

2020-04-03

# Access and use of agricultural market information by smallholder farmers: Measuring informational capabilities

Magesa, Mawazo

WILEY

---

<https://doi.org/10.1002/isd2.12134>

*Provided with love from The Nelson Mandela African Institution of Science and Technology*

## RESEARCH ARTICLE

WILEY

# Access and use of agricultural market information by smallholder farmers: Measuring informational capabilities

Mawazo M. Magesa<sup>1</sup>  | Kisangiri Michael<sup>2</sup> | Jesuk Ko<sup>3</sup>

<sup>1</sup>Centre for Information and Communication Technologies, Sokoine University of Agriculture, Morogoro, Tanzania

<sup>2</sup>School of Computational and Communications Science and Engineering, The Nelson Mandela African Institution of Science and Technology, Arusha, Tanzania

<sup>3</sup>Department of Industrial Engineering, Universidad Mayor de San Andres (UMSA), La Paz, Bolivia

## Correspondence

Mawazo M. Magesa, Centre for Information and Communication Technologies, Sokoine University of Agriculture, P.O. Box 3218, Morogoro, Tanzania.  
Email: magesa@sua.ac.tz

## Abstract

While farmers sell their crops, middlemen provide a linkage between them, markets and buyers. Middlemen have good knowledge of working conditions of markets and have access to agricultural market information. Due to poor access to markets and agricultural market information by smallholders, there is a feeling that middlemen benefit more while farmers sell their crops. Good access to markets and market information may help farmers bypass middlemen while selling crops and thus benefit more. Thus, it is best to improve the informational capabilities (ICs) of farmers in agricultural marketing. Thus, this research measured ICs of farmers accessing market information, through a program NINAYO, while selling their crops. The research utilized the informational, psychological, social, and economic dimensions of the empowerment framework in identifying capability indicators to formulate survey questions. Data were collected from smallholders in six regions in Tanzania. The analysis utilized measures of life satisfaction and results showed that about half of the variation in the dependent variable, satisfaction with capabilities, was explained by the model. Backward elimination analysis confirmed that life satisfaction is multidimensional. Robustness test confirmed a positive relationship between satisfaction and capabilities. Overall, results confirmed ICs are multidimensions, their improvement empowers farmers in agricultural marketing.

## KEYWORDS

agricultural market information, capability approach, information and communication technologies, informational capabilities, life satisfaction, smallholder farmers

## 1 | INTRODUCTION

Among the opportunities provided by ICTs include access to knowledge, skills, resources, and services, leading to social and economic development. To individuals, ICTs develop their capabilities in finding, evaluating, and using strategic and tactical information. Individual's capabilities can be demonstrated in accessing, evaluating, and using information for coordinating his dealings. This gives rise to the concept of informational capabilities (ICs) related to the role of information in developing the capacity of an individual in using information for making a timely and informed decision in his dealings. Gigler (2014) described ICs of an individual as *the ability of a person to use ICT to find, process, evaluate, and use the information and to produce and share local contents with others through the network*. The ICs concept relates the role of information with the capacity to find, process, and classify it according to the particular socio-cultural context of a person (Avilés, Larghi, & Aguayo, 2016). While assessing how individuals or businesses can remain competitive, Ismail, Rose, Uli, and Abdullah (2012) considered ICs in perspectives of knowledge (ie, what people know about ICT), skills (ie, what people do with ICT), and ability (ie, their abilities in using ICT). Thus, improved ICs enhance social aspect (ie, connectedness), skills and knowledge of individuals and are linked to improved competition, businesses, and performance gains.

To smallholder farmers, access to information through ICT is vital for their agricultural dealings as it can help them learn the best farming techniques for more agricultural production, enable them to learn the weather and climate information necessary for their agricultural farming, and also can help them access information about markets, buyers, and traders while marketing and selling their agricultural produce. All these require smallholders to develop their capabilities in ICT. Thus, improved ICs can enable smallholder farmers to become more active market participants; reach markets and buyers of their agricultural produce, for more profit, for their improved livelihoods and the improved agricultural sector.

In developing countries like Tanzania, middlemen play a great role in linking farmers to markets and buyers in the agricultural value chain (Ismail, Srinivas, & Tundui, 2015; Magesa, Michael, & Ko, 2014). Middlemen are conversant with market operations and have direct access to markets and agricultural market information (AMI), and have links with buyers and traders of agricultural produce. Middlemen benefit more while farmers sell their crops (Molony, 2008; Otekunrin, Momoh, & Ayinde, 2019). Farmers have no good knowledge of market operations as they occasionally reach markets while selling their crops. The results are that farmers do not get a good price while selling their crops, they continue depending on subsistence farming and agriculture does not improve their livelihoods, poverty prevails in rural areas, rural areas are underdeveloped and agricultural sector, in general, continues to be underdeveloped.

Scholars (eg, Ismail et al., 2015; Magesa et al., 2014; Otekunrin et al., 2019) have acknowledged an information gap where smallholders have poor access to AMI. Thus, it is important to bridge such a gap by developing the capabilities of smallholders in agricultural marketing to make them more active market participants. Not much has been explored with developing ICs of the poor including smallholder farmers. Pamungkas (2018) has explored ICs while studying the application of the village information system for supporting public services in Java, Indonesia and argued that the development of ICs is influential in assessing the distribution of information and the participation of villagers involved in rural development particularly in developing creative economy based on the villages' resources and specific knowledge and practices owned by the villagers. Avilés et al. (2016) while studying impact of the adoption of ICT in poverty reduction by understanding how the poor obtain, share and use ICT on their everyday life in three rural communities in Mexico, found that ICT adoption changes the pattern of information seeking and enhances ICs and existing assets of low-income communities. Gigler (2014) has defined and explored more on the ICs concept and argued that expansion of the ICs can have a positive "multiplier effect" on the other capabilities and as a result of the enhanced ICs, individuals will be able to expand their control over important life choices. Thus, not much has been written about ICs, and it is not explored in the African context. This leaves a research gap for more exploration of the ICs concept in different context (eg, Africa), environment (eg, rural areas), sector (eg, agricultural marketing), and people (eg, poor smallholder farmers).

Thus, this research intended to study and measure the ICs of smallholder farmers in agricultural marketing while selling their farm produce. Such farmers, living in rural Tanzania and engaged in agriculture as their main economic activity, access different AMI (eg, price produce, demand for a certain produce, buyers/traders of produce, availability of markets for their produce) via different ICT devices (eg, mobile phones, radios, Internet) while selling their agricultural produce. Governments and other development partners supporting farmers can use the research findings to ensure rural areas are digitally connected, markets are reached and even help to develop the ICs of farmers.

A thorough analysis indicates that ICs concept has been conceptualized from the literature on information literacy (*IL*) (Behrens, 1994; Burchinal, 1976; McClure, 1994). In 1974, Paul Zurkowski (as quoted in Behrens, 1994), was the first to use the concept of *IL*, and he suggested that: information resources are applied in a work situation; techniques and skills are needed for using information tools and primary sources, and information is used in problem-solving. Burchinal (1976), linked *IL* with: skills that included locating and using information; use of information for problem-solving and decision making; and efficient and effective information location and utilization. Also, in 1985, Martin Tessmer (as quoted in Behrens, 1994) defined *IL* as the ability to effectively access and evaluate information for a given need and its characteristics included integrated set of skills (research strategy, evaluation) and knowledge (knowledge of tools and resources), which are developed through acquisition of attitudes. Thus, based on literature, it can be said that *IL* develops individual's capabilities to: *know the kind of information required; to locate the source of information; find and get information from the source; and to process, organize and use the information.*

McClure (1994) considered *IL* to develop person's capability to use information to solve problems, and identified its four components: *traditional literacy*—basic capability of reading and writing; *media literacy*—ability to use multimedia to solve information problems; *computer literacy*—capability to operate a computer; and *network literacy*—ability to identify, access, and use electronic information from the network. Thus, ICs concept emanates while applying the capability perspective to ICT (Gigler, 2014). Based on the four components of *IL* by McClure (1994), Gigler identified four components of ICs, that is, the person's capability or ability to use ICTs in an effective manner (*ICT capability*); find, process, evaluate, and use information (*information literacy*); communicate effectively with others (*communication capability*); and produce and share local contents with others through the network (*content capability*). Based on the capability perspective, Gigler (2014) visualized ICs as a person's "capability" to transform his existing informational capital, such as level of access to ICT (the entitlement), into the human agency and real opportunities in society to achieve the things he values doing/being. Gigler added that ICs refer to a person's positive freedom to use ICT within the institutional and socioeconomic setup of a society. The next section briefly explores the capability approach from which ICs concept emanates.

## 2 | THE CAPABILITY APPROACH

Amartya Sen's Capability Approach (CA) is a framework for the evaluation of individual welfare, and as such can provide the theoretical basis for inequality, poverty, and policy analyses (Kuklys, 2005). It is defined by its choice of focus upon the moral significance of individuals' capability of achieving the kind of lives they have reason to value (Nussbaum & Sen, 1993). Nussbaum and Sen (1993) defined a person's capability to live a good life in terms of the set of valuable "beings and doings" like being in good health or having loving relationships with others to which they have real access. Its core characteristic is its focus on what people are effectively able to do and to be; that is, on their capabilities (Robeyns, 2005). Its major constituents are "functionings" and "capabilities" (Sen, 1985). Functionings are the "beings and doings" of a person, whereas a person's capability is "the various combinations of functionings" that a person can achieve. Capability is thus a set of vectors of functionings, reflecting the person's freedom to lead one type of life or another (Sen, 1992). According to Sen (1987), the two concepts are distinct in that functioning is an achievement, whereas a capability is the ability to achieve. Functionings are, in a sense, more directly related to living conditions, since they are different aspects of living conditions. Capabilities, in contrast, are notions of freedom, in the positive sense: what real opportunities you have regarding the life you may lead.

The ICs concept combines the person's livelihood resources, including information, and his agency, or ability to strengthen the resources and use them to achieve the beings and doings he would like to achieve. Developed ICs is expected to play a transformative role in a person's life and provide him with different opportunities in different dimensions of life. Also, the socioeconomic factors and the community settings of an individual may affect an individual's capability to find, process, use, and communicate information. Available local knowledge within the community can aid in improving a person's ability to use the information and thus contribute to enhancing an individual's ICs. However, factors that limit access to information such as economies, education, technology availability, etc. may impede the development of ICs among individuals within the society.

Several scholars have attempted to operationalize the CA by combining it with other theoretical approaches and thus contributed to considerable literature. Bebbington (1999) integrated the CA into the sustainable livelihoods framework and then developed his version based on capitals (assets) and capabilities. Based on the CA, Alkire (2005b) developed a framework for specifying valuable capabilities and applied it to case studies of nongovernmental organization activities on poverty reduction. Other scholars have attempted to operationalize the CA by integrating it with other developmental approaches. Using the Capability, Empowerment, and Sustainability virtuous spiral model, Grunfeld (2011) explored how an ICT4D project deployed in a community can contribute to Capability development of an individual, Empowerment of an individual and Sustainability of the project. Hatakka and De (2011) considered technology as a commodity which can influence the individual's or community's ability to make a choice and thus developed the CA framework which he used to evaluate the enabling of people's intended and unintended functionings, through the ICT initiatives. Kivunike (2014) proposed an ICT4D evaluation model, which among others, included ICT characteristics, capabilities, and achievements/achieved functionings. As it puts people at the centre of development, the CA can be used to assess and analyze poverty, inequality, and well-being in terms of the capability or freedom people have to achieve the various "beings" and "doings" they have reason to value (Sen, 1999).

### 2.1 | Measuring ICs

The CA has been used for different types of analysis, with different epistemological goals, relying on different methodologies, with different corresponding roles for functionings and capabilities (Robeyns, 2005). Measurement and analyses have focused on functionings and capabilities rather than on resources or utility as the CA conceives development or improvement as the freedom people have to enjoy valuable activities and states. The assessment using the CA can be made depending on the purpose of the measure, the place and situation (or, if comparability is required, the places and situations), the level(s) of analysis, the data available, the policies it will guide, and the kind of analyses required (Alkire, 2005b). Robeyns (2005) indicated that the CA serves quite different goals (eg, welfare/quality of life measurement, thick descriptive analysis, normative theories), spanning a wide range of disciplines.

Many creative and worthwhile works for which scholars have assessed/measured capabilities can be found. Using the CA, social scientists such as Chiappero-Martinetti (2005) and Kuklys (2005) have measured the quality of life, and Unterhalter (2005) has made descriptive analysis while examining the CA and gendered education in South Africa. In Pakistan, Alkire (2005a) assessed three poverty reduction projects to learn how capability-enhancing they were, Yeung and Breheny (2016) explored the determinants of subjective well-being among older people in New Zealand, and Vaughan (2011) evaluated ICT programs using two case studies of indigenous communities in Cape York, Australia. Van Ootegem and Verhofstadt (2012) demonstrated a way in which capabilities can be measured on the level of life domains. Anand, Santos, and Smith (2007) have explored whether and how capability can be measured.

How can the CA be operationalized? While employing the CA in an analysis, Robeyns (2006) described three helpful specifications. First, one has to decide to focus either on the capabilities or functionings. Focusing on capabilities, as this research did, one aims at providing a range of possible ways of living and allows individuals to be held responsible for their own choices. After deciding to focus on capabilities, the next step is to

**TABLE 1** Empowerment framework through ICTs

Context	Capitals	Institutional processes	Capabilities	Outcomes
Social-economic conditions	Economic capital Natural capital	Existing social structures	Economic Social	Informational capabilities strengthened
Cultural context	Human capital		Informational	Human capabilities strengthened
Political context	Social capital Informational capital Psychological capital	Introduction of ICTs	Psychological Cultural	
ICT	Material capital Geographical capital Cultural capital			Social capabilities strengthened

Source: Scoones (1998).

select relevant capabilities that can be included in the analysis. As Sen (2004) did, the selection of relevant capabilities is a democratic process based on reasoning. Lastly, comes the issue of weighing the different capabilities for an overall assessment. Once relevant capabilities are selected, Chiappero-Martinetti and Venkatapuram (2014) argued that variables and indicators that can be used as a proxy need to be identified and also to identify the primary unit of analysis (ie, individuals, household/family, specific group/population). With these specifications, the following sections discuss the measurement framework that guides while selecting the capabilities, the development of capability indicators and the techniques for measuring the capabilities.

## 2.2 | A measurement framework

This research has adopted a framework by Scoones (1998) in Table 1 while discussing and analysing the impacts of ICTs to an individual smallholder. With the framework, Scoones made a thorough analysis of poverty reduction using a sustainable livelihood approach. Based on the framework, an important question to ask is: *Does the expansion of ICs of a smallholder farmer lead to the expansion of other capabilities?* To answer the question, we employ Sen's concept of the role that human capital plays in enhancing person's ability not only to generate income but also to lead a freer and more fulfilled life and to reach his valued functionings (Sen, 1997). In this sense, the focus is on the role of human capabilities as an agent for bringing about social change. To put it right, ICs of an individual will be studied to understand its effect (expansion) of other aspects (capabilities) of human life. Marchand, Kettinger, and Rollins (2000) has concluded that there is a relationship between ICs and human capabilities.

The framework in Table 1 has several basic elements. Given a particular context, the institutional structures and processes can facilitate the transformation of particular livelihood resources to expanded capabilities, thus contributing to the attainment of development outcomes. Thus, a clear understanding of the interrelationship between the existing social structures and the ICT intermediation is required. Supports from ICT intermediaries help to overcome barriers of access costs, skills, ICT equipment, and connectivity and to provide support in training and capacity building. Also, intermediaries can support access to ICT products and services relevant to information needs of local communities, and support the collection, storage and dissemination of local and relevant contents, thus contributing to expanding the livelihoods of smallholders. During intermediation, individuals can adopt and integrate ICT into their lives, works, practices, and routines to take possession of the ICT technology. Also, the information provided by ICTs can be contextualized to be relevant and meaningful to smallholders, while improving their understanding of the information contents. This can help information provided by ICT to do away with challenges such as language barriers and irrelevant contents.

The framework in Table 1 identifies five dimensions (*informational, psychological, social, economic, and cultural*) that are considered during the process of individual empowerment. Establishing indicators of outcomes for each of these dimensions requires a precise answer to the question: *What is a capability?* The analysis of the items can stress their interdependency while investigating whether or not they reinforce each other. The next section discusses how to identify and develop indicators for measuring ICs based on the four dimensions: *informational, psychological, social, and economic*. The *cultural* dimension is preserved as it is more specific to a segment of people.

**TABLE 2** Outcome indicators of individual empowerment and human capabilities

Dimension	Objective	Indicators
Informational	To improve the access to information and informational capabilities	<ul style="list-style-type: none"> <li>• Ability to use different forms of ICTs</li> <li>• Enhanced information literacy</li> <li>• Recognize information needs</li> <li>• Ability to find, locate, and evaluate the quality of information</li> <li>• Make effective and ethical use of information</li> <li>• Apply information to create and communicate knowledge</li> </ul>
Psychological	To support a process of self-reflection (critical conscientization) and problem-solving capacity	<ul style="list-style-type: none"> <li>• Increased sense of self-worth</li> <li>• Stronger self-confidence, self-awareness, and assertiveness</li> <li>• Improved ability to analyze one's situation and solve problems, providing emotional support</li> <li>• Stronger ability to influence strategic life choices, bridging social divisions, and facilitating others' empowerment</li> <li>• Stronger self-esteem</li> <li>• Sense of inclusion in the "modern" world</li> </ul>
Social	To strengthen people's human capital (skills, knowledge, ability to work, and good health)	<ul style="list-style-type: none"> <li>• Involvement in informal and formal networks, use of ICTs to communicate with neighbors and engaging with recreational activities</li> <li>• Linking individuals in communities for more effective participation</li> <li>• Online interactions to enable identification of peers with similar interests for sharing experience, knowledge and entrepreneurial skills</li> </ul>
Economic	To enhance people's capacity to interact with the market	<ul style="list-style-type: none"> <li>• Use of ICT to market products</li> <li>• Improved access to markets for different farm produce</li> <li>• Enhanced entrepreneurial skills using ICTs</li> <li>• More income from sales of farm produce (lower transaction costs, reduced transport costs, and increased timeliness of sales)</li> <li>• More investment in agricultural production</li> <li>• Dependence of ICTs in daily dealings</li> </ul>

### 2.3 | Development of capability indicators

Indicators are important in evaluating the level of development of capabilities and for assessing the impact of introducing/using ICT to the community. They have great value in pointing to significant problems, and when taken collectively, they allow us to conclude development progress. Indicators are not expected to give a complete representation of the state of the problem and its developmental progress after the intervention. They just give an indication and the nature of that indication will depend on the choices of indicators made concerning definitions and data.

Anand et al. (2009) have insisted that the method employed to generate a set of capability indicators should have some grounds for being viewed as principled. Other theories/principles can be adopted while developing indicators as their sense is just to indicate the level of development/progress. As of this, this research adopted the four principles laid down by Atkinson, Cantillon, Marlier, and Nolan (2002) while developing social indicators as part of the social agenda in the European Union. The principles are that an indicator should: *identify the essence of the problem and have a clear and accepted normative interpretation; be robust and statistically validated; be responsive to research goals but not subject to manipulation, and be timely and susceptible to revision.* Indicators can be of different types with different properties. Based on the four dimensions, indicators for each are constructed based on stated objective(s), experience and reading from other scholars' works. Table 2 summarizes the list of indicators for each dimension based on the stated objective.

#### 2.3.1 | Informational dimension

With the informational dimension, the ultimate is to ensure individuals can use ICT devices and can access AMI, relevant while selling their agricultural produce. With this, users are expected to have the capability to use different ICT devices; build and enhance informational literacy (Gigler, 2014); recognize the needs for information (Li, Van Heck, & Vervest, 2009); communicate information using ICTs (Gigler, 2014); and make effective and ethical use of information (Marchand et al., 2000).

### 2.3.2 | Psychological dimension

With the psychological dimension, ICT plays a direct role in enhancing well-being through a process of “self-reflection” and “critical analysis” of the critical consciousness and self-esteem of poor people (Freire, 1972). Psychological empowerment through ICT can be interpreted as transforming skills into actions to produce a self-determined change. Grant, Franklin, and Langford (2002) described self-reflection as the inspection and evaluation of one's thoughts, feelings and behavior and insight, the clarity of understanding of one's thoughts, feelings, and behavior. The intrapersonal component of the Zimmerman's model of psychological empowerment describes how people think about themselves and includes domain-specific perceived control and self-efficacy, motivation to control, perceived competence, and mastery (Zimmerman, 1995). In their classic work on empowerment, Thomas and Velthouse (1990) illustrated the essence of psychological empowerment as a sense of meaning, competence, self-determination, and impact.

A work by Maier and Seligman (1976) on psychological empowerment suggests empowerment as actions that strengthen the values of self-sufficiency or that weakens learned helplessness. The nature of psychological empowerment process is characterized as being motivating based and focuses on improving individuals' subjective interpretations (eg, self-confidence, self-awareness, assertiveness) so that they feel in control of their destiny (Thomas & Velthouse, 1990). Other examples of outcome indicators for the psychological empowerment of smallholders, through ICT, include improved ability to analyze one's situation and solve problems, providing emotional support (Kieffer, 1984), cultivating a supportive climate (Spreitzer, 1996), stronger ability to influence strategic life choices, bridging social divisions, and facilitating others' empowerment (Christens, 2012), stronger self-esteem (Leung, 2009) and sense of inclusion in the “modern” world.

### 2.3.3 | Social dimension

Human empowerment through ICT can be interpreted as strengthening people's human capital (skills, knowledge, ability to work, and good health) to increase individual's or collective productivity (Goldin, 2014). Human capital affects the growth of an individual, firms' productivity, and national economy. Specific outcome indicators for the human empowerment of rural smallholder farmers through ICTs include the enhanced ICT literacy and technology skills (eg, use of ICT devices), enhanced leadership skills, and improved program management skills.

### 2.3.4 | Economic dimension

ICTs can produce positive results when they are fully integrated into daily dealing and in service deliveries. Based on benefits of using ICTs, one can claim that ICTs can economically empower an individual based on the following indicators: improved access to markets for different farm produce and enhanced entrepreneurial skills using ICTs, more income from sales of farm produce (lower transaction costs, reduced transport costs, and increased timeliness of sales) (Ahmed, Islam, Hasan, & Rahman, 2006), more investment in agricultural production, and dependence of ICT in daily dealings (McClure, Fraser, Nelson, & Robbins, 2000). Benefits from which indicators can be derived include increased access to markets (Ahmed et al., 2006), and access to business, job and career support-related information. Other indirect benefits are improved farming practices, access to business contacts, and creation of jobs (Ulrich, 2004).

## 2.4 | The technique for measuring informational capability

To measure capabilities is like measuring how people are satisfied with and experience their lives. This has been associated with subjective well-being (SWB) and is defined as *a person's cognitive and affective evaluations of his life* (Diener, Suh, Lucas, & Smith, 1999). The cognitive element refers to what one thinks about his life satisfaction in global terms (life as a whole) and domain terms (in specific areas of life such as work, e.g., in agricultural marketing, relationships) while the affective element refers to emotions, moods, and feelings (Diener et al., 1999; Tinkler & Hicks, 2011). The three components of SWB are *life satisfaction*, *positive affect*, and *negative affect*. The effect is considered positive when the emotions, moods, and feelings experienced are pleasant (eg, joy, elation, affection) (Tinkler & Hicks, 2011). The effect is deemed negative, though, when the emotions, moods and feelings experienced are unpleasant (eg, guilt, anger, shame) (Tinkler & Hicks, 2011). The three SWB components are independent factors that are measured and studied separately (Diener et al., 1999; Tinkler & Hicks, 2011).

To measure SWB, one can use the measures of life satisfaction which are perhaps the most well-known and commonly used evaluative measure because they are seen by policymakers as useful. Evaluative measures ask the respondents to stand back and make an assessment of their life and, in the case of life satisfaction, score their life concerning their satisfaction (Tinkler & Hicks, 2011). Tinkler and Hicks (2011) added that any measure of SWB should have a good theoretical underpinning and that for measures to be useful, they should be relevant to policy needs.



This research has chosen and adopted the measure of life satisfaction for measuring ICs for a good number of reasons. A choice of this method is based on: the concept of ICs is fairly precisely defined in SWB; the phenomenon (capabilities) thus defined can be measured fairly well; there are empirical data on this matter which allow answers to the questions raised, and focusing on an “objective” conception of happiness would involve a priori answers to several of the questions under discussion.

In this research, SWB is measured by responses to the question: *How satisfied/dissatisfied are you (ie, smallholder farmer) with your ICs after initiatives of accessing AMI via technologies like ICTs?* Based on the capability indicators identified in Section 2.3, questions which were expected to be asked to smallholders to measure their ICs were constructed as presented in Table A1. The first column of this table gives the dimensions and the descriptions of the questions, the middle column indicates how responses were coded for the purposes, and the last column gives a variable related to the concept to be measured.

### 3 | DESCRIPTION OF THE CASE STUDY

This research utilized a digital platform NINAYO ([www.ninayo.com](http://www.ninayo.com)) while measuring the ICs of smallholders. NINAYO provides for free the selling and purchase services of agricultural produce to farmers and traders in Tanzania and uses crowd-sourced data to provide actionable business intelligence for its users. Launched in Tanzania in 2015, NINAYO users are typically small-scale farmers with an average annual income of TAS1,274 000 (\$637). Membership to NINAYO is free and thus any farmer is allowed to enroll in the program. Also, farmers are encouraged to register with NINAYO as there are no access charges.

In the agricultural sector, NINAYO solves specific problems including *lack of supply visibility* (buyers do not know what farmers are selling), *lack of demand visibility* (farmers do not know how much buyers are willing to pay), and *lack of logistical coordination* (inefficient transportation sky-rockets costs). By enabling farmers to post their supply of crops, they gain access to a far wider range of demand. Traders, likewise, have a much clearer view of the crops available in their regions. By improving supply visibility, demand visibility, and logistical coordination, more food will go to those in need at a fairer price.

### 4 | RESEARCH METHODOLOGY

The study adopted descriptive research to learn, measure, and understand the ICs of smallholder farmers while accessing AMI when selling their farm crops. Based on the four dimensions of the empowerment framework, capability indicators were identified and included in the study. Data collection methodology involved surveys in different regions using a well-developed questionnaire. For data analysis, measures of life satisfaction were adopted as explained and used in relevant sections. A total of 22 variables were measured on a standard, five-point Likert scale while five variables comprised yes/no answers. Questions developed from the capability indicators plus a small number of socio-demographics comprised the questionnaire that took approximately 30 minutes to complete. To determine the validity of the questionnaire, a presurvey was conducted which involved 20 smallholders in Kilosa, and final adjustments to the questionnaire were made.

#### 4.1 | Research area

The study was conducted in Tanzania mainland and involved 10 districts from six regions. The regions were Arusha (Meru district), Kilimanjaro (Hai and Same districts), Mbeya (Kyela district), Morogoro (Mvomero and Kilosa districts), Ruvuma (Mbinga, Nyasa, and Songea Rural districts), and Songwe (Mbozi district). Table 3 presents the regions and the districts from which respondents were drawn.

#### 4.2 | Sample data collection

For data collection, respondents were identified with the help of two NINAYO field officers who have a database of small-scale farmers and traders from different wards, districts, and regions in Tanzania who access and use NINAYO platform. Also, the NINAYO field officers have established three WhatsApp groups with about 470 members and have registered both farmers and traders for sharing AMI.

With the help of the field officers, farmers were approached, either physically or through phone calls, and requested to fill the questionnaires based on their experience of using the NINAYO program. Respondents were selected randomly based on their availability and readiness to participate in the study, and they filled either an online questionnaire or a printed one. Field officers volunteered to elaborate on some issues to respondents in case of difficulties during the filling of the questionnaires.



### 4.3 | Data analyses

Two techniques were used for data analyses. The descriptive technique was used to present the regions and districts from which respondents were drawn; characteristics of respondents (eg, gender, age, education level, and monthly income); ownership and use of ICT devices by respondents; knowledge of respondents on computer use and the Internet; and access to and use of NINAYO program. With descriptive statistics, the frequencies and their percentages of respondents in a particular item were calculated and tabulated.

The measure of life satisfaction technique using regression analysis was used for measuring the ICs of smallholder farmers in accessing and using AMI. The dependent variable was the measure of satisfaction with ICs and it was presented using the bar chart. The ordinary least squares method was used to determine the correlation between the dependent variable and the capability indicators and formed the first model. The second model involved backward elimination exercise meant to identify and remove capability indicators with insignificant coefficients. To pursue how strong the second model was, three social-demographic variables (gender, age, and education level) were introduced in it (ie, second model) and their impacts learnt. Lastly, further analysis was done on the second model by learning the impact of sub-grouping of respondents based on gender and age.

## 5 | RESULTS

### 5.1 | Respondents and characteristics

Respondents included smallholder farmers drawn from different districts in different regions\* in Tanzania. A total of 355 respondents were involved in this phase of research as summarized in Table 3 and their characteristics presented in Table 4. Males were dominant (64.5%), while females were a few (35.5%), suggesting that in a household, males are more concerned with agricultural marketing of farm produce than women. Results show that majorities were youths with ages between 18 and 43 years, constituting about 99.2%, suggesting that youths are more used to technologies than elders as they volunteered more in filling and completing the questionnaires. Also, results from Table 4 reveal that rural farmers have different levels of education as the sample constituted 19.7% standard seven, 23.4% form fours, 9.9% form sixes, 33.1% certificate holders, and 15.8% diploma holders. Respondents also showed that their monthly incomes range between TAS300,000 (\$150) and TAS800,000 (\$400). All respondents identified agriculture as their main economic activity, though they also indicated engaged in other economic activities. They also agreed that their incomes are greatly contributed by agricultural activities.

### 5.2 | ICT use among respondents

Two sets of questions (Table 5) were asked to learn respondents' knowledge of ICTs. The first assessed the respondents' ownership of ICT devices and use, and the second set of questions targeted to learn the respondents' knowledge of computer use and the Internet. From the two sets, it can be concluded that ownership of ICTs (specifically mobile phones) has increased and even more farmers (99.2%) are owning Internet-enabled mobile phones. Also, a good number of farmers (78.3%) attended computer training and thus are acquainted with email (94.4%), have a good knowledge on computer use (ie, 89.01%), can use Internet search engine such as Google (98.30%), and also can use social networks like Facebook (82.81%). Results indicate that a few respondents are not knowledgeable about computer use and the associated Internet access.

### 5.3 | Access and use of information from NINAYO

Respondents indicated that different ICT devices (eg, mobile phones, PCs, and laptops) are used in accessing AMI from the program NINAYO. Time length of using the program has been varying, ranging from a year to 3 years. Respondents also indicated that they access the program to get buyers of their farm produce. To learn respondents' access, use and experience of the program, various items were assessed as depicted in Table 6. Results show that respondents were able to upload into the program the AMI of their farm produce. Respondents were also able to find, analyse and use AMI relevant to their agricultural marketing dealings. Further, respondents used the AMI they got from the program to negotiate on the prices of their farm produce with traders and buyers. Overall, the use of agricultural information by farmers can influence the selling decision of their agricultural produce and also link them with both distant markets and traders.

**TABLE 3** Districts and regions from which respondents were drawn

Region							Total
District	Arusha	Kilimanjaro	Mbeya	Morogoro	Ruvuma	Songwe	Total
Meru	23						23
Hai		32					32
Same		27					27
Kyela			26				26
Kilosa				43			43
Mvomero				61			61
Mbinga					40		40
Nyasa					32		32
Songea Rural					53		53
Mbozi						18	18
Total (%)	23(6.48)	59(16.62)	26(7.32)	104(29.30)	125(35.21)	18(5.07)	355(100.00)

#### 5.4 | Measuring ICs of small-scale farmers

With this, the target was to understand the satisfaction which can be taken to explain the ICs of an individual smallholder. The first task was to analyze the basic regression model and then to make additional analyses which can address the robustness and subpopulation variation issues. During these analyses, the dependent variable was a *measure of satisfaction with ICs*, distributed as indicated in Figure 1. The rating of satisfaction with ICs is indicated by the numbers 1, 2, 3, 4, and 5. The higher the number, the more satisfied with ICs is the smallholder. During analysis, the second model, obtained from the first model (ie, ordinary least squares regression) was used for further analysis by learning the impact of introducing control variables and subgrouping of respondents into it (ie, second model).

Table 7 presents the first model which depicts the ordinary least squares (OLS) of the dependent variable as a function of 27 capability indicators. The  $R$  value represents a simple correlation and is 0.733, which indicates a high degree of correlation. The  $R^2$  value indicates how much of the total variation in the dependent variable, can be explained by the independent variables. In this case, 53.8% can be explained, which is more than half. The *coefficient*, in the second column, represents values for the regression equation for predicting the dependent variable from the independent variables. The SE values, in the third column, are associated with the coefficients. The *significant value*, in the last column, tests whether a given *coefficient* is significantly different from zero using an  $\alpha$  of .05. The *constant* under the *coefficient* column is the predicted value of the dependent variable when all other variables are zero. Results show that several capability indicators have significant coefficients while others do not have.

The second model (second column of Table 8) depicts the results of backward elimination exercise meant to remove variables with insignificant coefficients. This model shows that 13 capability indicators, drawn from different dimensions of ICs, have coefficients that are significant at the 5% level. These results are consistent with economic literature on poverty, which accepts that different sectors are involved in poverty reduction. Also, the results are consistent with psychological literature on happiness, which accepts that life satisfaction is multidimensional depending on different life domains.

To pursue how strong the second model is (ie, robustness), we test whether the introduction of different variables makes an impact on its results. To learn the impact of other variables on the model, three social-demographic variables (gender, age, and education level) were added as shown in Table 8. The introduction of the variables *gender* and *age* (column 3 of Table 8) causes no capability indicator to become insignificant, which confirms that satisfaction of an individual with his ICs is not related with his gender or age. The control variables gender and age are insignificant, even at the 10% level. However, the introduction of the variable *Education level* into the model (column 4 of Table 8) causes one capability indicator *Ability to analyze information* to become insignificant. The change of significant level as the introduction of another variable (ie, education) confirms the fact that developing individual's ICs depends on his level of education. These findings confirm that ICs depend on the level of education and thus during its measurements, one needs to consider the inclusion of such a variable. It is also interesting to note that, the same variable *Ability to analyze information* ceases to be significant when all three social-demographic variables were combined and introduced in the model (column 5 of Table 8). This combination of variables does not change the conclusion one might draw about the relationship between capabilities and satisfaction. To note, all three control variables (*gender*, *age*, and *education level*) were insignificant, even at the 10% level. Thus, to this point, it can be said that the findings and analyses indicate a degree of robustness in the relationship between satisfaction with ICs and capability indicators.

Sex	R(%R)	Age	R(%R)
Male	229(64.50)	Between 18 and 25 years	87(24.50)
Female	126(35.50)	Between 25+ and 31 years	185(52.10)
Total	355(100.0)	Between 31+ and 37 years	46(13.00)
		Between 37+ and 43 years	34(9.60)
		Between 43+ and 49 years	3(0.80)
Monthly income (TAS)	R(%R)	Total	355(100.00)
Less than 300 000	67(18.87)		
Less than 400 000	104(29.30)	Education level	R(%R)
Less than 500 000	70(19.72)	Standard seven	70(19.7)
Less than 600 000	57(16.06)	Form four	83(23.4)
Less than 700 000	39(10.99)	Form six	35(9.90)
Less than 800 000	12(3.38)	Certificate	111(31.30)
More than 800 000	6(1.69)	Diploma	56(15.80)
Total	355(100.00)	Total	355(100.00)

**TABLE 4** Characteristics of respondents

Abbreviation: R, respondents.

**TABLE 5** Respondents' ownership, use and knowledge on ICTs

Ownership and use of ICT	Yes	No	Knowledge on ICTs	Knowledgeable	Poor	Do not know
	R(%R)	R(%R)		R(%R)	R(%R)	R(%R)
Own mobile phone?	352(99.15)	3(0.85)	Knowledge on computer use	316(89.01)	30(8.45)	9(2.54)
Mobile phone is Internet-enabled?	352(99.15)	3(0.85)	Use of Google to search information	349(98.30)	3(0.85)	3(0.85)
Attended computer training?	278(78.31)	77(21.69)	Use Internet to disseminate information	349(98.30)	3(0.85)	3(0.85)
Can read and send -emails?	335(94.37)	15(4.23)	Use of social networks (eg, Facebook) for communication	294(82.81)	58(16.34)	3(0.85)

Abbreviation: R, respondents.

In his framework, Sen (1985) incorporated measures of individual differences to allow for different personal production functions. One method of achieving this is through the use of person-specific effects, and with this, Ferrer-i-Carbonell and Frijters (2004) suggested for a need of more information on the aspects of persons that influence life satisfaction. With this, Anand et al. (2009) proposed analyses that break down the data by subpopulations. Thus, Tables 9 and 10 present the analyses of the model in Table 8 estimated for two sets of population subsamples. Table 9 presents the results of breaking down the sample by gender, whilst Table 10 summarizes a similar analysis for respondents below and above 29 years of age—the approximate mean age for the overall sample. The groupings based on gender and age may give us a heterogeneous picture of the differences between the subgroups. Some differences are expected as subgroupings reduce the data sample size of each regression.

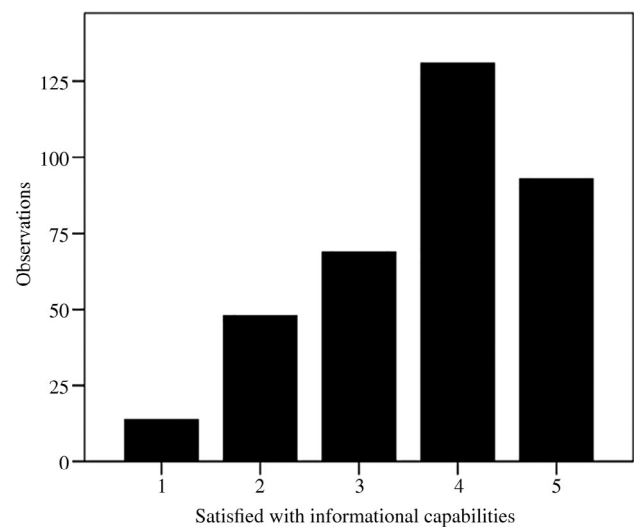
With Table 9, gender roles are not depicted in the results. The three indicators *Enhanced ability to evaluate the quality of information*, *Impression for a better price* and *Improved negotiating skills* have significant coefficients for women and not for men. The *Enhanced ability to evaluate the quality of AMI* for women gives them the ability to negotiate better on the prices of their farm produce. The overall, to women, is the impression that they get better prices for their farm produce. These may suggest that women are more serious with issues of marketing of farm produce. Also, three indicators: *Use the information to negotiate on price*, *Ability to analyze information*, and *Improved communication* are significant for men. Use of information to negotiate on the prices of farm produce by men and their improved ability to analyze such information has effects on their agricultural marketing activities. Among the effects of men is the improved communication of agricultural marketing information. Unfortunately, there are no similarities in indicators for both men and women. Lack of similarity can be explained by a low percentage (36.2%) of the dependent variable for men, which is explained by the independent variables, as compared to 67.1% for women which is explained by the independent variables.

Table 10 gives another attempt to explore more on the sample by breaking it based on age. The findings show that those aged 29 years and below are satisfied with their *Improved communication* and *Knowledge sharing* while those above 29 years are satisfied with *Impression for a better price* and *Increased income* from sales of agricultural produce. As for the case of gender, there is no similarity in indicators for both age groups

**TABLE 6** Access and use of NINAYO program by respondents

Item	Responses	
	Yes R(%R)	No R(%R)
Ability to upload into the program the AMI	334(94.1)	21(5.9)
Ability to find from the program the AMI	341(96.1)	14(3.9)
Ability to get search results	321(90.42)	34(9.58)
Ability to analyze information from the program	331(93.24)	24(6.8)
Use information from the program to negotiate on prices of farm produce	325(91.55)	30(8.45)
Ability to share with others information accessed from the program	329(92.68)	26(7.3)

Abbreviations: AMI, agricultural market information; R, respondents.

**FIGURE 1** Distribution of satisfaction with informational capabilities

though more than half (50%) of the dependent variable is explained by the independent variables in each case. Lack of similarity can be attributed to the low age range (18–49—the result of involving more youths in the study).

## 6 | DISCUSSION

Improving the ICs of smallholder farmers depends on some factors and sectors. Accessibility of ICT devices in rural areas depends on the availability of electricity and network connectivity. Communication companies in Tanzania are expanding their network infrastructure to even in rural areas. Due to the establishment of hospital centers, government offices, schools, etc. in rural areas, the government is working hard to improve rural infrastructures including the provision of electricity. This is enhancing ownership, access and use of ICT devices and the associated use of Internet technology by smallholder farmers in rural areas. We are noticing increased electronic transactions even in rural areas such as mobile money transfer, Internet banking and even access and use of AMI among smallholders. In this way, ICs of smallholder farmers may be improved to become active market participants.

Satisfaction with ICs has indicated to depend on educational level and the higher the education level the more analysis can be done by an individual. As a government strategy of educating its citizens, primary schools have been established in each village while each ward as a secondary school. Thus, much Tanzanians are joining secondary schools and thereafter are joining high school or study certificate or diploma course. The number of universities has also increased thus many Tanzanians are studying degree programs. Due to the low employment rate, majorities are joining the agricultural sector after their studies. The educated farmers are expected to conduct modern agriculture and thus depend much on information during different activities in the agricultural value chain. Much dependence on ICT technology may improve the ICs of farmers, including smallholders.

Variable	Coefficient	SE	Sign. Value
Constant	2.209	0.357	0.000
Access purpose	-0.171	0.191	0.372
Ability to get search results	-0.182	0.258	0.482
Ability to analyze information	0.227	0.190	0.232
Ability to share information	-0.302	0.300	0.315
Use information to negotiate on price	0.920	0.273	0.001
Enhanced ability to evaluate the quality of information	-0.694	0.186	0.000
Enhanced Internet knowledge and skills	4.596	0.840	0.000
Confidence enhancement	-4.960	0.750	0.000
Sell produce at different markets	0.175	0.209	0.403
Sell produce to different buyers	0.911	0.370	0.014
Impression for better price	-1.088	0.272	0.000
Improved negotiating skills	0.583	0.186	0.002
Sales decision making	0.800	0.286	0.006
Enhanced entrepreneurial skills	-0.840	0.425	0.049
Empowerment in agricultural marketing	-0.247	0.367	0.501
Improved communication	-0.376	0.065	0.000
Improved participation in Community activities	-0.027	0.257	0.917
Experience sharing	0.548	0.255	0.033
Knowledge sharing	1.227	0.331	0.000
Sense of inclusion in the modern	-1.157	0.368	0.002
Easy to market farm produce	-0.188	0.417	0.653
Ability to access different markets	-0.450	0.435	0.302
Low transaction costs	-0.689	0.368	0.062
Reduced transportation costs	2.836	0.774	0.000
Increased income	-0.858	0.315	0.007
Encouraged use of ICTs in delivering services	0.446	0.460	0.333
More investment in agricultural production	-0.701	0.429	0.103
Observations	355		
R	0.733		
R <sup>2</sup>	0.538		
Adjusted R <sup>2</sup>	0.500		
Log likelihood	-361.698		

**TABLE 7** Regression of satisfaction with informational capabilities on capability indicators

Satisfactions with ICs have shown to depend on different dimensions. It is the role of the individual, the government and of the well-wishers to help smallholders to improve different aspects of each dimension (informational, psychological, social, and economic). This will help smallholders to improve both their access to information and ICs, to have self-reflection and improve their problem-solving capacity, to strengthen their human capital (skills, knowledge, ability to work, and good health), and to enhance their capacity to interact with the market. The ultimate is to ensure smallholder farmers become active market participants.

Improving the ICs of smallholder farmers can be considered as empowering them in agricultural activities. Empowered smallholder may engage in the modern agricultural practice for more production. In this way, the economies and livelihood of smallholders may improve, the agricultural sector may improve as well as the economy of the country. As of this, the sector may attract many Tanzanians including youths and the educated ones.

In its agricultural marketing policy, the Tanzania government recognized agricultural marketing information (inputs and outputs) as vital in the development of the agricultural sector as it provides signals to stakeholders to maximize their efforts and help on how best to allocate resources (URT, 2008). The policy acknowledges that the agricultural marketing system at the national level is inadequate and highly fragmented. In its statement, the policy recognizes farmers' organizations, groups, and cooperative societies, and public-private-partnership in strengthening

**TABLE 8** Regression of satisfaction with informational capabilities, with gender, age, and education level controls

Variable/Indicator	Capability			Capabilities and gender and age			Capabilities and education			Capabilities and gender, age and education		
	Coefficient	SE	Significant value	Coefficient	SE	Significant value	Coefficient	Std. error	Significant value	Coefficient	SE	Significant value
Access purpose	-0.437	0.141	0.002	-0.421	0.147	0.004	-0.421	0.142	0.003	-0.396	0.149	0.008
Ability to analyze information	0.400	0.204	0.050	0.437	0.206	0.034	0.382	0.205	0.064	0.415	0.207	0.055
Use information to negotiate on price	0.596	0.164	0.000	0.581	0.166	0.001	0.591	0.164	0.000	0.573	0.167	0.001
Enhanced ability to evaluate the quality of information	-0.598	0.210	0.005	-0.529	0.215	0.014	-0.630	0.214	0.003	-0.564	0.217	0.010
Enhanced Internet knowledge and skills	1.841	0.332	0.000	1.657	0.351	0.000	1.851	0.333	0.000	1.656	0.351	0.000
Confidence enhancement	-1.957	0.343	0.000	-1.851	0.350	0.000	-1.953	0.343	0.000	-1.836	0.350	0.000
Sell produce to different buyers	0.504	0.221	0.023	0.524	0.221	0.018	0.541	0.226	0.017	0.570	0.226	0.012
Impression for better price	-0.771	0.204	0.000	-0.867	0.210	0.000	-0.757	0.205	0.000	-0.856	0.210	0.000
Improved negotiating skills	0.734	0.198	0.000	0.831	0.205	0.000	0.708	0.201	0.000	0.805	0.206	0.000
Improved communication	-0.298	0.098	0.002	-0.333	0.100	0.001	-0.312	0.099	0.002	-0.351	0.102	0.001
Knowledge sharing	0.745	0.177	0.000	0.760	0.178	0.000	0.745	0.177	0.000	0.759	0.178	0.000
Increased income	-0.495	0.186	0.008	-0.460	0.188	0.015	-0.499	0.187	0.008	-0.464	0.188	0.014
More investment in agricultural production	0.347	0.181	0.045	0.349	0.181	0.041	0.364	0.182	0.046	0.372	0.183	0.043
Gender				0.194	0.127	0.128				0.211	0.128	0.101
Age				-0.097	0.066	0.145				-0.099	0.066	0.137
Age <sup>2</sup>				0.001	0.001	0.161				0.002	0.001	0.151
Education							-0.020	0.025	0.421	-0.025	0.025	0.316
Observations	355			355			355			355		
R <sup>2</sup>	0.525			0.530			0.526			0.532		
Adjusted R <sup>2</sup>	0.507			0.508			0.507			0.508		
Log likelihood	-370.02			-365.03			-369.6			-364.2		

**TABLE 9** Model estimation for subsamples by gender

Variable/Indicator	Female				Male			
	OLS	SE	P value	Ordered logit P value	OLS	SE	P value	Ordered logit P value
Access purpose	-0.018	0.236	0.938	0.029	-2.313	0.679	0.001	0.070
Ability to analyze information	0.253	0.374	0.500	0.470	1.093	0.454	0.017	0.020
Use information to negotiate on price	0.447	0.258	0.086	0.000	1.408	0.411	0.001	0.003
Enhanced ability to evaluate the quality of information	-0.612	0.285	0.034	0.024	-0.278	0.474	0.559	0.570
Enhanced Internet knowledge and skills	-0.345	0.543	0.526	0.000	1.731	0.584	0.003	0.972
Confidence enhancement	0.116	0.557	0.835	0.000	-2.145	0.534	0.000	0.971
Sell produce to different buyers	0.262	0.360	0.467	0.103	0.320	0.522	0.541	0.260
Impression for better price	-0.961	0.236	0.000	0.000	-0.705	0.379	0.064	0.060
Improved negotiating skills	0.815	0.257	0.002	0.001	0.971	0.442	0.029	0.080
Improved communication	-0.322	0.485	0.508	0.028	-0.338	0.125	0.008	0.009
Knowledge sharing	0.451	0.455	0.323	0.000	0.728	0.387	0.061	0.004
Increased income	-0.444	0.381	0.246	0.222	-0.569	0.347	0.102	0.189
More investment in agricultural production	0.942	0.322	0.004	0.186	0.572	0.384	0.138	0.651
Age	-0.331	0.115	0.005	0.028	-0.109	0.099	0.274	0.665
Age <sup>2</sup>	0.005	0.002	0.005	0.030	0.002	0.002	0.303	0.699
Education	0.085	0.034	0.015	0.759	-0.029	0.035	0.411	0.139
Observations	126				229			
R <sup>2</sup>	0.671				0.362			
Adjusted R <sup>2</sup>	0.623				0.314			
Log likelihood	-98.168				-241.69			

Abbreviation: OLS, ordinary least squares.

collection, analysis, storage and dissemination of AMI and in undertaking marketing research. The policy also insists on the promotion of the use of ICT in agricultural marketing. This can also be considered as a strategy of developing ICs of farmers including rural smallholders.

Base on the results, several comments can be drawn. Firstly, this study has focused on the significance of coefficients and the  $R^2$  values which determine the values of the dependent variable explained by independent variables. Some researchers have commented on the good values for  $R^2$ . In general, the higher the  $R^2$  value, the better the model that fits the data. But care should be taken as  $R^2$  value does not indicate whether a model is adequate. You can have low  $R^2$  value for a good model, or a high  $R^2$  value for a model that does not fit the data. Sometimes, low values for  $R^2$  are desirable. Fields, such as psychology, which attempt to predict human behavior have lower  $R^2$  values than 50%. Some items in Table 3 are reflected in works related to psychology and thus can partly constitute satisfaction.

The second comment is about how capability (ie, informational) can lead to satisfaction and ultimately to happiness. The list of indicators in Table 3 has been statistically trimmed down to 13 items. Upon the introduction of control variables, 13 items have significant coefficients. Though, some items in the subsamples in the population were statistically not significant. Both the initial and final lists contain items from different domains and thus we can consider satisfaction as a multi-dimension concept. To build the ICs of an individual, different sectors are involved. We have seen how the introduction of the control variable *education* in the second model changed an item, *ability to analyse information*, to be insignificant. Individual farmers must invest more in education to build and enhance their ICs.

Lastly, breaking the sample into subsamples allows for deeper exploration and analysis. This study has attempted to break the sample based on gender and age, though other options are available. Settings can be done to break the sample based on education level, income and even based on main economic activities. In all these subsampling, the target should be to allow further analysis and investigation to come out with finer results and conclusion.

## 7 | IMPLICATIONS FOR THEORY AND PRACTICES

Within this study, the concept of ICs has focused on the process of developing the capabilities of an individual. There are also some important insights from this work that can contribute to clarifying the concept and meaning of ICs. Other areas and contexts can also contribute to this



**TABLE 10** Model estimation for subsamples by age group

Variable/Indicator	Aged 29 years and below				Aged above 29 years			
	OLS	SE	P value	Ordered logit P value	OLS	SE	P value	Ordered logit P value
Access purpose	-0.296	0.258	0.253	0.175	-1.333	0.410	0.001	0.923
Ability to analyze information	0.528	0.315	0.095	0.025	0.756	0.501	0.134	0.012
Use information to negotiate on price	0.321	0.228	0.161	0.164	1.360	0.341	0.000	0.382
Enhanced ability to evaluate the quality of information	-0.809	0.364	0.027	0.099	0.611	0.598	0.309	0.104
Enhanced Internet knowledge and skills	1.345	0.975	0.169	0.124	1.169	0.650	0.075	0.983
Confidence enhancement	-1.265	1.030	0.221	0.096	-4.407	1.087	0.000	0.987
Sell produce to different buyers	0.434	0.339	0.201	0.211	3.401	1.310	0.011	0.315
Impression for better price	-0.343	0.350	0.328	0.125	-1.069	0.421	0.012	0.041
Improved negotiating skills	0.621	0.322	0.055	0.002	1.003	0.401	0.014	0.067
Improved communication	-0.396	0.129	0.002	0.006	-0.280	0.176	0.114	0.992
Knowledge sharing	0.531	0.256	0.039	0.009	0.516	0.545	0.346	0.986
Increased income	-0.502	0.299	0.095	0.039	-0.930	0.357	0.010	0.012
More investment in agricultural production	0.432	0.239	0.072	0.021	0.067	0.397	0.867	0.689
Age	0.147	0.357	0.682	0.634	-0.572	0.354	0.109	0.002
Age <sup>2</sup>	-0.003	0.007	0.695	0.663	0.008	0.005	0.106	0.002
Education	-0.095	0.034	0.006	0.001	0.095	0.039	0.017	0.286
Observations	213				142			
R <sup>2</sup>	0.537				0.618			
Adjusted R <sup>2</sup>	0.499				0.569			
Log likelihood	-220.61				-115.40			

Abbreviation: OLS, ordinary least squares.

concept. First, ICs can be associated with an organization. With this, an organization develops the capability of collecting information, processing, using it for its benefit and improvement and even distributing such information. Also, groups of farmers such as farmers' associations and cooperatives can build their ICs for the same purpose. In terms of development, then, improving capabilities can be seen as an active process of engagement in the social world.

Second, there has been little discussion in development literature about the relationship between improved ICs and development or efficacy. Much of the responses in this study have attributed the development to an individual developing his ICs. Improved ICs has been attributed to more gain, and both personal and community development. However, the belief of people in their capabilities and unique personal characteristics can help foster confidence in their activities including agricultural marketing. Also, interdependence is an important part of the ICs development process as it enables interaction among people.

Third and last, this study confirms the importance of ICT technology in developing the ICs of the people. Capability development is regarded as a result of accessing and using technology and no one becomes empowered on his own. Rather, the informational, psychological, social, and economic contexts were critical to understanding the changes that individuals experienced during ICs development. However, a dilemma arises as the development of individual ICs is not certain that it can lead to the development of community ICs.

While several important learning about the concept of ICs has emerged from this study, continued work on concept clarification is needed. Careful attention needs to be paid to the ICs concept and its meaning so that it can well be practiced. Thus, conceptual work in relationship with empirical research can be done to understand more on the ICs concept by considering more dimensions. Also, a study on the contribution of improved ICs to development can be done in the case with smallholders. The research presented here in many ways reflects a substantial struggle for smallholders to be successful in agricultural marketing of their crops. The process of developing capabilities involves continual struggle in the agricultural value chain with the ultimate of abandoning to develop/improve their ICs. Some of these principles include:

- Institutions, both public and private, should encourage the use of technologies in services deliveries.
- Institutions (public, private) should encourage or support the development of platforms that facilitate the provision of information to citizens, especially AMI to farmers.

- For ownership to occur, farmers should also be allowed to supply their AMI to the platforms. This will encourage collaboration among farmers and owners of platforms.
- Institutions (public, private) should work to eliminate barriers that hinder access and use of AMI by smallholder farmers.
- Institutions (public, private) should provide training on technology use to citizens including farmers.

Provision of education (ie, enrolling children in primary schools, encouraging children to join secondary schools, providing adult education) can also be considered as a means of improving the use of technologies. With this, more schools (primary, secondary) need to be established, and ICT be mainstreamed in teaching and services deliveries. However, we are noticing some developments in Tanzania, for example, primary schools are being established in each village, secondary schools are being established in each ward, more universities are being established and even we are noticing the use of electronic machines in tax collection.

## 8 | SUMMARY, CONCLUSION, AND RECOMMENDATIONS

To summarize, this research was motivated by much interest in the application of CA to measuring ICs of smallholder farmers accessing AMI via ICTs. Capability indicators were developed based on the dimensions of social, informational, psychological, and economic. Results depict that satisfaction of farmers with information is highly multivariate concerning capabilities and to improve the ICs of the individual farmer, all dimensions need to be considered. However, much work can be done as researchers can develop indicators that require the attention of policymakers and development partners, and also work more on the best ways of generating capability indicators and of generalizing the techniques of measuring the capabilities. However, based on the study sample results, the following **generalization** can be drawn out in Tanzania and other developing countries: access and use of information (eg, AMI) should be promoted and encouraged as they build the ICs of farmers and motivate them toward their agricultural activities; different sectors be involved in developing ICs of farmers; and lastly, education development be encouraged as the result has shown the dependency of ICs on education.

To conclude, CA remains a useful approach to developing an individual's capacity and capability to carry on his undertakings. With this, ICs require the development of different perspectives of an individual to be informational competent. The different perspectives take in different actors (eg, governments, private sector, communities) and the early identified dimensions. The overall is to bring satisfaction to an individual farmer by developing his ICs. One should note that there are gaps between the two (capability and satisfaction) and this study was an attempt to build bridges between such two sides.

Access to markets for their farm produce by smallholders in Tanzania remains the issue that attracts the attention of researchers, politicians and government. It is anticipated that improved access to markets can boost the economies of an individual farmer, of rural areas and the country at large. Target should be access to district, regional, national and even export markets.

Based on the research findings, some recommendations can be suggested. Governments in developing countries should continue to invest more in education to ensure citizens are literate and thus improve their agricultural activities. Farmers, educated and thus literate, can engage themselves in modern agriculture and thus improve their agricultural production. Literate farmers can embrace modern technologies in their life for improved livelihood.

Government and development partners are also tasked to ensure infrastructures are established in rural areas that support agricultural marketing activities. For rural areas to be accessible, rural roads need to be constructed, and rural areas are supplied with electricity and be connected with communication infrastructure. This may ensure physical access to markets by even farmers.

Lastly, it is recommended that online services and marketing be encouraged in developing countries. This can link sellers and buyers while assuring the visibility and availability of markets for services and products. With this, farmers can access traders, distant markets and even export markets. This is a good strategy of empowering smallholders to access export markets. The ultimate is the improved livelihood of farmers and rural communities, agricultural sector development, and the improved economies of the country at large.

### ORCID

Mawazo M. Magesa  <https://orcid.org/0000-0003-3852-5120>

### ENDNOTE

\*Tanzania is divided into administrative areas known as regions and a region is also divided into a number of administrative areas known as districts. Number of districts varies in each region.

### REFERENCES

Ahmed, A., Islam, D., Hasan, A. R., & Rahman, N. J. (2006). *Measuring the impact of ICT on women in Bangladesh*. In *Proceedings of the International Conference on E-Learning, E-Business, Enterprise Information Systems, E-Government, & Outsourcing, Las Vegas, Nevada, USA, June 26–29, 2006*. CSREA Press 2006, ISBN 1-60132-006-X, (pp. 180-185). Retrieved from <http://www.academia.edu/download/32247017/EEE4168.pdf>

- Alkire, S. (2005a). Subjective quantitative studies of human agency. *Social Indicators Research*, 74, 217–260. <https://doi.org/10.1007/s11205-005-6525-0>
- Alkire, S. (2005b). *Valuing freedoms: Sen's capability approach and poverty reduction*. Oxford: Oxford University Press. Retrieved from <https://ideas.repec.org/b/oxp/obooks/9780199283316.html>
- Anand, P., Hunter, G., Carter, I., Dowding, K., Guala, F., & Van Hees, M. (2009). The development of capability indicators. *Journal of Human Development and Capabilities*, 10, 125–152. <https://doi.org/10.1080/14649880802675366>
- Anand, P., Santos, C., & Smith, R. (2007). *The measurement of capabilities*. *Open discussion papers in economics*, No. 67. The Open University, Economics Department, Milton Keynes. Retrieved from <http://hdl.handle.net/10419/65692>
- Atkinson, T., Cantillon, B., Marlier, E., & Nolan, B. (2002). *Social indicators: The EU and social inclusion*. Oxford, England: Oxford University Press. <http://doi.org/10.1093/0199253498.001.0001>
- Avilés, J. M., Larghi, S. B., & Aguayo, M. A. M. (2016). The informational life of the poor: A study of digital access in three Mexican towns. *Telecommunications Policy*, 40, 661–672. <https://doi.org/10.1016/j.telpol.2015.11.001>
- Bebbington, A. (1999). Capitals and capabilities: A framework for analyzing peasant viability, rural livelihoods and poverty. *World Development*, 27(12), 2021–2044. [https://doi.org/10.1016/S0305-750X\(99\)00104-7](https://doi.org/10.1016/S0305-750X(99)00104-7)
- Behrens, S. J. (1994). A conceptual analysis and historical overview of information literacy. *College and Research Libraries*, 55, 309–322. [https://doi.org/10.5860/crl\\_55\\_04\\_309](https://doi.org/10.5860/crl_55_04_309)
- Burchinal, L. G. (1976). *The communications revolution: America's third century challenge*. In *The future of organizing knowledge. Paper presented at the Texas A&M University Library's Centennial Academic Assembly, September 24, Texas*.
- Chiappero-Martinetti, E. (2005). Unpaid work and household well-being: A non-monetary assessment. In A. Picchio (Ed.), *Unpaid work and the economy: A gender analysis of the standards of living* (pp. 135–169). New York: Routledge.
- Chiappero-Martinetti, E., & Venkatapuram, S. (2014). The capability approach: A framework for population studies. *African Population Studies*, 28, 708–720. <https://doi.org/10.11564/28-2-604>
- Christens, B. D. (2012). Toward relational empowerment. *American Journal of Community Psychology*, 50, 114–128. <https://doi.org/10.1007/s10464-011-9483-5>
- Diener, E., Suh, E. M., Lucas, R. E., & Smith, H. L. (1999). Subjective well-being: Three decades of progress. *Psychological Bulletin*, 125, 276–302.
- Ferrer-i-Carbonell, A., & Frijters, P. (2004). How important is methodology for the estimates of the determinants of happiness? *Economic Journal*, 114, 641–659.
- Freire, P. (1972). *Pedagogy of the oppressed (1968)*. Trans. Myra Bergman Ramos. New York, NY: Herder.
- Gigler, B. S. (2014). Informational capabilities: The missing link for understanding the impact of ICT on development. In B.-S. Gigler & S. Bailur (Eds.), *Closing the feedback loop: Can technology bridge the accountability gap?* (Vol. 17, pp. 17–42). Washington, DC: The World Bank. <https://doi.org/10.1596/978-1-4648-0191-4>
- Goldin, C. (2014). Human capital. In M. Hauptert & C. Goldin (Eds.), *Handbook of cliometrics* (pp. 1–27). Berlin/Heidelberg: Springer. <https://doi.org/10.1007/978-3-642-40406-1>
- Grant, A. M., Franklin, J., & Langford, P. (2002). The self-reflection and insight scale: A new measure of private self-consciousness. *Social Behavior and Personality: An International Journal*, 30, 821–835. <https://doi.org/10.2224/sbp.2002.30.8.821>
- Grunfeld, H. (2011). *The contribution of information and communication technologies for development (ICT4D) projects to capabilities, empowerment and sustainability: A case study of iREACH in Cambodia*. Melbourne, Australia: Victoria University, Retrieved from [http://vuir.vu.edu.au/19359/1/Helena\\_Grunfeld.pdf](http://vuir.vu.edu.au/19359/1/Helena_Grunfeld.pdf)
- Hatakka, M., & De, R. (2011). *Development, capabilities and technology: An evaluative framework. Paper presented at the IFIP WG9. 4: 11th international conference on social implications of computers in developing countries, Kathmandu, Nepal, 22–25 May 2011*. Retrieved from <http://orcid.org/0000-0003-1076-3442>
- Ismail, A. I., Rose, R. C., Uli, J., & Abdullah, H. (2012). The relationship between organisational resources, capabilities, systems and competitive advantage. *Asian Academy of Management Journal*, 17, 151–173. <https://core.ac.uk/download/pdf/89468776.pdf>
- Ismail, I. J., Srinivas, M., & Tundui, H. (2015). Transaction costs and market participation decisions of maize small holder farmers in Dodoma region, Tanzania. *Global Journal of Biology Agriculture and Health Sciences*, 4(2), 12–20.
- Kieffer, C. H. (1984). Citizen empowerment: A developmental perspective. *Prevention in Human Services*, 3, 9–36. [https://doi.org/10.1300/J293v03n02\\_03](https://doi.org/10.1300/J293v03n02_03)
- Kivunike, F. N. (2014). Towards an ICT4D evaluation model based on the capability approach. *International Journal on Advances in ICT for Emerging Regions*, 7(1), 1–15. <http://doi.org/10.4038/icter.v7i1.7152>
- Kuklys, W. (2005). *Amartya Sen's capability approach: Theoretical insights and empirical applications*. Berlin/Heidelberg: Springer. <https://doi.org/10.1007/3-540-28083-9>
- Leung, L. (2009). User-generated content on the internet: An examination of gratifications, civic engagement and psychological empowerment. *New Media & Society*, 11, 1327–1347. <https://doi.org/10.1177/1461444809341264>
- Li, T., Van Heck, E., & Vervest, P. (2009). Information capability and value creation strategy: Advancing revenue management through mobile ticketing technologies. *European Journal of Information Systems*, 18, 38–51. <https://doi.org/10.1057/ejis.2009.1>
- Magesa, M. M., Michael, K., & Ko, J. (2014). Access to agricultural market information by rural farmers in Tanzania. *International Journal of Information and Communication Technology Research*, 4, 264–273.
- Maier, S. F., & Seligman, M. E. (1976). Learned helplessness: theory and evidence. *Journal of Experimental Psychology: General*, 105, 3–46. <https://doi.org/10.1037/0096-3445.105.1.3>
- Marchand, D. A., Kettinger, W. J., & Rollins, J. D. (2000). Information orientation: People, technology and the bottom line. *Sloan Management Review*, 41, 69–80.
- McClure, C. R. (1994). Network literacy: A role for libraries? *Information Technologies and Libraries*, 13(2), 115–125.
- McClure, C. R., Fraser, B. T., Nelson, T. W., & Robbins, J. B. (2000). *Economic benefits and impacts from public libraries in the state of Florida, final report*. Tallahassee: State Library of Florida, Division of Library and Information Services, Florida State University.
- Molony, T. (2008). Running out of credit: The limitations of mobile telephony in a Tanzanian agricultural marketing system. *The Journal of Modern African Studies*, 46(4), 637–658.
- Nussbaum, M., & Sen, A. (1993). *The quality of life*. Oxford: Clarendon Press.

- Otekunrin, O. A., Momoh, S., & Ayinde, I. A. (2019). Smallholder farmers' market participation: Concepts and methodological approach from sub-Saharan Africa. *Current Agriculture Research Journal*, 7(2), 139–157.
- Pamungkas, A. S. (2018). Informational capability and the development of village information system and village owned-Enterprises in Four Villages in Java. *Jurnal Pemikiran Sosiologi*, 5(2), 54–79.
- Robeyns, I. (2005). Selecting capabilities for quality of life measurement. *Social Indicators Research*, 74, 191–215. <https://doi.org/10.1007/s11205-005-6524-1>
- Robeyns, I. (2006). The capability approach in practice. *Journal of Political Philosophy*, 14, 351–376. <https://doi.org/10.1111/j.1467-9760.2006.00263.x>
- Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis. IDS working paper 72. Brighton, England: Institute of Development Studies. <http://opendocs.ids.ac.uk/opendocs/handle/123456789/3390>
- Sen, A. (1985). Well-being, agency and freedom: The Dewey lectures 1984. *The Journal of Philosophy*, 82(4), 169–221.
- Sen, A. (1987). *The standard of living*. Cambridge, England: Cambridge University Press.
- Sen, A. (1992). *Inequality reexamined*. New York: Oxford University Press Inc.
- Sen, A. (1997). Human capital and Human capability. *World Development*, 25(12), 1959–1961.
- Sen, A. (2004). Capabilities, lists, and public reason: Continuing the conversation. *Feminist Economics*, 10(3), 77–80. <https://doi.org/10.1080/1354570042000315163>
- Sen, A. K. (1999). *Development as freedom*. New Delhi: Oxford University Press.
- Spreitzer, G. M. (1996). Social structural characteristics of psychological empowerment. *Academy of Management Journal*, 39, 483–504. <https://doi.org/10.5465/256789>
- Thomas, K. W., & Velthouse, B. A. (1990). Cognitive elements of empowerment: An “interpretive” model of intrinsic task motivation. *Academy of Management Review*, 15, 666–681. <https://doi.org/10.5465/amr.1990.4310926>
- Tinkler, L., & Hicks, S. (2011). *Measuring subjective well-being*. Office for National Statistics, London, England. Retrieved from <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.366.3593&rep=rep1&type=pdf>
- Ulrich, P. (2004). Poverty reduction through access to ICTs in rural areas: An analysis of the survey results from the social impact assessment conducted by the Chinese Ministry of Science & Technology and the UNDP: With recommendations on issues of future sustainability and household participation. *The Electronic Journal of Information Systems in Developing Countries*, 16(1), 1–38. <https://doi.org/10.1002/j.1681-4835.2004.tb00108.x>
- Unterhalter, E. (2005). Global inequality, capabilities, social justice: The millennium development goal for gender equality in education. *International Journal of Educational Development*, 25, 111–122. <https://doi.org/10.1016/j.ijedudev.2004.11.015>
- URT. (2008). *Agricultural marketing policy*. Dar es Salaam, Tanzania: Ministry of Industry, Trade and Marketing.
- Van Ootegem, L., & Verhofstadt, E. (2012). Using capabilities as an alternative indicator for well-being. *Social Indicators Research*, 106, 133–152. <https://doi.org/10.1007/s11205-011-9799-4>
- Vaughan, D. (2011). The importance of capabilities in the sustainability of information and communications technology programs: The case of remote indigenous Australian communities. *Ethics and Information Technology*, 13, 131–150. <https://doi.org/10.1007/s10676-011-9269-3>
- Yeung, P., & Breheny, M. (2016). Using the capability approach to understand the determinants of subjective well-being among community-dwelling older people in New Zealand. *Age and Ageing*, 45, 292–298. <https://doi.org/10.1093/ageing/afw002>
- Zimmerman, M. A. (1995). Psychological empowerment: Issues and illustrations. *American Journal of Community Psychology*, 23, 581–599. <https://doi.org/10.1007/BF02506983>

## AUTHOR BIOGRAPHIES



**Mawazo M. Magesa** received a PhD in Information and Communication Sciences and Engineering from The Nelson Mandela African Institution of Science and Technology, Arusha, Tanzania, in 2019. He also received his master's degree in Computer Science from the University of Dar es Salaam, Tanzania, in 2010. He received his bachelor's degree in Computer Engineering and Information Technology from the University of Dar es Salaam, Tanzania, in 2004. Magesa is currently a lecturer in Computer Science studies at the Centre for Information and Communication Technologies of the Sokoine University of Agriculture, Tanzania. His research areas include ICT for development, data and big data analytics.



**Kisangiri Michael** has been working with NM-AIST as a lecturer then senior lecturer since December 2011. Before joining NM-AIST he worked with Dar-es-Salaam Institute of Technology (DIT), Tanzania. He is PhD holder in the field of Telecommunications which he graduated

from the Wroclaw University of Technology, Poland. He has successfully managed dozens of researches in the level of MSc degree and several in the level PhD degree. He possesses good knowledge in Artificial intelligence, Antenna design, and wireless communication systems. His research interest is in Machine learning, IoT, and MIMO antenna.



**Jesuk Ko** received his PhD degree in Systems Engineering from Royal Melbourne University of Technology (RMIT) in Australia, and his MEngSc degree in Industrial Engineering from Pohang University of Science and Technology (POSTECH) in Korea, respectively. He is currently a visiting professor in the Department of Industrial Engineering at Universidad Mayor de San Andres (UMSA) in Bolivia. Also, he is an adjunct professor of the Nelson Mandela African Institute of Science and Technology (NM-AIST) in Tanzania. He was a visiting scholar in the Department of Engineering at the Australian National University (ANU) for the period of September 1, 2008 to August 31, 2009. He was also a Head of Department (HOD) in the Department of Industrial and Information Engineering at Gwangju University. He served as a full-time lecturer, Graduate School of Engineering (GSE) at RMIT. He has been involved in Paper Review Committees as an Editorial Board Member of the prestigious international journals such as JHM, AJOR, APMR, IJPE, and others. He is a principal consultant with the Korea Chamber of Commerce & Industry (KCCI) and a Certified Associate of the Korean TOC Academy (KTA). At present, he is a senior organizing member of the Korean Theory of Constraints Association (TOC Korea), an academic trustee member of the Korean Society of Supply Chain Management (KSCM), and a member of the Korean Institute of Industrial Engineers (KIIE). He also is a member of the Korean Council on Systems Engineering (KCOSE). His research interests include related topics of systems engineering, AI applications in decision analysis and problem-solving issues, healthcare management systems, and health informatics, etc.

**How to cite this article:** Magesa MM, Michael K, Ko J. Access and use of agricultural market information by smallholder farmers: Measuring informational capabilities. *Electron j inf syst dev ctries*. 2020;86:e12134. <https://doi.org/10.1002/isd2.12134>

## APPENDIX A

**TABLE A1** Capabilities, survey questions, and variables

Dimension		
Description	Survey questions	Variable
Informational		
To recognize information needs	Do you access the program with the purpose of getting AMI for the farm produce you want to sell? Yes = 1, No = 0	Access purpose
Being able to find and locate information	Were you able to get the AMI you were searching for in the program? Yes = 1, No = 0	Ability to get search results
Being able to analyze and interpret information	Were you able to analyze and interpret the AMI you got from the program? Yes = 1, No = 0	Ability to analyze information
Being able to share information	Did you share with others the AMI you got from the program? Yes = 1, No = 0	Ability to share information
Make effective use of information	Did you use the AMI you got from the program to negotiate for the price of the produce you wanted to sell? Yes = 1, No = 0	Use information to negotiate on price
Knowledge in agricultural marketing improved	Please rate how the program has enhanced your ability to find, locate, and evaluate the quality of AMI you are interested with. <i>Strongly agree</i> = 5 <i>Agree</i> = 4 <i>Undecided</i> = 3 <i>Disagree</i> = 2 <i>Strongly disagree</i> = 1	Enhanced ability to evaluate the quality of information

(Continues)



TABLE A1 (Continued)

Dimension		
Description	Survey questions	Variable
Knowledge in Internet search improved	Please rate how generally the program has enhanced your knowledge and skills in searching, locating and using information in the Internet. <i>Strongly agree</i> = 5 <i>Agree</i> = 4 <i>Undecided</i> = 3 <i>Disagree</i> = 2 <i>Strongly disagree</i> = 1	Enhanced Internet knowledge and skills
Enhanced confidence during the selling of produce	Please rate how the program has enhanced your confidence with the information you have during the selling of your farm produce. <i>Strongly enhanced</i> = 5 <i>Enhanced</i> = 4 <i>Undecided</i> = 3 <i>Not enhanced</i> = 2 <i>Not enhanced at all</i> = 1	Confidence enhancement
Being able to sell at different markets	Please rate how the program has enabled you to sell your farm produce at different markets depending on the information you have. <i>Strongly enabled</i> = 5 <i>Enabled</i> = 4 <i>Undecided</i> = 3 <i>Not enabled</i> = 2 <i>Not enabled at all</i> = 1	Sell produce at different markets
Being able to sell to different buyers	Please rate how the program has enabled you to sell your farm produce to different buyers depending on the information you have. <i>Strongly enabled</i> = 5 <i>Enabled</i> = 4 <i>Undecided</i> = 3 <i>Not enabled</i> = 2 <i>Not enabled at all</i> = 1	Sell produce to different buyers
Feeling of receiving better price	Please rate your impression whether the program has enabled you to receive better prices for your farm produce. <i>Strongly impressed</i> = 5 <i>Impressed</i> = 4 <i>Undecided</i> = 3 <i>Not impressed</i> = 2 <i>Not impressed at all</i> = 1	Impression for better price
Being able to negotiate the prices	Please rate your feeling whether your price negotiating skills has improved through the program. <i>Strongly improved</i> = 5 <i>Improved</i> = 4 <i>Undecided</i> = 3 <i>Not improved</i> = 2 <i>Not improved at all</i> = 1	Improved negotiating skills
Being able to make sales decision	Please indicate to what extent you agree or disagree with the following statement: Based on the information you get from the program, you can decide whom to sell to, where to sell, and the time to sell your farm produce. <i>Strongly agree</i> = 5 <i>Agree</i> = 4 <i>Undecided</i> = 3 <i>Disagree</i> = 2 <i>Strongly disagree</i> = 1	Sales decision making
<b>Social</b>		
Being able to share entrepreneur skills	Please indicate how the program has enhanced your interaction with others for sharing entrepreneurial skills. <i>Strongly enhanced</i> = 5 <i>Enhanced</i> = 4 <i>Undecided</i> = 3 <i>Not enhanced</i> = 2 <i>Not enhanced at all</i> = 1	Enhanced entrepreneurial skills
Empowered in agricultural marketing	Please indicate to what extent you agree or disagree with the following statement: Generally, use of the program has empowered you in agricultural marketing issues. <i>Strongly agree</i> = 5 <i>Agree</i> = 4 <i>Undecided</i> = 3 <i>Disagree</i> = 2 <i>Strongly disagree</i> = 1	Empowerment in agricultural marketing
Being able to communicate with others	Please indicate how the program has improved your ability to communicate with others on AMI. <i>Strongly improved</i> = 5 <i>Improved</i> = 4 <i>Undecided</i> = 3 <i>Not improved</i> = 2 <i>Not improved at all</i> = 1	Improved communication
Being able to participate in community activities	Please indicate how the program has improved your participation in community activities. <i>Strongly improved</i> = 5 <i>Improved</i> = 4 <i>Undecided</i> = 3 <i>Not improved</i> = 2 <i>Not improved at all</i> = 1	Improved participation in community activities
<b>Psychological</b>		
Being able to share experience	Please indicate how the program has enhanced your interaction with others for sharing experience. <i>Strongly enhanced</i> = 5 <i>Enhanced</i> = 4 <i>Undecided</i> = 3 <i>Not enhanced</i> = 2 <i>Not enhanced at all</i> = 1	Experience sharing
Being able to interact with others	Please indicate how the program has enhanced your interaction with others for sharing knowledge. <i>Strongly enhanced</i> = 5 <i>Enhanced</i> = 4 <i>Undecided</i> = 3 <i>Not enhanced</i> = 2 <i>Not enhanced at all</i> = 1	Knowledge sharing
Feeling of inclusion in the modern world	Please indicate how the program has transformed your sense of feeling of inclusion in the modern world of science and technology. <i>Strongly transformed</i> = 5 <i>Transformed</i> = 4 <i>Undecided</i> = 3 <i>Not transformed</i> = 2 <i>Not transformed at all</i> = 1	Sense of inclusion in the modern
<b>Economic</b>		
Being able to market farm produce	Please indicate to what extent you agree or disagree with the following statement: At present you find it easy to market your farm produce when you want to sell. <i>Strongly agree</i> = 5 <i>Agree</i> = 4 <i>Undecided</i> = 3 <i>Disagree</i> = 2 <i>Strongly disagree</i> = 1	Easy to market farm produce
Being able to visit different market	Please indicate how the program has improved your ability to access different markets for your farm produce. <i>Strongly improved</i> = 5 <i>Improved</i> = 4 <i>Undecided</i> = 3 <i>Not improved</i> = 2 <i>Not improved at all</i> = 1	Ability to access different markets
Being able to lower transaction costs	Please indicate to what extent you agree or disagree with the following statement: The program has lowered the transaction costs and hence increased your income	Low transaction costs

**TABLE A1** (Continued)

Dimension		
Description	Survey questions	Variable
	from sales of farm products. <i>Strongly agree</i> = 5 <i>Agree</i> = 4 <i>Undecided</i> = 3 <i>Disagree</i> = 2 <i>Strongly disagree</i> = 1	
Being able to lower transport costs	Please indicate to what extent you agree or disagree with the following statement: The program has reduced the transportation costs and hence increased your income from sales of farm products. <i>Strongly agree</i> = 5 <i>Agree</i> = 4 <i>Undecided</i> = 3 <i>Disagree</i> = 2 <i>Strongly disagree</i> = 1	Reduced transportation costs
Being able to increase income	Please indicate to what extent you agree or disagree with the following statement: The program has increased the timeliness of sales and hence increased your income from sales of farm products. <i>Strongly agree</i> = 5 <i>Agree</i> = 4 <i>Undecided</i> = 3 <i>Disagree</i> = 2 <i>Strongly disagree</i> = 1	Increased income
Being encouraged to use ICT in delivering services	Please indicate how the program has encouraged you to use ICTs in other areas in delivering services. <i>Strongly encouraged</i> = 5 <i>Encouraged</i> = 4 <i>Undecided</i> = 3 <i>Not encouraged</i> = 2 <i>Not encouraged at all</i> = 1	Encouraged use of ICTs in delivering services
Being able to invest more in agriculture	Please indicate how appropriate you find to invest more in agricultural production as a result of the skills you have acquired through the program. <i>More appropriate</i> = 5 <i>Appropriate</i> = 4 <i>Undecided</i> = 3 <i>Not appropriate</i> = 2 <i>Not appropriate at all</i> = 1	More investment in agricultural production

Abbreviation: AMI, agricultural market information.