they have a routine approach to introducing themselves and their products to new communities and recruiting potential *rafikis*: they speak to the leadership of communities first. In such communities some of those same leaders become interested not only in being among the first to try the new technologies offered by GCS, but also in taking the route of training and commissioning to become a *rafiki*. Over five of the clients who were interviewed fit the description of early adopters. Most technology users explained that the way they heard about GCS for the first time was through either their own village chairman calling a meeting or through some community organizations such as women or village SACCOs (Savings and Credit Co-operatives) spread all over Tanzania.

Another SE, Kakute, uses a somewhat similar approach to that used by GCS. They introduce themselves first to the community leaderships such as the village councils and district governments. Kakute has been diffusing technologies for a longer time than any of the other cases, and the leadership of Kakute have a larger network of acquaintances and friends in communities, district governments, village councils and community organizations. In that sense one can say that Kakute's social capital is larger than the other SE cases, and it uses its social capital to promote technologies. Not surprisingly, some of Kakute's clients who were interviewed also displayed characteristics of early adopters (above 7 clients). For example, one client was the catholic priest that worked with Kakute towards realizing a hospital's off-grid solar PV system, and persuading the surrounding community to install solar home systems for their households. This priest is a highly-educated person (PhD holder) whose work revolves around rural communities in which he lives for years at a time and builds communities of faith.

Not all the early adopter characteristics were found in each adopter, but a sufficient combination of them, when applicable to individuals, were found among the adopters interviewed. Communities that were covered in this study, in which early adopters were found, had rates of adoption that were considered relatively high by both the community and the SE staff. Particularly, if the early adopters themselves were satisfied with the product and with the SE in question, they often persuaded a significant number of other community members to adopt. Such were communities as Longido district (Arusha), Ngaramtoni (Arusha) and Turiani (Morogoro), in which technologies of solar power home systems and solar lanterns were introduced by Kakute and GCS.

Some early adopters were targeted and recruited early by the SEs. Others became interested and involved due to peculiar circumstances, such as hearing about the new products and services and seeking to try them or being introduced to the social enterprise and their products or services due to their official title (such as being the village

chairman, district officer, known merchant or farmer in the area, etc.). Findings demonstrate that SEs engaged early adopters but it is not clear whether they did so consciously – i.e. by intentionally targeting such individuals. If we apply Rogers' terminology rigidly (2003), it will be difficult to say that any of the case SEs had an intentional strategy of engaging early adopters. However, we could see that SEs have learned over time that certain community members are more likely to adopt the technologies earlier than the rest and that some of them are quite influential in their communities if they happen to like the technologies.

Satisfaction of respondents with their technologies

The third sub-question, to the research question, asked whether clients and partners of SEs gave overall favourable accounts of the technological change that they experienced. The majority of interviewees were asked to respond to likert-scale questions about their experience with the technologies they adopted or promoted. Seventy-seven interviewees responded to those questions (mostly technology users). Table 3 shows a summary of their responses. The questions examined perceived qualities of the new technological products and services, namely: their relative advantage (compared to locally existing alternatives), compatibility with existing values and practices, simplicity and ease of use, trialability and observable results (Rogers, 2003).

As a second measure, we made independent assessments of the general economic and marketing performance of the case SEs. In the interviews technology users were asked questions about the performance of the SEs particularly regarding how they introduce the technology and engage the target communities to spread the product. One fundamental factor that is essential to the success of the diffusion effort is the technology itself. If the technology product or service itself does not prove to be effective, in good quality and meeting serious demands in the community, it is highly unlikely to be adopted. In the interviews with adopters, some of them had unsatisfactory experiences with some products or services (not necessarily those of the case SEs), and they communicated their dissatisfaction to other members in their communities. For example, in interviews with GCS clients and *rafikis* in the Morogoro region, they spoke about another brand of solar PV lantern that was already in the market before GCS opened its Morogoro branch. Apparently, those lanterns were of lower quality, durability and warranty than the ones GCS provided, so users were not generally satisfied with them. When GCS lanterns were diffused in Morogoro initially, people were suspicious, but the demonstrated quality, and the warranty guarantee, eventually persuaded many.[6]

Technology users who were associated with Kakute varied in their responses because their experiences were not uniform. The users of Kakute were not all direct

6 However, based on interviews with *rafikis* from Morogoro region, the competitor lanterns are lower in price than the ones marketed by GCS, so some people still buy them because of affordability.

Responses Criteria[a]	Positive	Neutral	Negative
Relative advantage	73 (out of 77 responses)	3	1
Compatibility (∼)	70 (out of 77)	3	4
Simplicity	66 (out of 77)	7	4
Trialability	55 (out of 77)	11	11
Observability	Majority observed benefits of technologies within a few months. Few observed benefits over years or immediately.		

Table 3: Satisfaction of respondents with their technologies.

[a]Borrowed from Rogers' (2003) criteria of innovations that contribute to the success of their diffusion. A series of interview questions were designed to relatively measure criteria from the perspective of respondents.

recipients of technology products or services from Kakute, since Kakute's profile, unlike GCS' or Dorgo's profile, is not dominated by direct sales of products to communities (as explained above). Technology users associated with Kakute were a combination of direct beneficiaries of a renewable energy project of Kakute and members of communities where Kakute conducted promotional work for the products of one of its incubatees. Despite the variety of users associated with Kakute it is the SE that received the highest collective praise from technology users. One group of Kakute clients we interviewed consisted of 15 clients in the same district (2 villages), and they described how they were hesitant about trying solar home systems, but with the persuasion of Kakute and the church they decided to try them. Currently they say that they look back to their lives before solar power and they see big differences. Some of the benefits they mentioned were: a) Some house-shops can remain open after sunset for more hours, and that helped improve their businesses; b) School kids have more time to do their homework in the evenings; and c) Since this area is close to a national park, they used to have problems with animals, such as elephants and hyenas, crossing their communities, especially at night, which was obviously a problem. Solar lights in households at night reduced these occurrences.

Unfortunately, we did not have sufficient access to the technology users and clients of either Twende or Rafikisoft, to know their assessment of the technologies and the performance of the SE. During the field research period, Twende was not yet active in selling or diffusing products or services to communities (as it dealt more with training and innovation support during the time of the field study), while Rafikisoft only had one accessible client, GCS, which could only provide a one-client perspective (however, GCS has been intimately involved in this ICT product since it was originally designed for its *rafiki* network) (Jackson, 2015).

As for the case of Dorgo, six clients of theirs, located in the Arusha and Kilimanjaro regions, were comfortable in saying that the Dorgo machines were of good quality and even comparing them favourably to machines imported from China, India or Brazil.

		Technology localization activities			Engaging early adopters	Satisfaction of clients with change
		Diffusion	Institutional Support	Technical Adaptation		
Cases	GCS	α	β	β	α	α
	Kakute	α	α	α	α	α
	TDBP (& BCEs)	α	α	β	α	α
	Dorgo	β	•••	α	β	α
	Twende	•••	N/A	α	•••	β
	Rafikisoft	B	N/A	α	•••	•••

Table 4: Cases and signs of effective technology localization.

Legend: α = active involvement; β = somewhat involved; N/A = not applicable; ••• = indistinct/inconclusive information.

Four of Dorgo's clients interviewed were agricultural experts: an engineer with an agricultural institute, a retired veterinary doctor and head of agricultural department in his district, an emeritus professor of Agricultural science, and a manager/trainer in forestry at another university. Each one knows agricultural technology well and have qualities of early adopters or innovators. All four clients generally agreed that Dorgo products are of good quality (albeit there is room for improvement or modification); that the prices of its products are generally not accessible to the average farmer household (unless with alternative payment methods or with sharing schemes among multiple farmers); and that Dorgo's weak points requiring immediate attention are its communication and marketing.

Overall, clients of the case SEs in this study had positive feedback about their experiences with the technological change brought by the SEs. Their satisfaction was not complete, but they were more satisfied than dissatisfied. They suggested ways of making their experiences better but had no regrets about the experiences.

Conclusion

Technology localization is a concept that merges theory and practice aspects of technological change in developing societies. It refers to activities that aim to overcome resistance to technological change among targeted communities. Tanzania has a vibrant scene of emerging social enterprises active in localization, with relative successes, setbacks, and a persistent presence. Interviews with adopters of new technologies, in this study, revealed variations and similarities in their stories of adoption.

Based on the results of this study, we can conclude that social enterprises can be effective agents of localization, provided that they plan and commit do be so. As indicated, activities of technology localization – diffusion, institutional support and technical adaptation – seem to be evident among the cases of this study in general, but without each one being active on all localization activities equally. With regards to engaging

early adopters, a visible number of the cases demonstrated that they have early adopters among their clients. Early adopters in such cases played key roles in diffusing the technologies in their respective communities. As for satisfaction of clients with the technological change experiences, the results were reasonably favourable. They generally had few complaints about the technological products themselves. Table 4 summarizes the overall findings from exploring the sub-questions of the study.

Two main technology types are the focus of the case SEs in their localization activities in Tanzania: sustainable energy technologies and agro-machinery. Sustainable energy technologies include solar PV, biogas, and biofuel efficiency, while agro-machinery include a variety of post-harvest and agro-processing tools and techniques. Satisfying technologies may not guarantee successful adoption, but unsatisfying technologies are very unlikely to be successfully adopted.

Are the findings of this research applicable to other East African countries? The response is a conditional 'yes'. Some of the SEs explored in this study also operate in some capacity in other East African countries (such as GCS in Kenya, and Kakute in Rwanda for some consultancy work), or have counterparts there (such the TDBP equivalents and partners in Uganda and Kenya). Rural conditions in East Africa are often comparable across national borders. Differences in contexts would depend different national policies and their attitude towards non-state actors.

Overall, there are legitimate prospects for SEs to contribute to technological change efforts in Tanzania and East Africa. Due to their inclination for innovation, their decentralized nature (compared to corporate businesses for example), and their overall pursuit of balance in social and economic value creation, SEs could be effective agents of localization.

The big differences in developmental contexts between East Africa and western countries make the use of the term 'social enterprise' very different or almost irrelevant in Tanzania, while social enterprise models – i.e. social mission with business model – exist and will likely continue. In Swahili there is not even an adequate translation of the term social enterprise (yet) despite the proliferating number of them and the continuing use of the term in English and in international communication (between SEs in East Africa and the outside world, particularly the international donor, media and research communities). As yet, local social enterprises are either officially registered as private businesses (for-profit) or NGOs (non-profit); i.e. no legal category of social enterprise.[7]

7 The closest example for a legal registration as a social enterprise, among the explored SE cases in Tanzania and East Africa, was the case of Kakute's registration – registered as a company limited by guarantee (LBG), which is a form of registration often used by non-profit organizations that need/want to have legal personality. Instead of shareholders, such organizations have guarantors. In the cases where some profits are made from any project/venture, they are generally reinvested in the company.

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