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RESEARCH PAPER

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When Institutional Logics Meet Information and Communication Technologies: Examining Hybrid Information Practices in Ghana's Agriculture

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Abstract

In this paper, we describe how changes in the availability of information artifacts—in particular, information and communication technologies (ICTs)—among smallholder farmers in Ghana, led to a process of hybridization of information practices, and how this process could be linked to underlying institutional change. We use the notions of institutional carriers and activity systems to study the evolution of the prevailing "smallholder" institutional logic of Ghanaian agriculture toward an incoming "value-chain" institutional logic concerned with linking farmers to output markets, improving the knowledge base in agriculture, and increasing its information intensity. We draw on a mixed-methods approach, including in-depth qualitative interviews, focus groups, observations, and detailed secondary quantitative data. We cultivate activity theory as a practice-based lens for structuring inquiry into institutional change. We find that information artifacts served to link the activities of farmers that were embedded in the smallholder logic with those of agricultural-development actors that promoted the value-chain logic. Hybridization occurred through the use of artifacts with different interaction modalities. In terms of conceptualizing change, our findings suggest that hybridization of the two logics may be an intermediary point in the long transition from the smallholder toward the value-chain logic.

Keywords: Institutional Carriers, Activity Theory, Information Artifacts, ICT4D, Africa

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1 Introduction

Academic studies (Avgerou, 1998; Jensen, 2007) and international development reports (Waverman et al., 2005) increasingly testify to linkages between information and communication technologies (ICTs) and development. Based on this evidence, and on advancements such as increased ICT penetration rates, policy-makers and development practitioners have looked to include marginalized populations in the information society (Woodard et al., 2014). In Africa, smallholder farmers (farming families with livelihoods based on growing a mixture of cash and subsistence crops) are at the bottom of the pyramid and at the periphery of the information society. This type of micro-organization is under researched, despite its prevalence in agriculture in the wider developing world (Thapa & Gaiha, 2014). Development actors are increasingly attempting to transform smallholders' livelihoods and to improve local food security by

introducing policies aimed at including them in national and international value chains. ICTs have often been central to such policy efforts (World Bank., 2011). Unfortunately, the success of these efforts has frequently been frustrated by problems characteristic of African rural life; for example, insufficient information and skills, fluctuations in commodity prices, unreliable rainfall, and slow-moving institutions (Antwi-Agyei et al., 2012; Christoplos, 2009). This has resulted in smallholder farmers becoming confined in a "smallholder" institutional logic, characterized by cash-in-hand and informal trading, dominated by rural norms, plagued by governance problems and lack of access to markets, ICT, and information (Collier & Dercon, 2014; Fafchamps, 2004; Webber & Labaste, 2010). African smallholders remain unable to convert their operations to a "value-chain" institutional logic defined by a greater knowledge base and information intensity, as well as by the availability of facilitation services that link farmers to output markets. As a result, the opportunities offered by global agricultural markets remain out of reach for them, and the promise of ICTs to propel such changes continues to be limited.

In order to generate insights into the capacity of ICTs to transform agricultural markets by including the poor, we develop understanding of how ICTs facilitate the evolution of the smallholder institutional logic in Ghanaian agriculture toward a value-chain logic. Institutions can be understood as social structures that bring stability and meaning to social life, whereas logics or "institutional logics" (Friedland & Alford, 1991) are defined as "the socially constructed, historical pattern of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material substance, organize time and space, and provide meaning to their social reality" (Thornton & Ocasio, 1999, p. 804). Institutional logics has been used as a sense-making lens for understanding the behavior of actors (Lounsbury, 2012) and for explaining ICT use (Sahay et al., 2010; Sandeep & Ravishankar, 2014). We use it to link farmers' information practices—as social, collective, intersubjective, and contextually oriented (Savolainen, 2007)—to the institutional setting of Ghanaian agriculture. Our research is directed by two research questions.

1. How do technical and nontechnical information artifacts transform farmers' information practices in rural Ghana?
2. How do new information practices challenge the existing smallholder logic and enable the value-chain logic in agriculture?

To address our research questions, we used an in-depth mixed-methods approach, framed by an activity theory perspective. We made the focus of our inquiry technical and nontechnical information artifacts ("information artifacts" for short), their use in the interconnected network of activities of smallholder farmers and agricultural-development stakeholders, and their role as institutional carriers. We define information artifacts as the technical artifacts (e.g., letters, newspapers, radio, mobile phones, Internet, Twitter, etc.) by means of which a subject interacts with the information pertaining to the object of his or her activity, or their nontechnical equivalents (e.g., people, relationships, etc.).

Our contribution is twofold. First, we develop a practice-based account that links macrolevel processes of institutional change to microlevel artifact-mediated practice. This responds to recent calls in information systems (IS) for multilevel theory and research (Bélanger et al., 2014). Empirically, we contribute by revealing how, through a process of hybridization, information artifacts serve as carriers of institutional change in Ghanaian agriculture. Second, we cultivate interaction modalities as a lens for structuring inquiry into the symbolic elements of various technical and nontechnical information artifacts. By doing so, we build on the body of knowledge in ICT for development (ICTD), which argues that ICT solutions need to be conceptualized in a broader sociotechnical environment (Walsham, 1993), rather than in isolation.

This paper is structured as follows. In the literature review (Section 2), we position our research in the body of IS and ICTD research, and characterize institutional change in African agriculture as a pertinent societal problem. We outline our theoretical contribution in Section 3, and our methodological approach in Section 4. In Section 5, we present our analysis, while Section 6 outlines our main research findings and their theoretical and empirical implications. Section 7 concludes the paper by summarizing the main findings.

2 Literature Review

2.1 Smallholder and Value-Chain Logics in Africa

The African agricultural sector accounts for roughly 20 percent of gross domestic product and supports the livelihoods of two-thirds of the sub-Saharan African population (Badiane & McMillan, 2015). Alongside poverty reduction, sustained economic growth, educational attainment, and climate change, ensuring agricultural-sector development is a major challenge facing Africa (Collier & Dercon, 2014; Hazell, 2013). A key strategy among policy-makers in the pursuit of transformation is inclusion of agricultural smallholders in value chains (i.e., people, organizations, and activities needed to create, process, and deliver food products to consumers). Value-chain development is a process associated with improving market access, bridging agronomic knowledge gaps, and realigning

farmers' worldviews from traditional identities toward a market orientation (Slavova & Karanasios, 2014).

In the smallholder logic, farming is indistinguishable from the rural way of life. This is consistent with a cash-based flea market economy in the agricultural sector and is thus plagued with numerous governance problems (Noman et al., 2012). Informal market transactions with traders or village markets governed by indigenous institutions prevail as the dominant distribution mechanism for small-scale producers in Africa (Fafchamps, 2004). Regulatory norms (e.g., measurement units, grades, and standards) remain hard to verify (Lyon, 2000), and resistance to their adoption persists as a significant barrier to including African producers in global value chains. Problems with the governance of agricultural market trades are often underpinned by the unsophisticated nature of smallholder production and its unverifiable quality, due to low levels of adoption of improved inputs, such as seeds and fertilizers (Fafchamps, 2004). For instance, instead of using verified seeds and inorganic fertilizers, smallholders continue to follow the custom of relying on recycled seeds and manure. Consequently, the smallholder logic is characterized by produce heterogeneity, inconsistency of produce quality, personalized trading relationships, and lack of standardization (Fafchamps, 2004; Noman et al., 2012).

The value-chain logic captures an understanding of agriculture as a business. Relationships among value-chain partners are governed by cooperation, coordination, and punctuality, as well as by legal norms. Transparency and governance are achieved through the exchange of text-based documents (e.g., contracts, guidelines, and standard operating procedures), rather than relying on informal arrangements. The logic is consistent with policy strategies for value-chain development and is widely recognized as the way forward in improving the competitiveness of African agriculture (Webber & Labaste, 2010). Table 1 compares the two logics.

Strategies to facilitate the emergence of value-chain behaviors include strengthening the demand for improved inputs among smallholders, ensuring the availability and uptake of agricultural advice and consultancy services (Christoplos, 2009), and introducing market-facilitation services that link farmers to output markets. ICT is expected to play a role in better informing smallholders and better connecting them to the value chain. While African agricultural production and trading practices have traditionally not been characterized as knowledge- and information-intensive, this is beginning to change and competitive advantages are expected to spring up in agricultural value chains from the introduction of ICTs (Armstrong et al., 2011). However, the role of ICTs as enablers or barriers to the transition from smallholder to value-chain logic has not been rigorously treated in IS.

Table 1. Smallholder and Value-chain Logics in Agriculture

	Smallholder logic	Value-chain logic
View of agriculture	• Way of life	• Business
Relational networks	• Interpersonal ties	• Business contacts
Dominant interaction pattern	• Oral, in-person	• Text-based, intermediated via documents and technologies
Locus of practice	• Unsophisticated, smallholder production with variable quality	• Certifiable knowledge- and information-intensive production
Governance	• Lack of measurement transparency • Lack of standardization • Indigenous institutions	• Regulatory norms (e.g., measurement units, grades, and standards) • Legal contracts
Transactions	• Informal market transactions • Informal brokerage	• Formal exchanges • Market-facilitation services

In Ghana, practices in the agricultural sector remain rooted in the smallholder logic, and personalized market transactions continue to dominate (Robinson & Kolavalli, 2010). These transactions occur in networks of spatially separated markets, where price signals are transmitted primarily through the activities of itinerant traders. While increased ICT penetration rates and improved telecommunications in Ghana have been hailed as enhancing coordination and improving trust within trader networks (Overaa, 2006), the adoption of improved agronomic practices remains low, with the preference for information accessed via in-person

social networks being a key factor (Conley & Udry, 2010). ICTs are considered key because they improve access to advisory information and facilitate adoption of improved agronomic practices (Davis & Adom, 2010). Historically, radio has played a large role in disseminating agricultural extension information (Chapman et al., 2003), whereas other agricultural-information services (e.g., Short Message Service (SMS) pricing and weather information) are provided largely by international nongovernmental organizations (NGOs) (Gakuru et al., 2009) rather than by the commercial sector.

2.2 ICTs in Agriculture

The ICTD subfield concerned with agriculture is focused on fostering sustainable agricultural practices and food-security outcomes through improved access to pertinent and timely information (e.g., advisory, market, and weather information) using ICT (Flor & Cisneros, 2015; Houghton, 2015). Following Jensen's (2007) seminal work showing that the use of mobile phones has a measurable impact on prices at Indian fishery markets and on fishers' income, researchers have been drawn toward estimating impact rather than understanding how change occurs. Positivistic studies from agricultural economists, hypothesizing the measurable impact of ICTs on rural livelihoods in fixed time periods, have dominated the field. Such researchers have often struggled to find any quantitative evidence of significant livelihood changes, and have captured only marginal changes (Aker, 2010; Fafchamps & Minten, 2012). Indeed, recent research following Jensen's findings was unable to corroborate links between mobile technology and improved economic welfare among Indian fishers (Steyn, 2016).

In order to develop understanding of how microlevel changes triggered by ICT translate into macrolevel impact we adopt an interpretative approach. Existing qualitative research has failed to address this knowledge gap because it has maintained a focus on microimpact evaluations, rather than on developing broader understandings of impact (e.g., Dangi & Singh, 2010; Kumar, 2004) and its change mechanisms. This has resulted in a lack of convincing qualitative impact studies (Heeks, 2006), and hence reservations persist around the overhyped potential of ICTs to mitigate persisting social and economic inequalities (Warschauer, 2003).

Studies have, however, provided detailed microlevel understanding of the role of ICT in rural smallholder agriculture. Recent research shows that despite the hype around mobile technology, it remains underused, and digital content for agriculture is plagued by issues such as access and accuracy (Mubin et al., 2015). Farmers continue to rely on strong peer networks (Mubin et al., 2015) and, where mobile technology is commonly used, relevant content services remain scarce (Islam & Grönlund, 2011). Farmers' ICT adoption and use face other challenges such as lack of infrastructure, low affordability, low literacy, and lack of conducive social norms, such as trust (Flor & Cisneros, 2015; Molony, 2007). Importantly, the integration of farmers' knowledge and information needs is rarely considered in ICT initiatives (Ajani, 2014).

The main identified microlevel uses of ICTs are coordinating access to agricultural inputs, accessing market information, monitoring financial transactions, and consulting with agricultural experts (Aker, 2010; Molony, 2008). Unique uses include storing local market trends on mobile phones, using the speakerphone function for group consultation with agricultural experts, and taking photos of agricultural demonstrations (Martin, 2011). While these studies have been successful in cataloging behaviors of ICT use, their methodological approaches have stopped short of accounting for how such progressive information practices can be institutionalized among smallholder farmers. Consequently, blending understandings of microlevel use with macrolevel processes is key to recognizing the developmental impact of ICTs.

In addition, one consistent finding is that smallholder farmers rely on, and prefer, low-tech artifacts and contextually relevant content (Prakash & De', 2007). Legacy technologies, like radio, and farmers' relational networks remain the most cost-efficient and omnipresent platforms for the transmission of agricultural knowledge and information (Flor & Cisneros, 2015; Venkatesh & Sykes, 2013). Consequently, substantial benefits may result from complementing inquiries into ICTs like the Internet or mobile, with an increased interest in legacy technologies (e.g., radio and television) and farmer-information networks (Islam & Grönlund, 2007). In other words, delivering real developmental change may well be dependent on understanding synergies among various information artifacts and on capturing the complexity of the rural information environment. Setting out to do this, we turn to combining ICTD and institutional perspectives.

2.3 Blending ICTD and the Institutional Perspective

With few exceptions (e.g., Foster & Heeks, 2013), ICTD research tends to focus on isolated interventions or on narrow microlevel practices of individuals and organizations. The extant ICTD literature has favored a mono- rather than poly-technology-oriented approach (e.g., Duncombe & Boateng, 2009; Loudon, 2016), sidelining the issue of how new ICTs (e.g., the Internet, mobile phones, and smartphones) take root, coexist, and compete with existing information artifacts (Edgerton, 2007). These considerations are particularly important in rural settings where legacy technologies and traditional information artifacts

dominate use while social networks contribute significantly to magnifying information reach (Venkatesh & Sykes, 2013). In our study, we capture the nuanced interplay of new and legacy technologies (Dewan et al., 2010) with social carriers of information (e.g., communities and people) (Donner, 2008) in propelling change in the rural agricultural context.

The notion of aligning sociotechnical change with development is complemented by the institutional perspective that views institutional transformation as a macrolevel process where institutional logics (Thornton et al., 2012) are disrupted and amended under pressure from practices at the levels of individuals, organizations, and organizational fields. While multiple framings of institutional logics exist (Friedland & Alford, 1991; Thornton & Ocasio, 1999), all presuppose a fundamental principle: Individual and organizational behavior is located in a social and institutional context, which both regularizes behavior and provides opportunity for agency and change (Thornton & Ocasio, 2008). In short, institutional logics are socially shared cultural beliefs and assumptions that shape and constrain actors' cognitions and behaviors (Lounsbury, 2012), and describe the way a particular world works (Thornton & Ocasio, 2008).

Despite its concern with shifts in beliefs, norms, and activities provoked by the introduction of ICT artifacts, the ICTD field has not been able to take full advantage of the explanatory opportunities offered by the literature on complex institutional logics and institutional change. Equally, while institutional approaches dominate mainstream development studies and have a rich tradition in the organizational and management literature, their use in IS has remained quite limited (Weerakkody et al., 2009). Linking ICTD and institutional logics offers IS scholars the opportunity to go beyond pragmatic concerns with ICT applications and to elevate the discipline to an examination of the role of ICTs in influencing far-reaching and transformative social processes. IS scholars have drawn on the competing-logics perspective to understand the sustainability of ICTD interventions (Sanner & Sæbø, 2014), and to explore practice-level tensions during the nationwide introduction of health management IS (Sahay et al., 2010). While such work adopts the institutional perspective, it remains liable to the criticism of capturing largely organizational patterns in the implementation of ICTD projects, rather than full-scale institutional change resulting from the introduction and use of ICT. Hayes and Rajão (2011) have come closest to our concern with their understanding of the institutional mechanisms through which ICTs can create developmental impact. They show that conflicting institutional logics have surrounded the use of ICT in the Amazon region, leading to patchy progress toward achieving the Millennium Development Goals.

3 Theoretical Development

Having outlined the motivation for blending ICTD and institutional perspectives, we now turn to the domains of activity theory and institutional theory, and to unifying the means they provide for sorting and organizing our findings. Rather than building theory per se, we elaborate the understandings of information artifacts and of activities, by drawing on the complementary aspects of activity theory and institutional theory. The resulting theoretical categories offer us a suitable fit for presenting and explaining our findings of institutional change in Ghanaian agriculture, resulting from the introduction of new information technologies.[1]

3.1 View of Information Artifacts

In response to calls in the IS discipline for explicitly theorizing information technology (Orlikowski & Iacono, 2001), we offer an interpretation of information artifacts that is aligned with activity theory and its principle of mediation, and that links with understandings of institutional change (Scott, 2003). First introduced in the work of psychologists and activity theorists (Leont'ev, 1978; Vygotsky, 1978), the notion of artifact-mediated activities has enhanced understanding of the development of the mind. Vygotsky and Leont'ev conceptualized human activity as comprising a subject (a person or collective) acting upon an object (the problem, situation, or focus of the activity), with the activity being mediated by means of material artifacts, also referred to as tools, along with their symbolic elements. For instance, in some contexts the use of a smartphone may be symbolic of modernization; and as the meaning is internalized it may drive users to behave accordingly. More recently, this framework has been expanded, in the form of an "activity system," to include social and cultural rules and norms (which govern the activity), division of labor, and the community involved in the activity (Engeström, 1987). For a detailed description of activity theory in IS, ICTD, and organization studies, see Karanasios (2014; 2018) and Engeström (1987).

Our conceptualization of information artifacts is consistent with their serving as complex (material and symbolic) mediators in the interactions between the subject and the object of an activity (Ruckriem, 2009). Humans interpose technology-based, culturally

[1] See Appendix A for a summary of key terms used in the theoretical development that follows.

established, and socially accepted information artifacts between themselves and their objects of interest, thereby allowing themselves to accomplish their intended results (Miettinen et al., 2009). As elements of activity systems, information artifacts are aligned with the ensemble view of IS (Orlikowski & Iacono, 2001). A key property of such artifacts is their ability, derived through the mediation principle, to make visible (Kuutti, 1996) to actors specific symbolic elements of their cultural-historical environment. In order to capture this property, we introduce the notion of interaction modalities ("modalities" for short), which can be linked to changes in institutional logics. For example, instant notifications (e.g., prompts and alerts), which fit the ICT-based modality, may embody meanings such as timeliness, professionalism, and punctuality. Perceptions of such meanings shape human action. Consequently, in compliance with professional expectations, behaviors of constant availability arise and are institutionalized.

By unpicking the phenomenon of changes in the dominant interaction modalities, we are able to expose the process of institutional change (Scott, 2013). Introducing interaction modalities in activity systems allows us to capture the process of subjects decoding institutional meanings through interactions and transmitting them in their subsequent activities. An interaction modality is understood as the classification of the channel—regardless if it is a technology or nontechnology channel—for an interaction that occurs between an information artifact and its user (Saroha et al., 2011). Modalities serve as signs, and following the principle of mediation, they are reflected in behaviors and procedures. Our notion of modality includes interpretations, perceptions, and expectations arising from actors' interactions with different information artifacts, via different channels. The notion is similar to ideas of functionality, affordances, and notions of IS use being shaped by function, structure, and context (Burton-Jones & Gallivan, 2007); yet, it differs in emphasizing the subjective element in the use of information artifacts and the process of reflective mediation.

To preview our findings, we suggest that different information artifacts offer a range of interaction modalities. For example, new ICTs (e.g., mobile phones and the Internet) offer an ICT-based interaction modality; legacy technologies (e.g., radio) offer a print-and-broadcasting modality; and in-person contacts offer both a formal modality (through interactions organized and led by development organizations and local government) and an informal modality (through interactions with family, friends, and peers). These interaction modalities can be linked to either the smallholder or the value-chain institutional logic.

3.2 Activities as Microfoundations of Institutional Change

Studies have explored institutional changes derived from competing logics (Currie & Guah, 2007; Lounsbury, 2012), coexisting logics (Reay & Hinings, 2009), short-lived logics marked by constant change (van Gestel & Hillebrand, 2011), and shifts from one logic to another (Hayes & Rajão, 2011). A criticism, however, has been put forward that scholars typically apply a macrolevel institutional lens to microlevel organizational and interorganizational phenomena. In response, arguments have been made in favor of a practice approach to institutional change (Smets et al., 2012), which can link everyday work practices to organizational and field-level changes. We propose activity theory, and activity systems in particular, as a mechanism for bridging the gap between microlevel understandings of practice and macrolevel understandings of institutional transformation.

Foremost, the two perspectives are compatible because they share the dialectical understanding that the activities of individuals and organizations are shaped by their context; meanwhile, the inverse process is also taking place and the actions of individuals have a role in shaping their institutional setting (Thornton et al., 2012). In activity theory, the actions of individuals are mediated by artifacts (e.g., ICT) in a cultural-historical context; however, in the process, contradictions and tensions emerge, reshaping individual activities (Kuutti, 1999). Parallels can be drawn between dialectical understandings of institutional change (Seo & Creed, 2002) and the role of contradictions in activity theory, because both expose tensions, dynamic inefficiencies, and—most importantly—opportunities for change (Kuutti, 1999).

Activity theory is particularly suited to understanding changes in practices and their associated meanings, as a result of the introduction of new information artifacts (Karanasios & Allen, 2014; 2013). While its application is growing with regard to microlevel phenomena in organizational and IS research (Chen et al., 2013; Miettinen et al., 2009), the relevance of activity theory to wider societal issues remains understudied, and there have been calls to apply it to larger-scale phenomena (Engeström, 2008).

Scholars have considered information artifacts as institutional carriers (e.g., Currie et al., 2011), and viewed their use through the lens of activity theory (e.g., Karanasios & Allen 2013; Allen et al, 2013). However, so far, the two approaches have not been blended in IS studies to offer explanations of the microfoundations of institutional transformation. Institutional carriers provide understanding at the institutional level, and appear to imply a progression from material artifacts to their socially constructed and symbolic elements. Meanwhile, activity theory enables

us to anchor understandings of these carriers by capturing interactions at the practice level. By linking institutional carriers to activity systems, we are able to locate the microelements of institutional change and to trace institutional change from its microfoundations to the macrolevel.

The theoretical concept of institutional carriers is composed of artifacts, activities (also referred to as routines), relational networks, and symbolic systems, which serve as vehicles for the transfer of institutional meanings (Scott, 2013; Scott, 2003). Activity theory allows us to explore institutional carriers by reflecting on the use of information artifacts, the rules and norms governing them, and information practices captured in activity systems. We view information artifacts through the activity theory notion of mediating artifacts. As a practice theory (Nicolini, 2013), activity theory is instrumental in drawing understanding of how changes in the availability of information artifacts are reflected in changes in information practices (i.e., practices governed by cultural-historical rules and norms). The novelty of information artifacts may cause tensions and contradictions, thereby giving rise to changes in the overarching activity (e.g., farming). By suggesting that new information artifacts lead to adaptations in information practices, activity theory enhances the institutional carriers' notion that new artifacts alter activities. The activity theory approach does not privilege people, technologies, or organizations; therefore, it allows us to capture how relationships among actors (i.e., relational networks) are augmented by the use of new information artifacts. Importantly, this means that we account for the dual—material and symbolic—nature of information artifacts. We are able to explore how new information artifacts affect patterns of relationships (e.g., rules and norms, like strong interpersonal ties), change notions of "insiders" and "outsiders," and transform normative practices like trust. The cumulative changes in information artifacts, information practices, and relationships transform symbolic systems. Namely, they impact how meaningful messages are conveyed through media, how information is interpreted, and how the overall activities in the course of which information is used are conceived. We add the notion of interaction modalities toward understanding symbolic systems because it allows us to consider how abstract categories such as preference for media of communication (e.g., in person, voice, or text) arise, and how new meanings (e.g., standardized measurements) are adopted and diffused. Thus, the proposed approach addresses in full the components of institutional carriers.

Based on the foregoing discussion, our conceptual framework combines activity systems (Engeström, 1987) with the four types of institutional carriers—artifacts, activities, relational networks, and symbolic systems (Scott, 2003). As illustrated in Figure 1, our conceptual framework comprises interconnected activity systems, represented by triangles for farmers, "development partners" (DPs), and "technology information-service providers" (TISPs). DPs include processors, input suppliers, aggregators, exporters, agricultural-service providers, and NGOs. They focus on providing complex interventions (e.g., demonstrations, visual aids, agronomic inputs, logistics, and resources), including ensuring farmers' access to information. TISPs include technology companies, media broadcasters, and NGOs that provide information directly to rural populations and smallholder farmers via ICTs rather than downstream impact.

Figure 1 presents diagrammatically how activity systems and institutional carriers may relate to one another. The figure depicts as triangles the activity systems of DPs and TISPs acting as producers of farmers' information artifacts, which in turn play a role in mediating farming activities. Hence, the interconnected actors (DPs, TISPs, and farmers) and their activities are interwoven into an activity network, crossing both logics. The activities of DPs and TISPs clearly sit in the value-chain logic, whereas the farmers' activity lies in the smallholder logic, as noted by the horizontal curved line that represents the impermanent nature of logics. Meanwhile, the three concentric circles represent the remaining three elements of institutional carriers—information artifacts, relational networks and symbolic systems; with information artifacts forming the conceptual intersection of activity systems and information carriers. The increasing variety of information artifacts is poised to ripple out, impacting interpersonal relationships and the relational networks they form, as well as symbolic elements and the symbolic systems they constitute. The figure positions the information artifacts used in Ghanaian agriculture in their activity context and their institutional setting. Consequently, we reveal "the process whereby the information system influences and is influenced by the context" (Walsham, 1993, pp. 4-5).

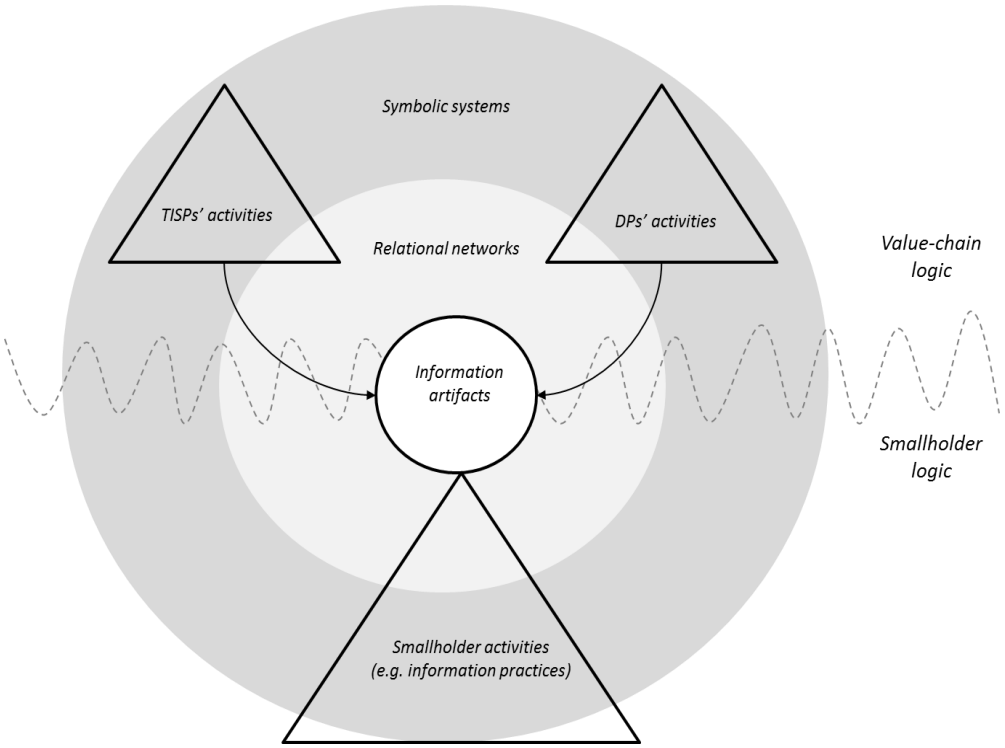

Figure 1. Conceptual Framework

4 Research Setting and Method

4.1 Research Site and Data Collection

Our empirical work centered on three regions in Ghana that span the possible combinations of infrastructures (e.g., surfaced roads and electricity availability), and of activities by both DPs and TISPs. The study and data collection commenced in 2009 and were completed in 2014. Figure 2 illustrates the location of the study regions and communities, and presents some location and demographic data. Building on institutional logics and activity theory, our research approach could be described as practice-based and interpretive, following the principles for conducting interpretive research set by Klein and Myers (1999). Activity theory studies typically follow an interpretive philosophical perspective; likewise, interpretive methods are used in order to enrich the analysis of institutional logics (Thornton & Ocasio, 1999; Thornton & Ocasio, 2008).

Our study design could be described as mixed-methods (Venkatesh et al., 2013),[2] relying on qualitative and quantitative data collection from community, regional, and national levels. Venkatesh et al. (2013) argued that mixed-methods research undertaken in development settings may generate new insights. Furthermore, the multilevel component (Bélanger et al., 2014) is critical in showing different understandings of the phenomenon (Trauth & Jessup, 2000). We produced a detailed and broad analysis, explanation, and narrative (Anderson, 1999; Venkatesh et al., 2013), crucially informed by our conceptual framework. This allowed for understanding institutional change at the macro- and microlevels.

[2] Our approach follows Venkatash et al's., (2013) recommendations on mixed-methods research because we are interested in synthesizing data (e.g., interviews and surveys) aligned with different ontological and epistemological positions. The pluralistic nature of our method is also consistent with Mingers's (2001) view on the need to draw on multiple methods.

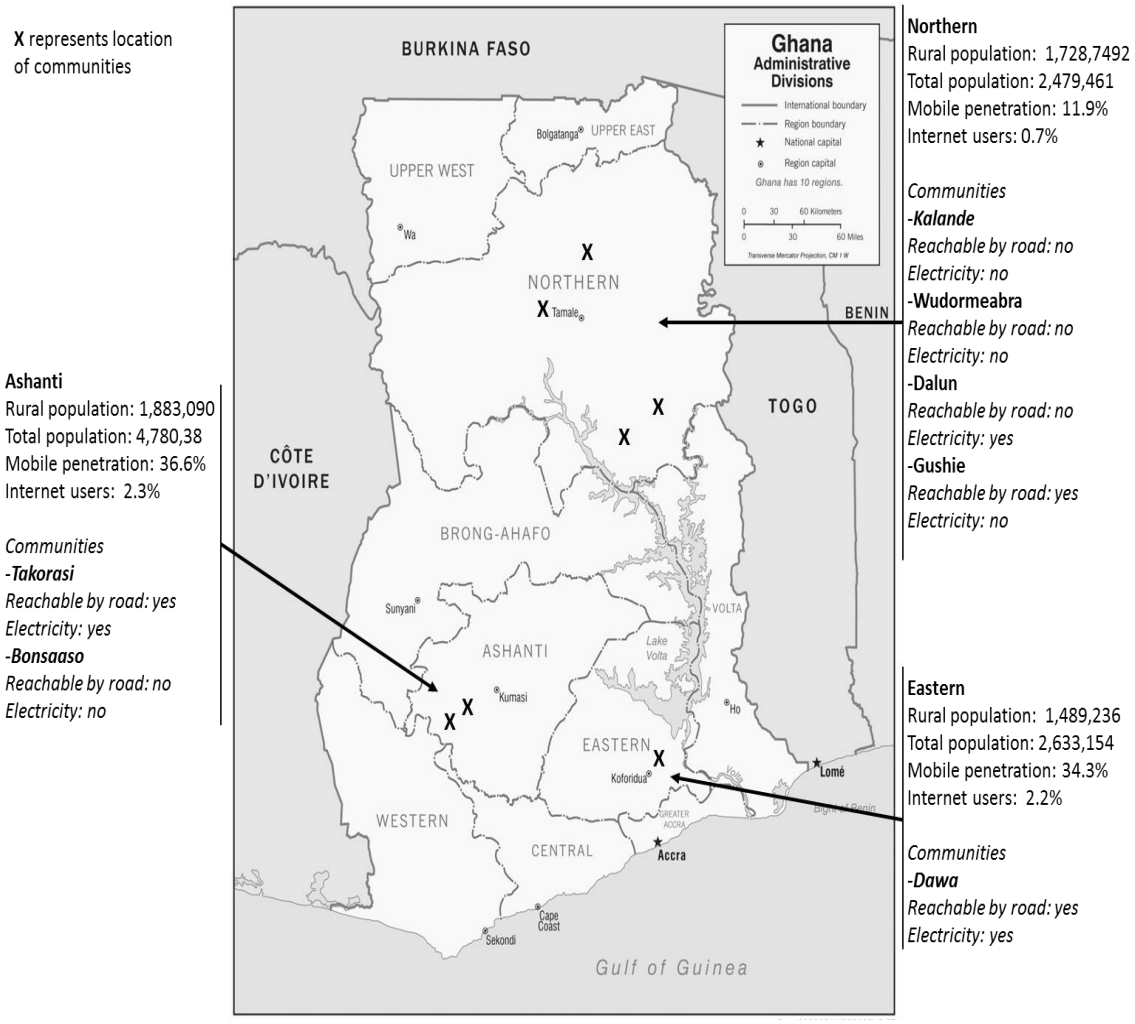

Figure 2. Map of Study-Site Location. Adapted from CIA (2014) and GSS (2012)

Scholars argue that both qualitative and quantitative forms of data may be mutually supportive (Lee, 1994; Trauth & Jessup, 2000). We follow Venkatesh et al.'s (2013) guide for mixed-methods study design and analysis. As a starting point, this involves establishing the appropriateness of the mixed-methods design. In our case, its aptness is derived from the need to gain complementary data about the same phenomenon (Soffer & Hadar, 2007), and to achieve data completeness by ensuring that a rich and comprehensive picture can arise (Piccoli & Ives, 2003) in line with our theoretical position.

In our study, we drew on multiple qualitative-data sources and a single quantitative source; hence, the qualitative data could be considered as taking dominance (Lee, 1994). The gathering of qualitative and quantitative data is discussed in detail below, followed by a description of our data-analysis process.

4.1.1 Qualitative-Data Collection

The main qualitative-data sources were focus groups and interviews (Myers & Newman, 2007). First, seven focus-group discussions were undertaken with the help of local service providers in communities across the three regions, capturing the voices of 119 farmers (see Table 2). The focus group discussions lasted up two hours each, and used the native language of the visited communities, with the aid of interpreters. See Appendix B for the focus-group discussion questions. The focus groups followed appraisal methods for participatory rural communication (Mefalopulos & Kamlongera, 2004) and included exploratory semistructured questions about information channels and facilities, farming activities, and ICT ownership and use. Focus groups allowed us to explore attitudes, feelings, experiences, and reactions in a manner not possible in interviews or surveys (Bryman, 2004).

Table 1: Focus Group Participants by Community

	Takorasi	Bonsaaso	Dawa	Kalande	Wudormeabra	Dalun	Gushie	Total
Men	12	12	7	10	10	10	25	**86**
Women	1	6	7	6	12	1	0	**33**
Total	**13**	**18**	**14**	**16**	**22**	**11**	**25**	**119**

In addition, we carried out 13 interviews with DPs and TISPs at regional and national levels (see Table 3). Interviewees included agricultural-outreach specialists and ground-level project officers, exploring the themes arising from the focus groups (Neuman, 1997); and representatives of national stakeholders (e.g., NGO and technology-company executives, and promoters of improved inputs), exploring strategic issues. We identified subjects through existing contacts, events, and the snowballing technique. Interviews were semistructured, lasted between 45 and 90 minutes, and were conducted in English. A copy of the interview questions is provided in Appendix B.

Table 2. Interviewees

Category	Regional level	National level
Technology information service providers (TISPs)	• Coordinator, Radio Ada • Presenter and agronomic discussion panelists, Radio Simli • Radio presenter, Radio Classic	• CEO, Esoko (platform for agricultural-information services) • Founder, Literacy Bridge[a] • National coordinator, African Farm Radio Research Institute (AFRRI)
Development partners (DPs)	• Inputs promoter for Northern Region, Golden Stork—Tamale • Project Manager, Integrated Tamale Fruit Company (ITFC) • Market-information officer, Social Enterprise Development Foundation (SEND)—Tamale • Food-security project officers, SEND—Salaga • Director, District Agriculture Development Unit, Amansie West	• Outreach specialists, Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance (ACDI/VOCA) • Nationwide sales agronomist, Golden Stork—Accra

[a]An audio computer program devoted to overcoming literacy barriers; see http://www.literacybridge.org/talking-book/

We also undertook field observations of extension agents who worked directly with farmers, shadowed information-service providers, and visited information facilities. This added further embeddedness into our research (Harvey & Myers, 2002), which aligns with the epistemological commitments of activity theory (Vygotsky, 1978). We also included other sources such as radio programs, presentations, photos of demonstration plots, maps of irrigation installations, information maps (see Appendix C for examples), ICT-solution specifications, advertising materials, press cuttings, project monitoring and evaluation reports, field research reports, and learning briefs (Jarvenpaa, 1991). The qualitative data yielded several hundred pages of transcripts, field notes, observation sheets, field maps, videos, and photos.

4.1.2 Secondary Quantitative Data

Complementing the qualitative data, we drew upon a national survey collected by InterMedia (AudienceScape, 2014)—to our knowledge, the most comprehensive source of data on ICT availability and

information practices in Ghana—with access granted through an academic-NGO relationship. Importantly, the use of secondary data—a growing practice in the IS field (Venkatesh et al., 2013) and common in other disciplines—validated the generalizability of qualitative findings.

InterMedia administered the survey, using a standard questionnaire adapted to the Ghanaian environment, covering ICT availability and use, information needs and practices, and trust (see Appendix D). The survey followed a probability-proportional-to-size sampling plan, based on the GSS 2000 Population and Housing Census (the most recent census at the time). 6,720 contacts were attempted, resulting in 2,051 interviews. The overall margin of error was ±2.2 percent, at the 95 percent confidence level. For this study, we extracted a subsample of 305 households living in the selected regions (Ashanti 38.7 percent, Eastern 18.7 percent, and Northern 42.6 percent) whose income in the previous 12 months came predominantly from farming.

4.2 Data Analysis

We analyzed the qualitative and quantitative data concurrently (Cresswell, 2003; Venkatesh et al., 2013). All qualitative data were initially analyzed by one researcher, and authenticated in 2014 by the two research-team members (Weber, 1985). Qualitative data analysis was carried out in NVivo, initially by free coding and then by axial coding. Our coding system was informed using our conceptual framework, reflecting the logical steps of the interpretive process (see Appendix E for coding scheme). Our approach also shared similarities with the grounded-theory approach to data analysis, because we allowed themes to emerge from the data, and used inductive thinking to interpret and structure the findings. Where necessary to clarify the data gathered and support findings, we contacted the research subjects. Meanwhile, we analyzed the quantitative data in SPSS, using descriptive statistics, to provide an overarching picture of the ICT landscape and information practices.

The qualitative and quantitative data were analyzed in parallel to expand and validate our findings. This involved incorporating into the findings diverse and opposing views from the data (bracketing), as well as developing a consensus between the qualitative and quantitative data where possible (bridging) (Lewis, 1999). For instance, the quantitative analysis provided data on the number of users of mobile technology and modes of use on a regional scale. Meanwhile, the qualitative data presented a deeper farmer-perspective on the meaning of technology; how it is embedded (or not) in agricultural practice; and how contradictions, tensions, and complementarities arise. Insights from both analyses were amalgamated to develop our understanding. We verified the resulting meta-inferences and established narrative by undertaking a mixed-methods validation (Teddlie & Tashakkori, 2009). This approach not only added validity to our understanding (Venkatesh et al., 2013) but also helped to overcome some qualitative field-research challenges (Myers & Newman, 2007)[3].

The analysis was undertaken in three stages, which integrated our qualitative and quantitative data (Cresswell, 2003). At the first stage of our analysis, we captured the elements of the three activity systems, including their primary elements: subjects, objects, and outcomes. Specifically, we documented the artifacts mediating interactions between farmers (as subjects) and crops (as objects of their activities). At the second stage of our analysis, we connected elements of the three interconnected activity systems (farmers, DPs, and TISPs). We focused on emerging information practices, subsumed in farming activities, and on the strategic motives for the tool-producing activities of DPs and TISPs. More precisely, we concerned ourselves with new information practices resulting from the extended set of information artifacts available to farmers. At the final stage of analysis, having encountered a number of interaction modalities and their effect on farmers' information practices and on the strategic positioning of DPs and TISPs, we focused our analysis on the network of activities (i.e., farmers, TISPs, and DPs) in its entirety. In doing this, we linked activity rules and norms to relational networks, and interaction modalities to symbolic systems. We aligned the microelements of the network of activity systems with the macrolevel understandings of institutional carriers.

5 Analysis

In Section 5.1, we trace the interconnected activity systems of farmers, DPs and TISPs, marked by triangles in Figure 1. We also describe the technical and nontechnical information artifacts used by farmers (central circle in Figure 1), as well as their interaction modalities. In section 5.2, we examine more closely the network of activity systems and show evidence of the hybridization of information practices, pointing to changes in activities as an institutional carrier. We continue by reviewing changes in rural relational networks (middle circle in Figure 1) in Section 5.3,

[3] Methodologically, our work builds on established principles for combining qualitative and quantitative approaches (e.g., Tashakkori & Teddlie, 1998). As a result, the process followed is not incompatible with suggestions made by other authors relying on similar sources—e.g., Mingers's (2001) steps for multimethod data analysis, consisting of appreciation, analysis, assessment, action.

and changes in symbolic systems (outer circle in Figure 1) in Section 5.4.

5.1 Complexity of the Rural Information Environment

In this subsection, we show that the complex institutional environment, comprised of the smallholder and the value-chain logics, is reflected in a complex rural information environment, characterized by levels of ownership and use of technical and nontechnical information artifacts, as well as by the diverse set of interaction modalities they offer. This environment is shaped by the interconnected activities of farmers, TISPs and DPs, and by the differences in subjects' normative assumptions and choices of interaction modalities. We use the lenses of institutional logics and interaction modalities in order to understand our qualitative activity theory findings (Table 4) and our secondary quantitative data on ownership (Table 5) and use of information artifacts (Table 6). We find that the information artifacts used by farmers can rely on either oral or text channels, endorse inclusiveness or personalization, and value trust in people or in documentation. Summarizing, a TISP manager eloquently captured this complexity as follows:

> *People have always used multiple sources, relatives, commercial transporters . . . all those sorts of things; now there is greater diversity and a greater preponderance of technology and a greater amount of personalization within the delivery of those multiple sources.* (Esoko, interview)

5.1.1 Interconnected Activities and Information Artifacts

Our analysis shows that smallholder farmers, DPs, and TISPs were the subjects in a network of interconnected activities. DPs offered farmers opportunities to access agricultural information through interactions such as in-person consultations with field agents (e.g., agricultural extension officers), meetings with the members of farmer-based organizations, promotional events, and outreach campaigns. DPs relied on information artifacts (like SMS) to supplement their active presence in the field and the materials (e.g., subsidized fertilizer) they offered in promoting value-chain practices. By contrast, technologies played a leading role in the TISPs' approach. Sometimes, their activities involved introducing innovative technology-based products and services; more often, they leveraged popular channels in order to enhance the volume of value-chain information available in the rural environment. Their interventions could be as simple as producing participatory radio programs about agronomic practices or as complex as developing, building, and promoting new ICT devices.

Based on our analysis of the fieldwork, Table 4—which is a summary of the qualitative work and shows practices consistent with the smallholder and value chain logic—outlines an activity-theory understanding of the network of activities of farmers, DPs, and TISPs. It shows that the objects of the DPs' and TISPs' activities were embedded as artifacts in the central activity of the network; namely, the activity of smallholder farmers. They can be viewed as instrument-producing activities (Engeström, 1987) that add to the complexity of the rural information environment by introducing new information artifacts. While farmer activity was oriented toward tending and harvesting agricultural crops, the neighboring activities of DPs and TISPs were concerned with enabling access to support services and agricultural information. All activities were linked by the underlying motive throughout the network of achieving improved harvests and sustainable livelihoods for smallholder farmers.

Table 4: Agricultural Activities

Activity theory concepts	Development Partners (DPs)	Technology Information Service Providers (TISPs)	Farmer activity
Activity and motive: (What is the activity? What is the stimulus for doing the activity?)	Improve agricultural practice: • Provide farmer-support services (e.g., extension) • Access to inputs (e.g., seeds and fertilizers) • Intervention impact	Improve agricultural-information artifacts and services: • Deliver information • Provide multichannel access • Add value to agricultural processes	• Grow, harvest, and sell agricultural products • Sustain livelihoods and welfare
Subject (Who is carrying out the activity?)	• Processors, input suppliers (e.g., Golden Stork), aggregators, exporters, NGOs (e.g., SEND), value-chain facilitators (e.g., ACDI/VOCA), etc.	• Broadcasters (e.g., radio stations and AFRRI), technology-solution providers (e.g., Esoko and SOFTtribe) and NGOs (e.g., Literacy Bridge)	• Smallholder farmers
Object (Why is the activity taking place?)	• Organized support services, delivered in person; complex agricultural-development interventions (e.g., improving food security) • Facilitating value-chain linkages	• Development of technology-based information artifacts and services, emphasizing content delivery (e.g., Talking Book, call-center advice, and market-price SMS service)	• Farm crops • Produce harvest
Artifacts (By what means is the subject carrying out the activity?)	• Outreach strategies via digital and legacy technologies (e.g., radio and SMS) • In-person training • Seeds, fertilizers, processing equipment, weighing scales, etc. • Additional services (e.g., equipment hire)	• ICTs • Broadcasting equipment • Innovative content formats (e.g., radio phone-ins, multimedia) • Technology development skills • Media and marketing skills • Innovation capabilities • Highly interested/proficient in ICT	• Agricultural information accessed via agents, family, friends, peer farmers, radio, and mobile • Agricultural inputs • Equipment (for planting, irrigation, processing, marketing, etc.)
Community (Who are the actors?)	• Farmer organizations • Value-chain participants (e.g., input suppliers, output buyers, and exporters) • Technology providers	• DPs • Farmer-based organizations • Content providers	• Social networks • DP-partner field staff • Value-chain participants
Rules and norms (Are there cultural norms, rules, laws, etc.?)	• Accountable to donors • Enthused by improvement for smallholders	• Responsive to demands from farmers and DPs • Excited about leveraging ICTs to development goals	• Respect for officials • Strong personal bonds • Inclusive, open, and egalitarian
Outcome (What is the desired outcome?)	• Behavior change, and improved agricultural practices, processes, and value chains	• Knowledge, awareness, and improved access to agricultural information	• Harvested and marketed farm production for improved livelihoods

As noted in Table 4, the communication norms governing farmers' activities were consistent with the smallholder logic, structured according to the relational dynamics of farming communities in rural Ghana. Smallholders saw their connections to the land and to their farmer peers not only as links to productive assets but also as sources of identity. Maintaining relationships was essential for sustaining farmers' collective livelihoods. As a result, they favored the use of communication channels that were accessible to everyone in the community. Traditional information artifacts (e.g., drums, loudspeakers, and public-address systems) and the social roles embodying them (e.g., gong-gong beaters, town criers, and porters) were used to broadcast oral announcements about farmer-group meetings and to convene farmers for mutual-labor days.

The identified patterns of preference for open communication and the significance of maintaining interpersonal relationships informed farmers' use of information artifacts during their agricultural activities. The secondary quantitative data (Table 5) suggest that the ownership of legacy broadcasting technologies, like radio (89.2 percent) and TV (43.9 percent) was particularly high. Expanding on this, in the focus groups, farmers reported listening to radio every day and explained that "almost every household [owns a radio] including the fish seller (referring to a poor woman)" (Dalun, focus group). This sentiment was echoed by a DP representative who commented: "I would say pretty close to 100 percent of the farmers listen to some type of agriculture radio program" (ACDI/VOCA, interview).

As tools for oral interpersonal communication, mobile phones registered similarly high levels of ownership (63.6 percent). Text-based communication was uncommon among farmers. The secondary quantitative data shows, for example, that computers and access to the Internet were rarely available to farmers (Table E). As many as 94.4 percent of the farmers had never used the Internet, and 49.5 percent did not know what it was (see Appendix F for a detailed table on agricultural-information practices). Drawing on farmers' use of traditional information artifacts and on ownership data showing a preference for oral rather than text-based communication, we surmised that the information artifacts used were more closely aligned with the smallholder than with the value-chain logic.

Table 3: Information artifacts available in working order (n=305)

Legacy technologies (% ownership)			**Digital technologies (% ownership)**		
Radio 89.2%	**TV** 3.9%	**Landline** 1.3%	**Mobile phone** 63.6%	**Computer** 3.3%	**Internet** 1%

By contrast, the instrument-producing activities of TISPs and DPs were concerned with developing information artifacts that not only were acceptable to farmers but also served the purpose of promoting value-chain practices. TISPs and DPs inscribed norms in their artifacts, such as expectations of accuracy, timeliness, and compliance with legal obligations and industry standards. For example, adherence to global agricultural-production standards was achieved by distributing agronomic guidance in-person and via text-based information artifacts that codified practices and instilled compliance through written handbooks, checklists, etc. Such artifacts also acted as mechanisms for strengthening trust and transparency and overcoming power inequalities among farmers and their value-chain partners. For example, clear text-based documents were key in sustaining perceptions of mutually beneficial relationships between "outgrowers" (i.e., contract farmers)[4] of organic mangoes and their aggregators (i.e., collective buyers).

> *After delivering their fruit to the company's packing house, each outgrower receives a clear statement of the number of kilograms harvested, the amount exported and sold within Ghana, the loan payment, the balance of their loan, and the profit for their farmer. While outgrowers and their families will benefit for many generations to come from a more profitable agricultural crop, ITFC stands to benefit by gaining a bulk-marketing advantage.* (ITFC handbook manual)

[4] A farmer in a contractual relationship with a processor, trader, or aggregator, who usually provides inputs for production with the intention of recouping the cost after harvest.

5.1.2 Modalities for Access to Agriculture Information

We now scope out the typology of information artifacts used by farmers for access to agricultural information. Such artifacts are grouped into four categories (i.e., modalities) according to the types of interactions they offer: ICT-based modality (mobile SMS, mobile voice, and the Internet), print-and-broadcasting modality (radio, TV, newspapers, magazines, posters, and traditional broadcasting), formal modality (extension officers, farming-supply vendors, and NGOs), and informal modality (family, friends, farmers, and other social networks). Table 6 uses secondary quantitative data on farmers' access to agricultural information to present these modalities. While we draw on data about farmers' use of information artifacts to access a variety of agricultural content, we make inferences about the relative frequency of different types of interactions. Table 6 shows the dominant role of print-and-broadcasting, formal, and informal interaction modalities. With the exception of mobile SMS, which was used by one respondent for access to agricultural information about seed varieties, use of the ICT-based modality was virtually nonexistent.

Table 4: Modality of Access for Agricultural Information (respondents could give more than one answer) (n=305)

Logic	Modality		Market prices	Fertilizers	Seed varieties	Soil problems	Weather
VALUE-CHAIN LOGIC	ICT-based modality	Mobile SMS	0	0	1	0	0
		Mobile voice	-	-	-	-	-
		Internet	0	0	0	0	0
			0	**0**	**1**	**0**	**0**
	Formal modality	Farmer organizations, cooperatives, and unions	33	45	38	36	36
		Extension office	62	89	98	77	72
		Farming-supply vendors	27	30	26	11	11
		NGOs	8	11	13	10	8
			130	**175**	**175**	**134**	**127**
SMALLHOLDER LOGIC	Print-and-broadcasting modality	Radio	98	141	115	91	116
		Traditional broadcasting	-	-	-	-	-
		TV	40	73	42	42	54
		Newspapers and magazines	2	6	1	1	2
		Posters, billboards, and brochures	1	6	2	3	3
			141	**226**	**160**	**137**	**175**
	Informal modality	Family and friends	84	80	68	57	58
		Other farmers	88	87	83	72	72
			172	**167**	**151**	**129**	**130**

The prevalence of radio can be explained by its low barriers to use and the strong oral culture. The role of radio was prominent in providing access to all types of agricultural information. The use of printed broadcasting media was constrained by low literacy rates and a lack of scheduled publication deliveries. Farmers in the focus groups pointed to a preference for newspapers read over the radio, yet again confirming their preference for oral rather than text-based interactions. They also explained that despite poor access to the electricity grid, weak network signals, and poor reception, TV ownership was not only common but also valued and aspired to.

Formal and informal in-person interaction modalities were also prominent. Personal relationships with experts and formal officers, as well as with fellow farmers, were highly valued in rural communities. As noted in Table 6, DPs' formal outreach activities also had a leading role in ensuring access to agricultural information. In focus groups, farmers indicated personal links to extension agents, whom they contacted for advice via mobile voice, or expected to deliver guidance via personal visits. Informal social channels—in terms of family and friends, and other farmers—were also important sources of information, particularly about market prices. In focus groups, farmers expressed high-levels of trust in the information received via informal contacts, as well as in information from representatives of official government services.

Even though Table 6 shows almost exclusive reliance on modalities other than ICT-based ones, the secondary quantitative data in Table 6 do not capture the use of mobile phones as a voice channel. The secondary quantitative data did, however, show that 54.5 percent farmers reported using their mobile phones in the previous two days. Farmers stressed the importance of mobile phones as tools for accessing formal and informal networks—for instance, calling extension agents for clarification of practices (e.g., dealing with pests), or reaching out to fellow farmers for assistance. In other words, mobile-voice technology acted as a magnifier of the formal and informal modalities. No use of mobile web applications was encountered during fieldwork. This was consistent with the assessment of an interviewee: "[No] farmer is using Android in West Africa at this stage" (Esoko, interview). Yet mobile phones were acknowledged as symbolic of modernity and change. Farmers represented their social identities through personalized ringtones, and inscribed mobile phones with value through derogatory references to basic phones as "bars of soap" (Bonsaaso, focus group).

The findings above, suggest that the informal and print-and-broadcasting modalities corresponded to the smallholder logic because they were embedded in the rural context of oral culture, community inclusiveness, openness, and strong personal ties. Participatory maps of information sources in rural communities (see Appendix C for examples), developed during focus group discussions, conveyed that information was often embodied in knowledgeable people and shared through interactions occurring at community locations (e.g., market, bus stop, cocoa shed, church, and mosque). Farmers pointed to informal modalities (i.e., "liaising with [their] friends and with [their] family friends"—Dalun, focus group) through technology and nontechnology means, and broadcasting mechanisms (e.g., loudspeakers and radio) as dominant channels for accessing information. Meanwhile, DPs and TISPs were able to interject, in the rural environment, value-chain messages by means of alternative (formal and ICT-based) interaction modalities. Engaging in artifact-producing activities, DPs were able to formalize in-person support services; meanwhile, TISPs, by leveraging existing information artifacts (especially mobile-phone ownership), configured ICT-based interactions purporting values such as personalization and information accuracy.

In summary, we presented the network of interconnected activities of farmers, DPs, and TISPs and showed how they reflected the availability of information artifacts in the rural information environment. Complexity of the information environment was raised by the alignment of information artifacts with different institutional logics: smallholder and value-chain. We proceed by exploring how the multiplicity of available artifacts impacted farmers' DPs' and TISPs' information practices.

5.2 Evidence of Hybridization: Farmers' Information Practices, and Dps' and Tisps' Dissemination Practices

We now consider how different types of interaction modalities, and the information artifacts associated with them, were used in the development of "hybrid information practices" among farmers, and how DPs and TISPs were able to leverage such practices in promoting value-chain development. By bringing practices into focus, we reflect more closely on the normative and culturally embedded aspects of the network of interconnected activity systems.

5.2.1 Farmers' Hybrid Information Practices

In their information practices, farmers mixed the use of artifacts with modalities characteristic of the smallholder logic, with artifacts offering modalities characteristic of the value-chain logic (Table 7). We understand hybrid information practices as practices combining artifacts of different interaction modalities. Rather than positioning the available artifacts in opposition, farmers were able to exploit

complementarities among them. For instance, faced with a range of artifacts that offered different interaction modalities for access to information about fertilizer application, farmers in Kalande reported (during our fieldwork) forming and enacting the following hybrid practice. They were able to learn about new fertilizer products from discussions on the radio (i.e., print-and-broadcasting modality) and to use mobile phones (i.e., ICT-based modality) to source products from agricultural-input dealers in Tamale (154 kilometers away) who were willing to visit the village to collect orders and deliver inputs (formal modality). This example demonstrates how the three interaction modalities and their respective artifacts worked together in a noncontested fashion—enabling a new, hybrid information practice and strengthening the value-chain linkages between farmers and their input suppliers. The hybrid information practice resulted in the adoption of improved agronomic practices and intensified use of fertilizer. Consequently, it gave rise to interpretations of production consistent with agronomic best practice, and facilitated farmers' move away from the smallholder logic of production, toward a value-chain logic.

Table 5: Hybridization of information practices

Information practice	Smallholder logic (informal and print-and-broadcasting modalities)	Value-chain logic (formal and ICT-based modalities)	Hybrid modalities	Examples of hybrid information practices
Advisory information about fertilizer application	• Other farmers • Radio	• Farming-supply vendors • Mobile voice	• Broadcasting-formal • Broadcasting-ICT • Informal-formal	• Radio campaigns by farming-supply vendors • Radio phone-in show • Formal demonstrations by supply vendors to informal village audiences
Access to market-price information	• Family and friends • Other farmers	• Mobile SMS • Mobile voice	• Informal-ICT	• Social networks accessed via mobile voice to confirm prices received via mobile SMS
Information about seeds	• Family and friends • Other farmers	• Extension office	• Formal-ICT–informal	• Recordings of advice by extension officers are shared in social networks
Weather information	• Radio	• Mobile SMS	• Broadcasting-ICT	• Mobile-voice call to interactive voice-recognition system

Having captured the hybridity of information practices that arose among farmers, we now explore how DPs and TISPs leveraged the process of hybridization.

5.2.2 DP's and TISP's Hybrid Dissemination Strategies

In order to fulfil their roles as change agents, DPs and TISPs followed hybrid outreach strategies, fusing modalities characteristic of the smallholder logic (i.e., print-and-broadcasting and informal) with modalities and messages representative of the value-chain institutional logic (i.e., ICT based and formal). The trend resulted in two strategic approaches. On the one hand, some development actors advocated value-chain practices by engaging in interactions of both value chain modalities—i.e., via formal in-person channels, and via ICTs. On the other hand, more moderate approaches promoted value-chain content via legacy technologies and formats reminiscent of established smallholder patterns of interaction (e.g., oral, community based).

The DPs that preferred more assertive tactics for value-chain development were highly aware of the preference of their beneficiaries for in-person interactions. Consequently, they tended to work using formal modalities for information delivery, organized through the field presence of outreach staff, and often complemented it with ICT-based outreach. Supplementary digital technologies were used in order to contact outgrowers directly, organize farmer meetings, coordinate payments, record deliveries, and enable "two-way communication in order to ensure that there are accurate information flows" (ACDI/VOCA, interview). That is, DPs' practices channeled formal and ICT-based modalities working together toward promoting the value-chain logic. As such tactics relied on

strong field presence, they were often enhanced through hybridization with informal interactions at gatherings, community events and festivals.

Other DPs preferred a more holistic hybridization approach. They made sure that their chosen outreach channels carried a considerable degree of cultural awareness and sensitivity. Such concerns prompted them to partner with radio broadcasters who favored participatory methods for content development, with verifiable impact: "Yes, the message is definitely there; [the farmers] are listening" (Radio Classic, interview). Radio stations offered discussion-based formats, radio drama, storytelling, and scripted conversations between extension agents and farmers unwilling to adopt value-chain advice. An outreach specialist summarized the role of radio for DPs and their preferred formats.

> *The growers and the processors, the input suppliers, the financial-service providers, the aggregators, any member of the value chain we are tying into radio so they can use that as a platform to communicate to a mass audience. . . . So, we get, you know, the input companies to be talking on the radio show, using radio-theater drama to communicate a message.* (ACDI/VOCA, interview)

Echoing the significance of radio, AFRRI explained that a rigorous evaluation supported the effectiveness of radio campaigns, with "knowledge [about the new rice variety Nerica] over 80 percent in both the active and passive [listening] communities," while adoption of the promoted agronomic practices in active listening communities was up to 50 percent.

Among TISPs we also observed hybridization strategies combining interaction modalities characteristic of the smallholder and value-chain logics. For instance, use of mobile technologies (i.e., ICT-based modality) was often balanced by radio programming (i.e., print-and-broadcasting modality). Such hybrid combinations of interaction modalities increased farmers' exposure to agricultural information and their awareness of improved practices:

> *An SMS alert is sent to remind farmers of meeting times when the program is aired, to enable them to listen. There is another technology that involves announcing the telephone number of extension agents on air so farmers are able to call for information they need. There is another technology that enables farmers to call in and listen to the recorded program.* (AFRRI, interview)

TISPs saw the demand for value-chain information as critical to the adoption of their products and services. However, farmer demand for content was cyclical and often unreliable. Consequently, some TISPs resorted to assertive tactics of diversification and bundling approaches in order to meet farmers' demand for value-chain content, if and when it occurred. For example, Esoko offered bundles of content services covering a spectrum of logistics information (e.g., on market prices, weather, and trade offers) and best-practice advisory information (e.g., on fertilizers, seeds, and soil problems).

> *The critical lesson . . . is that it cannot be a single service—it has to be a bundle—that the costs to acquire those clients, to support them, and to deploy it (the technology solution), you need to spread them across services, within a single deployment channel, as it were. So, we don't think that just market prices, or just weather, or just advice really is a sustainable model.* (Esoko, interview)

As a more moderate alternative to bundling, other TISPs chose to provide farmers with content that enhanced their existing smallholder practices, rather than replacing them. For instance, Literacy Bridge chose a hybrid approach in which its novel information artifact (i.e., Talking Book) was aligned with established preferences of rural audiences (e.g., oral communication) and with existing norms (e.g., trust in officials and information-sharing). Rather than advocating the use of certified seeds to replace the widespread practice among smallholders of recycling their seeds, Literacy Bridge chose to inform farmers on how to improve this practice by germination testing.

In summary, having sketched farmers' information practices, and the strategies of DPs and TISPs, we found that a high degree of hybridity across interaction modalities representative of both smallholder and value-chain logics was present in the network of interconnected activities. We proceed by exploring the concurrent evolution of relational networks and symbolic systems.

5.3 Rural Relational Networks

Through a synthesis of qualitative data and secondary quantitative data, we have established that hybrid information practices among farmers, often leveraged by TISPs and DPs, facilitated the adoption of unfamiliar information artifacts. The hybrid information practices also forged trust in the information delivered through them and facilitated the inclusion in rural communities of new stakeholders (e.g., input suppliers, output buyers, and processors) who operated in the value-chain logic.

By enhancing interactions of informal and print-and-broadcasting modalities, mobile phones (ICT-based modality) served to reinforce interpersonal relationships and norms of openness among farmers. First, mobile technology strengthened bonds in the rural community by enabling information exchanges

between family, friends, and fellow farmers. In focus-group discussions, farmers explained that they used mobile phones (voice, rather than SMS) to maintain relationships with relatives, friends, and other farmers. Second, mobile technology served as a complement to—rather than as a substitute for—broadcasting. Consequently, norms of openness and inclusive information-sharing were strengthened rather than challenged. Third, even though the practice was considered "*profligate*" (Takorasi, focus group), mobile technology was used by farmers to share local information about DP interventions. As such, the use of mobile technology not only complemented formal modalities but also revealed strong commitment to interpersonal bonds.

Through hybridity, TISPs and DPs were able to reinforce rural information-sharing norms and to strengthen their value-chain impact. For example, the Talking Book was a handheld audio computer (similar to a radio) with a library of orally recorded best practices, to which farmers could add. It was intended for the learning needs of illiterate populations. Literacy Bridge (its creator) observed how sharing practices were not only inscribed in the device but also complemented it and contributed to social learning. Farmers shared devices and recordings. Those who could not access the device visited nearby villages to see "what [the other farmers] are learning . . . through the Talking Book," thus obtaining access to "messages from best-practice peers" (Literacy Bridge, interview). Thus, information-sharing norms were reinforced.

The secondary quantitative data clearly indicated that trust levels in information received in person—either informally (via personal contacts) or formally (through DP representatives)—were consistently high (41.6 percent of farmers considered information from family and friends to be very trusted; 39.7 percent considered information from other farmers to be very trusted; and 37.7 percent considered information from extension agents to be very trusted). Familiar broadcasting technologies (e.g., radio and TV) also carried high levels of trust, with over 59 percent of farmers considering information from radio—and 39.3 percent information from TV—to be very trusted. Meanwhile, unfamiliar technologies (e.g., SMS and the Internet) were considered uncertain propositions, which linked to their low use, with 7.9 percent of farmers considering information from SMS—and 5.6 percent the Internet—to be very trusted. See Appendix F for details.

Farmers, DPs, and TISPs explained that relational norms, like trust, were strengthened rather than challenged by the hybridization of information artifacts. Farmers' accounts pointed to using mobile voice and informal contacts to verify information received from digital services. That is, hybridizing the information practices and combining information artifacts of different interaction modalities appeared to be a strategy for improving trust. The quotation below demonstrates how diversified information artifacts were used in order to generate trust in the information supplied. It also highlights how, as a result of the trust generated in the market-price-information service, transparency was improved, and relationships between farmers and traders were strengthened.

> *As we go out and we do our training among farmers, we can sit with a group of 30 farmers. . . . We can go through the service and describe to them in fairly simple terms what it is that they want—market prices, some information on where and how to buy fertilizer, etc., etc. And there is general nodding, and appreciation. And there is a demo [of] SMS. And they can see the markets and somebody will read it for them, or their kids will read it. But the minute that you bring out a phone and you ask them to ring the call center, and they can speak in their local language to somebody, there is trust. And there is a much more familiar environment. So, this has been very successful for us not only in marketing the call center as a service but in bringing trust and understanding for the SMS service as well.* (Esoko, interview)

During fieldwork, farmers who received Esoko's market-price information via SMS reported using voice calls to validate the received information with family and friends. Thus, social networks were used to strengthen trust in an information artifact representative of the value-chain logic. Trust in the received information enabled farmers to adjust their marketing practices according to the value-chain logic, and to improve their earnings.

In promoting adoption of the value-chain logic, DPs and TISPs made sure that existing rural relational norms were extended to incoming new stakeholders (e.g., input suppliers, output buyers, and processors). DPs and TISPs were able to do so by improving information flows and ensuring that new actors are perceived as trustworthy by farmers. The use of digital information artifacts—especially mobile technology—and the resulting increase in information in the rural environment fostered legitimacy of new business practices and trust in new business partners. For example, emerging SMS use was seen as instrumental to sustaining trust and to affirming a new way of practicing agriculture. It was considered vital to strengthening the two-way relationships between contract buyers, processors, and outgrower farmers.

> *I mean the major ones [SMS platforms] are Esoko, SOFTtribe, and SMSGH, right. So, for example, CITRUS-PRO [pseudonym for a processor with reputation problems due to*

> *late payments], they are developing a system with SMSGH. And it is an SMS communication platform. So it sends data [about raw material needs and payments] to all these different farmers, right. It is what it does.* (ACDI/VOCA, interview)

In summary, rural relational norms and the associated information-sharing and social-learning practices were not threatened by the influx of new information artifacts carrying the value-chain logic. Through hybridization, TISPs and DPs were able to reinforce the strength of rural relationships, as an advantage of the existing smallholder logic, and to extend trust to new partners and practices in promoting the value-chain logic.

5.4 Symbolic Systems

We find that the changing use of technology in rural Ghana altered symbolic systems by introducing new meanings into the environment. By bringing in text-based communication and the use of standard metric weight measurements, new technologies exposed farmers to new ways of doing agriculture in terms of record keeping, negotiating, and marketing. The data suggest that a step change in the institutional logic of agriculture was occurring as such new practices were being decoded and integrated within existing practice.

Our work suggests that information artifacts that offered opportunities for oral communication and personal conversation—such as mobile phones—were readily appropriated by farmers in rural Ghana. By contrast, the novelty of text-based information artifacts—SMS and the Internet—was met less readily. A result, that is in agreement with established findings of resistance to the adoption of text-based symbolic systems (Innis, 1995; Scott, 2003). The preference for spoken media and the aversion to text-based media (SMS, the Internet, and print media) among farmers was corroborated qualitatively by participants in focus-group discussions. Participants agreed that "only educated people use SMS" (Bonsaaso, focus group) and indicated limited use of narrowcasting SMS solutions. They explained that computer access tended to be enabled via educational facilities and was constructed in the "this-and-that" (Dalun, focus group) space of learning and youth development, rather than in the space of work.

By introducing text-based information artifacts in rural communities, DPs and TISPs extended the range of meaningful messages used there. They enabled the emergence of shared understandings, consistent with the value-chain logic. For example, marketing practices aligned with the smallholder logic across all regions of Ghana used volume measurements such as crates, bags, and bowls. TISPs and DPs, by introducing market-price information services via SMS, challenged the established marketing practices not only by introducing text-based SMS artifacts but also by using standard metric weight measurements, rather than traditional volume units. Because SMS prices were denominated in kilograms, a problem emerged for farmers in terms of measuring their produce. Relying on the formal modality, TISPs and DPs were able to alleviate the discrepancies in farmers' understandings of the market-price information they received by engaging fieldworkers who could explain to farmers the meaning of weight measurements and of the received text messages.

Deciphering of the messages that the farmers received enabled a range of interpretations in the context of farmers' marketing practices. Consistent with value-chain understandings, some farmers reported changing the locations of their marketing activities so that they could get higher prices. Yet, the majority of farmers reported less obtrusive responses to the newly available market information; they interpreted the messages in the context of their established relationships with market traders. Acknowledging the advantages of the text format, they kept records of the SMS messages received, monitored market-price trends, and used these records in their negotiations with market traders at harvest time. DPs and TISPs expected that the text messages would enable farmers to find more-competitive markets, in line with the value-chain logic. Instead, farmers made sense of the market-price service and integrated it in their existing personalized marketing activities. That is, rather than using the SMS information to find new marketplaces, smallholders used it mostly to strengthen their position with their existing market partners. By so doing, they were able to achieve a step change in—rather than a transformative replacement of—the institutional logic in line with which their marketing behaviors were patterned.

6 Discussion

This study explored institutional change in Ghanaian agriculture and was directed by two interrelated research questions. Our first research question considered how technical and nontechnical information artifacts transform farmers' information practices in rural Ghana. We identified that information artifacts formed a complex information environment in rural communities, where some of them were perceived as illustrative of the existing smallholder logic, while others represented the incoming value-chain logic. Considering interaction modalities revealed a process of hybridization: Farmers mixed-and-matched modalities, depending on the availability of artifacts and on the interaction context. Mobile phones and radio, while distinct in terms of their inscribed properties, were found to be the dominant and complementary ICTs permeating the network of smallholder, TISP, and DP activities. These technologies are likely to remain core to smallholder information practices.

The panoply of available information artifacts enabled the simultaneous use of artifacts with different interaction modalities. Hybrid sociotechnical information practices included:

- access to information about agricultural inputs: radio discussions among fellow farmers and local experts (i.e., print-and-broadcasting, formal, and informal modalities); consultations with local experts and transactions in-person or via mobile (i.e., formal and ICT modalities); accessing voice recordings by local experts (i.e., ICT and formal modalities), and sharing those recordings (i.e., ICT and informal modalities)
- access to information about marketing agricultural outputs: accessing prices via SMS (i.e., ICT modality), and verifying them via mobile phone and through personal contacts in destination markets (i.e., ICT and informal modalities); accessing prices via SMS (i.e., ICT modality), and sharing them on the radio (i.e., print-and-broadcasting modality), or with friends and neighbors (i.e., informal modality); and radio announcements and SMS campaigns by processors (i.e., ICT and print-and-broadcasting modalities).

Our second research question asked how new information practices challenge the existing smallholder logic and enable the value-chain logic in agriculture. We found that hybridization brought the two logics closer together and made them mutually understandable, in contrast to previous research emphasizing competitive pressures (Currie & Guah, 2007; Lounsbury, 2012). Hybridization was the result of TISP and DP strategies that were contextualized, and that focused on congruency rather than on substitution. It was also the result of the way smallholders embedded ICTs within their own activities and frames of reference. Importantly for conceptualizing change, hybridization—as opposed to competition between the two logics (Currie & Guah, 2007; Lounsbury, 2012)—may be seen as an intermediary point in the transition toward the value-chain logic. This suggests that short-term shifts in information practices can be used as indicators of underlying institutional change. By tracing the use of information artifacts in agricultural-information practices, we captured change processes that included not only the embedding of new information artifacts but also the evolving use of existing and widespread artifacts.

The normative and symbolic elements inscribed in hybrid information practices enabled institutional change not only by introducing the hybrid logic in rural areas but also by extending the use of smallholder understandings. Contrary to the expectation that ICTs would create radical change by eliminating dependence on personal relationships and allowing farmers to bypass market intermediaries, we found that ICTs introduced transparency that strengthened trust and that allowed farmers to renegotiate existing relationships. Hybrid information practices were able to transform rural relational networks by instilling trust in new information artifacts and new actors (e.g., input sellers, aggregators and processors) that were representative of the value-chain logic. Similarly, hybrid information practices normalized new and emerging elements in the rural symbolic system, such as the use of text-based media and standard measurement units.

6.1 Contribution to IS and Institutional Theory Literature

Our study provides a different perspective on the role of ICT-mediated change by bringing together institutional and practice-level perspectives. Previous research has pointed to the role of ICTs and addressed improved access to information in radically transforming small-scale agricultural activities in developing countries (e.g., Jensen, 2007); research has also noted that the interrelationship between the macro- and microcontext is key to developing a comprehensive understanding in ICTD studies (Lin & Myers, 2015). Yet, researchers have not previously integrated micro- and macroperspectives into all-embracing explanations of developmental change, triggered by ICTs. By using institutional logics alongside activity theory, a rare approach in the IS literature, we were able to demonstrate how hybridization of microlevel information practices drives macrolevel institutional change. Thereby, the approach allowed us to surpass the limitations of privileging one level of analysis (Bélanger et al., 2014).

While theory suggests that conflicting logics can be resolved (Thornton & Ocasio, 2008), few scholars have focused on understanding this as a microlevel process. Institutional theory has largely failed to link microlevel practices and artifacts, such as ICT, to broader macrolevel phenomena of institutional change. By linking activity systems and institutional carriers, we have been able to address this gap and to develop a practice-driven account of institutional change. Activity theory allowed us to reflect on how practice-level problems manifest themselves (Miettinen, 2006) at the macrolevel of institutions. By capturing the process of hybridization in the use of information artifacts, we illuminated the underlying change processes stemming from the introduction of digital technologies, rather than simply reflecting the presence—or absence—of measurable economic impact.

Contradictions are prominent among existing explanations of institutional change at the field level. Examples include shocks in institutional arrangements (Seo & Creed, 2002), as well as explanations revealing a process of diffusion of new practices (Smets et al., 2012) that is precipitated by pragmatic concerns. While our study follows this line of inquiry, we are

able to recognize congruencies, rather than contradictions, as leading the process of hybridization. Hybrid information practices emerged among farmers, and they were used strategically by DPs and TISPs. Such hybrid practices tended to strengthen relational norms and to propel the value-chain-development objectives inscribed in the activities of DPs and TISPs. In the absence of urgency and external shocks, the process of institutional change was gradual and intermittent, rather than radical and conclusive.

Our study adds to the broader ICTD and IS literature in several ways. First, ICTD studies are typically monotechnology focused, concentrating on mobile technology, the Internet, or other information artifacts. Our study broadens the focus (polytechnology) and avoids relegating the issue to the adoption of ICTs (e.g., the Internet, mobile phones, and smartphones). Such an approach allows scholars and practitioners to resist the allure of technology fads that may not be contextually relevant (Kleine & Unwin, 2009). Second, few studies have examined the role of ICTs in connecting bottom-of-the-pyramid populations to the market (Tarafdar et al., 2013). Our study adds to this literature by providing insights into the broader role of ICTs in the agricultural sector, as well as addressing calls for insights into how ICTs can better connect farmers with agricultural value chains (Flor & Cisneros, 2015).

6.2 Implications for Practice

In addition to an enhanced theoretical understanding, our research provides several implications for practice. First, we provide a narrative of the process of change and the role of ICT. While practitioners often wish to demonstrate that ICTD interventions have a measurable impact on livelihoods (Jensen, 2007), our study introduces realism and serves to highlight the complexities of employing ICTs in achieving development objectives. We highlight hybridization as having a beneficial and worthwhile institutional impact, rather than offering explicit economic gains. We suggest that donors, implementing agencies, and development workers are best advised to moderate their immediate expectations from ICTD initiatives, and to include them as elements linked to transforming symbolic systems in long-term development strategies. Second, our research adds to the body of evidence that has underscored the poor fit of interventions with local practices (Islam & Grönlund, 2007; Okon, 2015) and with stakeholder needs (Mamba & Isabirye, 2014) as a major reason for the failure of ICTD initiatives. Our study adds to this by showing how development actors strategically positioned their ICTD initiatives in the smallholder logic, and by demonstrating how farmers appropriated ICTs in their extant practices, in ways congruent with such framing. In the context of a policy push for the inclusion of smallholders in agricultural value chains, our findings suggest the promising intervention strategy of framing ICT initiatives in extant information and cultural practices, and allowing scope for their appropriation by farmers (or other beneficiaries). While such an emergent, bottom-up approach—anchored in local practice rather than in policy discourse—appears challenging to resource, manage, and govern, it remains the only viable method for bridging design-reality gaps. Third, we suggest that implementers of technology projects in agriculture should not assume that the desired user behaviors encoded in their designs are necessarily decodable by beneficiaries. Dedicated efforts need to be made to ensure that solutions are usable and are likely to give rise to the desired behaviors, considering the social context of their use. In particular, we would encourage development practitioners, technology providers, academics, and policy-makers who seek to stimulate value-chain linkages in African agriculture to acknowledge and tackle structural barriers to behavior change, and not to assume individually rational, market-oriented behaviors as immediate responses to improved availability of—and access to—market information.

6.3 Limitations, and Directions for Future Research

There are several limitations of this study, which may also serve as avenues for future research, spanning its implementation, methodology, and application of theory. First, longitudinal studies, by their very nature, are subject to limitations in terms of delayed results, continuity, and cumulative attrition. Consequently, replicating the study as a series of more focused and time-bound projects in an African agricultural setting could contribute to improving the precision of our findings. Alternatively, a follow-up study of ICTs in Ghanaian agriculture could validate and expand on the institutional dynamics that we captured—for instance, progression toward the value-chain logic.

Second, our mixed-methods approach has limitations, in particular the challenge of developing meta-inferences from broad cross-paradigmatic data (Venkatesh et al., 2013). While we acknowledge these challenges, our five-year time frame and mixed-methods approach to data collection (which accounts for multiple levels and perspectives) was necessary given that we were examining shifts in ingrained institutions and practices. We suggest that future research adopts embedded and mixed-methods studies to provide deeper accounts of change. In doing so, future research should also consider developing techniques for integrating longitudinal qualitative data with cross-sectional quantitative data.

Third, the combination of an institutional perspective with activity theory is novel, and new in the field of IS, and it helped address the multilevel dimension of this study. A key argument in our study is that we believe it is necessary to couple the institutional-logics

perspective and a microlevel analytical framework (such as activity theory) to ground the logics in activity. We contend that our methodological and conceptual approach helps deliver insights that avoid narrow findings, the seduction of new technology, and short-term, uncontextualized impacts (see Steyn, 2016). As an approach, it lends itself to some generalizability in contexts where institutional stability and strong cultural-historical norms are challenged by ICTs. While our study has focused on the ICTD space, our approach can be applied to other IS settings where new technologies augment activities and contribute to institutional change (e.g., public services, financial institutions). Additionally, future studies may further explore how beneficiaries' activities are linked to the strategic and grassroots activities of development actors, and investigate ways to propel institutional- level change.

Last, both institutional logics and activity theory are broad theoretical perspectives with vast analytical and explanatory potential. It has not been possible to account for the vast array of insights achievable by means of the two theoretical perspectives in our study; many opportunities for further work therefore exist. We have introduced the concept of interaction modality as a bridging element between the two theories. Further refinement and exploration of this concept is only one of the possibilities for new theoretical contributions that are warranted by the joint use of the two approaches. Such tools are opening new pathways for understanding how new technologies are disseminated across cultures, as well as how they evolve from purely material instruments to socially constructed artifacts, adorned by symbolism, within a new setting. While accounts tracing the evolution of material culture are well-established in anthropology (Pfaffenberger, 1992), this line of analysis has remained largely outside the scope of IS research. Further research that enhances the understanding of how new technologies move through cultural membranes, and how they are being assimilated to fit the themes of new cultures, is bound to enhance the ICTD literature and its impact on development.

7 Conclusion

Drawing on an in-depth mixed-method study, we provided an understanding of the hybridization process triggered at the microlevel of information practices and at the macrolevel of institutional logics, by changes in the availability of information artifacts for use in agricultural activities in rural Ghana. We found that farmers mixed-and-matched modalities, depending on artifact availability and on the interaction context. Information artifacts served to link the activities of farmers (embedded in the smallholder logic) with the activities of DPs and TISPs (promoting the value-chain logic). In terms of conceptualizing change, our findings suggest that hybridization of the two logics may be seen as an intermediary point in the long transition toward the value-chain logic. We also cultivated activity theory as a practice-based lens for structuring inquiry into institutional change. Empirically, we have shown how ICTs afford hybrid information practices in an ecology of technical and nontechnical information artifacts. In terms of development policy and the practice of promoting market-oriented solutions in African agriculture, we have identified the significance of symbolic elements of ICTs in prompting changes in practice.

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Appendix A. Key Terms and Definitions

Table A1. Key Terms and Definitions

Key terms	Our Definition/ Examples	Literature
Activities	Habitualized behaviors and patterned actions providing a basis for order and continuity. Activities are in their simplest structural form, they are analyzable in transformation, analyzable as contextual and cultural phenomena. As elements of institutional carriers, activities are synonymous to routines.	(Engeström, 1987) (Scott, 2013, p. 100- 101)
Activity system	System consisting of motive, subject, object, artifacts (synonymous to tools), rules and norms, division of labor, community	(Engeström, 1987)
Artifacts	Elements of material and symbolic culture that assist in the performance of activities. Technical (e.g., physical instruments) and nontechnical (e.g., social networks) artifacts mediate activities and carry both, material and symbolic elements. As part of activity systems, artifacts are synonymous to tools.	(Scott, 2013, p. 102) (Engeström, 1987)
Contradictions	Contradictions are historically accumulated structural tensions within and between activity systems which promote dialectical transformation.	(Engeström, 2001)
Information artifacts	Artifacts by means of which a subject interacts with the information pertaining to the object of his or her activity. They can be technical information artifacts (e.g., letters, newspapers, radio, mobile phones, Internet, Twitter, etc.) or their nontechnical equivalents (e.g., people, relationships, etc.).	(building on Lee, Thomas, & Baskerville, 2015)
Information practices	Information practices are collective, intersubjective, and contextually oriented social practices. They include activities such as purposive and serendipitous information seeking, active scanning, information production and communication.	(Savolainen, 2007)

Table A1. Key Terms and Definitions

Institutions	Social structures that bring stability and meaning to social life.	(Scott, 2001, p. 48)
Institutional carriers	Artifacts (synonymous to tools), activities (synonymous to routines), relational networks, symbolic systems	(Scott, 2003; 2013)
Institutional logic	Put concisely, institutional logics are socially shared cultural beliefs and assumptions that shape and constrain actors' cognitions and behaviors (Lounsbury, 2012), and describe the way a particular world works (Thornton & Ocasio, 2008).	(Lounsbury, 2012; Thornton & Ocasio, 2008)
Interaction modality	The classification of the channel for an interaction, occurring between an information artifact and its user. Within mediation processes, modalities are the symbolic elements of technical and nontechnical artifacts.	(Saroha et al., 2011)
Logic, smallholder	Institutional logic in African agriculture characterized by cash-in-hand and informal trading, dominated by rural norms, and plagued by governance problems and lack of access to markets, ICT and information.	(Collier & Dercon, 2014; Fafchamps, 2004)
Logic, value-chain	Institutional logic in agriculture characterized by greater knowledge base and information intensity, as well as availability of facilitation services that link farmers to output markets.	(Slavova & Karanasios, 2014)
Mediation	The principle whereby human activity is mediated via artifacts: material tools and symbolic elements. Material tools are externally oriented and serve as channels of influence on the objects of human activity. By using them, individuals may internalize symbolic elements that are reflective and require consciousness of one's (or other persons') procedures.	(Vygotsky, 1978) (Engeström, 1987)
Relational networks	Includes interpersonal and inter-organizational linkages and ties	(Scott, 2003)

Table A1. Key Terms and Definitions

Symbolic systems	Symbolic schemata into which meaningful information is coded and conveyed; includes rules, laws and regulations, values and norms, classifications and so on.	(Scott, 2003)
Value-chain development	Development of links among people, organizations and activities needed in order to produce, process and deliver food products to consumers. Key elements include improving market access and standardizing agronomic practices.	(Armstrong et al., 2011; Webber & Labaste, 2010)

Appendix B. Focus Group and Interview Questions (Abbreviated)

Script for focus group discussions

During focus group discussions, a research assistant collects details about the profile of the community: geography, social composition, economy, culture of the community, past/ current experiences with development projects, details about the group (number of participants, gender, age, literacy level).

1. **Introductions** of the researchers and the topic access/delivery of extension services, and extension service responsiveness to information needs
2. Participants introduce themselves through the participatory ice breaker
3. Develop **historic/ time line** for agriculture in the community for the **last 20 years (since the time of JJ Rawlings).**
    - **a.** How has the village changed? Positive changes? Negative changes?
    - **b.** Any crises in the environment? (flood, draught, famine)
    - **c.** Any population shifts? Any migration?
    - **d.** How has agriculture production changed?
    - **e.** Good and bad agricultural periods experienced through the years?
    - **f.** How have people coped with the changes?
4. Participatory discussion of **communication resources in the community:**
    - **a.** Who has a **mobile phone**? How many men / women in the group have mobile phones? How many mobile phones are in the village?
    - **b.** What functionality do people use (voice, SMS, data)?
    - **c.** Who has the nicest phone in the village? What is it? Describe it.
    - **d.** How many credits do you buy? How often?
    - **e.** How do you charge your phones? What do you do if your phone has no battery left?
    - **f.** What is the mobile phone coverage? Which networks? Where?
    - **g.** Where are the mobile phone antennas?
    - **h.** Who has a **radio**? How many in the group have radios? How many men / women? How many radios are in the village?
    - **i.** What radio stations you can get? Where?
    - **j.** How do you listen to the radio? Do you listen together, or on your own?
    - **k.** Who has a **TV**? How many men / women? What TV stations you can get?
    - **l.** Are there **newspapers** delivered to the village?
    - **m.** Who buys? Who doesn't? Why?
    - **n.** Where is the **school**?
    - **o.** Is there a **library**? Is there anywhere to borrow books? Is there anywhere to borrow videos / DVDs?
    - **p.** Are there any very **knowledgeable people** whom to turn to for advice / gossip? Who? Where?
    - **q.** Where do you go to learn the news?

r. Is there a loudspeaker?
s. Is there a "town crier"?
t. Where do you meet your Agriculture Extension Agents?
u. Churches / mosques?
v. ICT center?
w. Has anyone used a computer/ Internet?
x. What roads are there? How do you get transportation (e.g., a car, bus, truck, tro-tro, etc.)?

1. Participants to draw a **map of the resources discussed**
2. Derive a **problem tree** about the productivity gap between yields that are achievable and the participants' yields

Discuss the agriculture crop cycle and what information is necessary/ important at different stages of the crop cycle

Script for interviews

1. Organization details:

a. Public, private, community (or other)?
b. Overview core mission and how provided extension / training / information / advice services fit.
c. Human capacity (number of employees, education, skills, experience) and resources available (budgets, buildings, field vehicles)

2. Work in extension and provision of agriculture information

a. Is extension service provision a core business for your organization or project-based?
b. What are the specific performance targets / objectives for this service? What does it aim to accomplish?
c. How do you (your organization) know that the project is achieving its goals?
d. What sustainability strategies does your organization (or donor) have in place?
e. Would you describe the advisory content distributed by your service as information and/or knowledge?
f. What is the primary source of the information/ knowledge dispersed?
g. Is the information/knowledge internally generated, or acquired from external partners?
h. How confident are you in the reliability of the information/advice you provide?
i. Can you describe briefly the training activities carried out by the project?
j. What groups (AEAs, smallholder farmers, commercial farmers, FBOs, local government) are the clients of your advisory service? How many clients are in each group?
k. What are the training /advisory methods (demonstrations, field schools, short courses, discussion groups) used?
l. What technologies (specific in-house technology, Internet, telephone, mobile applications, handheld devices, rural radio, television, public access facilities) are you using for the distribution of the advisory content? How are they applied?

Appendix C. Participatory Maps of Information Resources

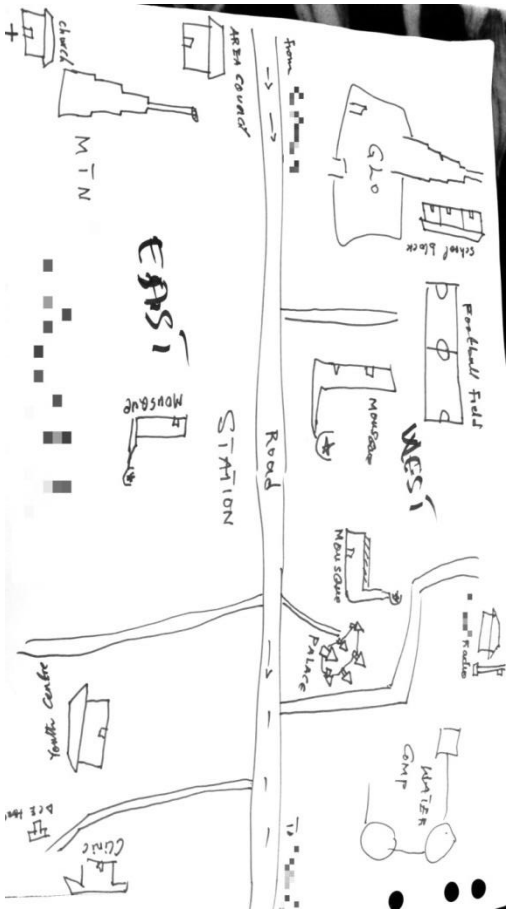
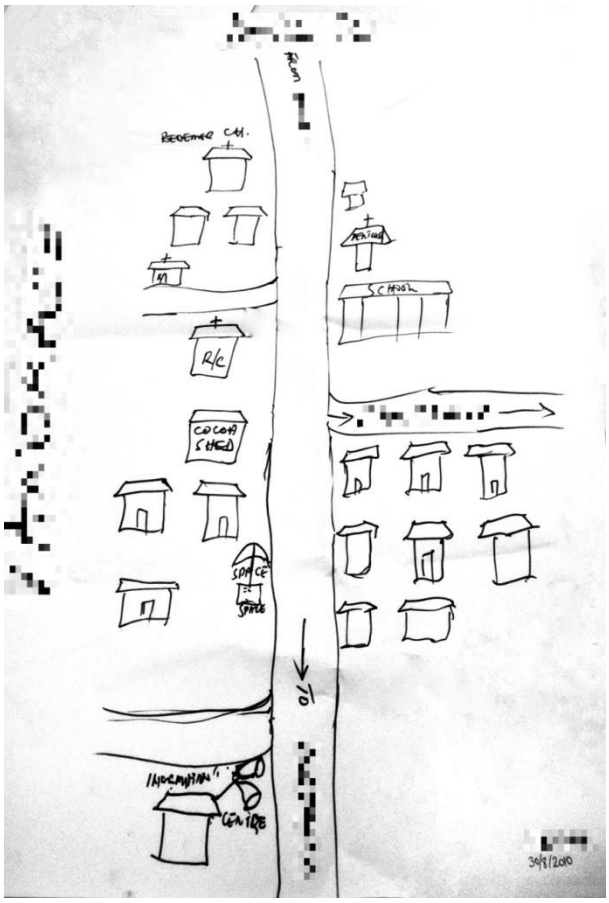


Figure C1. Participatory Map of Information Resources, Dalun



FigureC2. Participatory Map of Information Resources, Takorasi

Legend: **Space-to-space**—MTN paid phone services, staffed by "umbrella sellers"; **Information Centre**—loudspeaker facility; "**Cocoa shed"**—COCOBOD representative, **School**, **Churches**: Pentecostal, Christ the Redeemer, R/C church, M church

Appendix D. Secondary Quantitative Data Thematic Areas

Table D1. Secondary Quantitative Data Thematic Areas

Demographic info	Public opinion and trust	ICT availability and use practices, per technology	Information needs and information practices, per content area
Sex, age and language	Social issues of concern (e.g., cost of living, crime and violence, corruption, etc.)	Available ICT (e.g., TV, radio, computer, Internet access, etc.); news and information access;	Financial information (e.g., information sources per financial issue; information satisfaction per issue; trust in financial information per source etc.)
Opinion leader	Perceived progress on issues	Radio as information source; practices (e.g., frequency of listening, top three stations, how received, level of importance as source of news / info)	Health information (e.g., information sources per health issue; information satisfaction per issue; trust in health information per source etc.)
Respondent information (education, English language use, income and employment, etc.)	Trust in "institutions" (e.g., parliament, financial institutions, the media, the police, etc.)	TV as information source; practices (e.g., frequency of viewing, top three stations, how received, level of importance as source of news / info)	Crop agriculture (e.g., information sources per crop agriculture issue; information satisfaction per issue; trust in crop agriculture information per source etc.)
Enumeration data	Trust in news and information provided by different sources	Newspapers as information sources; practices (e.g., frequency of reading, top three publications, how received, level of importance as source of news / info) Mobile phone as information source; use practices (e.g., frequency of use, MNO, sharing practices) Internet as information source; use practices (e.g., frequency of use, uses / applications, level of importance as source of news / info) Dwelling electricity and sanitation	Livestock (e.g., information sources per livestock issue; information satisfaction per issue; trust in livestock information per source etc.)

Appendix E. Coding Scheme*

1. Information artifacts (tools)

ICT (mobile-voice, mobile- SMS, platforms)

Broadcasting (Radio, TV)

Formal (extension service, NGOs, input suppliers, others)

Informal (family and friends, farmers)

2. Activities (routines)

Smallholder activities (motivation, actions, subject, object)

DP activities (motivation, actions, subject, object)

TISP activities (motivation, actions, subject, object)

3. Relational networks

Rural norms (trust, participation, commitment, community, social learning)

Business norms (info flows / sharing, trust, contracts)

Old relationships (disputes, creditors, power)

Changed relationships (transparency, bargaining power, newcomers)

4. Symbolic systems

Oral media

Text media

Measurements (standard, volume)

Content format (song, theatre, interview, message, discussion, demonstration)

5. Smallholder logic

Agricultural practices (production, marketing, risk of change, resources)

Communication norms

Information practices

6. Value-chain logic

New practices (switching behavior, risk of inaccurate information, risk of change)

Communication norms

Information practices

7. Complexity/ interconnections

Complex information environment (sources, logics)

Linked activities (DP–smallholder, TISP–smallholder, DPs–TISPs, Among DPs)

8. Contradictions/ congruencies

Contradictions (primary, secondary, tertiary, quaternary, resolutions)

Congruencies (reinforcement, efficiency, effectiveness)

Workarounds

9. Hybridization

Mixing modalities (ICT-broadcasting, broadcasting-formal, ICT-informal, ICT-formal, broadcasting-informal, informal-formal)

Mixing technologies

Mixing logics

10. Transformational changes

Advisories (use of fertilizer, verified seeds, marketing, informed decision making, managing risk)

Barriers (resources, knowledge)

Advantages (yields, quality, improved livelihoods)

Practices

11. Step/incremental change

Advisories (compost, own seeds)

Barriers (standards)

Advantages (minimal resources, reliable, yields, customer, preference, indigenous knowledge)

Practices

12. Actors

DPs (extension service, NGOs, input providers, other)

TISPs (radio stations, services, technology, other)

Government actors

Other

13. Knowledge transfer

Relational aspects (testimonials, endorsements, demonstrations, group meetings, community acceptance, peer teachers)

Informational aspects (understandable advice, verified advice, own experts, third parties, information accuracy, information quality)

Delivery (face-to-face, remotely via technology, both)

14. Outcomes

Reaching farmers (by travel, via technology)

Delivering messages (efficiency, effectiveness, user feedback, listener surveys, channel preferences)

Adoption (transformational advice, step change advice, barriers, enablers)

15. Context

Social context (rural setting, business setting)

Economic context (skill shortages, limited resources, equipment, financing, government support)

Cultural context (rituals, storytelling, praying, chieftaincy)

**Note:* The coding tree was simplified for presentation in this article.

Appendix F. Secondary Quantitative Data

Table F1. Agriculture Information Practices (Respondents Gave More Than One Answers) (n=305)

		Never	Less than once a month	At least once a month	At least once a week	Everyday	Very untrusted	Somewhat untrusted	Don't know	Somewhat trusted	Very trusted
ICT-based modality (digital technologies)	SMS	74.1	7.2	5.2	7.2	1.3	1.3	3.6	79	7.9	7.9
	Internet	85.9	1.6	0.7	1.3	0.3	0.7	1.3	87.5	4.6	5.6
Print and broadcasting modality (legacy technologies)	Radio	0.7	7.2	2	15.4	74.8	0	0	21.3	21	57.7
	TV	12.5	33.1	4.6	20	28.9	0.3	0.3	44.3	15.7	39.3
	Newspapers, magazines	79	8.2	1.3	2.6	0.3	1.3	2	76.7	8.5	11.1
	Posters, billboards, brochures	74.4	10.8	2.6	3.3	1.6	1.6	2	74.4	7.5	14.1
Informal modality (social networks)	Family, friends	7.2	18.7	12.8	31.8	28.9	1.3	2.3	22	32.8	41.6
	Local farmers						1.3	4.3	34.1	26.2	34.1
	Community	18.4	24.6	15.7	28.2	12.1	-	-	-	-	-
	Other farmers	-	-	-	-	-	1.6	4.6	21	33.1	39.7
Formal modality (DP outreach)	Extension office	0.7	3.3	41	17.4	37.7	0.7	3.3	41	17.4	37.7
	Faming supply vendors	1.3	7.5	32.1	36.1	23	1.3	7.5	32.1	36.1	23
	Gov't Officials	53.4	30.2	6.9	3.6	3.3	-	-	-	-	-

Table F2. Mobile Trends

Last time used mobile (other than today)						Reasons mobile not used						How often do you use mobile to access the Internet				
Never	**> 12 months ago**	**In last 12 months**	**In last 4 weeks**	**In last 7 days**	**Yesterday**	**I don't have access**	**I do not own one**	**Handset too expensive**	**Credit is too expensive**	**Other**	**Never**	**At least once a month**	**At least once a week**	**Once a day**	**Every day**	**Don't know**
11.8	6.2	7.5	7.9	11.8	54.8	5.9	12.8	5.6	3	3	75.4	0.3	0.7	0.3	0.7	4.6

Table F3. Internet Use

Last time use Internet (other than today)						Reasons Internet not used					
Never	**More than 12 months ago**	**In last 12 months**	**In last 4 weeks**	**In last 7 days**	**Yesterday**	**Difficult to access**	**Connection to slow**	**Too expensive**	**Don't need it**	**Don't know how**	**Don't how what it is**
94.4	0.7	1.6	1	1.3	0.7	49.5	4.9	14.8	5.2	52.8	52.1

About the Authors

Mira Slavova is an assistant professor of organization studies at Warwick Business School. She works on topics of information and communication technologies (ICTs) and their use by people, within organizations and in society more broadly. Mira is passionate about digitization in African settings (e.g. Liberia, Ghana, South Africa) and its impact on organizing. She has held positions at International Food Policy Research Institute (Washington, DC), SAP Africa Innovation Center (Pretoria), Gordon Institute of Business Science (Johannesburg), ESSEC Business School (Paris) and London School of Economics and Political Science. Her work has reached academic and non-academic audiences, across a range of outlets.

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