ICT

AND

Food Security

IN

Africa

ADEBUSUYI ISAAC ADENIRAN
DJANE KABRAN ARISTIDE

ICT and Food Security in Africa

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By

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To Almighty God

TABLE OF CONTENTS

List of Illustrations

LIST OF TABLES

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PREFACE

This book explores the relevance of information and communication technology (ICT) in the drive towards the attainment of food security in Africa. Despite having well over 90% of its rural communities sufficiently covered by various Global System of Mobile Communication (GSM) service providers, a significant proportion of rural dwellers in Africa, for instance women farmers, have not been making appropriate use of related facilities in the process of food production, transportation, and distribution. The significance of ICTs (such as mobile telephony) in enhancement of communication and rebalancing of information between rural food producing areas and urban food consuming areas is analysed in the book. A comparative methodology, which combines focus group discussion (FGD), in-depth interviews (IDI), key informant interviews (KII) and observation, was employed in sourcing useful information from selected locations of the study. The book succinctly espouses the specific contributions of ICTs (especially mobile telephony) to the improvement of processes of food production and distribution from rural areas (regions of high production and low production) to urban centres in parts of Africa. Inherent situational dynamics in each of the research locations were routinely identified and juxtaposed across time and space.

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The contributions of our co-investigators, Mrs. Tolulope Esther Adebusuyi and Ms. Tanoa Michele Koffi, are also appreciated. Many thanks to our research assistants, Tayo Fajobi and Ijeoma Nwanwene.

More importantly, we would like to express our gratitude to the members of our respective families for their varying degrees of support that we received in the course of the project. From Dr. Adebusuyi Isaac Adeniran, many thanks to Tolu, Othniel, Ehud, Hadassah, and Zuriel, as well as Dotun Afolabi and Seyi Jegede for their varying degrees of support. To the family of Dr. Djane Kabran Aristide, many thanks for being there.

CHAPTER ONE

INTRODUCTION: INNOVATING AFRICAN AGRICULTURE

The need to innovate agricultural practice in a modernising Africa is becoming more daunting than ever, particularly in light of the continent's constantly expanding population—the growth rate for most countries has remained as high as 5%, for example, in the case of the Republic of Niger. To transform food value in Africa so that food security is enabled across the length and breadth of the continent, it has been observed that Information and Communication Technology (ICT) will have to play a pivotal role. A state of food crisis has remained a reality on the African continent because the processes of food production, distribution, and consumption have been predicated upon rudimentary procedures. Despite having well over 90% of their rural communities sufficiently covered by various Global System of Mobile Communication (GSM) service providers, a significant proportion of rural dwellers in Africa, such as in Côte d'Ivoire, Burkina Faso, Ethiopia, Ghana, Kenya, Nigeria, Rwanda, and Uganda, have not been making appropriate use of related facilities in the processes of food production, transportation, and distribution. This misnomer has been significantly associated with rural women farmers. With all the opportunities that ICTs (such as the mobile telephone network) offer to the attainment of sustainable agricultural practice globally, the need to enhance communication processes and rebalance imperative information between rural food production areas and urban food consumption areas in Africa has been a Herculean endeavour, and in most cases, seemingly unrealisable. Expectedly, the drive towards food security has remained unduly clogged.

In order to facilitate food sufficiency in present-day Africa, it is necessary to explore and utilise all benefits derivable from various ICT applications, especially at the level of policy planning. Being reputed to be the continent with the highest "demographic divide" globally as reflective of its increasing number of youthful populations, Africa needs to leverage this status by digitalising its agricultural value chain. In this regard,

relevant sensitisation programmes that focus on unravelling the significance of ICT platforms, such as mobile phones, in the processes of food production and distribution have to be prioritised. Although the current volume of agricultural products that are traded via mobile appliances has improved in a few African countries (for example, in Malawi and South Africa), there is still the need for improvement if food security for the entire continent is to be approached realistically. The centrality and usefulness of mobile phones (and other ICT mechanisms) in the processes of food production and distribution should be presented to all participants (that is, food producers, middlemen and women, transporters, wholesalers, retailers, and even final consumers) through sensitisation and training programmes by both mobile operators and governments at various levels. Specific interventions would have to be facilitated for agricultural stakeholders who are currently discouraged from using ICT applications in their daily routines. For instance, in the case of poor women farmers in most rural communities in sub-Saharan Africa, the problem of illiteracy has to be addressed through functional adult literacy programmes. A fitting reference here is rural Korhogo in Côte d'Ivoire where the farmers (male and female) do not own any kind of mobile phones despite the availability of mobile networks within their villages. Of course, government and various mobile communication service providers could offer to empower such people to own mobile phones through various subsidy and promotional programmes, respectively.

To explore other possibilities offered by the ICT platform beside routine "call-making," adequate sensitisation programmes from various mobile operators are desirable for all participants in the web of the food chain (that is, food producers, middlemen and -women, transporters, wholesalers, retailers, and even final consumers). Governments (at all levels) and various ICT service providers in Africa should be prepared to execute functional policies that would serve as a bulwark of impetus for those who are involved in the web of food production and distribution on the continent (that is, food producers, middlemen and -women, transporters, wholesalers, retailers, and even final consumers).

The problem of food security in an expanding African society

Food security is defined as an individual's ability to access a nutritious and reliably calorific food intake. It is, in fact, described at a macro-level as the balance between food production and demand for food by a population. In practice and, significantly, in the majority of African countries, most of the

foods that are consumed in the cities come from the countryside. Sustaining the extant balance between urban food demand and rural food supply has remained a problematic equation for practitioners of food security in most African countries, for instance in Nigeria and Côte d'Ivoire. Indeed, the integrated framework for the classification of food security by the United Nations (UN) (2009) in its international report on World Food Security affirmed that around 78% of food products that were consumed in the cities came from the countryside. In addition, food production and distribution have been observed as the main source of income for most rural dwellers in Africa, and for most of the participants in the informal sector within urban spaces on the continent.

Besides the poor quality of inputs, several problems have been observed regarding the wasteful distribution of agricultural products from rural areas to urban centres across Africa. Such problems have included the poor organisation of cooperative farming and trading organisations, and a lack of a communication platform to engage markets in the production and distribution processes. Consequently, relevant solutions are deemed necessary to enable an imperative balance between the growing demand for food products in the cities and the options offered by the farmers producing food crops in rural areas. The issues of communication and information between the two binary poles (that is, rural producers and urban consumers) in the processes of food distribution and consumption in Africa have to be addressed to guarantee sustainable sectorial output. While mobile telephone services were available as far back as 1996, no major impact was recorded on the agricultural sector. Indeed, the introduction of mobile phones into Nigerian and Ivorian socio-economic spaces has had minimal or negligible outcomes for the agricultural sector. Today, Nigeria has more than twenty operating mobile phone companies, covering a considerable percentage of the country's landmass of 923,756 square kilometres and Côte d'Ivoire has about ten mobile phone companies with an almost total coverage of the country, which is a penetration rate of 315% as of 2009 (UN 2009). Areas of high agricultural production have 98% coverage from all companies. In Nigeria, a similar trend has been noted. Indeed, both countries (Nigeria and Côte d'Ivoire) have had most mobile phone facilities installed since 2002. Meanwhile, on a comparative note, accessibility to ICT facilities has been quite encouraging in West Africa relative to other regions of Africa.

However, the impact of ICT on the enhancement of communication and rebalancing of information between rural production areas and urban consumption areas of food products in Africa has not been particularly noted, especially as it pertains to food security. Therefore, the content gap

that drives this book is that, despite the fact that many rural communities in Africa have been sufficiently covered by various mobile service providers, a significant proportion of the rural farmers have not been making use of relevant facilities in the process of food production, transportation, and distribution in their respective countries. This situation seems contradictory. Essentially, the real impact of mobile telephony on transportation (and distribution) of agricultural products from the rural areas to the urban centres depends on the perception or the use to which the agricultural practitioners put their mobile phones, in cases where they possess the devices. Thus, if these practitioners (that is, the rural farmers, transporters, wholesalers, and retailers) do not view mobile phones as tools for socio-economic improvement that rebalance communication and information between rural agriculturists and urban consumers, and as being capable of enhancing their incomes, it will ultimately be difficult to grasp clearly the impact of mobile phones on the food value chain.

Evidently, the challenge of climate change has resulted in an urgent desire to reconstruct the way food sufficiency is projected in Africa. Ensuring food security amidst a changing climate should be a top priority for policy advancement in Africa. More significant is the issue bordering on the agricultural productivity and incomes of rural farmers, which of course has implications for the quality of their livelihoods. Within resource-dependent contexts affected by more frequent and intense climatic manifestations, redefining the approach to food security involves embracing the notions of *change* and *transformation*. This includes the adoption of "climate-smart" practices, the use of emerging tools and technologies, and in some cases, the need to reconcile emerging technologies with the long-standing techniques of agricultural practice on the continent. As a matter of importance, the attainment of sustainable food sufficiency should be focused on. Above all, it involves identifying new ways of solving problems, of making decisions, of accessing and processing information, and of applying knowledge to agricultural practices in order to achieve more resilient production systems (Ospina 2012).

Nevertheless, evolving evidence from the field suggests that ICTs are playing an increasing role as enablers of *change* and *transformation* within vulnerable contexts. Mobile phones, radio, internet-based applications, and social media are being integrated as part of strategies to adapt to, mitigate, and monitor climate change, especially within agricultural communities in Africa.

Table 1. Schema for connecting specific ICT frameworks with feasible food security outcomes in Africa

	Specific ICT Interventions	Expected ICT Outcomes
Agricultural Production	—Text messages (SMS) to farmers via mobile telephone devices could be utilised as mechanisms for making available the latest and best possible practices (for instance, SMS messages could be sent regarding where, when, and how to apply soil nutrient enhancing substances like fertilisers).	—ICTs would be relevant in enabling the sustainable monitoring and evaluation of the agricultural production system, especially in respect of advisory services provisioning from experts on precision farming.
	—Radio jingles and expert discussion forums could offer a reliable framework for disseminating information on improved land management practices in rural agricultural producing areas. For instance, knowledge on how to improve soil fertility, how to preserve harvests, and how to profitably market produce could be derived via local radio stations.	—ICTs could be useful in raising awareness of veritable production and marketing mechanisms, which would in turn not only improve the quality of farmers' livelihoods, but also make the drive towards food sufficiency realistic. For instance, routine awareness programmes on improved land management practices would naturally translate into higher crop yields.
	—Interactive video programming could enable a comparative participatory mechanism for rural agricultural producing communities to come together to discuss and document related outcomes of applying pre-existing and new farming inputs. For example, outcomes of using traditional and climate-compliant seeds under the regime of changing climatic conditions. This could be particularly relevant in the process of crop selection (drought or saline resilient seedlings).	—ICT interventions could facilitate impactful crop diversification through adequate documentation and sharing of the outcomes of utilising traditional knowledge and experience of utilising climate tolerant seedlings.

	—Internet-centred applications such as the geographic information system (GIS), remote sensing, and data mapping could be useful in agricultural production, especially in the minimisation or aversion of risks.	—Reduction or aversion of risks, particularly those that are associated with changing climatic conditions could be attained via relevant ICT interventions.

Inferring from the above schema, the attainment of related goals of specific ICT interventions vis-à-vis sustainable food security in Africa is basically linked to a series of factors that are presented thus:

i. Acknowledging the role of field facilitators (for instance, agricultural extension workers, local-based functionaries and youths) who can obliterate the gap between scientific knowledge and technical climate change data, and their practical application in the field.
ii. Building the capacity of local stakeholders to benefit from the full potential of ICT tools (e.g., identifying and interpreting relevant information, establishing contact with broader agricultural networks and experts, exchanging technical information with local and external peers).
iii. Raising awareness among policy-makers on the importance of integrating ICT tools into climate change strategies as well as into broader poverty reduction programmes that tackle the multiple stresses that threaten food and nutrition security at the local level.
iv. Tackling issues of access and connectivity in remote rural areas to ensure that farmers, fishers, herders, and foresters have access to a diverse range of ICT services.

However, there seems to be a plethora of traditional knowledge and emerging adaptation and mitigation experiences that various African countries can share and disseminate with the help of ICT tools.

Nevertheless, merely making information available cannot be sufficient since the main challenge for engaging ICTs in regard to food security transcends the provision of information. It pertains to ensuring that the knowledge and information made available actually reach the appropriate stakeholders—that they are appropriated by local audiences and, most importantly, that agricultural producers are able to apply it or act upon it in order to strengthen their livelihoods. Essentially, ICT-enabled information and knowledge should contribute to informing the decision-making processes of local actors, to strengthening their capacity to deal with uncertainty, and to building new bridges of collaboration and exchange towards more resilient, food-secure agricultural systems.

While Africa accounts for more than 60% of all arable land globally, countries on the continent have been spending nearly $50 billion a year on food imports because vast portions of this land remain uncultivated (African Agriculture Status Report 2013). Of course, the ongoing food crisis on the continent could be directly linked to this untoward situation. To reverse the trend, African countries are increasingly adopting ICT as a tool for agribusiness reform and crop and animal production management. More than ever, technocrats, government officials, professional farmers, and entrepreneurs in African agribusiness are advancing the adoption of ICTs as a strategy to fast-track improved yields in crop and animal production because of the increasing need to feed more people across Africa, where more than half the continent's one billion population live below the poverty threshold. Thus, agricultural experts, farmers, young innovators, ICT companies, and government officials on the continent are focusing their attention on improvements in agricultural practices that can be brought about by technological innovation, capacity building, and creating enabling policies and infrastructure.

The statistics confronting Africa are instructive in the new drive on the continent for the adoption of ICTs to bring about food sufficiency. As aptly observed in 2014 by former Nigerian minister of agriculture Dr. Akinwumi Adesina, Africa is a continent with enormous potential for agricultural growth, yet one where food insecurity and malnutrition are widespread and persistent. To him, the scourge of poverty in the world is unacceptable. Drawing a parallel from current data, he noted that while many gains have been made in reducing global poverty, nearly 50% of the world's people still live below the poverty line (Abiodun, Agugoesi, and Ndubuisi 2014). According to the former minister, "nearly 850 million of the 7.1 billion people in the world, or one in eight, are hungry . . . malnutrition is the cause of 45% of deaths in children under five years old; that is 3.1 million children each year." He observed that while global

wealth in 2013 reached a new all-time high of $241 trillion, up 68% within the past 10 years, “the challenge is that we are having more poor people despite high economic growth rates. Today, seven of the 10 fastest growing economies in the world are in Africa. Much is said about a rising Africa on the global economic stage. To be sure, there is a new energy and dynamism across the continent. It can be seen in an emerging middle class, improved governance, and a heightened interest by foreign investors. But amidst this excitement, there remains a disturbing paradox”: poverty amidst plenty.

An enduring disconnect has existed between the nature of economic growth, the driving sectors and the growing number of poor people. The growth in Africa is being driven largely by the oil sector, mineral extraction, telecoms, and financial services. “But we must recognize that over 70% of the world’s poor are in the rural areas and depend on agriculture for their livelihoods. Therefore, to substantially reduce poverty, we must start by transforming the rural economies and the way to do this is to transform agriculture,” the former minister remarked. He further buttressed his argument by saying that the agriculture sector growth is pro-poor growth. A 1% growth in agriculture GDP leads to a reduction in poverty of more than three to four times compared with growth driven by the non-agriculture sector. According to him, the key is to generate wealth from agriculture, and expand opportunities for millions. In other words, the rural economy should be made the new wealth economy through the ICT framework. What are needed are economic ladders out of poverty. African leadership had, over time, needlessly shifted the focus from developing the rural economy by diverting attention to the development of the urban cities and “scarce foreign exchange had been spent on importation of food products for the urban areas, to keep the price of food down.” As such, African countries had become net food importers.

Besides, a major contributor to poor performance of agriculture in Africa has been the fact that it had been treated as a development sector, as a way to manage, rather than eliminate, poverty. It is imperative for actors (policy makers and practitioners) to desist from treating agriculture as a routine development programme rather than as a business. Before the oil breakthrough, in the 1960s, Nigeria was self-sufficient in food production. Nigeria was also a major global producer and exporter of cocoa, crude palm oil, cotton, and shelled groundnuts. The discovery of crude oil changed the landscape, as the country soon became over-dependent on this resource as the economic driver of growth, export income, and development. One tragic result of Nigeria’s dependence on oil was an abandonment of the nation’s farmers and food processors.

In Nigeria and Côte d'Ivoire for instance, corruption had equally found its way into the agriculture sector, as government officials in collusion with middlemen had continued to divert enormous funds brought in from both oil revenue and income from cocoa and coffee, respectively. The procurement of seeds and fertiliser had always been tainted by sleaze on the part of government functionaries. In Nigeria and Côte d'Ivoire, investments in rural infrastructure had been relied upon; as such, rural economies had slid into poverty and unemployment. Nigeria had notably become a food-importing country, spending an average of $11 billion a year on wheat, rice, sugar, and fish imports alone. For an economy that is import-dependent is also a "poverty manufacturing economy" (Adesina 2014). Nigeria, like most African countries, has no business importing food because the country's fundamental resources included abundant land, water, and human capital. Of the abundant arable land on the continent, Nigeria has an estimated 84 million hectares. However, published statistics showed that Nigeria only cultivates 40% of this land and only 10% of it optimally. Second, Nigeria is also home to two of Africa's largest rivers, the Niger and the Benue. Much of the country receives adequate annual rainfall to support farming. Third, Nigeria is also blessed with a large and young workforce to support agricultural intensification. According to Adesina, this is a "workforce for whom we need to create jobs and opportunity. And Nigeria's 180 million consumers offer a large domestic market to support increased food production and processing."

In addressing associated challenges, the Nigerian government had launched the "Agriculture Transformation Agenda" as also being obtainable in Côte d'Ivoire. The first action under this agenda, according to Adesina, was to cut out the rent-seeking middlemen who for decades had cheated farmers. An Electronic Wallet System was launched. The system allows smallholder farmers to receive subsidised electronic vouchers for seeds and fertilisers directly on their mobile phones to pay for farm inputs from private sector agricultural input dealers. The impact was instant and dramatic. The system has been working as initially projected. Within the last three years, the system has reached six million smallholder farmers and has enhanced food security for 30 million persons within rural farm households. Women farmers—who had not received fertilisers and seeds for decades under the old government system—now had better yielding fields through subsidised farm inputs on their own mobile phones. Nigeria is the first country in Africa to develop an electronic wallet system for reaching farmers with subsidised farm inputs on mobile phones. The impact is already being noticed beyond Nigeria. Several African countries,

Brazil, India, and China have expressed an interest in adopting Nigeria's Electronic Wallet System in their own agriculture sectors.

The revolutionary impact of ICTs on the agriculture sector is spreading throughout the continent. In some parts of Africa this was kicked off with land reform, which is a core requirement in food and animal production. Security of land is especially crucial for women and youths. In Rwanda, for instance, the experience with land reform was such that within four years the country was able to digitise 10 million parcels of land in the country, and 8.4 million titles were approved for farmers. The cost of land titles was as low as $1.60 in rural areas. Connecting the digitised land information system to banks allows the poor to use land as collateral. Meanwhile, the subsisting, obnoxious "land use decree" in Nigeria that gives ownership of all lands in the country to the government has remained a huge disincentive to investments in agriculture. "Land registration and titling are essential for the poor to use their land as collaterals for securing loans and for building their assets."[1]

Methodological Modelling

Since the principal focus of this book is to present how the application of various ICT frameworks in agricultural practice in Africa could play a pivotal role in the continental drive towards sustainable food security, a comparative research design is therefore engaged with the following purposes: to determine the actual volume of commercial negotiations being conducted daily between rural food producers and urban food consumers; to analyse the proportion of female farmers who engage ICTs in processes of food production and distribution relative to male farmers; to identify which ICT application(s) is preferred and is most widely used and to which food product(s) it is engaged; and to infer if any operational (and institutional) policy supports exist to encourage the application of ICTs by participants in the processes of food production and distribution across the length and breadth of Africa.

With the aid of the "most different systems design" (MDSD) method, the impact of the application of mobile phones on the processes of food production and distribution in Nigeria and Côte d'Ivoire are juxtaposed. Mobile phones are conceptualised as Variable "X," food production/distribution from village to city as Variable "Y," and the

[1] Nigerian Minister of Agriculture Akinwumi Adesina, quoted in "Will Africa Adopt ICT for Food Security?," *Africa Telecom & IT*, http://africatelecomit.com/adopting-icts-for-food-security.

application of mobile phones to food production/distribution as the intermediate Variable "T" to explain the link between "X" and "Y" in all the selected communities in Côte d'Ivoire and Nigeria (that is, in areas of food production [rural] and areas of food consumption [urban]). This research is largely predicated on a diagnosis framework since useful case studies in both Nigeria and Côte d'Ivoire have been utilised. The study engages research participants that cut across individual rural producers and cooperative-based rural producers and urban individual buyers/urban direct consumers and urban market-based middlemen/retailers surrounding the production areas of interest.

Specifically, in Nigeria, the research was domiciled in the south-west. The village of Ilo (rural production area) that serviced the town of Ilesha (urban consumption area) (both situated in Ilesha East Local Government Area) and the village of Aba Iyagani (rural production area) that serviced the town of Ile-Ife (urban consumption area) (both situated in Ife Central Local Government Area) were selected as the study locations. In Côte d'Ivoire, production areas in the south-west—that is, locations within the radius of high production of foods—were selected. These regions are: the Soubré region, an area with very high production of food; and Korhogo, an area with very low production of food. Soubré is a town in south-western Côte d'Ivoire. The inhabitants of the region of Soubré are from the Kru group.[2] The sites or villages that were visited during the fieldwork in this region included Soubré town, Koreyo I, Logboayo, Sokozoua, and Oureyo. Furthermore, Soubré is an important agricultural area that produces some of the best quality cocoa and coffee. Our reason for choosing this area is that it will give us insight into an area that has an active and lucrative agricultural sector. Korhogo is a town in the northern area of Côte d'Ivoire. It is the capital of the Savannah Region of the country. It is also the fifth largest city in Côte d'Ivoire. In the local language Senufo, *korhogo* means "inheritance." In addition to visiting Korhogo, interviews, discussions, and observations were also carried out in Gbalogo, Gbaméleguekaha, Takalé, and Natchokobadara. Because of its geographical location (that is, situated in an arid zone), the region of Korhogo is not as fertile as the region of Soubré. Korhogo is, nevertheless, the location of many agricultural projects that focused on enabling food security in Côte d'Ivoire.

[2] The Bete constitute the vast majority of the indigenous population, followed by Bakoué and some Kouzié. Soubré is a prefecture and the capital of the new region of Nawa, born from the split of the former Bas-Sassandra. The region includes the sub-prefectures of Soubré, Liliyo, Oupoyo, Okrouyo, Buyo, Méagui, and Grand Zattry.

Figure 1. Map of Osun state, Nigeria (Research Locations 1 and 2).

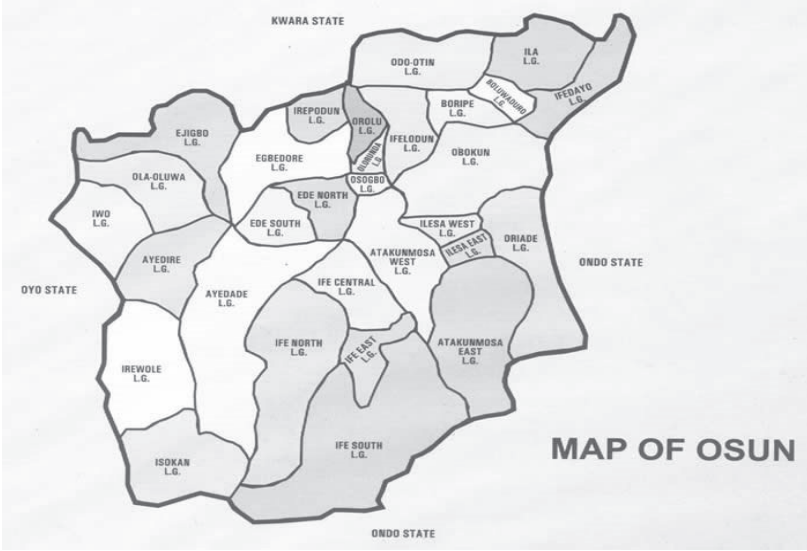


Figure 2. Map of Soubré, Côte d'Ivoire (Research Location 3).

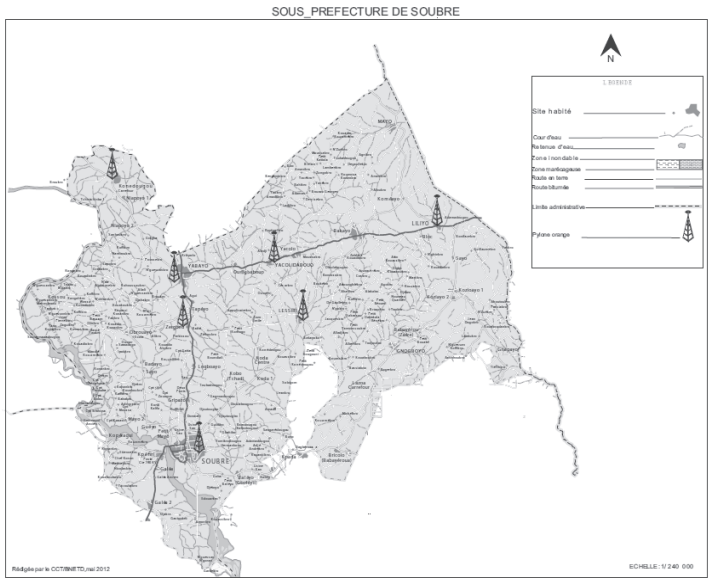


Figure 3. Map of Korhogo (Research Location 4).

Moreover, due to variations in perception of use of mobile phones between the rural producing areas and the urban consuming areas, the application of the "theory of spatial dynamics" has become expedient in this investigation. The study engaged a comparative spatial model with in-depth analysis of each location of production and consumption.

Sources of data

Relevant data used in this work have been derived from these qualitative sources: document and literature review, in-depth interviews, key informant interviews, focus group discussions, and observations. The document and literature review entailed a comprehensive and analytical desktop review of applicable institutional and operational policies and other documents on the subject under investigation: the usefulness of ICTs in the process of enabling regular food supply from the countryside to urban centres, bringing sub-Saharan Africa into consideration. The purpose of the review was primarily to gain a deeper understanding of the specific impacts of ICTs, particularly mobile phones, on the drive towards food security in

Africa. Relevant research studies and evaluations already conducted by individual academic researchers and other research agencies on the subject at stake in Africa were equally undertaken. The aim of this review was to assess current knowledge on the relationship between ICTs and food production and distribution from rural African settlements to urban African centres. Current empirical literature that puts into cognisance variables such as gender, geography, policy, and so forth vis-à-vis the use of ICTs in the processes of food production and distribution were explored.

To buttress the study's specificities, IDIs were conducted in all locations of the research in Nigeria (Ilo and Ilesha in Ilesha Local Government Area and Ile-Ife and Aba Iyagani in Ife Central Local Government Area) and in Côte d'Ivoire (Soubré and Korhogo regions) putting into consideration variables such as gender, age group, farming focus, and geography in the process. In each of the four selected study locations in south-west Nigeria (that is, Ilo, Ilesha, Ile-Ife, and Aba Iyagani), four IDIs were conducted. In Côte d'Ivoire, seventeen IDIs were conducted in all sub-prefectures and villages within the two regions selected for the study, that is, Soubré and Korhogo. This action assisted in unravelling the specific impacts of application of mobile phones on rural farmers and urban buyers/consumers on productive food production and distribution. The interviews were conducted between September 2013 and March 2014 at the study locations in Nigeria, and between September 2013 and February 2014 at the study locations in Côte d'Ivoire.

Two face-to-face, key informant interviews (KII) (one female and one male) were conducted in each of the four study locations in south-west Nigeria, while a total of eighteen KII were conducted in all the sub-prefectures and villages that constitute the regions of Soubré and Korhogo in Côte d'Ivoire. Essentially, the KIIs were conducted to provide first-hand information on all the locations selected for the study and to provide leeway in gaining access to people of research interest.

Sixteen focus group discussions (FGDs) comprising eight participants each were conducted in each of the study locations in south-west Nigeria (that is, Ilo, Ilesha, Ile-Ife, and Aba Iyagani). The sessions were held thus: females, aged 18–39 years (Ilo and Ilesha); males, aged 18–39 years (Ilo and Ilesha); females, aged 40 years and above (Ilo and Ilesha); and males, aged 40 years and above (Ilo and Ilesha); females, aged 18–39 years (Ile-Ife and Aba Iyagani); males, aged 18–39 years (Ile-Ife and Aba Iyagani); females, aged 40 years and above (Ile-Ife and Aba Iyagani); and males, aged 40 years and above (Ile-Ife and Aba Iyagani).

In Côte d'Ivoire, a total of eighteen FGDs were conducted in all the sub-prefectures and villages that constitute the regions of Soubré and Korhogo. During all the sessions of the FGDs in Nigeria and Côte d'Ivoire, individuals of the same sex and age group worked with the researchers as co-facilitators of discussions for their respective groups. This was done to enable a free and conducive atmosphere for the exchange of information.

On a general note, the focus group sessions as a whole enabled the researchers to derive pertinent information from the people in a much more natural setting than would have been obtainable in one-to-one interviews. However, in combination with the key informant interviews, in-depth interviews, and observations, the focus group sessions provided a veritable platform for gaining access to various cultural, social, and agricultural peculiarities of the research subjects. Indeed, unexpected issues of significance to the entire study were thrown up, intermittently, for subsequent exploration.

For the purpose of participant observations, relevant farming, distributive and transactional spaces, and settings for food production and distribution within the study locations in Nigeria and Côte d'Ivoire were selected for collection of observational data. By virtue of such a participatory approach, relevant first-hand information and other useful hints on individuals' dispositions towards the applications of mobile phones for agricultural production and distribution were derived from the interactive process. That is, information was obtained on their attitude to a shift from the routine, non-economic use of GSM to its use to request fortified crop seedlings from agricultural extension workers and its actual application for marketing and distribution of farm produce from the village to the city.

The procedures for engaging mobile phones by both rural farmers and urban retailers (and wholesalers) in the processes of food production and distribution were given adequate consideration; other participants who do not use mobile phones in their day-to-day agricultural production and distribution practices were equally well captured in this work. Non-probabilistic sampling orientation in the likeness of purposive (and snowball) techniques were employed in selecting the required participants in the study. Initially, the selected respondents (KIIs) were engaged in gaining further access to other members of their respective groups. All the IDI and FGD participants were selected while considering the length of their agricultural and business experiences, genders, and locations in both Côte d'Ivoire and Nigeria.

Equally, for the collection of useful observational data through observations, relevant public and private spaces and settings were purposively selected in all the study locations in Côte d'Ivoire and Nigeria. As a whole, the study put into cognisance specific areas of study within the study locations in the sampling process, that is, Ilesha, Ilo, Ile-Ife and Aba Iyagani in Nigeria and Soubré and Korhogo, Côte d'Ivoire. Through the sampling procedure, the study had incorporated individuals who worked as independent farmers, cooperative farmers, farm labourers, truck drivers, traders, and regulatory organisations involved in agricultural production and distribution.

Procedure for data gathering and analysis

Essentially, a pilot study had preceded each of the main surveys in Nigeria and Côte d'Ivoire. This was done to pre-test the potentiality of the research instruments that were engaged in the study, and indeed, to get accustomed to the study's locations. All the data gathered to explore the role of ICTs, notably mobile phones, in the processes of food production and distribution were based on prevalent situational peculiarities in each of the study locations in Nigeria and in Côte d'Ivoire. Our investigations in all the study locations so far took place from September 2013 to April 2014.

The interview guides for the study are presented as appendices. The subjects of the interviews and discussions include those who used mobile phones and those who did not use mobile phones in their day-to-day routines.

Texts of the information collected during interviews (that is, from the KIIs, IDIs, FGDs, and observations) were first transcribed from the tapes. These, with all data gathered from the participant observations, were coded and interpreted appropriately using manual content analysis and qualitative software packages: software Sphinx Lexica, WeftQda.

CHAPTER TWO

CONTEXTUALISING ICT AND FOOD SECURITY IN AFRICA

Ostensibly, the usefulness of ICT has cut across every stratum of human life. As such, its significance in modern-day agricultural production cannot be over-emphasised. In particular, the role played by the deployment of various applications of the global system for mobile communications (GSM) in enabling food security within the African context has been conspicuous. Due to the lack of reliable storage facilities (silos), the non-existence of facilities for processing perishable produce into finished products, and the poor road network (that inhibits the timely transportation of food products from the countryside to urban centres), the advent of GSM services on the African continent has been quite timely.

For nearly three decades, that is, from 1970 to 1989, the dominant issue in various discussions centring on food production, distribution, and consumption in Africa has been the functionality of the existing network for getting food products from rural producing areas to urban consuming centres. Meanwhile, the period of the 1950s and 1960s had seen an unwholesome drive toward the development of the cash crop sub-sector (primarily for foreign earnings) to the detriment of domestic production of food crops by various African governments. From the period of the mid-1990s there has been a significant renewal of interest, for instance, by the Food and Agriculture Organization (FAO) (1996), in smoothening the process of supplying urban settlements with food products from rural communities due to the immanent challenge of the urban explosion; nevertheless, the goal of sustainable food security has remained largely unrealised in most countries in sub-Saharan Africa (especially in the urban centres), including in Nigeria and Côte d'Ivoire. The push has been predicated on the need to respond to the increasing demand for food in the urban consuming areas by developing domestic capacity for production. This would essentially imply reduced dependence on imports, and a focus on at least cost routing for food items. This approach has also had the potential for social regeneration since a web of interpositions has existed amongst sprawling urbanity, poverty, and food insecurity (Molony 2007).

Notable earlier studies have analysed the nexus of food production and supply from rural areas to large cities in Africa. For instance, Goossens, Mintem, and Tollens (1994) focused on food supply from various Congolese villages to the city of Kinshasa; Chaléard (1996) focused on the supply of food products to the Ivorian cities of Abidjan and Bouake from the countryside; and Akinsanmi (2005) explained extant dynamics within the Nigerian configuration. According to Argenti (2007), there is an urgent need to give "priority to improving the efficiency of marketing systems and links between areas of food production and consumption in order to facilitate access to food and thus improve food security. Ordinarily, the processes of food production and distribution would entail several spatial scales: first, there is the suburban or rural areas where the production and collection of food products take place; second, there is the intervening logistical space of exchange and redistribution that stretches from rural collection to the urban markets; and finally, we have the urban centres as the locations for final disposal and consumption of food products from the countryside. Nevertheless, if rural food producers are to derive maximum benefits from the process of supplying the urban centres with food products, an efficient communication system is deemed expedient. This would enable timely connections between the rural producers and urban retailers/consumers. Aside from having better pricing for their food products, routine wastage that has often been an offshoot of the lack of a reliable storage system would be curbed, or at least, lessened.

While examining the spatial dynamics of urban–rural relations, Courade (1985) suggests that the impact of the urban centres on the development of the countryside depends largely on the modes of peasant organisation and the structuring of rural areas of food production. In most cases, urban demand for food products (from the rural areas) will continue to be an engine of change provided that extant agricultural supply chains, that is, communication and transportation, are efficient, and transaction costs are as low as possible. The introduction of GSM services in most sub-Saharan African societies at the onset of the twenty-first century has presented veritable possibilities that have made related individual and group intents realistic. For instance, the ability for numerous participants to utilise mobile phones in the processes of food production and distribution (that is, rural farmers, transporters, retailers, wholesalers, final consumers etc.) in Nigeria and Côte d'Ivoire has prevented undue wastage of farm produce, and by implication, enhanced the extent of profitability of rural agriculture and urban food distribution.

As noted by Obasanjo (2011), in this age of ICT, opportunities for new ways for conducting agricultural business and for enhancing farming

profitability are limitless: "keep giving me information that we can pass around; information to serve as an incentive—information about how chickens can lay more eggs than the number they are laying today, information about new seeds, new inputs to increase yields, new markets, new processes; GSM is one thing that can change life" as a whole. He further observes that in this era of information technology, there is nothing that cannot be communicated: "Even research has to be passed, be disseminated. [The] age of information should be the golden age of agriculture, if ICT is brought in."

Domesticating ICT in enabling food security: selected case references in Africa

ICT sector reform has promoted large-scale investments in telecommunications infrastructure in African countries, in turn promoting the expansion and modernisation of fixed networks. According to the International Food Policy Research Institute Report (2014), telephone lines, for instance, grew by 9% per annum between 1995 and 2001 and nearly 100% of most networks have been digitised in most parts of Africa. Nevertheless, service availability is concentrated in the main cities (that is, well beyond 70% of service in Ghana and Uganda, for example, is in urban areas), and as a result the penetration rate in sub-Saharan Africa is one main line per 100 individuals. Such undersupply of fixed lines has led to an explosion of mobile networks, such that mobile phone subscribers now significantly outnumber fixed-line subscribers in most African countries. Fuelled by the introduction of pre-paid services and by the proliferation of mobile phone companies (due to inherent competition and deregulation), growth in mobile-subscriber numbers over a two-year period (2002–4) had ranged from 30% in Morocco to nearly 50% in South Africa and 125% in the severely underserved Kenyan market.

In light of the foregoing, an industry of retailing services has emerged across the African continent. Senegal's incumbent mobile operator, for example, introduced a simple franchise system creating over 10,000 commercially run public phone outfits that employ more than 15,000 people and generate more than 30% of the entire network's revenues. Besides, in markets where initial connection fees are high and rates are thus out of reach of most people, small entrepreneurs are reselling airtime at rates above those applied to subscribers. In terms of internet access, most infrastructure projects have focused on the countries' bandwidth availability. For example, a Southern Africa Development Community (SADC) initiative identified projects to connect countries to each other and

to fibre optic sea cables. Similar activities aimed at improving connectivity on a countrywide basis exist in East and West Africa, often involving developed-country assistance and, sometimes, indigenous private initiatives, as observable in the case of Globacom in West Africa. As a result, data services have become increasingly available in urban areas where they have been adopted by the educated elite. Because individual access is scarce, private cyber cafés and public call offices have become a regular feature of the modern African urban space. But donor-driven telecentre projects designed to serve areas with low population density and minimal private enterprise (such as rural agricultural centres) have almost entirely failed in terms of financial sustainability and acceptable service continuity. So despite the investments and government-driven telecommunication development programmes, the supply of phone or internet services in rural and remote areas is still hampered by underinvestment and the lack of stable electricity: approximately 60% of African households do not have access to their national grid, especially in rural areas.

A study conducted in rural Ghana has shown that the telephone has remained the only ICT tool used by farmers. While the proportion of households using public community call offices—where available—stands at an approximate 60%, average household telephone expenditure is more than 5% of monthly household income. The same study has also indicated that, in terms of agricultural production, prices of inputs such as seeds, fertilisers, and pesticides are the most commonly transacted over the telephone. Beyond that, more sophisticated ICTs could make the greatest contribution by lessening distance and, of course, reducing the cost of interactions among stakeholders. National and international policymakers and organisations working in aspects of rural development and agriculture require, generate, and provide information relevant to agricultural production. ICTs enable the exchange of information about innovations in crop varieties, pest control, manuring, weather forecasting, irrigation, and efficient monitoring methods. To take advantage of these opportunities, African farmers rely not only on good government decisions but also on intermediate agencies such as non-governmental organisations (NGOs), extension services, and producer associations, which are more likely to have the necessary capacity and access to nationally and globally available information. To be more effective, these agencies need to shift from purely disseminating information to assessing and brokering relevant information. Capacity building is another area of opportunity. ICTs, for example, have enabled the World Bank to initiate its Global Distance Learning Network with 50 learning centres around the globe, and the Commonwealth of Learning (COL), the Consultative Group on International Agricultural

Research, and the Food and Agriculture Organization of the United Nations (FAO) have also promoted distance learning and ICT applications within their training programmes. Other ICT applications relevant to resource-sensitive agriculture involve satellite-based systems.

On the important issue of land property rights, for instance, administrative bodies increasingly use Geographic Information Systems (GIS) and database applications for efficient land surveys and registration. Having a registered asset both encourages farmers to undertake sustainable land management and enables them to borrow funds against the asset (to invest in production means, for example). Nevertheless, geospatial and information tracking technologies are becoming inexpensive tools for monitoring environmental management. Best-practice databases can indicate new ways for intermediate organisations to encourage rural smallholders to use environmentally sustainable farming methods.

Meanwhile, the most significant ICT applications for addressing food insecurity and malnutrition in Mali relate to educating personnel and enabling efficient networking. The FAO's Food and Nutrition division, for instance, provides online training materials on many nutrition-related topics. Similarly, given that health and nutrition related information is usually disseminated to the general public via mass media, ICTs have the capacity to enhance the accuracy and timeliness of information flowing to journalists. Projects supported by the German government in Mali are currently exploring the impact of links between radio stations and ICTs on the quantity and quality of the information transmitted among stakeholders. Monitoring nutrition status—including reacting to large-scale threats—is a particular area of assessment and analysis that depends on ICTs. Food insecurity and vulnerability information and mapping systems (FIVIMS) are increasingly implemented to assemble, analyse, and disseminate information on who is food unsecured and malnourished, where they are located, and why they are persistently at risk.

In Namibia, ICTs are used to monitor water, pollution, desertification, climate, and population parameters, ensuring the availability of relevant information in planning, decision-making, and coordination processes. Collected data are published for both public consumption and for the attention of decision-makers in a series of State of the Environment reports, from which indicators of sustainable use and development can be identified and appropriate action for improved farming systems can be derived. While landscape analysis highlighted global best practices and sample cases, Africa Scan provides a closer look at recognised e-agriculture successes in Africa. Africa Scan provides an overview of ICT solutions in the agricultural sector in Africa, identifying reasons for their

success and the potential for them to be scaled up. These success factors had emerged from studying examples of ICT use. Good examples of the use of ICT in bringing together multiple stakeholders in the Kenyan agriculture sector include: DrumNet and the use of SMS-based services developed by Zambia's National Farmers' Union to make available relevant information on cheap faming inputs and in linking rural farmers with appropriate markets where they can obtain appropriate pricing for their produce; a system of Sissili Vala Kori in Burkina Faso that enables farmers to use various ICT applications to share new production, processing, and marketing skills between themselves; a mango traceability system, via telephone, linking Malian retailers and exporters to global consumers; Kilimo Salama, an index-based agriculture insurance scheme on agricultural inputs in Kenya; LiberFor, which entails the application of ICTs in improving forest governance in Liberia; and, in South Africa, mobile technology such as MXit and other mobile applications used by GSMA as an initiative to alleviate food security related problems, for example, mAgri.

Essentially, various justifications have been presented in respect of associated positive outcomes recorded in all the case references presented above, which are enumerated as follows:

i. Real economic value was added either because of savings resulting from the use of ICT or as an increase in revenue or profitability.
ii. The language and medium used to communicate with the farmers were important contributing factors in the farmers' response to the programme.
iii. Good conceptualisation and execution were achieved by including multiple stakeholders in win–win partnerships.
iv. Trust was built with stockists, support centre operators and the government by using local champions as facilitators. This is an essential element for success in any project.
v. Projects were often augmented by bundling many services together with the basic or original facilities to make them truly comprehensive.
vi. A government-recognised body used to implement a project provides the initiative with added credibility.
vii. Where mobile phone reception and signal coverage issues were problematic, local alternative media uses emerged to circumvent the problem.

viii. Additional faith and trust in the system are created when a solution is developed locally.
ix. Community members find it particularly useful if farmers are directly involved in training and can demonstrate a solution.
x. By increasing the scale at which knowledge and new techniques can be applied, and by reducing transaction costs, ICTs help create sustainable business models, based on the private sector.
xi. In instances where farmers were able to identify personally with a technology solution, they were more inclined to adopt it and continue to use it.
xii. In areas of low literacy and low ICT penetration rates, use of an appropriate medium was important to the success of the venture.
xiii. It is important to establish a long-term interest and commitment among all those involved.
xiv. In the precision farming case study, the adoption of satellite technology resulted in lower operational costs and an increased yield.

ICTs in the marketing and distribution of food products in Africa

The links between food security, markets, and ICTs are obvious when it comes to integrating farmers into national, regional, and international trade systems. ICTs improve the ability to search for information and increase the quantity and quality of information available, basically reducing uncertainty and enhancing market participation. Answers are found to questions such as, “how do buyers and sellers find each other, and what prices can be achieved?” and “is it better to store produce or sell it immediately?” ICTs open opportunities, support the functioning of markets—and hence the availability of food—and increase income. Positive externalities affect all aspects of development, ranging from better education opportunities to lower fertility rates to increased productivity—eventually feeding back to food security.

Inferring from the foregoing, it is surprising that most efforts to make ICTs available to rural farmers have sought to improve the availability and quality of information either indirectly through producer associations, extension workers, and the like, or directly through broadcast radio information, telecentres, and mobile phone messaging (SMS). Small farmers only rarely initiate using ICTs to market products beyond local and regional markets. Instead, globally active organisations aim to mobilise smallholders to join a programme and market their produce. Such

programmes use ICTs for overall coordination and to transfer knowledge, arrange transportation, and exchange market information. ICTs also benefit transport systems at various levels, from a one-vehicle truck business using a telephone to locate a destination or secure a return load, to larger businesses with sophisticated radio systems to locate and identify vehicles automatically and transmit posting instructions from a central control location.

Overall cost reductions and efficiency increases will eventually have an impact on the emergence of food markets and the distribution of food. ICTs will even be able to compensate—in part—for deteriorating transport infrastructure (not that the role of accessible rural roads is questioned because they are one of the most significant requirements for market development and food distribution). In cases where agricultural products are distributed unequally, shortages occur; and where transportation systems are inadequate to bring sufficient food into the deficit region, or where people are unable to afford the costs of the food imported for their needs, food shortages transmute into famine. It is widely agreed that the availability of appropriate information is an effective means of averting famine. Information on the variability of food production, for example, is needed to plan and accumulate food stocks. Further, the difficulties of moving food into isolated regions can be overcome if limited transportation facilities are used more efficiently, and the costs of food imports will be lower if there is sufficient time to purchase food on regional or world markets and to arrange for inexpensive shipment to the affected areas. Specifically, government action can be better coordinated to respond to shortages. Again, ICT-based systems such as the Famine Early Warning System (FEWS) and the Global Information and Early Warning System (GIEWS) for food and agriculture are means of leveraging action to avoid disasters such as famines. Where famines occur, ICTs can assist humanitarian aid organisations. Logistical support, timely information, and immediate feedback from the concerned region enhance the focus and effectiveness of aid. Timely food distribution and ICT-enhanced coordination helped World Vision and its partners, for example, to avoid a catastrophe in parts of Southern Africa in the food crises of 2003. Coordination could still be improved, however, to save critical resources, avoid redundant measures, and target priority problems effectively. The HumaniNet consortium has been founded to address related communication shortcomings. The consortium is investigating and testing affordable, integrated ICT solutions that enable the coordination of planning and operations, and facilitate information sharing among agencies

ICT and increased traceability of livestock in Africa

Various ICT applications have been engaged in order to improve the traceability of livestock and products. Livestock production is the most widespread and generally practised agricultural activity on the African continent. As a result of intensified use of ICT in improving the efficiency of livestock and meat production in selected African countries, significant increases in production are possible at affordable cost and these methods are relatively easy to duplicate in areas with diverse natural landscapes. The potential for general increased wealth creation in all parts of the continent could be enormous.

The Namibian Livestock Identification and Traceability System (NamLITS) is a good case at hand. This system provides for official identification of all livestock by means of animal identification devices as required by international standards. Both radio frequency identification (RFID) for automated data input and a visual plastic ear tag that supports remote pastoral production, where there is limited or no technological support, are used. As a backup system, branding of animals will continue. Eligible cattle are tagged as part of a specific campaign and further tagging takes place during annual vaccination campaigns or community visit-based surveillance activities. In cases where handling facilities are in disrepair, mobile crush pens are used. The Namibian case study has presented the following outcomes:

i. The traceability systems employed by the commercial farming community and its downstream role players have unlocked wealth along the entire value chain.
ii. The experience gained by the commercial livestock sector can serve as a valuable platform to roll out traceability systems in underdeveloped rural areas where livestock production is heavily relied on to sustain the people.
iii. New and streamlined traceability systems that have recently been developed allow a wider spectrum of functions to be included so that many additional services can be rendered.
iv. The coordinated extension of comprehensive systems of traceability can improve the lives of multitudes of poor people and the long-term sustainability of the entire livestock industry. This has the potential to positively affect the economy of the country at large.
v. The capital and operational costs involved in the rollout of such a comprehensive traceability programme are relatively low

compared with the benefits that can accrue to the livestock industry, the respective role players in the value chain, and the government of the country.

vi. An enabling environment should be created by the government and all other interested parties to ensure maximum efficiency of an advanced traceability system.

vii. Should international organisations involved in the provision of aid funding wish to contribute noticeably to Namibia, consideration should be given to concentrating their funding efforts on the provision and maintenance of a comprehensive traceability system.

viii. Traceability systems can be rolled out in many other African countries where they can be expected to bring about similar wealth creation, but an enabling environment must be created first.

ix. Investment in the intensified use of ICT can offer more advantages than investment in possibly any other interventions that may be considered.

ICTs and enhanced irrigation outcomes in Africa

It has been demonstrated in many areas of the globe that using good irrigation techniques can increase the efficiency and profitability of crop production as much as a hundredfold. Efficient irrigation practices provide a consistent moisture supply to crops. In this regard, water deficiencies can be overcome during periods of drought, more than one crop cycle per year can be achieved, and the effective use of all production resources can be improved dramatically. The pressure on the diminishing water resources can also be alleviated and, as a result, more land can be put under irrigation. The increased utilisation of ICT could have a positive effect on irrigation efficiency as already presented by the case study of Egypt, which depends almost exclusively on the Nile River for its water supply. Of this, 85% is used for irrigation. Two separate aspects of the use of ICT in managing irrigation are highlighted through the case of Egypt. The first of these is an Integrated Water Resource Management Action Plan, which the Ministry of Water Resources and Irrigation in Egypt has been implementing in response to the increasing demand for water while the options for increasing supply are limited. It is being implemented on more than 2,000 km^2 within the Nile Delta, covering the command of two main canals, Mahmoudia and Mit Yazid. The project aims at improving the management of irrigation and drainage and increasing the efficiency of

irrigated agriculture water use and services. The plan aims at improving irrigation and drainage systems and the water management institutional structure. The first phase of the project has resulted in crop yield increases of 20%, with drainage estimated to account for 15–25% of this increase. A further benefit is the reuse of drainage water. A second type of intervention is illustrated by the Magrabi Farms area, which was a green-fields operation and has been developed from actual desert to the 8,500 acres that are now fully irrigated and underpin an export-oriented agribusiness.

Magrabi exports produce to 38 countries. Magrabi is an ideal example of the development of a full-scale, economically sustainable unit that has used technology to reach its current status. They are completely independent in terms of being able to conduct all the functions required for good soil, water, and multi-cropping management. There are fully equipped laboratories on the farm that form part of an integrated quality control programme and the whole complex has a fully-integrated, reticulated irrigation system, which is managed by an irrigation engineer. All water passes through filters and all bypass water is tested for purity as fertigation—that is, the application of fertilisers is a normal practice. Efficiency of water usage is continuously monitored. An onsite weather station, for temperature monitoring and evaporation pans to determine moisture loss, is used to facilitate the correct irrigation scheduling. The Egyptian experience has so far presented the following outcomes:

i. Existing ICT systems employed by some of the commercial farming community in large-scale irrigated farming operations have increased the efficiency of water use and generated larger profits.
ii. The experience gained by the large and small-scale commercial irrigation sector can serve as a valuable platform for even more comprehensive ICT systems. Many more agrarian communities in Egypt can be reached and this will contribute towards the improvement of living standards.
iii. The intensified use of ICT can offer governmental organisations opportunities to diversify their services to all communities involved in irrigation farming.
iv. The capital and operational costs involved in the rollout of a range of ICT-based functions are relatively low compared to the large benefits expected.
v. The enabling environment that the government and all other interested parties create to ensure efficient use of irrigation water could serve as an example to other countries.

vi. International aid organisations could make a serious contribution to African countries by focusing funding efforts on the intensification of ICT-based irrigation systems.
vii. The systems can also be rolled out in many other African countries and can be expected to bring about a similar magnitude of wealth creation, provided that an enabling environment can be created.
viii. Investment in the intensification of the use of ICT for the improvement of crop production under irrigation can offer more advantages than investment in most other areas.

Mobile phones as facilitators of food security

The number of mobile phone subscribers in Africa is projected to hit 1 billion by 2015 (Totalite.com). The phenomenal uptake in mobile usage in Africa provides a unique platform towards enabling food security. Mobile phones have already provided platforms in various sectors: banking, advocacy, education, entertainment, disaster management, health and, of course, to a limited extent, agriculture. Information on the weather, market prices, and micro insurance schemes can be accessed via mobile phones. Mobile phones are likely to shift the farmer's mindset from waiting for the rains to waiting for information. This will only happen if investments are directed towards digitising strategic agricultural information for easy application on mobile phones. Mobile phones provide two-way traffic that can enhance data gathering to drive food productivity.

Agricultural productivity in Africa is likely to go up if farmers can at the touch of a button receive data on types of soil, weeds, and their remedies, storage, and packaging, among others. An agricultural data centre can, for example, receive pictures of diseased crops from farmers for analysis and feedback from experts. The surge in mobile phone usage in Africa calls for urgent digitisation of agricultural information to enhance access by farmers.

Across the world, an estimated 500 million small-scale farmers feed an approximate one third of the entire global inhabitants—that is, an estimated 2 billion people (Rojas-Ruiz and Diofasi 2014). However, farmers often struggle to improve their efficiency, productivity, and sustainability in the face of changing local and global uncertainties. Mobile phones can assist small-scale farmers to overcome the many risks they face during and after production, and thus help boost their performance, and indeed, productivity. They create access to much-needed services on several

fronts, from providing market and price information to knowledge sharing, insuring crop production, and monitoring children's nutritional status.

Typically, small-scale farmers in developing countries face difficulties in gathering information about the true value of their products and identifying a market for them. This leads to lower bargaining power and the inability to meet market demand. Mobile phones can help farmers overcome these difficulties by making crop market components accessible to all through provision of new marketing and trading opportunities, as well as improved crop price information sharing. Text messaging services are now being used to give farmers information about current crop prices. Such interventions reduce the asymmetry of information, thereby leveraging the playing field between producers and traders. One illustration of the latter type of text-messaging service is the Esoko mobile system across Africa, specifically in Mozambique. Esoko has developed software that enables information to be shared across different parties in the agricultural sector, making real-time market information available. Information on demand, crop prices, seed, and fertilisers are sent to farmers via text messages. Meanwhile, agricultural apps are not limited to crop management. For instance, a Kenyan mobile phone service, Icow, sends SMS reminders to farmers about their cows' expected date for calving, as well as tips on milk production efficiency and best dairy practices. Farmers can also trade livestock and livestock-related products using their handsets. Such systems empower farmers, improve their efficiency, and so help increase their income.

In addition to providing market information, mobile phones are now improving smallholder farmers' capability for food security by means of delivering innovative financial products, such as crop insurance. Farmers in Kenya can purchase insurance from Kilimo Salama, a crop insurance developed by the Syngenta Foundation. Small-scale producers can purchase the insurance as they buy agricultural inputs and receive a receipt and a copy of their policy via SMS immediately. Insurance payments are also all automated: the system relies on information transmitted by a network of weather stations. If they signal irregular rainfall, a payment is automatically sent to farmers' phones via M-Pesa. This eliminates paperwork and reduces transaction costs, making insurance affordable for small-scale farmers. With their crops insured, farmers can more readily experiment with higher-risk, higher-yield crops and be assured that regardless of the weather, they will be able to feed their families.

Food production is not the only aspect of food and nutrition security that can be aided through mobile phone technologies. In many rural areas, it is frequently difficult to monitor a child's nutritional status. As such,

various organisations like the Tigo Foundation in Guatemala have developed a nutrition monitoring system using SMS technology. Health promoters in rural communities are able to send in real-time children's nutritional data via text message to health information centres. Then, the nutrition status of the child is diagnosed and information on care is immediately sent back to health promoters. Such a system promotes efficient monitoring of nutrition, which facilitates healthier children who will be able to collaborate in the food production of their family's farm in the future.

As producers look to meet global demand for food, mobile phones and other ICTs should be leveraged for both information sharing and productivity, as they will help small-scale farmers reach a level they have never reached before. With the use of smart phones predicted to grow astronomically in developing countries, the impact of mobile services and applications is also likely to be felt beyond food security and nutrition. Mobile health initiatives are being piloted worldwide to help with the diagnosis and treatment of chronic and non-communicable diseases. Cashless transactions using mobile money are already transforming the way business is done in many sub-Saharan countries. Mobile technology is quickly becoming one of the most important agents for change in agricultural practices.

Since an estimated three-quarters of the world's poorest people subsist within rural settings, the rural poor, and their very specific needs, must therefore be at the fulcrum of any attempt to tackle global poverty and the issue of food insecurity. But what are these very specific needs? Often they are things that people in urban areas take for granted—access to certain products or devices, to physical infrastructure, and to new technologies and ideas. These challenges have a range of negative effects. They can restrict educational opportunities. They can prevent people from getting the healthcare they need. They can also limit agricultural output, meaning the rural poor are often not able to produce the food they need for survival, and for commercial purposes. A growing body of evidence suggests that information and communication technologies (ICT)—and especially mobile phones—can help address these problems. They open up access to information and training opportunities. For this reason, they can bring about improvements in almost all areas, including health, education, financial services, and agriculture and food security.

Specifically, of the main potential gains in agricultural markets, the most important is market efficiency. For example, through increased access to mobile phones, farmers can better plan how much to plant each season and how much and what type of investments might be profitable,

on the basis of demand and supply. They can also gather information from extended networks and cooperatives regarding market conditions in higher-end markets and quality standards in those markets. ICTs can also be used to reduce price variability.

In another realm, ICTs can also play an important role in reducing the three main constraints faced by traditional extension services in developing countries. First, poor infrastructure makes it difficult and costly to visit remote areas. Second, traditional "extension programmes," in which specialists travel to remote areas to provide training and support, usually provide only one-off information to farmers; the lack of follow-up and feedback hampers long-term benefits. Third, as a matter of routine, related visits are not always reliable, and there can be a lack of accountability among the people and organisations that provide such visits. ICTs can overcome these problems by reducing the cost of extension visits, enabling more frequent two-way communication between farmers and agents, and improving the accountability of agents and other participants.

Some countries are already recognising the opportunity presented by these technologies, and have put in place subsidies to make them more widely available to under-served rural residents. Their goal has not only been to improve access but also to make sure that rural populations do not pay more for them than their urban counterparts. These subsidies make economic sense—increasing access to ICTs has a positive spillover effect on people's consumption and production. Nevertheless, the schemes are expensive and, as such, financially unsustainable. For instance, in Chile and Peru, telecommunication investment funds have been finding creative ways to get around this problem, using a small percentage of the gross operating revenues of existing private operators to pay for subsidies. Other countries, especially in Africa, could look to such options. Alternative technologies should also be explored. Broadband technology, for example, can provide access to both data and voice services. This could increase competition in the delivery of services, allowing rural communities not only to catch up with their urban counterparts, but even to overtake them in some areas. A dual broadband strategy that deploys wireless broadband networks and promotes the adoption of voice telephony applications targeting low-income users should be considered. The role that the public and private sectors should play, individually and in partnership, in rolling out such a strategy also needs to be explored.

Meanwhile, for these technologies to really make a difference, it must be about more than access. Connectivity and content are also crucial. The content we are making accessible when we extend connectivity must be relevant, useful and in an easy-to-use format. This content, particularly

when it comes to agricultural information and how that can help achieve food security, should be seen as a public good. Governments should invest in providing the best possible information about prices on different markets, produce varieties and quality, as well as production technologies and other agronomic information. If we invest in increasing access to these technologies, making sure everyone can connect—and in ensuring the content they can access is informative and relevant to their needs, we can provide the rural poor with the tools they need to escape poverty.

ICTs, livelihood resilience, and food security in Africa

Mobile technology offers a smart way to support rural agricultural development by providing information directly to farmers. To farmers who do not have any physical or financial access to information through current extension services, mobile phones and applications can act as a veritable avenue for obtaining locally relevant information. If the support package is right, there are huge opportunities for improvements in agricultural productivity, livelihood resilience, and future food security. Increases in agricultural production benefit local farmers and help food supply keep pace with population growth. Agricultural support services assist farmers in adapting to climate change with new cultivation techniques, following market prices, and understanding prevailing weather conditions. But this information is slow to permeate via traditional extension services. In Uganda for instance, there is just one extension officer for 46,000 farmers.

As of 2010, the mobile phone penetration rate in Africa was 68%, that is, over 3.8 billion subscriptions. This figure continues to grow every year as network coverage expands and prices for data fall. In this context, mobile telecoms offer a smart way to support rural agricultural development by providing information directly to farmers. As noted by the Swedish International Agricultural Network Initiative (SIANI) Report (2014), the future potential for the application of mobile technology within the agricultural sector, especially in Africa, would generate the following outcomes:

i. Mobile phones in agriculture would serve as a bulwark of learning for rural farming communities, in measures of best practices in seedling, cultivation, harvesting, and marketing.
ii. With appropriate learning procedures in place, ingrained technical hardware will adapt to greater user demands as time progresses.
iii. An appropriate scaling-up strategy would be institutionalised by means of provision of relevant content to an expanding user base.

iv. Sustainable agri-business models as presented by relevant mobile apps would ultimately lead to the creation of sustainable development.

As could be inferred from the SIANI case study, there are huge opportunities within the ICT sector for improvements in agricultural productivity, livelihood resilience, and future food security if the support is right. In some cases, mobile phones, despite costs, have improved local capacity to deal with unpredictable changes in food prices and thereby helped lower the severity of poverty. For example, farmers have used mobile phones to search and share market prices of produce, as well as bargain a fair price for their produce in Niger (Aker 2008). Another study conducted in Niger during the 2005 food crisis had shown that sharing pricing information via mobile phones could cause lower price dispersion across markets (Aker 2010). While mobile phones will certainly not be a means of feeding the hungry, they can be useful to access other resources and mitigate the major depletion of a household expenditure budget. The period 2007/08–2010 saw substantial levels of increased global poverty and a food crisis that inflated produce and fuel prices to extreme levels; nevertheless, at the same time it saw the great uptake of ICT on the African continent. Within this context, there remains a research gap on how these dramatic changes affect everyday life in East Africa. Putting Rwanda into focus, it has been noted that the application of ICTs in agriculture could enhance the drive towards food sufficiency. Notably, at the micro-level household context in the country, the use of ICTs had assisted various households located within the poorest rural communities to be able to feed themselves.

ICT applications in the African agricultural sector have continued to be on the rise. For instance, in 2008, 84% of farmers in Kenya had used a mobile phone with 35% of them using it to access agricultural information. ICT4D-supported research has looked at the value and impact of ICTs for subsistence farming at the start of the agricultural value chain. The eARN Africa project developed a framework to show how farmers with access to ICT-based market information services can market their products better and increase sales, leading to commercialisation, and eventually to food security. A pioneering LIRNEAsia study in Sri Lanka provided a market price SMS to farmers, which helped them save research time and negotiate better rates, resulting in average reported price increases of 23%. Fishermen and farmers who participated in similar projects in Senegal and Bangladesh also reported price increases with some noting that the

information had contributed to better decisions about how much to grow and when to sell.

The Knowledge Networking for Rural Development in Asia Pacific (ENRAP) projects had noted that farmers' use of ICTs was successful only if it was appropriate within the agricultural context or responded to the needs of their pricing strategies. A study in the Philippines found that introducing ICTs could also lead to farmers engaging in other economic opportunities, thus diversifying the resources that sustain the household and making them less vulnerable.

ICTs can be used by the farmers themselves to produce and share locally-relevant information: examples include the Huaral Valley agrarian telecentres in Peru, and the ongoing KariaNet project in the Middle East and North Africa region. For some farmers in the iREACH project in Cambodia, learning new farming methods helped improve agricultural yields and lower input costs. Equally, the DrumNet project used low-cost ICTs to provide about 2,000 Kenyan farmers with marketing, finance, and information advice. The result was an increase in adoption and marketing of export crops leading to income increases as high as 32%. Farmers were also sharing more food with their neighbours indicating livelihoods had improved.

Meanwhile, ICTs alone could not have got a sustained impact. Despite DrumNet's efforts, there were greater infrastructural and regulatory issues affecting exports. Farmers may not always know how to apply ICT-enabled knowledge without complementary capacity building. No doubt, further research on the impact of ICT use along the agricultural value chain is also desirable, such as on the changing roles of intermediaries or agricultural extension services.

Development of the agricultural sector in many African countries hinges on the development of the smallholder systems that have sustained African agriculture to date but continued to face challenges of low productivity and limited access to remunerative markets. Non-competitive value chains and limited information about remunerative markets, as well as the risk aversion of smallholders, limits their integration into markets. In Ghana, agricultural growth had been erratic and actually stood at an abysmal 5.2%, lagging behind the gross domestic product (GDP) growth rate of 5.9% according to the Institute of Statistical Social and Economic research (ISSER) Report (2005–10). Ghana's development strategies since 2001 have sought to turn the agricultural sector around through modernisation and commercialisation of smallholder agriculture (Republic of Ghana 2003, 2006). The Food and Agriculture Policy has as one of its key objectives the integration of smallholders into domestic and international

markets (Republic of Ghana 2007), with improvement in access to market information as a key strategy. The information communication technology (ICT) for the Accelerated Development Policy (Republic of Ghana 2003) also aims, among others, to facilitate the modernisation of the agricultural sector through the deployment and exploitation of ICTs to improve the sector's efficiency and productivity. Initiatives taken to improve investments in ICT deployment include the privatisation of the telecommunications industry, establishment of a regulatory authority, and investments in infrastructure such as an internet backbone, and masts for mobile phones. Community information centres (CICs) have also been provided in several districts to facilitate training in ICT on a wide scale.

The focus on ICT-based methods of information provision is driven by the role they can play in communicating knowledge and information to rural farmers. Access to market information can enhance farmers' access to markets through better negotiation and meeting the demands of the market (Barrett 2008; Moser et al. 2005), on condition that constraints to accessing inputs are addressed. The ICT tools have included modern tools such as the internet, mobile telephony, and interactive video and CD-ROM programs, as well as traditional ICTs such as the radio and television (Munyua 2007). There has been an increase in the use of ICT applications in rural Ghana in response to the enhanced policy environment, although issues of availability of the ICTs, electricity, literacy, telecommunications and content are still prevalent (Sampong et al. 2007; Alemna and Sam 2006).

An ICT-based agricultural market information service (MIS) was introduced by the private sector—Busy Lab—through its TradeNet (now Esoko platform). In 2006, the Sustainable Enterprise Development Foundation (SEND Foundation), a nongovernmental organisation operating in the north east of Ghana, adopted the TradeNet market information platform to access market information for smallholder farmers. Specifically, farmers were trained to access and provide market information through text message alerts, using cellular phones. Before this intervention, the SEND Foundation had been promoting agricultural activities and cooperative credit unions with the goal of enhancing food security in the area. The objective of introducing the ICT-based MIS was to link smallholder farmers with markets and to promote their commercialisation process. The project was implemented for three years between 2006 and 2009. Initiatives such as this are widespread in several African countries (for example, the Kenya Agricultural Commodity Exchange [KACE] and DRUMNET in Kenya; the Malawi Agriculture Commodity Exchange [MACE] in Malawi, and the Market Information Systems and Traders'

Organisation in West Africa (MISTOWA) (Tollens 2006; Munyua 2007; Okello and Ndiragu 2009).

Typically, the ICT-based MIS in north-east Ghana made a remarkable impact on small-scale farming communities and the markets they operate in terms of the improved level of agricultural commercialisation and inherent food security capability. The analysis of determinants of participation was conducted in 187 households in beneficiary communities, who were aware of the project and as such could choose to participate or not. Participants who were aware of the project were identified as ex-post (after the sampling) through their response to a question in the questionnaire, which asked whether the respondent was aware of the project. The likelihood of applying ICTs in various activities decreased by 0.5 and 7%, respectively, for a unit increase in age and distance to a local market. A unit increase in the value of assets decreased the likelihood of participation by 8%. Those who had participated in an agricultural project were 61% more likely to participate in the ICT-based MIS project. There is, therefore, a tendency for repeated participation in projects. This suggests a multiplicity of projects targeting same beneficiaries, and the likely creation of dependency of some farmers on external interventions. Contrary to expectations, farmers who accessed distant markets were less likely to participate in the project. Ordinarily, one expects these farmers to need information; however, the conduct of markets in the study area is such that those who sell or buy in distant markets usually have established trading partners (commonly called "customers") and therefore will have less need for an MIS. Participation in such projects also demands time, and distant traders who are more likely to be frequently absent from the community are unlikely to participate in the projects.

The effect of participation in the ICT-MIS project on smallholder farmers was estimated with the KBM method. The clustering of participants and non-participants in the propensity score range of 0.4 and 0.7 (Appendix 1) shows good matching based on the observed characteristics. Participants were 13% more likely than non-participants to used improved seed and this was significant at 1%. More participants than non-participants also attained higher levels of food security indicators, such as the recommended daily allowance (RDA) of caloric intake at the higher level of indicator based on IFPRI's RDA. Participants also spent more on pesticides but the level of significance was at 10% only. Since the use of pesticides is linked to growing maize, it suggests that participants were growing more maize than non-participants.

On the basis of the investigation, participants in the ICT-based MIS project tended to be younger than non-participants and slightly more

literate. The current study in Northern Ghana shows that participants of the ECAMIC project used more improved seed, spent more on pesticides, and attained higher levels of food security. The enhanced access to market information has increased their orientation to produce for the market. Since the analysis explicitly considered the causal relationship between participation in ICT-MIS and household adoption of improved farm technology (seed, fertiliser, and pesticides), it addressed the counterfactual questions that may be significant in predicting the impacts of policy change.

It has been succinctly revealed that promotion of high technology, such as ICTs for communication with farmers, should be more focused on youth in agriculture because such youths are already familiar with the communication tools and require little additional training in their use. Such programmes or interventions should be supported with complementary services, such as financial services, because project participants tend to have multiple needs. In addition, access to production inputs should be improved because the use of such inputs is the route to commercialisation and the ultimate realisation of the benefits of enhanced market information. There is a latent potential for ICTs, especially the mobile phone, to facilitate the transactions of rural farm households, which can be realised through positive partnership between the private and the public sectors; the latter has the responsibility to identify the needs of rural farm households that can be addressed most effectively by modern ICTs, while the former's role is to innovate to deliver the service's cost effectively. Policies that improve farm-level adoption of improved technology and facilities, and road surface conditions and networks will be needed to ensure that the farmers can produce more (through higher use of inputs and yields) and increase sales in more lucrative markets.

In the process of addressing food security concerns, ICT applications have continued to be reliable drivers. In fact, the submission of former Nigerian president, Chief Olusegun Obasanjo, who himself is a practising farmer, on this issue has been quite apt: "watching at close quarters, I do not believe that small-scale farmers have failed, rather they have been disappointed and neglected. If we understand them and give them what they need, I believe they will rise up to the occasion" (Obasanjo 1985). Again, he has affirmed that "while the seeming lack of progress in some aspects of our lives is bearable, lack of progress and actual retrogression in agricultural production and food security is particularly threatening, worrisome, disturbing, disconcerting and discomforting" (Obasanjo 1999). Unfortunately, the neglect of agriculture and the Nigerian farmer, who is the most important producer and stakeholder, has remained unchanged. It

is indeed not only an irony but also an embarrassment that Nigeria, a vast agricultural country, "endowed with substantial natural resources which include 68 million hectares of arable land, fresh water resources covering about 12.6 million hectares, 960 kilometers of coastline and an ecological diversity which enables the country to produce a wide variety of crops and livestock, forestry and fisheries products should find itself in the unenviable group of low-income, food-deficit nations in Africa" (FAO 1997). The potential of ICTs has persistently been underused, especially in promoting food security and agricultural sustainability.

ICT usage should attract special attention, as food security is being emphasised globally (FAO 1996). Among the several ways of addressing food security, ICTs should be placed centrally in the light of their multivariate capabilities. The preceding decade has proved the importance of ICTs in promoting social and economic development at international, national, and local levels (Braga et al. 2000; Mansell and When 1998; Opoku-Mensah 1999). ICTs also play a supplementary role towards achieving the primary objectives in development by meeting the information and communication needs of the target group as observed by Heeks (2002). However, most rural communities in the developing world have not explored the full potentials of varying possibilities of the ICT in promoting the three dimensions of food security. These dimensions are food availability, food accessibility, and food utilisation. ICT applications have been largely limited to one aspect, which is food production that leads to food availability, but for the other dimensions, a niche exists. ICTs could be employed to avail effective and relevant information concerning food accessibility and absorption to attain a satisfying state of food security and agricultural sustainability (MAAIF and MoH 2004).

Over the past 19 years, the government of Nigeria has implemented its overall policy objective, which is poverty eradication through a number of policies, for instance enhanced food production capability (Deniva 2004; Jouni 2004). Through such policies, the government had envisaged a poverty-free and food-secured Nigeria, the same thing that is also applicable in Côte d'Ivoire, an African country facing similar challenges, but to a rather minimal extent. Research outputs have shown that 68% of Nigerians live below the poverty threshold of 1% (United Nation's Human Development Report 2012). Besides revealing that adequate attention towards improving the practice of agriculture in rural areas—for instance engagement of ICTs in food production and marketing—has been lacking, the subsisting trend presents a daunting challenge to the process of policy-making and execution. Meanwhile, a considerable percentage of Nigerians (that is, well over 70%) live in rural agricultural areas. Poverty is widely

acknowledged as being multidimensional, encompassing agricultural sustainability, food security, and health rights among other elements (Batchelor et al. 2005). Food insecurity is a major dimension of poverty that requires efforts from all people to eradicate it (FAO 1996; South Centre 1997). Causes of food insecurity have included, but are not limited to, poverty, low agricultural productivity and sustainability, poor health and sanitation, inappropriate feeding practices, and natural disasters like drought, as observed by USAID/NIGERIA (2004). All these causes have had ICT deficits at their epicentres and as such have to be attended to pragmatically.

Indeed, the USAID/NIGERIA project had affirmed that resolving problems of chronic food insecurity requires development solutions not temporary food relief (USAID/NIGERIA 2004). In the fight against poverty and food insecurity, the government has implemented the Plan for Modernisation for Agriculture that aims at commercialising subsistence farming, as in the case of Uganda (MFPED 2000). Efforts were directed to the agricultural sector because it employs over 80% active labour force of the rural population. This makes agricultural growth critical for poverty eradication and food security in rural transformation (Deniva 2004; MFPED 2000; Misika 2000). For poor farmers, their priority in poverty reduction is food security, which is unfortunately not being addressed by the Governments of most African countries (Deniva 2004). Focus has been on increased agricultural production but there is an urgent need to address all the dimensions of food security (MAAIF and MoH 2004). Food security administrators have called for greater awareness about food and nutrition through improved information communication links within rural populations who are severely faced by food insecurity and poverty (FAO 2000; CTA 2006; MAAIF and MoH 2004).

Knowledge is immeasurable and can travel the world freely enlightening the lives of people everywhere. Yet many people still live in darkness with absolutely no effective communication links, as noted by the World Development Report (Wilson 2003). Sharma and other researchers stressed this lack of information links within developing countries among its rural areas (Berge and Leary 2006; Bertolini 2004; CTA 2006; Fox 2006; Pringle and David 2002; Sharma 2005). The majority of the population in developing countries lives in a rural setting and often lacks access to basic needs such as water, food, health care, sanitation, communication, and information networks leading to low life expectancy and high infant mortality (McNamara 2003; Munyua 2000). Traditional ways of communication have been a monologue in nature and have not allowed much interaction with users (Munyua 2000). An important area of

innovation in ICT is by combining different ICTs to deliver a more complete communication package (Gillman et al. 2003; Harris 2005). New ICTs should be linked to traditional communication forms to meet identified needs and reach out to specific groups. The realisation of the opportunities offered by ICTs for rural development, agricultural sustainability and food security requires a culture of information and new skills (FAO 2000).

Agricultural technologies that can increase food security in developing countries have existed for decades yet hunger continues to plague these countries (Berge and Leary 2006). The reason is because these farmers are faced with a number of challenges yet these problems have workable solutions, but the global difficulty is getting the appropriate information to farmers (Berge and Leary 2006). "A critical challenge in ensuring food security in Africa is human resource development through knowledge building and information sharing" (Forno 1999). To benefit from knowledge, one should be able to acquire existing knowledge, produce new knowledge and apply this knowledge to foster development (Berge and Leary 2006; Mamusha and Hoffmann 2006). ICT should therefore be used to meet the needs of the local people in sharing both indigenous and acquired knowledge. This will solve these challenges and lead to increased agricultural production, increased awareness, and sharing of information that will eventually ensure food security for all.

New ICTs represent the greatest tool to date for value-addition to an individual or community's own efforts for development (Pringle and David 2002). This is further confirmed in the existing literature whereby in America, ICT has been the sole factor for productive growth in recent years with computers and websites as vital components of developmental programmes (NPCC 2007). Doubts about the capability of ICTs should no longer be entertained; rather, decision-makers should make efforts at understanding and harnessing them to make good use of them (FAO 2000). Use of ICTs as a developmental tool in day-to-day activities will eventually impinge on the lives of the poor positively (Batchelor et al. 2005; Batchelor and Norrish 2005).

The past few years have shown an increasing acknowledgement of the importance of ICT at international, national, and local levels, with developmental applications in education, environmental concerns, and other areas as noted by Mansell and When (1998). NEPAD and Bertolini state that any delay in implementing ICT programmes is a delay in poverty eradication (Bertolini 2004; NEPAD 2003).

CHAPTER THREE

E-AGRICULTURE ADAPTATION IN AFRICA

While ICTs could be procedurally viewed as processes and platforms that are used in accessing, establishing, managing, and communicating information, theoretically, however, they could offer veritable platforms that could allow people not just to acquire information but to produce and share such across diverse geographic and national boundaries. To be applicable, imperative information would have to be accessible (i.e., in the indigenous language), timely, and in the possession of people who are able to make good use of it (Gillman et al. 2003; Harris 2005). E-agricultural services can assist farmers in solving agriculture-related problems via SMS and providing weather forecasts and market prices. Farmers and producers can learn about farming advances, trade online, build new partnerships, reach new markets, and better allocate resources. Rural radio connects people in remote areas, improves agricultural practices, and requires only the kinds of resources ordinarily available to small-scale farmers (www.e-agriculture.org).

The traditional approach of providing agricultural information through extension services has several shortcomings and new approaches to promoting access to agricultural information by use of information systems are being explored (Bertolini 2004; Van Crowder and Fortier 2000; Deniva 2004; MAAIF and MoH 2004). Many authors share the view that ICTs can be used to deliver agricultural information that could stimulate increased production by linking farmers to remunerative markets (Asaba et al. 2006; Bertolini 2004; Deniva 2004). A clear example is of a farmer who benefits from technology by receiving daily market prices, buying seeds at a lesser percentage, and gaining an equivalent percentage through a sale by eliminating the middleman (Accascina 2000). This has worked for FAO through farm networks.

Some African countries have productively embraced the idea of using ICT in engendering agricultural sustainability and, of course, food security. Examples include countries such as Senegal, Ghana, Uganda, Cameroon, Kenya, Tanzania, Malawi, Zambia, Botswana, Gabon, and Zimbabwe (Berge and Leary 2006), and many more. Indeed, applications

of ICT have been recommended in enabling poverty reduction strategies (Batchelor et al. 2005; Harris 2005; Millar and Mansell 1999; Slater and Tacchi 2004) in development strategies (Daly 2003; Harris 2005; Mathison 2003) and in ensuring agricultural sustainability and food security (Chowdhury 2001; FAO 2000; Crowder and Rudgard 2000; MAAIF and MoH 2004). This shows that ICT both offers a range of benefits and should be harnessed. The Food and Agricultural Organisation promises to assist developing countries in harnessing the benefits of ICTs, to facilitate sharing and exchanging of relevant knowledge and information (FAO 2000) mostly in the agricultural sector, because it is a leading occupation in developing countries that promises food security and agricultural sustainability (Deniva 2004; MFPED 2000).

As of the time of writing, food production has been improved but food access and utilisation remain challenges (MAAIF and MoH 2004; Misika 2007; South Centre 1997). The gap between food availability and consumption should be bridged through mass sensitisation and creating awareness about food values and absorption, which is currently lacking in agricultural centres. Awareness should not be for farmers alone but all people must be sensitised about food and nutrition security (MAAIF and MoH 2004) and about their right to food so that they can exercise it (FAO 1996). Health care for the poor is very essential, as is reliable information about the causes of poor nutrition and how it can be remedied through internal household networks (South Centre 1997). ICT should therefore take the lead in this sensitisation for all to achieve food security. An example is Kerala state in India where nutrients are better utilised because people have been sensitised and know how to handle food issues (Murali 2003). Other methods through which ICTs could be employed, solely or jointly in facilitating the course of efficient rural agriculture include the following:

i. Local radio
   Local community radio is an old form of communication channel that has existed for decades and has helped people in rural communities access the information they need. Local community radios in particular have been recommended for use in promoting all food security and agricultural sustainability dimensions in rural communities (Ilboudo 2001; Zulberti 2003). In Uganda, farmers have been able to acquire information about food production and marketing through the use of local community radios (Deniva 2004; MFPED 2000). In Somalia, local radio has been used to address all food security issues. FAO, for example, works in

Somalia with 29 highly trained field monitors working in rural areas and at local markets assessing the food security issues (Campbell 2001).

ii. Internet
If an individual anywhere in the world has a marketable idea, he or she should be able to sell it over the internet (Accascina 2000). Health workers have long desired using the internet to access information concerning food utilisation. Thus, the immediate integration of the internet among existing communication channels will go a long way in improving nutrition standards of vulnerable people in rural communities (McNamara 2003). Internet use in accessing information concerning crop varieties, increased yields, prices and makers, food production, and other agricultural issues were recommended by McNamara. An example is in India where farmers were able to use the internet in sharing information about their new increased milk-yields; this led to improved production, marketing, and economic growth (McNamara 2003).

iii. Print-outs
This form of communication media works alongside other communication channels. An example is where technology (internet, radio, computer) is used in the centre of the district and then data is carried to village level on paper (print-out) or by organising a workshop to pass on the acquired information (Accascina 2000; McNamara 2003). Furthermore, farmers' production plans in rural community settings are produced in the form of printouts (Deniva 2004). Printouts can also be used in delivering information concerning food absorption; an example is in Uganda where the Ministry of Agriculture in conjunction with the Ministry of Health produced the national draft on food and nutrition strategy (MAAIF and MoH 2004).

iv. Mobile phones
In general, more complete and current information about prices at markets can be delivered to farmers via radios and mobile phones. By use of these ICTs, information can be delivered in a timely fashion (McNamara 2003). An example is where farmers use mobile phones to get daily market prices by direct contacts between the buyer and the seller (Accasciana 2000).

v. Workshops
Workshops are still seen as the best structures in the creation of supply chains to enhance efficiency in the agricultural sector. They provide a forum through which farmers can access information

concerning food production, planning, and food marketing (Deniva 2004). Especially as information concerning food absorption and good nutrition practices can be accessed through the use of workshops (McNamara 2003). Through workshops, farmers are able to receive information concerning seeds and markets (MFPED 2000). The FAO has also been able to help farmers in rural communities' access information concerning food productivity and food accessibility through FARMNETS, where a FARMNET is an organisation of farmers (FAO 2000).

vi. Participatory communication approach to development
Most studies recommend the use of participatory communication approaches for development; a planned activity based on participatory processes to help people take control of their lives, exchange knowledge and skills, reach a consensus, and improve the effectiveness of their organisations (Anzorena et al. 1998; Bessette 2004; CTA 2006; Ramirez and Quarry 2004). Ideally, the poor should be an active participant in the design of their programmes (FAO 2000; Harris 2005; Mansell and When 1998; Sharma 2005). The best way to find out what poor and food-insecure people want is to give them real choices (Pinstrup-Andersen 2001). ICT will provide them with alternative choices for development and food security.

vii. Action research
Action research methodology is at its best when dealing with local communities in the research of ICT projects. This methodology aims at bringing about new activities through new understanding gained from the research (Slater and Tacchi 2005).

The process of adapting e-agriculture in Africa

Despite the growing importance of oil, Nigeria has remained essentially an agrarian economy with agriculture still accounting for a significant share in its gross domestic product (GDP) and total exports as well as employing the bulk of the labour-force (Talabi and Onasanya 2011). No less than 70% of the Nigerian population of 180 million is involved in agriculture. Yet, there is an inherent threat to biting hunger and abject poverty. Therefore, the attainment of food security is a fundamental agricultural objective in Nigeria, as it is in Côte d'Ivoire. Such intent is focused on ensuring that various households, especially in rural communities, have access to good and nutritious food for healthy living outcomes. Even though domestic food production is on the increase in Nigeria, there have

not been enough to meet national food demand (Nigeria Agriculture and Food Security Challenges 2001). This goes to show that access to adequate and nutritious food is limited by low income/poverty as nutritious foods are most of the time expensive. Remove oil from the Nigerian scene and there is bound to be an almost total collapse of the economy. Diversification of the Nigerian economy through agriculture and industrial establishment is long overdue, and it cannot be shied away from any longer as a result of unmitigated falling global oil prices. Ostensibly, lip service has been paid to agricultural development by various leaders in Nigeria since 1970. A country's economy depending mostly on oil (a mono economy) is an ill wind that blows nobody any good.

Against the background of the foregoing, it has been noted that the quickest route out of economic stagnation for any country is through the application of various ICT possibilities in different sectors of its economy. Japan, South Korea, and, recently, China represent the visible modern examples of countries once regarded as backward and under-developed that have changed their fortunes by investing in ICTs and utilising these in every sphere of their national life (Odachi 2009). Hence, to remain afloat in this competitive world, Nigeria and Côte d'Ivoire have to adapt to the changing technology that is prevalent in advanced countries.

An overview of the objectives of the new Agricultural Policy and Food Situation in Nigeria reflects the following:

i. To achieve self-sufficiency in basic food supply and the attainment of food security.
ii. To increase production and processing of export crops, using improved production and processing technologies.
iii. To increase agricultural raw materials for industries.
iv. To generate gainful employment in agriculture.
v. To obtain the rational use of agricultural resources, the improved protection of agricultural resources from drought, desert encroachment, soil erosion, and food, and the general preservation of the environment for the sustainability of agricultural production.
vi. To promote increased application of modern technology to agricultural production.
vii. To improve the quality of life of rural dwellers.

While all the stated objectives above seem lofty, and indeed, recognising the importance of engaging "modern technology to agricultural production," the big questions that remain are: To what extent would modern technology be engaged in agricultural production? What type of modern

technology would be engaged in this regard? And, how would such modern technology be engaged?

Juxtaposing the nation's food balance and the level of national dependency on food imports, it has been observed that agricultural production in Nigeria failed to meet the national demand from 1994–2001 and lack of application of ICTs in agriculture has been largely implicated. Hence, there has been a dire need for importation of food crops to meet up with local food demand. The increase in demand for food productions observed might be due to high population growth rate (which presently stands at 3.5% annual growth rate). The above-discussed scenario has not been particularly different from the projections for subsequent years. Of course, while the value of exports and percentage of total merchandise for agriculture have declined on average from 1980 to 1998 in Nigeria, that of oil and mining have steadily increased within the same period. So, while the fortunes of agriculture have declined, on average those of oil and mining have increased until the recent oil crisis (in late 2014).

Meanwhile, in Nigeria and Côte d'Ivoire, as in most West African countries, the following challenges have been identified in the processes of agricultural production and networking, according to Anyanwuocha (2006):

i. Small farm size
   This arises from the land tenure system. In many areas, farms are very small because of fragmentation of land. This does not encourage large-scale farming.
ii. Climatic problems
   Adverse climatic conditions, such as insufficient rainfall and drought, affect agriculture in Nigeria.
iii. Pest attacks
   Attack by diseases and pests contribute to low productivity.
iv. Illiteracy and conservative attitude of farmers
   This is a major factor hindering agricultural production in Nigeria. Prevalent illiteracy has made it difficult to adapt new technology in production and networking in cases in which they are available.
v. Inadequate capital
   Some farmers are poor and many of them cannot afford the required capital for large-scale farming and new techniques for agriculture.

vi. Poor marketing facilities
Facilities for the marketing and distribution of crops are inadequate. As such, agricultural processes have continued to be discouraged.
vii. Inadequate storage facilities
Storage facilities for many agricultural products are inadequate in situations where they are available and accessible.
viii. Poor transport facilities
Transport facilities for evacuation of crops are inadequate.
ix. Use of crude implements for farming
Obsolete and traditional farming implements have been hindering the growth and efficiency of agriculture in both Nigeria and Côte d'Ivoire.

No doubt various solutions to the above problems so identified, which have been basically rudimentary in nature and scope, have not yielded any significant dividend. As such, there is an apt need to look for a new way out of the subsisting stagnation in agricultural growth in Nigeria and Côte d'Ivoire. In view of this development, the incorporation of the possibilities of various ICTs into agricultural practices in both countries presents an immediate and sustainable answer to various problems of agriculture.

According to Ozowa (2010), over the years, deliberate but ineffective efforts have been made by donors and African countries to bring about agricultural development without much to show for it. Much of the failure has been attributed to the non-integration of agricultural information with other development programmes to address the numerous related problems that face farmers. Information is an essential ingredient in agricultural development programmes, but farmers in Nigeria and Côte d'Ivoire seldom feel the impact of agricultural innovations either due to their inability to access such vital information or because it is poorly disseminated. The integration of information and communication technology (ICT) in agriculture can be utilised to provide accurate, timely, and relevant information and services to farmers, thereby facilitating an environment for more remunerative agriculture. With ICT facilities, farmers can be updated on temperature, humidity, and rainfall with additional parameters such as atmospheric pressure, solar radiation, wind speed, and soil moisture. In India, Ingen technologies provide this information to farmers. Ingen technologies also use predictions and analytical software to predict demand for beverages for a major soft drinks company.

The use of an ICT portal or agricultural website helps in the dissemination of vital agriculture information such as detailed online contents, crops, crop management techniques, fertilisers and pesticides, and many other agriculture-related materials. Most small-scale farmers sell their products to middlemen who now determine the prices to the detriment of the farmers. But with the provision of commodity prices and market information on a real-time basis available on the internet, the farming community can be provided with choices they lack today. This will ensure better price realisation and stimulate a drive towards better productivity. Again, with e-commerce, farmers can sell their products online. In this regard, the farmer can sell his product right inside his farm. What the farmer needs do is to register his location and products to ensure that products ordered online can be traced to a particular farmer (Samuel 2010). This has widened the market reach for farmers. With ICT, one can get information on the market potential of some agricultural products. For instance, instead of selling unprocessed groundnuts, one could further add value by packaging the nuts or processing them into butter and cooking oil. Prompt ICT information on weather, pests, and diseases can prevent the calamities experienced in agriculture in recent times due to the vagaries of weather and the attack of pests and diseases.

Still, in India, aQUA technology is applied to assist farmers. aQUA technology stands for "almost all questions answered". It is a farmer–expert question-and-answer database supporting Indian languages—an online multilingual multimedia informatics lab that answers farmers' queries, based on location, season, crop, and other information provided by farmers (Mukesh, Deepati, and Kamini 2010). ICT offers more avenues for the sharing of knowledge with stakeholders of different types and with different situations. Apart from canning and other methods of food preservation, various communities have their local ways of preserving agricultural products. This type of information can be shared among farmers. Information sharing is achieved through a computer network that helps in the dissemination of research products and messages. Using the Global Positioning System (GPS), one can describe the exact latitude and longitude of one's farm. This is a way of promoting what is known as precise farming (Hutchinson and Sawyer 2000). GPS can be used to control costs and boost crop yield. With GPS, farmers can map and analyse their fields for characteristics such as acidity and soil type.

Inadequate capital is one of the problems of agriculture in Nigeria. Some of the farmers, especially small-scale farmers, are unaware of existing loan facilities due to poverty and low levels of literacy. ICT can assist farmers by providing vital information on existing loan facilities.

Through information provided by ICT, farmers will become aware of the latest agricultural tools and methods that make farming easy, instead of the use of crude methods. They can form a group and hire these tools. Presently, it is pertinent to say that one does not claim to have exhausted what ICT can do for agriculture with the discussion above. The role of ICT in agriculture is enormous.

When rightly engaged, the framework of ICT is capable of lifting the Ivorian and the Nigerian agricultural sectors to the next level. It is a change agent that cannot be ignored as there is in existence a plethora of success stories of its utilisation across the globe. Côte d'Ivoire and Nigeria, as applicable to other African nations, cannot be isolated from the wind of globalisation, as presented by such platforms as the ICTs' application in agriculture. Applications of ICTs in agriculture have worked well, for instance in Korea, Japan, India, and China; these countries were once regarded as under-developed, but have now been lifted by ICTs into leading positions in the comity of nations. What Côte d'Ivoire and Nigeria need is serious investment in ICT infrastructures to make ICT facilities readily available to farmers on their doorsteps. The issue of adequate power supply is very important as far as ICT is concerned, particularly in Nigeria. Nigeria can learn from other countries that have recorded remarkable successes in agriculture by means of incorporating ICT.

Mobile telephone technology has been widely adopted in many African countries, especially since the beginning of the twenty-first century (Donner 2008). Of course, a major impact of the mobile system of communication is that it has been used by less-privileged or impoverished people to change their life situation across societies (Souter, Scott, Garforth, Jain, Mascarenhas, and McKenmey 2005). As such, the need to address the prevalent scourge of poverty or the urge to escape the entanglement of poverty has been a major determinant of increasing interest in the application of mobile phones by rural farmers in their day-to-day routines. Ostensibly, the platform of mobile telephony has enabled the processes of food production and distribution. As a point of reference, it has caused a significant improvement in the socio-economic condition of rural farmers (especially, women farmers) (Bayes 2001; Jensen 2007).

Flor (2009) affirmed that the use of mobile phones is capable of enhancing the productive capacity of cooperative-based farming and improvement in measure of development outcomes for practising farmers. Flor noted that appropriate institutionalisation of so-called "e-agriculture" as an important instrument with which to address various challenges confronting agricultural practices, especially in developing societies (for instance, as obtainable in sub-Saharan Africa) would not only lead to

improvements in the socio-economic standing of farmers but also make the goal of food security attainable.

In a related study to Flor (2009), the World Bank (2012) has suggested that since mobile telephony could strengthen accessibility to agricultural information and, as such, provide imperative platforms for exploring new markets by rural farmers, the urge to engage it in their daily routine should continue to be bolstered. A central motivating idea in this regard is that improvement in information flow in the value chain supports development at the levels of individual and communal participation. If all information contained within the value chain is easily accessible by the players, the idea is that the level of poverty among participants could be considerably lessened and, indeed, the goal of food security would become more realisable.

Meanwhile, Porter (2012) had queried the actual usefulness of mobile telephony in enhancing agricultural productivity and human development. According to him, despite the liberalisation of the ICT sector (in this case, mobile telephony), a significant proportion of the population across most developing societies is still dependent on face-to-face interaction in the process of conducting businesses, including agricultural transactions. This has been as a result of the prevalent dysfunctional or, better still, non-existent nature of most telephone services (be it public or private); and in most cases, various applications on mobile telephones have often been difficult to understand by the people due to high rates of illiteracy, especially in rural areas (International Food Policy Research Institute [IFPRI], 2003–4 Annual Report; Saravanan 2010; International Telecommunication Union [ITU] Internet Report 2001). In contrast to Porter's submission, the study by Rashid and Elder (2009) suggested a strong link between accessibility to mobile telephony and increased economic opportunities for rural farmers. Among other things, these authors noted that mobile telephony routinely enhances the capability of rural farmers to monitor pricing for food produce. As a consequence, they are empowered to make better judgement of when and how to sell their crops. Besides increasing the level of their incomes, they are routinely encouraged to produce more, though for improved profitability *ab initio*. In the long run, the goal of food security for the larger society is better enabled. Nevertheless, Porter (2012) had equally confirmed the relevance of such an economically based approach in examining the impact of mobile telephony on communal well-being, that is, the attainment of the goal of "food security" for the larger society. The outcome of his analysis had shown that mobile telephony is an instrument of social reconciliation among various agricultural stakeholders. Beyond related economic gains,

accessibility to mobile telephones in various countries (for instance, in sub-Saharan Africa) has continued to remain limited due to subsisting, unhealthy operational and regulatory policies on the parts of the GSM service providers and the governments at various levels, respectively.

Gender variability in e-agriculture adaptation in Africa

Since nearly half the people living in sub-Saharan Africa subsist on less than US$1 per day and 32% of them are undernourished, the "The Millennium Declaration" (2000) advocated for special attention to Africa. Against this background, Africa has remained a funding priority concern for The Hunger Project for several years. Of the four social determinants responsible for worsening persistence of hunger and poverty in Africa, the "marginalization of women food farmers" has been most crucial; others are "poor leadership, too little investment in building people's capacity in rural areas, and AIDS and the gender inequality that fuels the epidemic." To transform these conditions and empower the African people across various gender categories in meeting their basic needs in a sustainable pattern, The Hunger Project, as a case reference, has devised an "epicentre strategy," which is a unified, people-centred approach that has proven successful in different countries in sub-Saharan Africa: Benin, Burkina Faso, Ethiopia, Ghana, Malawi, Mozambique, Senegal, and Uganda.

Continually, however, numerous empirical studies have shown that mobile telephony is a significant empowering tool for rural farmers (especially, women food producers). In Uganda, for example, the use of mobile phones had enabled rural women farmers to increase their level of income since they were able to obtain information with regard to market developments with relative ease (GenArdis 2010). With mobile phones, farmers (men and women) can easily ascertain the prevalent market prices for their food products and, more importantly, are able to easily identify when it is best to sell for better returns on such food products. They can equally source a wide range of buyers from different locations since they are able to contact them directly. Besides, mobiles phones represent actual revenue in certain cases since the farmers are able to complete various transactions within and beyond their immediate community via GSM platforms.

To understand the specific impact of the ICT platform (in this case, the GSM) on the income and the living conditions of rural women farmers, GenArdis (2010) undertook an empirical study in which it was discovered that a strong link exists between poverty reduction and ICT accessibility for women rural farmers. In one case, through the project "Manobi,"

women members of the Federation of Mutual of Agro Diender (Senegal) were able to get mobile phones at affordable prices. Furthermore, training in and use of the Xam market gave them access to daily market prices and allowed them access to understanding the fluctuations in pricing for their food products (Dimitra Project 2006). With this knowledge, the women farmers, just like their male counterparts, were able to obtain better prices for their produce and also have better control over the distribution of food products (Asenso-Okyere and Mekonnen 2012).

Due to situational variations, it might be probable that the foregoing case study may not completely be applicable in explaining the case studies of Côte d'Ivoire and Nigeria; nevertheless, this analysis suggests that there is a veritable link between the use of mobile telephony and attainment of food security. While there are many possibilities associated with the adoption of mobile telephony, it is important to point out that there are also barriers. One such is that it negates the long tradition of oral interaction within the African context. Another issue is the suspicion with which various conversations (or interactions) on mobile phones is treated within the African context. The oral tradition for conversations (interactions) has been a well-established, inter-generational mode of knowledge transmission in Africa.

Given the centrality of the role of African women as the foundation for family life, Hafkin and Hodame (2002) affirm that the balance of the family institution vis-à-vis the drive towards food security largely rests on the womenfolk. Within the African context, women are seen as an essential element in understanding how the social structure functions. For instance, in the bid to develop new farming practices, rural women who engage in agriculture are the natural hub through which numerous partners communicate via mobile telephony. As observed by Fernandez-Ardevol, Barrantes Cáceres, and García (2011), there is usually an important contribution derivable from the application of mobile telephones in interpreting patterns of social relationships among various actors in either a female-based or mixed-gender agricultural system (or settlement).

Meanwhile, certain studies have noted that the adoption and usage of mobile phones in some settings carry specific negative connotations. In their work on South America, Fernandez-Ardevol et al. (2011) observe that the question of mobile-based myth and taboo is linked to the perception of in-group versus out-group classifications. Thus, under certain conditions, some individuals had affirmed that mobile phones are essentially an invention of the devil (Abraham 2006; Fernandez-Ardevol 2011). Similarly, in some sub-Saharan African countries, mobile phones are likened to the equipment of sorcerers and other *marabouts*, who it is

claimed use them to locate their enemies and cast spells on them from a distance. The spell is received just by picking up the phone. These perceptions are common in rural areas but less in the cities (Gakuru, Winters, and Stepman 2009). This variation indicates that such unfavourable perceptions of the usage of mobile phones could eventually be changed through civic education (and/or routine awareness campaigns) (Fernandez-Ardevol 2011; Sauvé and Machabée 2000). Nevertheless, such extant negative understandings of the mobile phones' applications in rural areas could hinder their successful engagement in the processes of food production and distribution.

On a general note, therefore, "rural food producers who tend to use mobile phones in the processes of food production and distribution do so if they perceive such mobile phones as capable of improving their productivity and, indeed, enhancing their level of income."

Preferred usage of e-agriculture in processes of food production and distribution in Africa

Across the board, four subsisting determinants (that are popular with different categories of farmers who use mobile phones in their daily routine) have tended to suggest the specific application(s) of mobile telephony. The first of these factors is prevalent illiteracy. For instance, in both Côte d'Ivoire and Nigeria, nearly 90% of rural-based farmers are not educated. As such, the extent to which they could apply mobile telephones is considerably limited. Usually, they prefer making calls to (or receiving calls from) their business associates over writing text messages. Of course, they cannot write text messages, and neither can they explore the internet via their mobile phones, due to high levels of illiteracy. However, among the few privileged rural farmers (usually, below 5%), who are often barely literate, that is, who have rudimentary knowledge of writing and reading, text messages, actual calls, and the internet platform are explored restrictedly in their daily routines. Expectedly, this has given these individuals undue leverage over their uneducated colleagues.

The second of the determining factors is "time." Especially, amongst the uneducated rural farmers (male and female) who are in the majority, and sometimes, among the few barely educated ones, "actual" call-making is deemed "time-saving" compared with writing text messages, which is considered "time-wasting."

The third is "cost." While the few barely educated rural farmers routinely engage text messages due to its cost effectiveness, the majority,

who are uneducated, believe that "internet surfing" over their GSM would not only be time consuming but also equally cost ineffective.

The last consideration is the epileptic nature of nearly all the applications, except "actual call," which is relatively better. Sometimes, text messages might never reach the intended business associates; so also, the internet might not be functional for several days. Therefore, among all participants, rural farmers (barely educated or uneducated; male or female), urban wholesalers/retailers (and consumers), and agricultural extension workers, call-making is preferred to any other applications on the GSM.

Policy frameworks and e-agriculture adaptation in Africa

The Rome Declaration on World Food Security and the World Food Summit Plan of Action organised by the United Nations (UN) Food and Agriculture Organisation (FAO) (1996) affirmed that "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." Against this background, the Global Harvest Initiative (GHI) through its annual Global Agricultural Productivity Report (GAP Report 2013) has continued to highlight key policies needed to encourage "more investment and innovation, and to build efficient, sustainable agricultural value chains" towards the attainment of improved "agricultural output to meet the 2050 demand for food, fibre, fuel and other agricultural products globally."

Among other pre-requisites for realising improved food and nutrition security through enhancement of agricultural productivity along value chains, that is, from rural farmers to urban consumers, is the need for adequate and reliable telecommunication systems. As such, routine agricultural loss and storage challenges are bound to be productively mitigated.

In most of the countries in sub-Saharan Africa, there has been an ostensible lack of functional regulatory policies in place to encourage the applications of ICT (in this case, the GSM) in the processes of agricultural production and distribution. Put differently, governments at various levels have failed to explore various possibilities that the platform of the GSM offers in the bid to attain food security, and by implication, making agricultural profession more productive and efficient. Although the "National Policy on Food and Nutrition in Nigeria" had recognised the importance of adequate access to ICT in the bid to make the policy workable, however, it had conspicuously failed to provide any specific

frameworks towards utilisation of various possibilities of the ICT (including the GSM) in the drive toward sustainable agriculture and attainment of food security in Nigeria. As noted in the policy: "the food distribution system in Nigeria remains largely inefficient due to factors such as crop seasonality, inadequate storage technology and facilities, inadequate transport and distribution systems, and inadequate market information. All of these result in considerable spatial and seasonal variation in food production and availability, and are responsible for the considerable food price variations in the country" (National Planning Commission [NPC] 2001). In Nigeria, the problem of inadequate food storage facilities has inhibited food availability, especially at the household level, whereas the existence of functional mobile telephony would have provided an alternative source for the timely transportation of agricultural produce from rural producing areas to urban consuming areas. "Losses of cereals such as maize, millet and sorghum, are estimated in the range of 25% to 30%; for root crops, from 50% to 70%, and approximately 70% for fruits and vegetables." Equally, inadequate storage facilities and economic pressures have continued to force rural farmers to sell their produce as soon as they are harvested (otherwise the produce will result in wastage) at routine ridiculously low prices. Of course, adequate access to relevant ICT facilities, such as the GSM, for productive business networking would have improved the "selling power" of the rural farmers and enabled the drive towards the attainment of food security for all.

In the light of the foregoing, none of the set targets of the National Policy on Food and Nutrition in Nigeria has been realised, largely because of the existing disconnect between the rural producing areas and urban consuming areas. Such set targets have included:

i. Reducing the level of poverty by 10% by the year 2010.
ii. Reducing starvation and chronic hunger to the barest minimum through increased food intake.
iii. Reducing under-nutrition, especially among children, women, and the aged, and, in particular, severe and moderate malnutrition among under-fives by 30% by the year 2010.
v. Reducing micronutrient deficiencies, particularly iodine deficiency disorders (IDD), vitamin A deficiency (VAD), and iron deficiency anaemia (IDA) by 50% of the current levels by the year 2010.
vi. Reducing the rate of low birth weight (2.5 kg or less) to less than 10% of the current levels by the year 2010.

vii. Reducing diet-related, non-communicable diseases by 25% of current levels by the year 2010.
viii. Improving general sanitation and hygiene, including the availability of safe drinking water.
ix. Reducing the prevalence of infectious and parasitic diseases that aggravate the poor nutritional status of infants and children by 25% of the current levels.

On the part of the GSM service providers, specifically in Côte d'Ivoire and Nigeria, there have been no deliberate policies in place to encourage the application of specific GSM packages in the processes of food production and distribution. Since governments at various levels have been quite inactive in exploring various possibilities as presented by the GSM platform in enhancing agricultural productivity, and to a considerable extent, in helping the course of the drive towards food security, the GSM service providers have equally been lackadaisical towards devising any specific interventionist package for the rural farmers and the urban distributors in the processes of agricultural production and consumption, respectively.

CHAPTER FOUR

COMPARATIVE FIELD ANALYSES OF ICT APPLICATIONS IN THE AFRICAN AGRICULTURAL SECTOR

In this segment of the book, relevant comparative details obtained from the field investigations are analysed. Further, a discussion of the procedures engaged in analysing all the gathered data and related findings so emanating is presented.

Table 2. Distribution of research participants in Côte d'Ivoire according to the regions of study.

Surveyed district / participants	Cooperatives	Farmers		Distributors		Consumers		Total
Gender of participants		M	W	M	W	M	W	
Soubré and environs	2	4	7	4	9	2	6	32
Korhogo and environs	3	3	3	3	3	1	6	19
Total	5	7	10	7	12	3	12	51

Table 3. Distribution of research participants in Nigeria according to regions of study

Surveyed district / participants	Cooperatives	Farmers		Distributors		Consumers		Total
Gender of participants		M	W	M	W	M	W	
Ilesha East LGA (Ilesha and Ilo)	3	8	8	7	6	5	9	43
Ife Central LGA (Ile-Ife and Aba Iyagani)	3	7	9	8	8	4	8	44
Total	6	15	17	15	14	9	17	87

Tables 2 and 3 above indicate that individuals ranging from representatives of farm/food cooperatives to rural farmers, to distributors (including truck drivers and urban retailers and wholesalers), to the final consumers (or buyers) were engaged in the research.

Table 4. Distribution of research participants in Côte d'Ivoire according to locations of study (region of Soubré).

Town/Village	Cooperatives	Farmers	Distributors	Consumers	Total
Soubré town	1	1	4	3	8
Koreyo I	-	2	3	2	7
Logboayo,	-	2	4	1	7
Sokozoua	1	2	1	1	4
Oureyo	-	4	1	1	6
Total	2	11	13	8	32

Table 5. Distribution of research participants in Côte d'Ivoire according to locations of study (region of Korhogo).

Town/Village	Cooperatives	Farmers	Distributors	Buyers	Total
Korhogo town	1	1	3	3	7
Gbalogo	-	1	1	1	3
Gbaméleguekaha	-	2	1	2	5
Takalé	1	1	1	1	3
Natchokobadara	1	1	-	-	1
Total	3	6	6	7	19

Table 6. Distribution of research participants in Nigeria according to locations of study (Ilesha East LGA).

Town/Village	Cooperatives	Farmers	Distributors	Buyers	Total
Ilesha Town	1	4	3	2	9
Atakunmosa	-	3	4	3	10
Ilo Ayegunle	-	3	2	2	7
Ilo I	1	3	2	3	8
Ilo II	1	3	2	4	9
Total	3	16	13	14	43

Table 7. Distribution of research participants in Nigeria according to locations of study (Ife Central LGA).

Town/Village	Cooperatives	Farmers	Distributors	Buyers	Total
Ile-Ife Town	1	3	4	2	9
Ajebandele	1	3	2	2	7
Aba Iyagani	-	4	4	3	11
Old Market	1	3	3	3	9
Eleweran		3	3	2	8
Total	3	16	16	12	44

Tables 4, 5, 6, and 7 present the attributes of the research participants in all the study locations in Côte d'Ivoire and in Nigeria in greater detail. It is important to note that the grand total for all the study locations did not reveal the total number of representatives from the farm and food cooperatives (that is, 32 for Table 4, 19 for Table 5, 43 for Table 6, and 44 for Table 7). In the case of the cooperatives, we have engaged a focus group approach in sourcing useful information for the investigation.

With the exception of a small number of study locations—Ilesha Town, Atakunmosa, Ife Town and Old market (Nigeria); Korhogo market and Soubré market (Côte d'Ivoire)—the rest of the study locations were rural (farm) locations—Ilo Ayegunle, Ilo I, Ilo II, Ajebandele, Aba Iyagani and Eleweran (Nigeria); Koreyo I, Logboayo, Sokozoua, Oureyo, Gbalogo, Gbameleguekaha, Takale, and Natchokobadara (Côte d'Ivoire). While the population of most of the rural (or farm) locations in Nigeria range from 700 to 1,200, most of the rural (or farm) locations selected for the investigation in Côte d'Ivoire range from 250 to 600. While none of the research subjects in rural (or farm) settlements in all the study locations in Côte d'Ivoire and in Nigeria had received more than a primary education (especially, among the female participants), most of the research subjects in the urban areas in Côte d'Ivoire and in Nigeria had received either a primary or middle school education. All our research subjects in all the study locations were over the age of 18 years.

Interestingly, all our research participants in Côte d'Ivoire and Nigeria (farmers, transporters, wholesalers, retailers, and buyers [consumers]) dealt in a wide variety of crops and foodstuffs. These included rice, maize (corn), banana, cassava, yam, eggplant, okra, cabbage, and pepper. Nearly all the farmers engaged in the study practised multiple cropping with cassava and yam being the most common crops in the case of Nigeria and cabbage and eggplant being the most common crop in the case of Côte d'Ivoire. The average household income of the farmers in the case of Côte d'Ivoire ranges from CFA 5,000 to CFA 850,000 (that is, approximately

US$10 to US$1,700) per month and the average household size was fewer than six people. In the case of Nigeria, the average household income of the farmers ranges from N 3,000 to N 200,000 (that is, approximately US$17 to US$1,180) per month and the average household size was five. Individuals who were affiliated with various farm and food cooperatives had a better income within the system in both Nigeria and Côte d'Ivoire. That is, farmers generate income ranging from CFA 180,000 to CFA 1,000,000 (that is, approximately US$ 365 to US$ 2,000) per month in the case of Côte d'Ivoire and income ranging from N 85,000 to N 340,000 (that is, approximately US$ 500 to US$ 2,000) in the case of Nigeria.

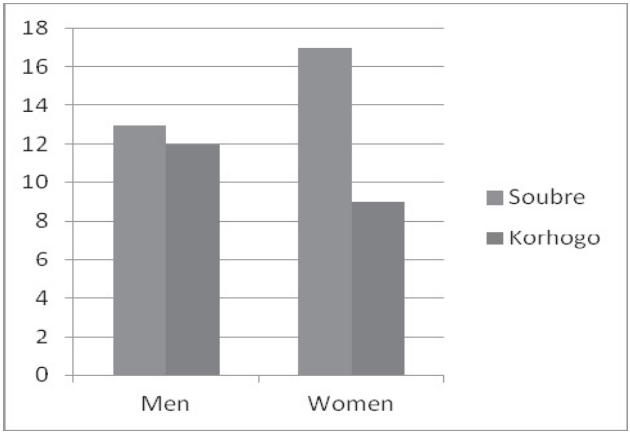
While all the research participants in Côte d'Ivoire claimed they had access to irrigation facilities, most of the people in Nigeria relied on rainfall to nurture their crops to harvest. Meanwhile, access to storage facilities and credit institutions was a recurring problem that was common in both Côte d'Ivoire and Nigeria. Considering the transportation system, the average age of trucks for food transportation in Côte d'Ivoire was 13 years, and in Nigeria it was 15 years. Wholesalers and retailers of food crops were very active in the system and were largely women (that is, approximately 92% in the case of Côte d'Ivoire and 78% in the case of Nigeria). Within the urban areas in Côte d'Ivoire (Korhogo and Soubré), 68% of the research participants had access to at least one mobile phone with the capacity for two SIM cards. In Nigeria, 82% of the research participants in the urban centres (Ilesha and Ile-Ife towns) owned at least one mobile phone with the capacity for one SIM card, while 71% of the research participants in the rural agricultural settlements (that is, Ilo Ayegunle, Ilo I, Ilo II, Ajebandele, Aba Iyagani, and Eleweran) had access to a minimum of one mobile phone with capacity for one SIM card.

However, some research participants in the region of rural Korhogo (Côte d'Ivoire) refused to be recorded because they believed that evil spirits could use their recorded voice for spell casting. In such cases, we had to transcribe their responses on a notepad.

Results of investigations: Profile of food producers and food production

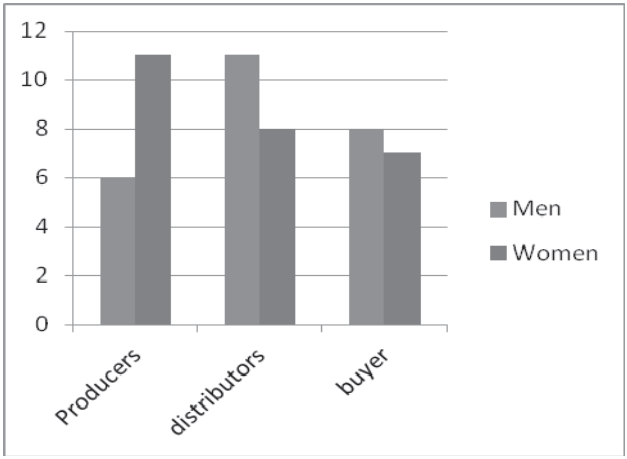
One hundred and two participants were engaged in the study within the localities of Korhogo and Soubré in Côte d'Ivoire as indicated in Figure 4 below. It is interesting to note that in both cases, that is, Korhogo and Soubré, there was active participation across all gender categories. This development has been quite similar to the situation in Nigeria, at both rural and urban levels.

Figure 4. Distribution of respondents in Korhogo and Soubré (Côte d'Ivoire).



As can be observed in Figure 5, three categories of individual participants have been identified in the study locations of Korhogo and Soubré in Côte d'Ivoire. These categories of individuals have been equally identified in the case of the Nigerian locations: both in urban and in rural settlements.

Figure 5. Categories of stakeholders in food supplies in Korhogo and Soubré (Côte d'Ivoire).



As can be inferred from Figure 5 above, a greater number of women have been working as producers of food crops (that is, rural farmers) in both Korhogo and Soubré, Côte d'Ivoire. Meanwhile, in the case of Nigeria, more men were working as rural farmers compared with the percentage of women farmers (that is, a ratio of 63:37). Hence, one could affirm the feminisation of food production in Côte d'Ivoire relative to the Nigerian situation.

Among the research participants who were involved in food distribution, retailing, and final purchasing, more men have been identified for all the study locations in Côte d'Ivoire. However, the Nigerian case contradicts the extant Ivorian version. In all the study locations in Nigeria, both men and women have been equally involved in the process of distributing food crops from rural areas to urban centres, while a considerable percentage of women research participants, that is, 78%, have been functioning as either wholesalers/retailers or final buyers/consumers.

Nevertheless, it has been noted in our investigations that in all the study locations in Côte d'Ivoire and Nigeria, major food crops of production and distribution have revolved around rice, corn, banana, plantain, cassava, yam, eggplant, okra, and pepper. This affirmation has been justified by the quantity of these types of produce cultivated, harvested, distributed, and consumed per year across all the locations engaged in the study in Nigeria and in Côte d'Ivoire. Meanwhile, a significant measure of variation, in relation to the volume of food production, has been noted between the two major regions of study in Côte d'Ivoire, that is, Korhogo and Soubré. Such an extent of difference is presented in Tables 7 and 8.

Comparing Tables 8 and 9, it is observable that food production has increased considerably in the south-west area relative to other areas in Côte d'Ivoire. Although, the two tables indicate an increase in food products' distribution by 12% per year in Soubré and 9% per year in Korhogo, it has been noted that food production, which was around 31,520.55 tons in the south west, was significantly less in the northern area; as such, food products are not adequately distributed within the zone.

Table 8. Profile of food producers and the rate of food production (Korhogo).

Food Crops	Farmers monitored ANADER			harvested areas (ha)			Production (t)	Prod. (t/ha)
	Men	Women	total	Men	Women	total		
Rice	5	0	5	15	0	15	44,1	2,94
Corn	25	16	41	27,5	17	44,5	64	1,44
Banana	0	0	0	0	0	0	0	0,00
Cassava	0	0	0	0	0	0	0	0
Yam	0	0	0	0	0	0	0	0
Eggplant	83	0	83	42,8	0	42,8	684,8	16,00
Okra	16	27	43	9,5	35	44,5	312	7,01
Pepper			0			0		0,00

Source: ANADER (2011).

Table 9. Profile of food producers and the rate of food production (Soubré).

Food Crops	Farmers monitored ANADER			harvested areas (ha)			Production (t)	Prod. (t/ha)
	Men	Women	total	Men	Women	total		
Rice	113	16	129	144,5	10,5	155	386,82	2,50
Corn	727	144	871	611,5	109	720,5	1035,53	1,44
Banana	91	3	94	224,82	9	233,82	0	0,00
Cassava	698	1099	1797	435	712,25	1147,3	18701,54	16,30
Yam	127	0	127	133	0	133	2609	19,62
Eggplant	442	314	756	274,87	146,78	421,65	6570,4	15,58
Okra	380	194	574	160,4	145,75	306,15	2143,55	7,00
Pepper	46	32	78	7,55	4,38	11,93	73,71	6,18

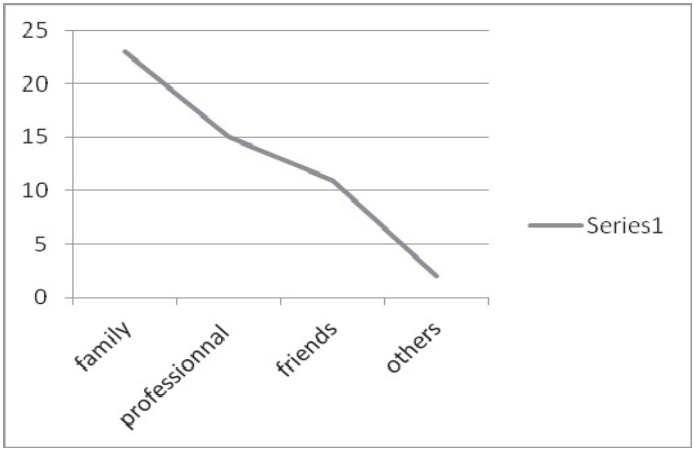
Source: ANADER (2011).

Analysis of usage of ICTs in the food chain

In all the study locations in Côte d'Ivoire and Nigeria, the meaning of ICTs and how mobile phones could be engaged in the food chain were not particularly clear to the majority of research participants. This situation was tenable for both rural and urban areas and for areas of both high and low production. Across the research locations (rural and urban) in Côte d'Ivoire, an average of 3% of the research participants knew what a computer is, while in Nigeria, an average of 5.3% knew what a computer is. However, 100% of the research participants in Côte d'Ivoire responded "No" to the question: "did you ever handle it [i.e., a computer]"?

Meanwhile, 97% of the research participants in Côte d'Ivoire had indicated that mobile phones are very useful to their existence as a whole. In Nigeria, nearly all (more than 95%) of the research participants believed that mobile phones are very critical to their daily business and family activities.

Figure 6. Reasons for using mobile phones (Côte d'Ivoire).



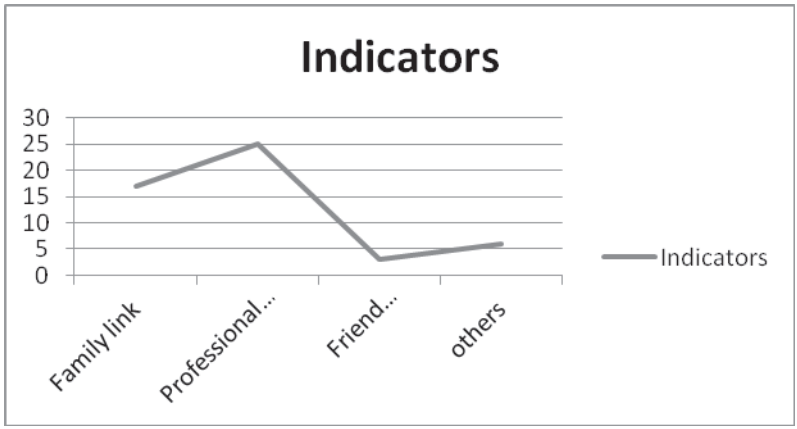
Unlike in the cases of the majority of the research participants in both rural and urban Nigeria, who primarily use their mobile phones for "business purposes," the majority of the research subjects in rural and urban Côte d'Ivoire routinely engage their mobile phones for "family concerns." While "business usage" closely follows "family concerns" in the hierarchy of mobile phone applications in both rural and urban Côte

d'Ivoire, "family concerns" occupied the second position in the Nigerian case (both rural and urban). In both Côte d'Ivoire and Nigeria (rural and urban), however, "leisure purposes" (as denominated by "friends") has been given a similar measure of significance, that is, taking the third position across the two countries. Mobile phones were rarely used for any other purposes except those already identified in both Côte d'Ivoire and Nigeria (rural and urban). However, the distribution differs by occupational categories in the sector and by whether one is male or female.

Specific impacts of mobile phones on food production and distribution

Among those research participants who applied GSM phones in conducting their daily routines in Côte d'Ivoire and in Nigeria (rural and urban areas), 100% indicated the existence of a strong improvement in the processes of food production and distribution as a result of coverage of their locations by various GSM service providers. Meanwhile, related improvements have come in varying dimensions.

Figure 7. Level of application of mobile phones (Nigeria).

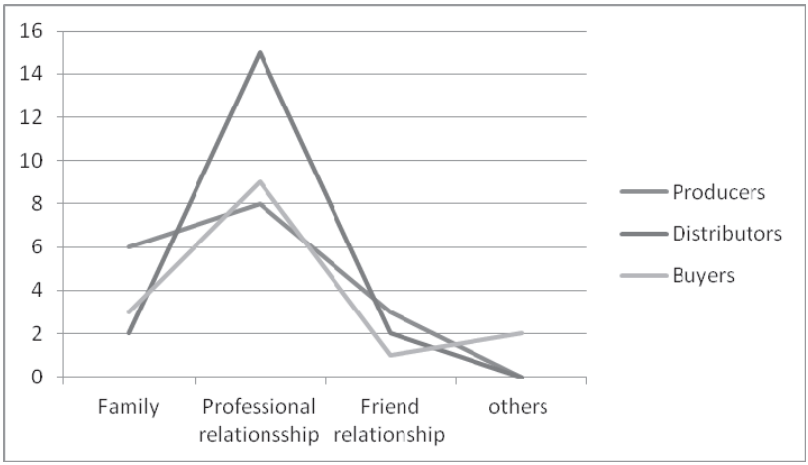


Across all the study locations in Nigeria (rural and urban), it has been quite visible that most of the research participants primarily use their mobile phones for "business purposes," as earlier noted, relative to the Ivorian case (see Figure 7 above as indicated with "Professional Relationship").

Extent of application of mobile phones by the stakeholders

In all the research locations, a remarkable variation exists in the extent to which various stakeholders, that is, the producers (rural farmers), the distributors (middlemen/women) and the buyers (wholesalers/retailers/final consumers) engage their mobile phones in their day-to-day routines. Figure 8 below presents an analysis of the level of use of GSMs in various activities of the research participants. In all the research locations in Côte d'Ivoire and in Nigeria, the distributors of food produce clearly surpass all other stakeholders in the actual application of mobile telephony in conducting daily business routines. They are distantly followed by the producers (that is, the rural farmers) and the buyers (that is, the wholesalers/retailers/final consumers) (see Figure 8 below).

Figure 8. Extent of usage of mobile phones by the stakeholders.



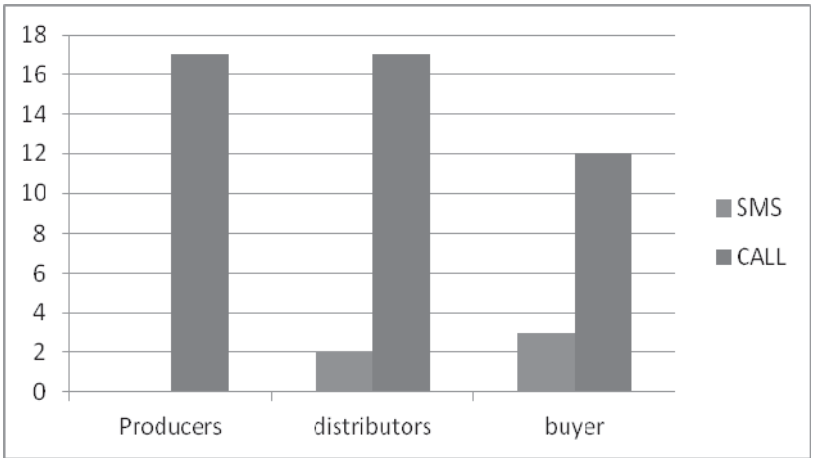
Specific application (s) of mobile phones by the stakeholders

In Côte d'Ivoire, over 63% of distributors of food products considered mobile phones an indispensable tool in their daily business activities, while in Nigeria, an average of 71% of all categories of research participants (that is, the producers [rural farmers], the distributors [middlemen/women], and buyers [wholesalers/retailers/final consumers])

believed that mobile phones are imperative for conducting their daily businesses of food production and distribution.

Across varying categories of stakeholders in all the study locations in Nigeria and in Côte d'Ivoire, however, "calls" are preferred to all other media (for instance, text messages, and internet surfing) for conducting daily routines over GSM phones (see Figure 9 below).

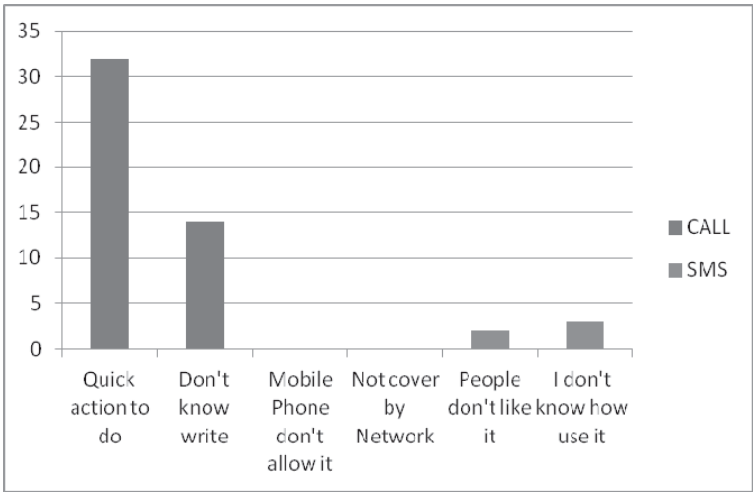
Figure 9. Preferred application (s) of mobile phones by stakeholders.



Justification(s) for preferences for specific application(s) of mobile phones by stakeholders

Relatively, "call-making" occupies a prominent positioning in the process of using mobile telephony by stakeholders engaged in the study in both Côte d'Ivoire and Nigeria. The SMS and other applications were used occasionally in conducting daily routines by the stakeholders (that is, the producers (rural farmers), the distributors (middlemen/women), and the buyers (wholesalers/retailers/final consumers) (see Figure 10 below).

Figure 10. Justification for preferences for specific application(s) of mobile phones.



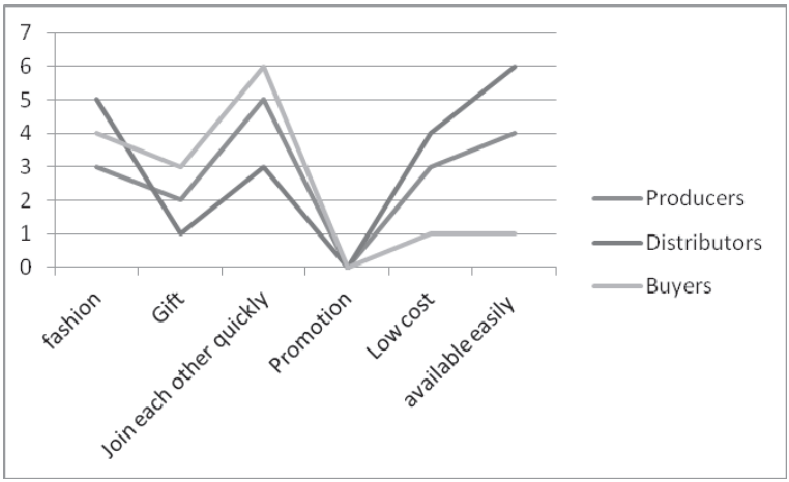
Although illiteracy has been generally presented as an important consideration for all the research subjects' preferences for engaging "calls" to the detriment of text messages (and other applications of GSM phones) in all the study locations in Nigeria and in Côte d'Ivoire, the shorter period that it takes to make calls relative to other applications has made "call-making" popular and, indeed, the most preferred. This could be observed in the rate of stakeholders (that is, the producers [rural farmers], the distributors [middlemen/women] and the buyers [wholesalers/ retailers/final consumers]) who fall within the "quick action to do" category in Figure 10 above.

It has been quite obvious that the "quick action to do" is the main reason for the use of "calls," as well as for most illiterate persons in the food chain. The use of SMS has been very difficult to conceive among all the research subjects in all the study locations in Nigeria and in Côte d'Ivoire. Also, the "I do not know how to use it" category has been quite supportive of the unpopularity of non-utilisation of the SMS by a significant proportion of the research participants.

Reason(s) for acquisition of mobile phones by individual stakeholders

Within the web of food production and distribution across various locations for this study in Nigeria and Côte d'Ivoire, the reasons for acquisition of mobile phones by individual participants range from justification as fashion, as gifts, "join each other quickly" syndrome, promotions by service providers, low cost, and availability (that is, ease of accessibility) (see Figure 11 below).

Figure 11. Reason(s) for acquiring mobile phones by individual stakeholders.



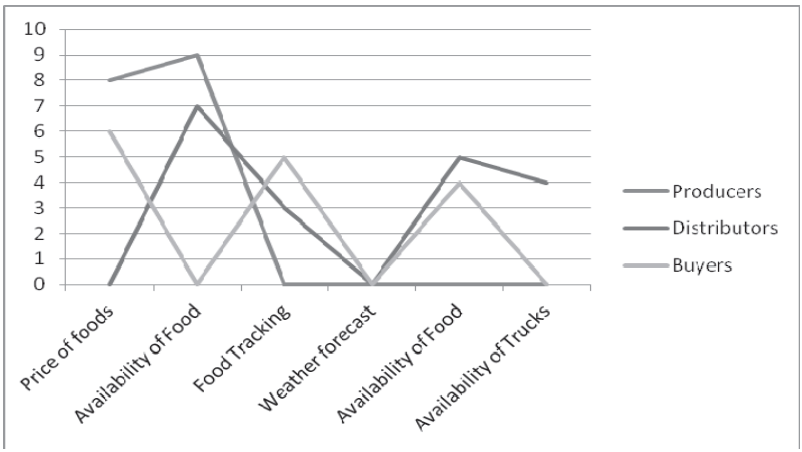
On a general note, the relative ease with which individual stakeholders sometimes access mobile phone markets, courtesy of their low costs and the extant status (or ego) consideration, as indicated by the "join each other quickly" syndrome, have been the most important determinants of why mobile phones have become popular across all the study locations in Nigeria and in Côte d'Ivoire.

Specific use(s) of the mobile phones by individual stakeholders

Moreover, in this study, it has been observed that individual stakeholders (that is, the producers [rural farmers], the distributors [middlemen/women], and the buyers [wholesalers/retailers/final consumers]) who engage mobile

phones in their businesses vary according to the specific roles they play or the specific functions they expect their mobile phones to perform for them within the chain of food production and distribution. The content analysis engaged in the research has enabled the observation of six major themes that were prominent in their daily interactive exchanges. These are "price of food," "availability of food," "food tracking," "weather forecast," "availability of trucks," and "availability of stocks areas" (see Figure 12 below).

Figure 12. Specific use (s) of the mobile phones by individual stakeholders.



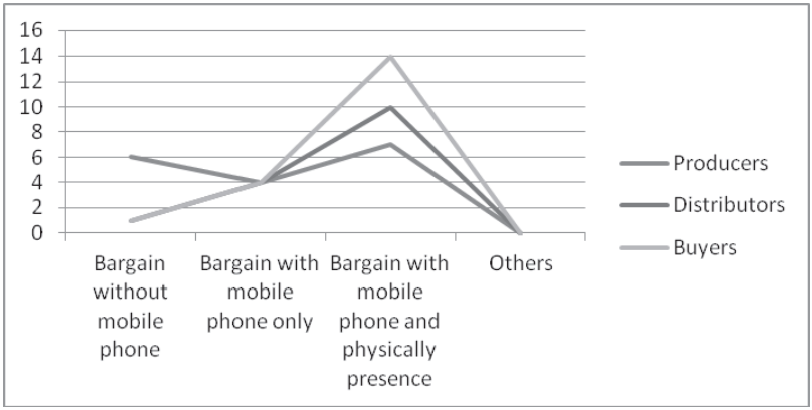
Thus, using mobile phones to discover the current "Price of foods" is more popular with producers (that is, rural farmers). They routinely seek to have contact or to transport their food stocks to the city to get a better price. This was closely followed by "availability of foods," which was common with the stakeholders, especially the distributors of food produce. Notably, the use of mobile phones to discover the current "price of foods" was equally common with buyers (that is, the wholesalers/retailers/final consumers).

Justification(s) for specific use of mobile phones by stakeholders

The reasons given by most of the research subjects across all the research locations in Nigeria and in Côte d'Ivoire were similar: that is, the need to

balance information between the demand and the supply of food products (see Figure 13).

Figure 13. Reason(s) for the specific use(s) of mobile phones by stakeholders.



In all the study locations, it has been quite conspicuous that mobile phones have been very helpful in facilitating business negotiations in the food chains, but that they cannot intervene productively in such negotiations in isolation. Against this background, all classes of research participants (that is, the producers [rural farmers], the distributors [middlemen/women], and the buyers [wholesalers/retailers/final consumers]) were unanimous on the significance of combining mobile telephony (calls) with physical interactions in order to make the chains of food production and distribution productive, effective, and indeed, sustainable.

Nature of pre-mobile telephony village–city food distribution in Côte d'Ivoire and Nigeria

Ostensibly, the pre-mobile telephony process of getting food from the countryside to the towns or cities in both Côte d'Ivoire and Nigeria has been patterned in a similar way. In both cases, mobile market women had played a prominent role. Indeed, they were central to the entire networking system that propelled related functioning. Such mobile market women in Côte d'Ivoire had functioned within the framework of the "chain of grandmother," while those in Nigeria had operated within the prism of "Alajapa," that is, trans-cultural mobile market women.

A central step in understanding the evolution of the food distribution system in Côte d'Ivoire is to revert to the system of hereditary distributive "chain of grandmother" and the way that market situation constructs the pricing system.

Just like the "Alajapa" system in Nigeria, the "chain of grandmother" system in Côte d'Ivoire has been an important intervening element in the process of getting food products from the producers in the rural agricultural villages to the retailers (and/or consumers) in the urban consuming areas. The "chain of grandmother" primarily draws on the engagement of subsisting traditional affinity or familial cleavage in the process of conducting businesses. The "chain of grandmother" indicates mainly the capacity for younger women to internalise the distributive business philosophy of their mothers and grandmothers and apply it in entering the web of food distribution between rural producing areas and urban consuming areas. This trend had equally been applicable in the case of the "Alajapa" in Nigeria. The term "chain of grandmother" had been developed by women in the regions of Korhogo and Soubré (Côte d'Ivoire) to project the business of food distribution as essentially hereditary. In a similar pattern, the women in the areas of Ilesha and Ile-Ife (Nigeria) had devised the practice of "Alajapa" as essentially an entrepreneurial means of bequeathing related distributive business endeavours to their offspring. Participation in the processes of food production, distribution, and marketing by individuals has been, to a considerable extent, a function of bequeathing a form of legacy to the younger generations. Women who were largely illiterate developed this system of distributive business undertaking well before the advent of the modern mobile communication system. Essentially, the "chain of grandmother" system (in Côte d'Ivoire) and the "Alajapa" system (in Nigeria) had been predicated on a kind of "mouth-to-ear" communication, which was clearly devoid of any intervening technology. The arrangement of logistics between producers, truck drivers, wholesalers, and retailers was based on a series of physical meetings.[3] Even though the majority of respondents had considered this approach as being quite difficult when determining the scheduling and pricing of farm produce, the physical contact has had the advantage of maintaining trust among stakeholders in the food distribution business.

Whenever a buyer from the countryside secures products for a retailer in the city, they usually negotiate a price and then mark the bags of produce with a piece of fabric that has the individual tag of the retailer.

[3] Sometimes, there are middlemen or -women between them. In such cases, the sender is obliged to pay the transportation of the middlemen or -women until the contact transforms the business relationship.

Such pieces of clothing with a unique colour and pattern must have been inherited from the retailers' forbearers (usually transferable from great grandmothers to grandmothers, to mothers, to daughters). They ordinarily enabled the truck drivers (or the transporters) to deliver the goods (farm produce) to the appropriate recipients in the city. The truck drivers had become an important instrument of communication in such cases (that is, between the rural producers and the urban retailers [and consumers]). Given the established nature of this system, there was no visible requirement for mobile communication.

Furthering the "chain of Grandmother" system, a group of women from Gouro, central-west Côte d'Ivoire, had during the economic downturn of the mid-1980s engaged in the process of food distribution from rural areas to urban centres. Of course, many husbands of these Gouro distributive businesswomen had lost their jobs due to the economic woes brought by the structural adjustment programme (SAP). Hence, the responsibility of household upkeep had fallen on this class of Gouro distributive businesswomen. As a matter of routine, they were in touch with various groups of food producers across different villages in Côte d'Ivoire. They usually organised in cooperatives and built on their capabilities as the connections between rural food producers and urban food retailers (and consumers). They were able to establish a sustainable association with the transporters, wholesalers, and retailers functioning within the web of food production and distribution system. As a matter of necessity, the physical contact between buyers and producers was a very important consideration in determining the quantity of food to be produced by the producers. Nevertheless, the contract was basically oral.

The process of determining the prices of food produce takes place within two realms: the farm and the market. Stakeholders usually inscribe the prices of various food products on the bags that contain them. Sacks of 50 kg capacity were usually used by the stakeholders. Meanwhile, prices for various products were routinely commensurable with the value of such products. Producers who were questioned indicated that the prices were also based on the frequency of rainfall during the planting season. As such, in situations whereby prices were mutually agreed upon by stakeholders, seasonal climatic conditions were also a significant determining factor. Prices for farm produce are physically constructed by the producers and buyers with the dimension ("full" or "not full") of the variable "bag of 50 kg," which puts into perspective prevalent climatic condition. For instance, the farm-gate price of a 50 kg bag of tomatoes was approximately equal to a 50 kg bag of plantain, although the products are different. A quick justification for this practice, according to the people, was to avoid

contradictions in transportation costs since the bags of 50 kg grades are used as a measure in the determination of boarding prices. In another district, the 50 kg bag was the only one that could be accessed easily in rural producing areas. In fact, in the words of some respondents, these bags were distributed freely by cooperative operators since the rural farmers paid taxes on their incomes to various cooperative organisations to which they were affiliated.

Another system of pricing for farm produce had entailed determination by market forces within different towns (around the areas of production). These processes of pricing farm produce were influenced by the specific area of production, the truck fees, the wholesalers, and retailers. As such, discussions for pricing farm goods depended largely on a mixture of procedures that were essentially associated with specific expenditure made by the producers and the buyers. It is worth noting that despite the usage of modern mobile communication technology, for instance GSM phones, related physical exchanges among stakeholders in the web of food production and distribution were still predominant (in Côte d'Ivoire and Nigeria). Essentially this is down to trust: existing interpersonal interaction has traditionally been the driver of ongoing business relationships. Transportation of food products by trucks was usually negotiated physically in the presence of the stakeholders. Initially, one third of the amount due for transporting foods to town was paid. However, such an informal arrangement of businesses often resulted in marriage between the woman (wholesaler) and the truck driver (transporter). In the course of this investigation, three such cases were reported in Soubré (Côte d'Ivoire) and none were reported in the case of Korhogo (Côte d'Ivoire). Meanwhile, in the case of Nigeria, such cases were very common occurrences within the study locations of Ilesha and Ile-Ife.

Inferring from the foregoing, it has been clear that the process of pricing farm produce across the length and breadth of the study locations (that is, in the "Alajapa" system in Nigeria and in the "chain of grandmother" system in Côte d'Ivoire) had been largely driven by extant subjective considerations. The pricing system has not primarily made relevant the forces of supply and demand. Rather, it has focused on the subsisting nature of stakeholders' relationship in determining prices for farm produce.

Impact of mobile telephony on food production and distribution

Across the length and breadth of all the study locations in Nigeria and in Côte d'Ivoire, all the actors in the systems of food production and distribution had been in contact before the introduction of GSM phones; nevertheless, the advent of mobile telephony has improved the volume and frequency of business interactions among the research participants.

Our interactions with some of the stakeholders allowed us to juxtapose relevant issues pertaining to pre-mobile phone and post-mobile phone production and distribution of food products:

> . . . previously, we used to have [a] regular link with the food distributors who were the wholesalers. And on each market day set by the village leadership, their trailers and trucks were allowed to carry goods from other villages, even, to our markets. Such trailer/truck drivers were also the conveyors of information between the buyers and us (producers). Since they usually brought relevant information on prices of goods from other markets to us, even the quantity and the availability of specific foodstuffs, the truck drivers (transporters) were central to the entire food networking process. Nevertheless, a significant proportion of our farm produce was still being lost due to [the] non-existen[ce] of reliable preservation technology. But today with the advent of cheap mobile phones, we [the food producers] are able to keep in touch with both buyers and transporters. (IDI, rural farmer, female, 54 years, Soubré, Côte d'Ivoire, 1 December 2013)

> . . . really, before the arrival of mobile phones in our village, we had suffered a lot because we did not know how to get the prices of rice (and other food stuffs) from other villages so as to know how we could fix our own prices for our products. Honestly, I was producing and selling at a massive loss and it had been very painful. (IDI, male, rural farmer, 29 years, Korhogo, Côte d'Ivoire, 3 December 2013)

> . . . my life has improved since I . . . acquired a cell phone. I can now follow the movement of various orders for food products that I asked from the producers of okra in the village. . . . the problem that we have has always been the unreliability of the network. It has been very epileptic. It does not cover the whole town and the surrounding villages and we need regular electricity supply to charge our phones from time to time. . . . (FGD, female, urban food wholesalers/retailer, 40 years +, Soubré, Côte d'Ivoire, 5 December 2014)

> . . . since the introduction of the mobile phones in our village (Ilo, Nigeria), I have always been kept abreast of information on the specific food stuffs

> that my customers in Ilesha town require. My phone has helped me to know when to make supplies to the city of Ilesha and its environ and to know the actual quantity needed. Sometimes, I would just inform my customers of the available products so that they could come for them. My (GSM) phone has changed my life for better . . . (IDI, female, rural farmer, 45 years, Ilo [Ilesha], Nigeria, 3 January 2014)

> . . . with the coming of the GSM (mobile phones), business in this market has never remained the same. The process of sourcing for food stuffs from the village has become very easy; and more importantly, unnecessary travelling has become a thing of history. Notably, profitability of our businesses has been enabled further by the introduction of the GSM. This development has been mutually benefiting to us and the farmers in the village. . . . (IDI, male, food retailer, 32 years, Ilesha, Nigeria, 5 January 2014)

> . . . the GSM has changed our lives for good. Besides making the process of getting food products from the village to our market in the town less cumbersome, the frequency of supplies has been outstanding. As such, we have been empowered to make food products available to our customers (consumers) regularly. The process of our business relation with our customers and suppliers has continued to be oiled since all stakeholders have been benefiting. This has equally been helpful to accruing income to us (that is, the urban wholesalers/retailers) and the producers (that is, the rural farmers) . . . (FGD, female, urban food wholesalers/retailers, 18–39 years, Ile-Ife, Nigeria, 14 December 2013)

One could easily infer from the foregoing submissions, across all the study locations in Nigeria and in Côte d'Ivoire, that the impact of mobile phones has been quite enormous on the transformation of the socio-economic status of all individuals who have been involved in the systems of food production and distribution. Aside from enhancing the income of both rural producing farmers and urban distributing business owners, it has equally left a significant mark on extant patterns of social relations across the length and breadth of the two study locations.

Figures 14 and 15 above reveal that a positive correlation exists between the increasing income of women who had worked as distributors of food products and the acquisition of mobile phones. Interestingly, this frequency increases with the number of mobile phones acquired and the number of daily calls made (see Figure 15).

Figure 14. Mean revenue of women in food distribution in Côte d'Ivoire, 2000–2010.

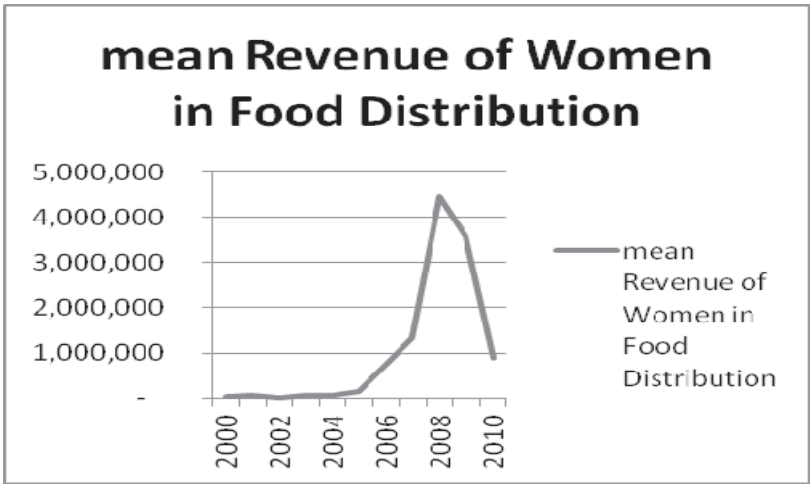
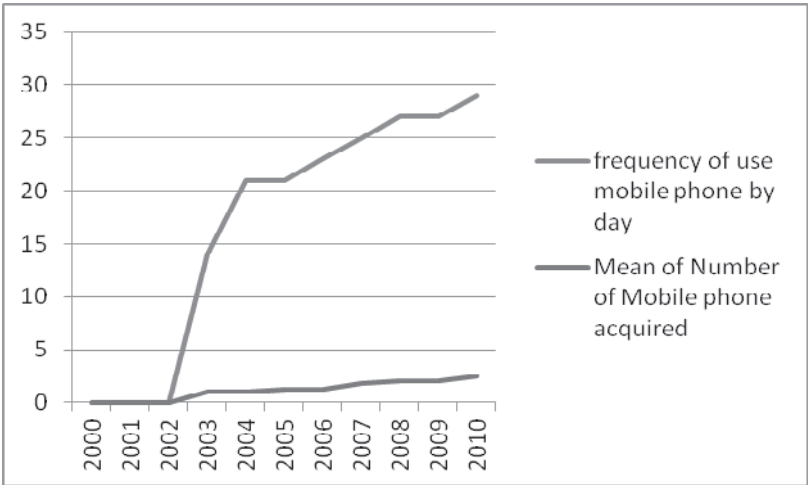


Figure 15. Frequency of using mobile phones and number of mobile phones acquired.



Mobile telephony from the perspectives of different actors in the food chain

Our analyses so far have indicated that mobile phones could have varying meanings and values to different individuals depending on the position and the use to which various stakeholders put them. In what follows below, we explore the production and distribution connotations of the usefulness of mobile phones, putting into cognisance various stakeholders within the web of the food chain.

i. Production perspective

On the production side, we focus on a single category of stakeholders (that is, the producers or the farmers in the rural areas or villages). Three types of producers were included in the analysis: small scale—including those with informal "kitchen gardens" or *jardin* (in Côte d'Ivoire) or *oko etile* (in Nigeria), medium-scale and large-scale producers. In Côte d'Ivoire, 17 farmers were involved; that is, 11 in Soubré and 6 in Korhogo. In Nigeria, 21 farmers were involved; that is, 11 in Ilesha LGA and environs and 10 in Ife LGA and environs. Tables 10 and 11 below present an overview of the farmers who were engaged in the investigation:

Table 10. Types of food producers interviewed in Côte d'Ivoire (Soubré and Korhogo).

Producers	Quantity of products (in kg)	Number in sample	Mobile phone used	Relation with recent interlocutors	Economic impact or reason for using mobile phone
Small *(jardin)*	1–250	8	3	Relatives (3)	Time savings Family strengthening
Medium	250–1000	6	5	Relatives (4) Business (1)	Family strengthening Time savings
Large	1000 kg- +	3	2	Relatives (2) Business (2)	Family strengthening Time savings
Total		17	10		

Table 11. Types of food producers interviewed in Nigeria (Ilesha and Ile-Ife).

Producers	Quantity of products (in kg)	Number in sample	Mobile phone used	Relation with recent interlocutors	Economic impact or reason for using mobile phone
Small *(jardin)*	1–250	8	4	Relatives (4)	Family strengthening Time savings
Medium	250–1000	9	7	Relatives (4) Business (3)	Family strengthening Time savings
Large	1000 kg- +	4	4	Relatives (4) Business (4)	Family strengthening Time savings
Total		21	15		

The data in Table 10 indicates that almost half the farmers in Côte d'Ivoire are small-scale producers; that is, eight.[4] Looking at these eight farmers, about half have a large area for production but a low level of production. Others practise what is termed *jardin*, that is, a type of kitchen garden (household-based farming) that is used for personal consumption. In the case of Nigeria, this group (that is, small-scale producers) was smaller on average—8:13. The size of this household-based farming is usually approximately 10 to 20 m²; located near the home where women and wards cultivate crops. In Côte d'Ivoire, this practice was more common in the areas near Korhogo. And in Nigeria, it was popular in all the study's locations. In addition to being available for domestic use, it could also serve as a source of income for the households. In the words of one of the informants in Korhogo, Côte d'Ivoire:

> …When you have a *jardin*, it prevents hunger from entering your household. You plant what you want around your home and one could be preparing what he or she likes in the kitchen while cutting (or harvesting) from the garden simultaneously . . . generally, it's for subsistence purpose[s] . . . but when the rainy season sets in, we could sell all excess crops that we could not eat in the markets . . . (IDI, female, small-scale farmer, 35 years, Korhogo, Côte d'Ivoire, 30 January 2014)

The concept of small-scale agriculture (that is, *jardin* or *oko etile*) appeared often in the discourse with the research participants. It was noted that tomatoes, pepper, carrot, eggplant, cabbage, and others foodstuffs

[4] The categorisation of the producers is based on the quantity of crops produced and not on the area of production. The quantity of products produced is a more reliable measure since some of the producers have a large area but only have a small output. Thus there is often no noticeable correlation between the area of a farm and its actual food production.

were grown. But when this production exceeds the needs of the immediate family, the woman farmer (or any other member of the household) sells the excess in the nearest market. Thus, the *jardin* or *oko etile* has become an economic opportunity for women especially. On average, the accruing revenues from such practice range from $10–$25 per day of selling. This cash becomes a source of finance with which these women can support their households and purchase personal gadgets, such as mobile phones with which they gradually entrench themselves into the business world (a result of numerous commercial benefits accruable from the use of mobile phones). In contrast, nearly all the women engaged in the study had noted that they sometimes help their husbands monetarily with these revenues besides using such for their personal development.

> . . . whenever my husband needs money to pay for the children's education or for the maintenance of the farm equipment . . . and he has no money, I usually lend him some money accruing from sales of products from my backyard farm. . . . (IDI, female, small-scale farmer, 40 years, Ile-Ife, Nigeria, 7 February 2014)

Expectedly, various interactions between the women (small-scale) farmers and the market had been quite informal; hence, there had been little need for the use of mobile phones. Of course, a considerable number of them did not actually own a phone (see Tables 10 and 11, above).

As observable in Tables 10 and 11, above, large-scale farmers were more likely to own and use mobile phones (although we had a limited sample of this category). It was noted that mobile telephony was primarily used to facilitate logistics in good time (that is, its "time-saving" capability) and in familial interactions. On a general note, familial interaction was often the main motivation for owning a phone across varying categories of actors (significantly, in Côte d'Ivoire). From our investigation, it was only the large-scale producers that were actually using their mobile phones in their line of work. Their GSM phones were utilised in relation to truck drivers, retailers, and wholesalers. Whenever food producers were able to interact with several retailers and wholesalers, then it was often possible to accept bids for goods face-to-face. Nevertheless, some research participants had opined that it was too complex to interact, by carrying out related negotiations, via mobile phones. Indeed, there were well-established meeting points where the producers and the retailers (and the wholesalers) could come together to negotiate the prices and quantities of goods. In such situations, there was usually a large degree of trust involved and this scenario has augured well as a substitute (or a complement) for the use of mobile phones.

However, whenever food producers were interacting with a single retailer or wholesaler, the use of mobile phones was more visible and more productive. In such cases, mobile phones were used to agree on the logistics of transporting food produce from the farm to the market (in the city). This type of interaction was much more common whenever such farm produce was sold to large cooperative organisations based in urban centres.

ii. Distribution perspective

The distribution side, which consists of the analysis of the transportation system and the procedures for marketing (and for the sale of food stuffs) has identified and incorporated three stakeholders: truck drivers, wholesalers, and retailers.

The truck drivers

This research has enabled us to encounter two types of truck drivers: those who were actually food truck drivers and those who were not (that is, door-to-door salesmen or packmen). The latter group consisted of truck operators who did not own a truck, but used their working time prospecting food products for transportation for their colleagues who own trucks. This set of transporters worked as real door-to-door salesmen and were very active in the process of sourcing for trucks that would pick up food stuffs from rural producers for onward transfer to the cities. Of course, their percentage visibly outweighs those for other categories of participants in the food distribution system. In Côte d'Ivoire, 83% was recorded for them, while in Nigeria, 78% was recorded for them.

The services of the door-to-door salesmen (or packmen) were very important within the web of food distribution since they naturally promote the supply of food products to the cities. By implication, they greatly lessened the challenges associated with the producers getting food products to the cities. While 93% of our research participants in Côte d'Ivoire had affirmed that they often engaged the services of door-to-door salesmen, 71% of the research participants in Nigeria had affirmed that they often engaged the services of door-to-door salesmen, especially in order to master the dynamics of the food market situation.

However, with the advent of mobile phones, the functions of the door-to-door salesmen in relation to the rural food producers and the urban buyers have become somewhat improved and relatively more reliable. Hitherto, the first contact often made between the producers and the

buyers has been continuously face-to-face. Related contacts are now made via mobile phones. The primary subject of discussions have remained what the prevalent prices of foods are, which goods were meant for pick up, which were relative to the available quantity, and what was the location(s) for pick up.

While 45% of the door-to-door salesmen in Côte d'Ivoire claimed to own a mobile phone, which they engaged in their daily routines, 58% of the door-to-door salesmen in Nigeria claimed they owned a mobile phone, which they engaged in their daily routines. Meanwhile, the rest of the door-to-door salesmen in all the study locations in Côte d'Ivoire and Nigeria affirmed that they did not require mobile phones in their transactions because they usually carry out their business prospecting missions in all the food-producing villages within their respective areas of coverage before the onset of the harvesting period. Such missions were essentially predicated on an individualised, one-to-one basis; hence, it requires less emphasis on the usage of mobile telephony.

Notably, unlike what was obtainable in Ilesha and Ile-Ife and their environs in Nigeria where mobile phones have become popular platforms for networking between rural producing areas and urban consuming areas, various transactions conducted in the areas of Korhogo and Soubré in Côte d'Ivoire by the door-to door salesmen had not entailed the use of mobile phones. Specifically, 55% of stakeholders affirmed that the bad quality of services provided by the GSM companies discouraged them from engaging their phones in the process of conducting their daily routines.

Interestingly, however, an approximate 85% of the truck drivers engaged in the study in Côte d'Ivoire and 92% of those engaged in Nigeria affirmed their usage of mobile phones and their actual application in the course of their business engagements. They even went a step further by claiming that mobile phones supported their business relationship with other participants within the food chain system. On a comparative note, the truck drivers in Nigeria used their mobile phones more in direct interactions with individual participants (that is, their business-related calls were 83% and their non-business-related calls were 17%). In Côte d'Ivoire however, the truck drivers had exchanges over their mobile phones more with the cooperatives (that is, 73% for direct business calls; 17% with door-to-door salesmen, and 10% with the food producers). Nevertheless, across the length and breadth of the study locations, there was no single exchange made over the mobile phones vis-à-vis mobile money transactions.

Wholesalers or cooperatives

Central to the Ivorian food-production and marketing system are the wholesalers (or the cooperatives), which can function as a typical cartel. These organisations often have an integrated position that includes contact with food producers (with whom they have provided seeds and fertilisers), transportation workers (who work as the conveyors of food products from the rural producing areas to the urban centres) and the provision of a market space in the cities where retailers can order foodstuffs from the cooperatives directly and thereafter sell them to the final consumers. These cooperatives have reliable accounting systems and a leader (who is popularly chosen by relatively older women in the markets, who, often, are the original founders of the cooperatives). As such, these cooperatives occupy a central position in the Ivorian food-production and distribution system. Meanwhile, such a system has been unpopular in the case of Nigeria, although they did exist. The processes of food production and distribution have always reflected a direct negotiating pattern among the participants.

The cooperatives, in the case of Côte d'Ivoire, use the "chain of grandmother" system in the process of delivering produce to the retailers. All women who occupied one position or the other in a cooperative claimed that mobile phones had visibly revolutionised and improved their jobs. The women who manage the cooperatives usually employ their mobile phones in tracking various truck drivers (sometimes, they make calls up to twice a day) to ensure the timely collection of food products from the rural producers, with whom they equally conduct transactions over their mobile phones. These cooperative women equally visit the rural producers in order to have direct, one-on-one interaction vis-à-vis the tendency for a glut or for a dearth of certain crops during a specific season. Since such tips are deemed critical to their business functioning, as it allowed them to watch prices and formulate an idea as to what the nature of future market conditions would be, mobile phones have helped them in obtaining imperative updates from the rural food producers.

In situations where certain crops are harvested and there are actual surpluses or shortages, these cooperative women would determine which other cooperatives were to be called in to mitigate such surpluses or shortages. Such contacts are routinely made over GSM phones. The calls usually lead to the diversion of trucks that are en route to some pre-determined locations to other new locations as situations might require. In all these processes, as submitted by these women, who manage the cooperatives, their mobile phones provide them with the critical capability

to balance the process of distribution of crops. As such, the group's use of mobile phones is reminiscent of the case study earlier described by Jensen (2007) in India. As noted by Jensen, the fishermen used their mobile phones to determine which ports had excesses or shortages of fish. On the basis of the information thus gathered, they determined the port in which they should dock to sell their catch. In a similar way, the women managing the cooperatives in the case of Côte d'Ivoire were able to route and reroute crops to the appropriate market where such crops were urgently needed and vice versa.

Petit wholesalers and retailers

The last group in the distribution system includes small (petit) wholesalers and retailers. Again, as with the managers of the cooperatives, women that were involved in the investigation in Côte d'Ivoire described as important the role of their mobile phones in the process of conducting their daily routines. Equally, independent retailers in Nigeria (both men and women) opined that their mobile phones were central to their business networking. In the ensuing discussions, the petit wholesalers also played the role of retailers, who usually have a small sales outlet in one of the larger food cooperatives (in the case of Côte d'Ivoire) and in one of the main markets (in the case of Nigeria). In actual fact, the sizes of such stalls are often a few square meters within the market area (the land is often owned by either the cooperatives or the local administrative authorities). In their roles as either petit wholesalers and/or retailers, they regularly use their phones to organise food crops for selling. Meanwhile, their interactions with the final consumers were largely face-to-face in both Côte d'Ivoire and Nigeria.

Nevertheless, it is possible for the retailers to desire quick disposal of some of the food products that they have not been able to sell in their stalls for a while—especially produce that is perishable due to lack of any storage facilities. In such cases, it is imperative for them to find other small-scale retailers who will be able quickly to sell the surpluses. Since urgent steps have to be taken, the use of mobile phones has become a veritable tool in establishing necessary contacts (that is, business networking).

In their roles as petit wholesalers, the retailers function as the suppliers for other smaller satellite markets. Of course, such roles require intensive utilisation of mobile phones by all participants. These roles have been more pronounced in the regions of Soubré and Korhogo in Côte d'Ivoire relative to the areas of Ilesha and Ile-Ife in Nigeria. A significant

determining factor has been the prevalence of cooperative organisations in Côte d'Ivoire, unlike in Nigeria, where most of the transactions within the web of the food chain are largely individual. In the case of Côte d'Ivoire, a series of calls could be recorded as early as possible in the morning on transactions of a number of 50 kg bags of produce. On the basis of such interactions, the retailers at the satellite markets come to the main market to collect the bags of produce from the petit wholesalers. There used to be some measures of financial negotiations often associated with such interactions.

> . . . in fact, I usually serve as a point of contact for other markets around here (Korhogo) . . . so whenever I have excess food products that are nearing expiration, I would promptly use any of my mobile phones to call other interested traders from other markets so that they could come and buy from me . . . it solves the problems of waste as quickly as possible . . . and, of course, incomes are generated. . . . (IDI, female, food wholesaler, 48 years, Sobre, Côte d'Ivoire, 8 January 2014)

The use of mobile phones by these retailers in disposing of their excess crops has been largely necessitated by the need to make quick contacts with other retailers and other locations where they could either dump or buy a particular product to supplement what they currently have. The outcomes of this investigation have clearly shown that the prevalent seasonal peculiarity of some produce, within the web of food production and distribution, has made the application of mobile phones essential in all the locations engaged in the study (in both Côte d'Ivoire and Nigeria). For instance, during the rainy season, when there is usually an abundance of harvests, the capability to dispose of excess foodstuffs is very crucial. Equally, during dry season when there is usually a visible shortage of crops, the ability to buy in good time and supplement shortage in supplies is very critical.

> . . . during rainy season, we usually have many food products in the market in excess . . . so one needs to call on other retailers in other markets to come and buy from one . . . our GSM phones have been quite useful in this regard . . . meanwhile, often time, the buyers purchase on credit . . . otherwise the products would rot away. (FGD, female, food wholesaler/retailer, 40 years+, Sobre, Côte d'Ivoire, 10 January 2014)

Inferring from the foregoing, in functioning within the frameworks of the large cooperative organisations or big wholesalers' structure, as petit wholesalers or as retailers of food produce, the role of mobile phones has been quite impressive. Besides facilitating the logistics for food

distribution due to its ability to open up a reliable flow of information within the food chain, it has equally been contributing to enhanced levels of income generation among participants. Nevertheless, the need for mobile phones routinely varies in accordance with the position and business roles of individual stakeholders and in relation to the traded volume of various foodstuffs across our various study locations. For instance, in Côte d'Ivoire, it has been quite evident that participants in the web of the food chain in Korhogo had applied their mobile phones in their day-to-day routines more than those in Soubré. In the case of Nigeria however, participants in the web of the food chain in Ilesha and Ile-Ife and environs had given similar levels of significance to the application of their mobile phones in conducting their daily routines.

Resistance to the application of mobile phones in food production and distribution

No doubt, the usefulness of mobile phones in modern-day functioning, especially within the web of agricultural production and distribution, has been visibly emphasised across the length and breadth of the study locations in Côte d'Ivoire and Nigeria. Nevertheless, few dissenting opinions have equally been identified in the course of our investigations. Such an extent of diversion has been situated within three contexts: the primordial factor (that is, the relevance of "African belief"), the relativity of distance (that is, between rural farms and urban markets), and language consideration.

i. African traditional belief and mistrust of mobile technology

The concept of "African belief" had minimal impact on the desire of individuals who are involved in the food production chain to own and use mobile phones, especially in some remote food-producing locations in Côte d'Ivoire. This disposition has been largely predicated upon accruable envy from other community members and, indeed, misgiving on the technology. Essentially, in such locations, an object like the mobile phone is indicative of riches or wealth. As such, it is believed capable of arousing envy or anger from other members of the community. Thus, it is best not to "flash" or "own" a mobile phone in order to ward off probable physical or spiritual attack. In the words of an FGD participant:

> . . . it is better to live a quiet life [in hiding] if you want to live [a] long time. . . . And the use of mobile phones cannot guarantee this. (FGD, female, rural farmer, 40 years +, Korhogo, Côte d'Ivoire, 3 January 2014)

Another issue of interest is that the people believe that the use of mobile phones endangers human lives. This belief has developed in tandem with the people's fear of any form of technological innovation (and eventual introduction) in their community. Such communal positioning has made a few individual participants within the web of the food chain in Côte d'Ivoire reluctant to acquire mobile phones.

> Portable objects [mobile phones] are good . . . but when you are opportune to know what lies behind them, you would never desire to buy one. Witches and wizards move quickly inside them to monitor and attack the users with relative ease since they can quickly know where one is . . . so around this community, I have been sensitising residents not to acquire the GSM phones. . . . (IDI, male, door-to-door salesman, 52 years, Korhogo, Côte d'Ivoire, 8 January 2014)

Quite a number of the research participants in Korhogo (Côte d'Ivoire), especially those who had never used a mobile phone, affirmed that they had relations who had gone mad upon receiving a call over their mobile phones (usually from a number starting +223).

When probed on how this madness had expressed itself, they responded:

> . . . they just began talking alone all the night long. . . . (FGD, female, rural farmer, 40 years+, Korhogo, Côte d'Ivoire, 20 January 2014)

In another claim from an IDI respondent in Korhogo, Côte d'Ivoire, it was the light function of the mobile phone that was believed to work against the spiritual world:

> Since Lacina [the interviewee's husband] got a mobile phone, he has always been sick . . . he says that someone that he did not know just called his number and thereafter hung up . . . he said when he went to consult an oracle over his illness, the oracle had told him that the spirits were very angry [with] him because every night they came visiting . . . he would always put the light function of his cell phone in on mode and . . . [this] bothers them [the spirits] a lot . . . so that [was] the reason they attacked him with sickness. (IDI, female, rural farmer, 38 years, Korhogo, Côte d'Ivoire, 8 December 2013)

Related issues bordering on subsisting African beliefs against the use of mobile phones have been largely domiciled in the rural Korhogo areas

of Côte d'Ivoire, among all the study locations engaged in the study in Côte d'Ivoire and Nigeria. As noted earlier, it is also such areas in which mobile phones have been of the least functional value. Indeed, there were often well-established alternative (traditional) methods for conveying information that allowed the people to avoid mobile devices. These have included the services of "town criers."

ii. Relativity of distance to the market

Another development that has militated against the application of mobile phones within the web of the food chain according to the research participants in Korhogo, Côte d'Ivoire, is the relative short distance of the market space from the rural food producing farms. Peradventure, if the distance had been somewhat longer, such rural-based farmers would have found it necessary to contact other stakeholders involved in the processes of food production and distribution (for instance, the urban retailers [and wholesalers], the truck drivers, and the door-to-door salesmen). In this regard, there would have been a dire necessity even to make use of any available GSM facilities irrespective of prevalent disincentives, for instance the epileptic nature of the GSM network and related primordial ill-luck considerations. However, since the distance has not really been much in such cases, especially in the Korhogo region of Côte d'Ivoire, the farmers could afford to take their produce to the market, either on their heads or in a cart. The need for mobile phones' application was clearly de-emphasised.

The poor state of the rural roads and the subsistence nature of food production were other contributing factors. For instance, using a GSM phone to call a truck owner to come and transport a small consignment of food produce, for example 5 to 100 kg, would be undesirable. Nevertheless, it is worth stressing that besides Korhogo areas in Côte d'Ivoire, there were no known locations in either Côte d'Ivoire or Nigeria where the notion of "relativity of distance" still held any meaningful sway. The reasons are not far-fetched. High rates of urbanity and longer distances between urban markets and farm locations have all been implicated in such cases.

While closeness to the market might suggest that an individual could forego the use of mobile phones, for instance as presented in the case of the Korhogo region of Côte d'Ivoire, there is also a valid safety concern. There had been sordid incidences of highway robbers attacking trekking rural farmers (producers cum retailers) on their way to the urban markets with their produce.

> . . . here [Korhogo, Côte d'Ivoire], there had been numerous highway robbers . . . in fact, it is the demobilised [military] personnel who have transmuted [in]to [the] majority of the armed robbers . . . they know that the farmers, especially the women farmers, are powerless . . . they usually attack us without any serious resistance; sometimes, they even killed us. I could vividly remember the case of my cousin who went to meet Adjoua producing credits to collect the money on her supplies [630,000 CFA]. [She] was stripped. She was very fortunate . . . because they even had the opportunity to rape her. Fortunately, the area was covered by the MTN [mobile phone] network . . . so she was able to manage to call her brother in the city who came to her rescue. In this case, I believe mobile has been quite helpful, but I still have my reservation on the technology, just like any other person around here [Korhogo]. (FGD, female, rural farmer, 40 years+, Korhogo, Côte d'Ivoire, 22 January 2014)

Thus, on the one hand, the ability to transport crops to nearby markets means that the individual does not need to arrange other forms of transportation, and as such, does not need a mobile phone. Nevertheless, there have been inherent safety and security concerns associated with non-utilisation of the mobile device within the web of the food chain (that is, in networking between the rural producing areas and the urban consuming areas).

iii. The language consideration

The last observed factor that has limited the possibility of individual participants within the web of the food chain owning and utilising mobile phones has been a lack of training on the use and actual applications of mobile devices by various mobile phone service providers. While the Esoko training programme in Côte d'Ivoire, led by the United States Agency for International Development (USAID), has been able to train women farmers from the Alepe areas and other women from the Soubré region in the use of mobile telephony as an imperative tool for information monitoring on the prices and quantities of food produced and the missing areas of production, there has not been any specific training programmes aimed at sensitising individuals on the benefits accruable from usage of mobile phones for their day to day engagements. Indeed, the language for operating GSM phones has remained strange to the people; basically, as a result of the prevalence of a high level of illiteracy in such rural communities.

> . . . we used to call our product buyers to inform them of our produce that are ready for purchase; but in cases whereby the prospective buyers do not

> speak one's dialect, there would be problem of communication over the GSM phones. How would I speak to you, for instance if I do not understand French . . . if I can only communicate in Senoufo and Dioula [local Ivorian languages]. (IDI, male, local farmer, 61 years, Korhogo, Côte d'Ivoire, 5 December 2014)

It should be noted that this language challenge was peculiar to the Ivorian case alone. In all settlements engaged in our investigations in Nigeria, every participant was able to communicate effectively using Nigerian "pidgin" English—a language that was still in conformity with the language of their mobile phones. As such, using GSM phones for the purpose of transactional networking within the web of the food chain was relatively functional in the Nigerian context.

In Soubré, Côte d'Ivoire, 23% of the research participants said that they had participated in at least one training programme on the use of mobile phones in the processes of production and distribution. In rural Korhogo, Côte d'Ivoire, none of the research participants had participated in any training programme centring on the use of mobile phones in the processes of food production and distribution; this was ostensibly the result of extant primordial (or cultural) beliefs within the communities. Furthermore, some of the research participants from the Soubré region (37%) had, as well, indicated that their reluctance to engage mobile phones in their day-to-day routines was the result of a lack of training (and information); while those who affirmed the impact of their communal belief stood at 10% and those who opined that it was due to language problems was 53%. Indeed, cultural domination and language barriers had been significant barriers to acquisition of mobile devices in most of the rural areas in Côte d'Ivoire. As mentioned earlier, cultural concerns had limited ownership of mobile phones in such rural localities. Nevertheless, a considerable percentage of the "chain of grandmother" operators (that is, 93%) have continued vehemently to canvass against such an obnoxious disposition towards the application of mobile phones in the processes of food production and distribution in Côte d'Ivoire. Ostensibly, such a standpoint has been necessitated by the extant need to enhance their business ventures since immanent difficulties in reaching out to different stakeholders, from time to time, had considerably inhibited their business networking capabilities.

Existing operational and institutional policies in support of the usage of mobile phones in food production and distribution

On a general note, available data from all the study locations in Nigeria and in Côte d'Ivoire points to the existence of perpetual lackadaisical dispositions from various policy planners and regulators (that is, governments at various levels) in both Nigeria and Côte d'Ivoire in respect of how mobile phones could be explored in enhancing agricultural productivity and, of course, food distributional efficiency. There have been no deliberate efforts from the governments to create awareness of how mobile phones could be engaged in ensuring the realisation of the goal of food security in both countries. Furthermore, and expectedly, all the GSM service providers in Nigeria and Côte d'Ivoire have followed in the governments' footsteps in terms of inactivity. They have equally been non-responsive over time and space. The views of the following FGD participants in Ile-Ife, Nigeria, and in Korhogo, Côte d'Ivoire, capture all issues at stake much better:

> . . . the governments and the GSM operators have all been quite callous and very, very uninterested in our [rural farmers'] progress. Instead of helping us by providing different interventions to support our work [farming], they [the GSM operators] have been deducting money from the credit on our phones anyhow . . . and for the governments, because of their corruptive cleavages, they cannot control the service providers not to be deducting money from us unnecessarily and to be implementing various palliative measures for the farmers in the rural areas . . . really, the governments at all levels and all the service providers have been unhelpful to the our [rural farmers'] plights. . . . (FGD, male, rural farmers, 40 years+, Ile-Ife, Nigeria, 9 February 2014)

> . . . to us here [Korhogo, Côte d'Ivoire], the mobile phone companies are just extortionists . . . hence, they are not interested in helping the society in any way; even to organise a forum where they would explain to their customers how to use their phones has never interested them . . . for the governments, there has not been any form of policy to make the mobile phone companies responsive to the needs of the society, especially the needs of individual rural farmers and of the people who transport and distribute farm products [truck drivers, wholesalers, and retailers of food products]. . . . (FGD, female, rural farmer, 18–39 years, Korhogo, Côte d'Ivoire, 12 December 2013)

What one could readily deduce from the inquiry over whether there was any deliberate interventions or policies from either the governments at various levels or the GSM service providers in Nigeria and in Côte d'Ivoire is that there has never been any specific effort in this regard. Hence, the drive towards the attainment of food security for the larger societies is being inhibited.

CHAPTER FIVE

GENDER VARIABILITY IN THE UTILISATION OF ICTS IN THE AFRICAN AGRICULTURAL SECTOR

According to statistics from the United Nations Educational, Scientific, and Cultural Organisation, the vast majority of women in Africa are still illiterate (as of 1995, the figure was 54% for women older than 15); even today, most girls do not receive more than primary education (in 1996, 45% of students enrolled in first-level schooling in Africa were girls, but many of them did not even complete this level). For instance, Nigeria was classified as a *low development country* by the *United Nations Human Development Report* (2005), in respect of equality in educational accessibility. The *Female adult literacy rate* (ages 15 and above) for the country was 59.4% compared with the male rate of 74.4%; the *Combined gross enrolment* for primary, secondary, and tertiary schools for female was 57% and male, 71% (Adeniran 2007). So how can they be expected to operate within an emerging new knowledge-based world order? On the threshold of a new millennium, most African women have not entered the information age.

Of course, women have a substantially central role in smallholder farming throughout the developing world, and constitute the majority of farmers in sub-Saharan Africa. Yet the ability of women to access and use resources such as ICT, and the innovations they enable, is often hampered by household gender relations, asset endowments, and cultural constraints. Given the key role of women both in household food security and in improving agricultural productivity, ICT-for-agriculture interventions should include explicit strategies for assuring access by women, and for strengthening the information, communication, and networking resources of women. Organisations such as the Women of Uganda Network (www.wougnet.org) and the Self-Employed Women's Organisation in India (www.sewa.org) have been leaders in developing strategies to use ICT to empower women economically and socially, both by promoting better information access for women and by using ICT to help women and

women's groups engage more effectively in policy advocacy and joint action.

So far, the outcomes of our investigations have revealed that both female and male participants in the web of food production and distribution in Nigeria were proportionally represented in the engagement of mobile phones for conducting their daily business routines. In most cases, there has been a record near half (50:50) utilisation of mobile devices across various gender categories in Nigeria. However, the case with Côte d'Ivoire has been quite different. In both regions of investigation—Soubré and Kohorgo—the male participants were unfairly represented in the usage of the mobile devices, save for the case of the urban-based women's cooperative organisations that are usually composed and managed by women. Within most rural locations, the ratio of men to women who used mobile phones sometimes reached 75:25, while in the case of the urban cooperative-based women participants the ratio of male to female usage of mobile phones sometimes reached 65:25. The implications of these developments are that rigorous enlightenment and incentive measures are desirable in the case of rural Côte d'Ivoire especially, while appropriate incentives towards the application of mobile devices by individuals, who function as operators within the web of food production and distribution in Nigeria, would suffice in correcting any inherent gender imbalances (though none has been visible).

Despite the many barriers that prevent women from becoming full participants in the knowledge society, increasing evidence is emerging that indicates that ICTs can provide many opportunities for women to improve their income generation, levels of education, and health, provide them with information and awareness concerning their public and private rights, and improve the wellbeing of themselves and their families. As argued by the Expert Group Meeting convened by the United Nations Division for the Advancement of Women in November 2002, "when there is an enabling environment, ICT can provide diverse avenues for women's social, political and economic empowerment." Nevertheless, existing analysis indicates that women will not be equal participants in the knowledge society, even in areas or projects that address their concerns, unless they are actively consulted and strategies are designed to integrate them fully into ICT projects and the IT sector. This involves:

— Creating an enabling environment that supports and encourages strategies to promote women's equal access to and opportunity to benefit from ICT projects, as well as creating a regulation and policy environment that supports women's use of ICTs.

- Developing content that speaks to women's concerns and reflects their local knowledge, and which is of value in their daily lives, business enterprises, and family responsibilities (including information on health, agriculture/small-scale production, natural resources management, and SMEs).
- Supporting the increased representation of women and girls in scientific and technical education, and using ICTs to promote their increased participation in education at all levels.
- Promoting increased employment in the IT sector for women.
- Implementing e-governance strategies that are accessible to women, and promoting women's lobbying and advocacy activities.

Enabling women's participation in the knowledge society

In view of low rates of female internet access, and the emerging results of ICT projects that indicate that women benefit less than men, supporting women's increased access to and opportunity to benefit from ICTs is a priority for policy and research.

ICT access strategies will benefit women when they address the barriers identified above, which include cost of access, distance of travel to the access point, language, socio-cultural practices, infrastructural restrictions, flexible access times, and content.

In the developing part of the world, telecentres are widely promoted as a low-cost and effective way to provide accessible community access to ICTs. The term usually refers to institutions that offer free and public access to information services for social development of disadvantaged groups. These centres are generally initiated by government and donor agencies to provide information to the local communities on market, government services, local resources, health care, and education. Such centres are dependent on government or donor support. One example of such an institution-based initiative is that of ACACIA, funded by the International Development Research Centre (IDRC) of Canada. The project intended to expand ICTs to rural and disadvantaged communities in Africa through social investments in pilot multipurpose community telecentres, school-networking activities, and accelerated ICT policy development initiatives in sub-Saharan Africa.

Recent evaluations of telecentres indicate that the emphasis has tended to be on the provision of hardware and on solving the technical problems of connectivity rather than on ensuring that telecentres address local needs, capacities, and preferences. Some analyses have commented that little

attention is paid to content, and in fact, start-up costs are extremely high—a South African estimate suggests it costs US$40,000 to set up a telecentre.

Further, preliminary evidence suggests that telecentres in developing countries are not particularly effective in helping women to gain access to better economic, educational, and other opportunities. Access costs and other factors remain a barrier for women. An evaluation of ACAIA-funded telecentres in Africa indicated that women consistently make up less than one third of telecentre users even when female trainers and facilitators and women-targeted training materials are made available. One of the primary determinants of women's use of the centres was considered to be cost: making internet access available at low cost did not substantially increase the numbers of women using the telecentre, since women tend to have little cash at their disposal. Other factors included social and religious barriers, and scepticism regarding the value of ICT access.

The long-term sustainability of these centres is also an unresolved question, since they depend on the income-generating capacity of the users, either as entrepreneurs or as distant employees. Technology mixes are an important factor in ensuring access to ICTs for women, in that they provide technologies that are adapted to local conditions and requirements, such as unreliable electricity or low literacy rates, and allow sharing, packaging, and presentation of information in ways that women understand and appreciate. For example, the Tanzania Media Women's Association distributes information it gleans from the internet through newsletters, radio, and other forms of locally based communication. Radio has proven to be an important communications technology for women, in that it does not require literacy, it is affordable, and women can work while listening. Examples of use of radio for literacy, information on food production, making women's concerns known to local policy makers, and other uses are well documented.

Against the background of the foregoing, the following aspects are deemed expedient for further research:

i. Assessment of women's use of telecentres and other kinds of community access points.
ii. Analysis of telecentre sustainability, including analysis that takes into account a broader assessment of results than profit margins (such as value to users; increase in local production; participation of community in national governance, etc.).

iii. Models for information delivery systems that incorporate a mix of ICTs appropriate to local conditions and the educational levels of the users.
iv. Training modes on the use of ICTs that are appropriate for women.
v. Evaluation of ICT projects, including gendered opportunities to benefit and assessments of best practices and lessons learned.
vi. Support to women to define and create content and information carried by ICTs.

Gender and telecommunications policy regulation

Given the constraints that women experience in using and benefiting from ICTs, ICT policy will not be gender-neutral, but will, in fact exacerbate existing gendered socioeconomic inequalities in a society, unless both gender and social implications are taken into account. Doing this doesn't require a large investment of resources, but rather a shifting of perspective. Communication regulation that focuses on licensing, spectrum issues, competition acts, and telecom codes as ends in themselves can lose sight of larger societal goals of connectivity, education, information, consumer protection, and resolving market failures. This kind of long-term perspective is more conducive to achieving the goals of IT policy and regulation, and to incorporating social considerations, including women's needs and gender concerns. If understood in this light, policies that support women's equitable access to and use of ICTs can be naturally integrated into a socially sensitive national e-policy. Reviews have been done of the gender implications and considerations relevant to ICT policy, as well as of steps that can be taken to encourage greater access to ICT and use of telecommunications by women. Examples of how infrastructure and regulations can affect women positively include:

— Infrastructure and deployment: Implementing cost-effective and appropriate solutions, including wireless, cell, radio, and "simple" computer technologies, and ensuring infrastructure is deployed in rural areas, where women make up a high proportion of the population.
— Liberalisation: Opening the telecom sector to competition can bring in investment and force down user prices.
— Licensing and regulation: Licensing fees, spectrum prices, and interconnection charges should be kept at reasonable rates. Certain numbers of licenses can be allocated to women-owned

businesses or businesses with women in management conditions; fees could be waived for businesses run by women entrepreneurs or those providing servicing to underserved areas.
— Universal access: Emphasise public access points as an alternative to more capital-intensive choices; ensure that appropriate elements are in place to support women, such as training, low cost, use of local languages, and locations that women can easily access.
— Intermediation: Provision of staff at telecentres or community access points or liaison with women's NGOs will facilitate use of ICTs by women and under-served groups.
— Build capacity: ensure women have equal access to opportunities, training, and education; implement mechanisms to support women's entrance into the sector at all levels; support programmes to train women in ICT technical and management programmes.

Meanwhile, the case for gender analysis of ICT policy is greatly hampered by the current lack of sex disaggregated statistics and indicators. As well, there is a general lack of understanding of gender analysis and potential implications of ICT policy among policy makers. A few countries in Africa have taken steps towards gender equality in areas of policy related to ICT. For example, South Africa has included a chapter on human resources capacity in its national research and development (R&D) strategy, while in Asia, the Republic of Korea has established a proactive ICT policy towards gender equality in its Basic Plan for Women's "Informatisation" (2002–6). Equally, it is known that governmental commitments to gender equality set the stage for the adoption of transformative strategies to mainstream gender perspectives in all policy areas, including those in which ICT policy is present and relevant: such as, rural development, education, health, universal access, and telecommunications regulation, among others.

The following areas are considered necessary for further research attention:

i. Collection of evidence and data to demonstrate the links between gender and development and between gender and ICTs for development.
ii. Analysis of the gendered effects of telecommunications policy and regulation, building on work done to date.
iii. Effects on gender equality and social equity of telecommunications policy, regulation, and technologies such as GIS.

iv. Research and packaging of guidelines on mainstreaming gender into ICT policy, including curricula development and information kits.
v. Research and analysis of strategies and approaches to integrate civil society consultation into ICT policy development and implementation.
vi. Identification and incorporation of social elements of long-term goals into regulation frameworks.
vii. Strategies for making low-income markets, including women, attractive to private sector providers and investors, including research on the opportunities in low-income markets.

Appropriate and relevant content for enabling gender balance in ICT's utilisation

More research is needed on identifying, developing, and disseminating women-appropriate content:

a) Content that is developed by women and reflects their knowledge and perspectives.
b) Content that helps women more effectively in fulfilling their daily tasks and responsibilities, as such increasing their well-being and that of their families.
c) Content that increases their income. The CD-ROM project implemented at a telecentre in Nakaseke, entitled "Rural Women in Africa: Ideas for Earning Money," is a response to the need for and access to information. It was developed after extensive consultation with local women, and provides information in local languages and in audio form for illiterate women. It is a good example of a way of offering rural women direct access to information in a form they understand and value and which helps them in a practical way to improve their productivity and socio-economic status.

As the FAO has noted, access to increased information in general contributes to women's income-earning capacity—even access to reproductive health will allow women to increase their productivity and income generation. This is an important area for further research and policy action, where strategically allocated resources and support could produce enormous benefits. Particularly important is the recognition and

valuing of women's local knowledge, in addition to building their capacity to generate content, through the strategies discussed in this chapter.

Women's local knowledge in small-scale agriculture

Women are holders and innovators of indigenous knowledge on seed preservation and storage, food processing, health practices, and local natural-resource management. Women play a strategic role in the incubation and transfer of critical knowledge, which often forms the blueprint of survival for communities to adapt and minimise their risks under adverse circumstances. Because of their biological and social roles, they are intimately acquainted with the social, economic, and environmental needs of their own communities. For example, a study carried out by the Intermediate Technology Development Group found that while women's knowledge and skills tend to be invisible because they are embedded in the perceived "domestic" nature of women's work, women's technical skills underpin survival responses.

A great deal of work has been done on the value of women's local knowledge concerning food production, natural-resource management, and health issues. This knowledge has been generally overlooked; nevertheless, it represents the accumulation of centuries and even millennia of environmentally and socially sustainable practices. Further research and analysis in this area need to be done on:

- How ICTs can be used to ensure women's knowledge is not lost.
- The role of ICTs in ensuring that women benefit from the proceeds (financial and otherwise) of this knowledge.
- Dissemination of women's knowledge where it may be beneficial in ways that do not disempower them or allow the theft of this knowledge.

ICTs in supporting women's productive and reproductive activities

For ICTs to contribute to poverty eradication, it is important that they help women fulfil their daily productive and reproductive activities. It is well-recognised that the work that women do provides for the health and well-being of their families and communities. They make major contributions to food production, are responsible for health care and prevention in their families, while the income they earn is often critical to family survival and maintenance. As a result, several sectors in which ICTs can make an

important contribution to poverty reduction and the wellbeing of people have been comparatively overlooked to date. They include health information that is directed to women; support for women's agricultural, food production, and natural resources management activities; and increasing access to education for women and girls.

ICTs and women's health

The use of ICTs by health practitioners in developing countries is quite well established. Organisations such as Satellife and HealthNet are successful examples of projects that provide health information and connections to their colleagues in other parts of the world for developing country health professionals. For example, the World Health Organization is in the process of providing free access to health journals and documentation via the internet to doctors and research institutions in the developing world.

While these kinds of projects provide successful examples of how ICT can contribute to improve health conditions in developing countries, the provision and use of health information to women directly has been given less attention. It is unknown to what extent women benefit from health information made available through ICTs. How many doctors and health workers participating in these programmes are women? Further, how many women on the ground gain access to this information? Comparatively few ICT-based health information projects to date have targeted women users despite the fact that they are the primary users of health information. As found by the AfriAfya health information initiative in Kenya, health information made available is often not easily understandable at the local level. AfriAfya found that it was necessary to "translate" HIV/AIDS information received from its World Space satellite receiver in order to use it in the community. The Association of Uganda Women Medical Doctors has begun a pilot project to electronically disseminate information on reproductive health to women-oriented NGOs for advocacy and personal use. Four members of the association, having received training in basic e-mail and internet skills, download necessary information, repackage it, and send it to the NGOs online. The programme distributes the latest medical information to those who would otherwise go without it.

While introducing ICTs to health workers for work in the field, the effects on gender relations and the status of female and male health workers need to be taken into account. For example, when female health workers in India were provided with personal digital assistants (PDAs) for data gathering in the field, it was found that the men became resentful and

demanded access to similar technologies (Hafkin and Huyer 2003). Evaluation of the project also found that the health data gathered was determined by government health departments, and bore little connection to the health concerns of women involved in the project.

The potential presented by software that gathers health information in new ways, and can present new kinds of health-related information could make an important contribution to the way women's health concerns are perceived. For example, the Tanzania Essential Health Interventions Project worked with rural health offices and policy makers to draw out and present raw data on the health status of rural populations. New software applications, along with the processed data, allowed district health planners to prioritise and allocate resources towards cost-effective health interventions on the basis of data reflecting the existing health picture. Thus, the planners were able to focus on the planning of curative and preventative interventions to address locally important diseases rather than the classical approach of planning for specific diseases that were assumed to be prevalent. As a result, resource allocation matched more closely the actual prevailing burden of disease in their area, so that infant and child mortality rates have decreased substantially since the new software was introduced.

ICTs, gender, and agriculture production

Women are responsible for 60–80% of food production across the developing world, and are responsible for half of food production worldwide. They are twice as likely to be involved in agriculture-related activity as men, either paid or unpaid. In sub-Saharan Africa, 90% of women are farmers, and they provide 70% of the subsistence production (FAO 2003; United Nations 2002). Agricultural production activities include cultivation, harvesting, processing, food preparation, care of livestock, and selling of produce. Despite this major contribution to agricultural production, women do not tend to own or control key resources, such as land, credit, technological productivity-enhancing inputs, and services on which their agricultural activities depend. Women's access to technological inputs such as benefits of research and innovation, improved seeds, fertilisers, pesticides, and technologies to improve production is limited.

ICTs are fostering change in agricultural knowledge and information systems even in the poorest nations. Mobile telephones allow farmers to verify prices, arrange transport, and communicate with distributors and clients. Rural radio programmes use email, fax, and mobile telephone to

enable sharing and dissemination of agriculture-related information. For example, the Zambia Federation of African Media Women (FAMW) facilitates advocacy and communication between farmer radio-listening groups and politicians through these technologies.

The effects on gender relations of ICTs are particularly important with respect to agricultural production, because subsistence agriculture remains an important part of many developing countries' economies. Agriculture also provides, both directly and indirectly, an opportunity for women to improve nutrition and increase income for themselves and their families.

Nevertheless, a major gap—both at the research and direct action levels—is that women living in poverty are unable to use ICTs as a tool for production. Women today still lack access to the technologies that could help them improve farm yields and increase the quality and diversity of their non-farm economic activities. A number of groups working with grassroots women's organisations from all regions of the world report that lack of access to improved techniques and technologies is a major constraint on the ability of their members to compete in an increasingly globalised world and to take advantage of the new economic opportunities arising.

CHAPTER SIX

OPERATIONALISING ICT FRAMEWORKS IN AGRICULTURAL POLICY PLANNING IN AFRICA

Attaining sustainable agricultural development is viewed as a global strategic imperative. Information and communication technologies (ICTs) have depicted a significant potential to contribute to achieving sustainable economic, social, and environmental benefits worldwide. Indeed, the productive application of ICTs now has a proven record in many parts of the world and a demonstrated potential to attain sustainable outcomes at the local, national, and global level. The past four decades have particularly recorded numerous attempts to understand the mechanisms for the adoption of different technological innovations as noted by Rogers (1962) in the general frameworks for ICTs' adaptability and Grilliches (1957, 1988) in the economics of specific agricultural innovation. Regardless of the frameworks for establishing an association between ICTs and agricultural productivity, the need for understanding the imperatives of relevant ICTs in agricultural production has remained. Such imperatives have continued to be driven by the following empirical questions:

- Would adoption of ICTs in agricultural production present different features and outcomes?
- Are there commonalities of ICTs' application among various agricultural activities, production chains, efficiencies, and countries?
- Is there any public dimension to the adoption of various threads of ICT in agricultural production, development, and rural sustainability?
- Are there any feasible responsibilities that could be assigned to end users in the food chain, mostly urban final consumers?
- Of what significance would an agricultural extension service, as a public concern, be in the productive utilisation of ICTs in agricultural productivity?

The ability to contextualise and approach related ICTs' adoption hindrances is viewed as a strategic concern, a public policy priority and a dilemma in allocation of research priorities. In the case of West Africa, it is suggested that this should be incorporated into the regional integration agenda. As observed by the World Bank (2015) in its report "Connecting Food Staples and Inputs in West Africa: A Regional Trade Agenda for ECOWAS Countries," governments within the sub-region should move beyond nationally focused food policies and approach regional trade within the ECOWAS to connect rural farmers with urban consumers in the regional booming cities. Of course, ICTs are central to realising this goal. "Food staples belong at the heart of the ECOWAS agenda on agriculture . . . the importance of cross-border cooperation to secure food supply, as well as manage common natural resources, regional diseases and security challenges has been made painfully clear in recent years" (World Bank 2015). A regional integration approach, which would prime the application of ICTs in agricultural development, is pivotal to attainment of food security within the sub-region. It is, however, essential that supports in forms of positive policies and commitments from all participating countries are institutionalised. While trade across the borders would necessitate economies of scale in food production, expansion of opportunities for food producers would significantly lessen the vulnerability of families, especially the poor, to price volatilities, drought, and other unforeseen emergencies.

All through this research, people (communities of food producers) emerged as the fulcrum of inherent discussions. Indeed, they have been observed as being the most significant factors for promoting and inhibiting the clamour for adoption of ICTs in agricultural production, agricultural development, and all aspects enabling rural sustainability. Identification and empowerment of agents of change was universally accepted as the critical adoption success factor. For instance, the Technological Innovation Adoption framework, as provided by Rogers (1962), has proved relevant in mobilising individuals for enhanced agricultural productivity, and of course, in realising the onerous goal of food security. Examining the procedure for engaging "people/community" in the ICT adoption process has often elicited a huge mass of successes and failures. Nevertheless, a cursory look has brought to the fore the extant interrogative issues of interest in the study as equally noted in the report "Global Forum on Agricultural Research" (2008):

i. We have to get the "people/community" and "processes" involved before engaging in efforts to adopt new technologies—ICT adoption is not an exception.
ii. ICTs are for communities, not just individuals. This dictates a more holistic view of the ICT adoption processes.
iii. The ICT tools themselves can do nothing. There must be effective participation of the communities as a prerequisite to identifying optimal solutions, empowering leaders to effectuate them, and ensuring relevant local content.
iv. Strong leadership from the community is essential for the success of any ICT project. Understanding and taking onboard the key requirements for users in terms of end-user skills, motivation, and their realities in terms of access must be factored into the ICT adoption process.
v. ICTs will not necessarily change the lifestyles of the rural communities. Rather they will introduce new methods of doing the same traditional activities and/or enable new activities.
vi. There is a crucial need to commence ICT adoption from a fundamental baseline understanding of the fine points of digital inclusion. This is a critical success factor. Digital divides and digital exclusion details are basic considerations in this context.
vii. There is a demonstrable correlation between social and digital exclusion. A significant proportion of the digitally excluded are at risk of deepening social and eventually economic exclusion. This can be extremely disruptive for rural viability and is a major ICT adoption consideration for agricultural development.
viii. Digital exclusion is unlikely to disappear over time through demographic developments alone.
ix. Digital exclusion cannot be adequately addressed in isolation from other policy issues. Consequently, ICT adoption policy priorities are a public responsibility.
x. This situation leads in turn to unavoidable lobbying and advocacy. Recognition of this eventuality led to a workshop consensus recommendation: adopt a bottom-up participatory approach for ICT adoption efforts.
xi. ICT penetration secured by market forces alone is unlikely to eliminate digital exclusion.
xii. ICT development is dashing ahead in technological aspects, in organisational structures and models without a "people's participation" focus. For example agri-food companies now increasingly participate as networked enterprises in, for example,

"multi-dimensional, dynamic and knowledge-based networks"—which from a "people's" point of view can be baffling at the least.

xiii. A long list of corrosive digital divide groupings was identified. Examples included unequal ICT access options, natural and acquired personal ICT skills, a deep generational divide, gender, personal impediments, tradition, and so on. Each unique "divide" dictates a unique approach for solutions effectively bridging over the differences. As a prerequisite, the divides must be recognised in order to overcome them. One way to overcome a divide, once identified, is to seek "champions"—agents of change—at all levels. An example would be access to ICT leaders. As articulated in the discussion: "It is not enough to effect change, as ICT is not a panacea; it is about people, about listening to them and understanding their needs."

Various results from this study have indicated that the use of mobile phones, within the web of food production and distribution, is very crucial in the process of making food security a reality for the people. We have explored the advent of various strands of ICTs in agriculture, especially the application of GSM phones in both Nigeria and Côte d'Ivoire, and various possibilities accruable from their applications, especially within the web of the food chain; describing the number of phones in possession of individual participants (producers, distributors, and buyers), determining the number of calls made per day by different categories of participants, and grasping the reasons for individuals' engagements or non-engagements of mobile devices in their day-to-day routines.

Meanwhile, since food production and distribution systems are becoming more interdependent, integrated, and globalised, with inherent escalation and heavily publicised outbreaks of food-borne diseases, there has been a subsisting need to engage relevant technologies to trace food consistently and efficiently from the point of origin to the point of consumption. "Traceability" is an increasingly common element of public and private systems for monitoring compliance with quality, environmental, and other product and/or process attributes related to food (World Bank 2012). Small-scale farmers may lack the resources to comply with increasingly strict food safety standards, particularly traceability requirements. Given the role of traceability in protecting consumers, ensuring food safety, and managing reputational risks and liability, it is vital to integrate and empower small-scale agricultural producers in the food supply chain through the frameworks of ICTs.

Implications of findings for policy advancement

The presentation of various outcomes of the investigation and their accompanying impacts for policy projection, execution, and monitoring is focused on in this section. Across the length and breadth of the study locations in Nigeria and in Côte d'Ivoire, all the research participants were unanimous in affirming the non-responsiveness of both the governments (at various levels) and the mobile service providers vis-à-vis enablement of appropriate utilisation of mobile technology in the drive towards the attainment of the goal of food security. Besides, such interventionist policies would have considerably curbed the menace of food wastage, and indeed, food scarcity confronting the two countries in question: Nigeria and Côte d'Ivoire.

Usefulness of mobile telephony

Essentially, the study has affirmed that despite limited ongoing misconceptions of the notion of ICTs (in this case, mobile telephony) by some research participants, especially in some isolated rural food-producing areas of Korhogo, Côte d'Ivoire, mobile phones still played a significant role in individuals' everyday routines across all the study locations in Côte d'Ivoire and Nigeria, for instance, in the processes of food production and distribution. It is, therefore, inferred that the ongoing resistance to the application of mobile phones in some localities within the study locations reflects an inherent "culture lag" that is bound to fade out with time. For instance, the benefits accruable to individuals and communities courtesy of the application of the notion of "traceability" within the web of the food chain cannot be over-emphasised. Notably, "traceability" is a concept developed in industrial engineering and was originally seen as a tool to ensure the quality of production and products (Wall 1994). Economic literature from supply-chain management defines traceability as the information system necessary to provide the history of a product or a process from origin to point of final sale (Wilson and Clarke 1998; Jack, Pardoe, and Ritchie 1998; Timon and O'Reilly 1998).

Traceability (or product tracing) systems differentiate products for a number of reasons. Food traceability systems allow supply chain actors and regulatory authorities to identify the source of a food safety or quality problem and initiate procedures to remedy it. While traceability in the food sector has focused increasingly on food safety (Smyth and Phillips 2002), agrifood and non-food sectors such as forestry and textiles (particularly cotton) have instituted traceability requirements for product identification,

differentiation, and historical monitoring. Specific standards for food traceability have been mandated internationally, by law in the European Union (EU), Japan, and more recently the United States, and by private firms and associations.

In the context of agricultural policy, traceability refers to full traceability along the supply chain, with the identification of products and historical monitoring, and not just the separation of products under specific criteria at one or more stages of the chain. The Codex Alimentarius Commission (CAC) (2006) defines traceability as:

> . . . the ability to follow the movement of a food through specified stage(s) of production, processing and distribution. . . . The traceability/product tracing tool should be able to identify at any specified stage of the food chain (from production to distribution) from where the food came (one step back) and to where the food went (one step forward), as appropriate to the objectives of the food inspection and certification system.

The International Organization for Standardization (ISO) ISO/DIS 22005 (20 November 2006) has largely adopted this definition; however, its definition is a bit broader in scope as traceability is viewed as a tool not only for meeting food safety objectives but also for achieving a number of other objectives in other sectors—for instance, in forestry for the chain of custody traceability, sustainable certifications, geographical indicators, or animal health. The EU General Food Law, Article 18 Regulation (EC) No 178/2002, defines traceability as

> . . . the ability to track food, feed, food-producing animal or substance intended to be, or expected to be used for these products at all of the stages of production, processing, and distribution.

In comparison to some international and commercial standards for traceability, the EU does not require internal traceability (that is, it does not require all inputs to match all outputs) (Campden BRI, 2009).

For food products that are genetically modified, many countries use identity preservation schemes, but only the EU requires traceability. The EU (Directive 2001/18/EC) additionally defines traceability in relation to genetically modified organisms (GMOs) and products as:

> . . . the ability to trace GMOs and products produced from GMOs at all stages of the placing on the market throughout the production and distribution chains facilitating quality control and also the possibility to withdraw products. Importantly, effective traceability provides a "safety net" should any unforeseen adverse effects be established.

As noted in CAC (2006), traceability can also help identify a product at any specified stage of the supply chain: where the food came from (one step back) and where the food went (one step forward). Simply knowing where a food product can be found in the supply chain does not improve food safety, but when traceability systems are combined with safety and quality management systems, they can make associated food safety measures more effective and efficient (CAC 2006).

By providing information on suppliers or customers involved in potential food safety issues, traceability can enable targeted product recalls or withdrawals. Similarly, the implementation of food safety management systems can support efficient, consistent traceability. For example, prerequisite programmes such as good agricultural and management practices and the Hazard Analysis and Critical Control Point (HACCP) system include requirements for record-keeping that can support requirements for traceability. The areas of animal identification, disease prevention and control, nutrient management, production safety, and certification for export all include practices that contribute to the efficacy of traceability systems. In summary, traceability can:

- Improve the management of hazards related to food safety and animal health.
- Guarantee product authenticity and provide reliable information to customers.
- Enhance supply-side management and improve product quality.

The benefits of traceability for food producers, food consumers, government authorities, and business operators are widely recognised. Yet, for small-scale farmers in developing countries, such as Nigeria and Côte d'Ivoire, traceability requirements can represent barriers to trade. The market for safe and traceable food can exclude small-scale agricultural producers who lack the resources to comply with increasingly strict standards, particularly requirements for tracking and monitoring environmental and supply chain variables through sophisticated technologies.

Apparently, enhanced accessibility to ICTs could potentially obliterate some of these barriers. The proliferation of mobile devices; advances in communications, and greater affordability of nanotechnology offer potential for small-scale producers to implement traceability systems and connect to global markets. Mobile phones, radio frequency identification (RFID) systems, wireless sensor networks, and global positioning systems (GPS) make it possible to monitor environmental and location-based variables, communicate them to databases for analysis, and comply with

food safety and traceability standards. In the context of food safety and smallholders' participation in global markets, it is expedient for small-scale, rural food producers, as observed in the case of Nigeria and Côte d'Ivoire, to explore incentives for investing in traceability systems and the prospects for traceability to empower small-scale producers in the value chain.

Food safety: a challenge and an assurance for food security

Food-borne disease outbreaks and incidents, including those arising from natural, accidental, and deliberate contamination of food, have been identified by the World Health Organization (WHO) as major global public health threats of the twenty-first century (WHO 2007a). The WHO estimates that 2.2 million people die from diarrhoeal diseases largely attributed to contaminated food and water (WHO 2007b). The global burden of food-borne illness caused by bacteria, viruses, parasitic micro-organisms, pesticides, contaminants (including toxins), and other food safety problems is unknown but thought to be considerable.

Food safety issues have human, economic, and political costs. These costs are exacerbated by animal husbandry practices that increase the numbers of human pathogens, antibiotic-resistant bacteria, and zoonotic pathogens in meat and dairy products; unsafe agricultural practices involving the use of manure, chemical fertiliser, pesticide, and contaminated water on fresh fruits and vegetables; the progressive influence of time and temperature on globally traded products such as seafood, meat, and fresh produce; the contamination of processed food by bacteria, yeast, mould, viruses, parasites, and mycotoxins; the presence of foreign objects causing injury to the consumer such as glass, metal, stones, insects, and rodents; and the threat of bioterrorism (Safe Food International 2005).

Cases recorded in the World Health Organization (WHO)'s epidemiological records, medical journals, and other record systems over several decades demonstrate the extent of the problem. The Centers for Disease Control and Prevention (CDC) estimated that 48 million cases of food-borne illness occur each year in the United States, including 128,000 hospitalisations and 3,000 deaths. The three primary avenues of contamination are production, processing, and shipping and handling. In light of global food safety concerns, the WHO Global Strategy for Food Safety, endorsed in January 2002 by the WHO Executive Board, outlined a preventive approach to food safety, with increased surveillance and more rapid response to food-borne outbreaks and contamination incidents

(WHO 2002). This approach substantially expands the ability to protect food supplies from natural and accidental threats and provides a framework for addressing terrorist threats to food (WHO 2008).

Components of food traceability systems

Not only food-borne illnesses but also globalisation, consumer demand, and terrorism threats have impelled the diffusion and growth of traceability systems in supply chains for food and agriculture. Food is a complex product (Golan, Krissof, and Kuchler, 2004), and modern food production, processing, and distribution systems may integrate and commingle food from multiple sources, farms, regions, and countries. Food products covered by traceability standards include fresh produce such as mangoes, avocados, and asparagus; bulk foods such as milk, soybeans, specialty coffee, and olive oil; fish and seafood; and livestock for meat and dairy.

Food products may be differentiated through systems of:

(1) identity-preserved production and marketing (IPPM),
(2) segregation, and
(3) traceability

IPPM systems are important for providing information to consumers about the provenance of a product when the attributes may not be visible or detectable in the product. They are also useful for capturing product premiums.

Segregation systems are used to prevent the mixing of novel varieties in the handling of like varieties or to discourage the mixing of a segregated product with like products if potential food safety concerns exist.

Traceability systems, on the other hand, allow sources of contamination in the supply chain to be identified (Smyth and Phillips 2002), which enables a transparent chain of custody, raises credibility, and makes it possible to transfer information on the steps taken to alleviate food safety concerns (McKean 2001). Unsafe food can be recalled because information on all possible sources and supplies of contaminated food can be traced one step forward, one step back, or end to end.

Traceability systems can be classified according to their capacity for (1) internal traceability and (2) chain traceability. “Internal traceability” refers to data recorded within an organisation or geographic location, whereas “chain traceability” involves recording and transferring data through a supply chain between various organisations and locations

involved in the provenance of food. Food contamination may occur at the farm, during processing or distribution, in transit, at retail or food service establishments, or at home. Fundamentally, traceability systems involve the unique identification of food products and the documentation of their transformation through the chain of custody to facilitate supply chain tracking, management, and detection of possible sources of failure in food safety or quality.

The smallest traceable unit will vary by food product and industry. Some of the data elements may include the physical location that last handled the product, as well as the type of supply chain partner (producer, processor, or broker, for example); incoming lot numbers of product received; amount of product produced or shipped; physical location where cases were shipped; lot number of the product shipped to each location; date/time when the product was received or shipped; date/time each lot was produced or harvested; ingredients used in the production of the product, along with corresponding lot numbers; and immediate source of ingredients and when they were received.

Good practices in traceability entail making the lot number and name of the production facility visible on each case of product and recording the lot number, quantity, and shipping location on invoices and bills of lading. Traceability requires each facility to record data when a product is moved between premises, transformed/further processed, or when data capture is necessary to trace the product. Such instances are called critical tracking events. Data captured in critical tracking events are vital to linking products, both simple and complex, within a facility and across the supply chain (IFT 2009).

Traceability data can be static or dynamic, mandatory or optional. Static data do not change, whereas dynamic data can change over time and through the chain of custody (Folinas, Manikas, and Manos 2006). “Trace back” implies that a system can identify production/processing steps that resulted in the creation of the product. “Trace forward” implies that a system can identify all derivatives of the product used as an ingredient in numerous other products. Food traceability systems and definitions in standards, laws, and regulations are broadly conceptualised to permit producers to determine the breadth, depth, and precision of systems based on specific objectives. “Breadth” denotes the amount of information a traceability system captures, “depth” refers to how far backward or forward the system tracks an item, and “precision” shows the degree to which the system can pinpoint food characteristics and movement.

Implementing food traceability systems in developing countries

About half a billion people subsist on small-scale agriculture in developing countries, such as obtainable in Africa. Their participation in markets typically is constrained by inadequate farm-level resources, farm-to-market logistical bottlenecks, and more general transaction costs in matching and aggregating dispersed supplies to meet buyer and consumer demand. These "traditional" constraints have been amplified and in some cases surpassed by "new" challenges related to complying with product and process standards, including strict traceability requirements set and enforced by governments and private supply chain leaders (Hazell, Poulton, Wiggins, and Dorward 2006). The implementation of traceability systems and assurance standards is controversial (Schulze, Albersmeier, Gawron, Spiller, and Theuvsen 2008), but it can be especially so in the context of small-scale producers. Weinberger and Lumpkin (2005) have expressed concern that traceability requirements and sanitary and phytosanitary issues will increasingly constrict exports of food products from developing countries, where poor regulation of chemical use, pollutants, and a steep learning curve in traceability capacity restrict growers' and processors' participation.

Many developing countries lag in developing and implementing food safety and traceability standards, but some have selectively met demands in high-income export markets thanks to regulatory, technical, and administrative investments. From 1997 to 2003, more than half of the List 1 countries recognised by the EU as having equivalent standards of hygiene in the capture, processing, transportation, and storage of fish and fish products were low- or middle-income countries.

Jaffee and Henson (2004) suggest that some countries use improved food quality and safety standards as a catalyst to reposition themselves in the global market; the key for developing countries is to "exploit their strengths and overcome their weaknesses such that they are overall gainers rather than losers in the emerging commercial and regulatory context." As an example, the value of Kenya's fresh vegetable exports increased from US$23 million to US$140 million between 1991 and 2003 after stricter food safety and quality standards led producers to reorient their operations.

Any application of product traceability systems must take into account the specific capabilities of developing countries. If an importing country has objectives or outcomes of its food inspection and certification system that cannot be met by an exporting country, the importing country should consider providing assistance to the exporting country, especially if it is a

developing country. Assistance may include longer periods for implementation, flexibility of design, and technical assistance (CAC 2006). In recent years, a variety of traceability systems have been implemented in the developing world, including systems for fresh fruit, vegetables, grain, oilseeds, bulk foods, seafood, fish, and livestock.

Support for traceability projects designed to connect small-scale producers to global markets comes from a variety of sources: (1) non-profit organisations and development agencies (such as IICD for Fresh Food Trace in Mali and IFC for olive oil tracking in Palestine); (2) governments (Botswana and Korea for livestock tracking; Thailand and Vietnam for seafood); and (3) the private sector (ShellCatch for seafood tracking in Chile). The sections that follow provide examples of how food traceability systems have been implemented, particularly in low-income economies.

In addition to support systems for developing countries, mobile technology provides new opportunities for smallholders to connect with export markets. Mobile technologies have not only alleviated asymmetries in the flow of information from the market to smallholders (Muto and Yamano 2009), but hold great potential for enabling the counterflow of information from small-scale producers to markets to meet traceability requirements. For example, farmers may use a mobile device to input information on the variety grown, planting and harvest dates, and use of farming inputs. Data captured by smallholders can be integrated with information systems and centralised databases to provide greater transparency to supply chain partners and consumers on the farming process, inputs, and output. The integration of wireless sensor networks, RFIDs, and mobile technology could yield sophisticated means to capture data during farming and minimise the need for manual data input through mobile devices.

By fostering more linkages, socialisation, and networks between small-scale producers, the diffusion of mobile technology can address issues of geographic dispersion and linkages to traders, other farmers, or market groups for quality assurance, marketing, and sales. Empowering Smallholder Farmers in Markets in a research project found that international trader-led linkages can empower smallholders to supply high-quality, traceable produce and gain from quality-linked awards funded by traders. For example, Italian coffee roaster Illycaffè increased its procurement of superior Brazilian green coffee from smallholders by investing significantly in quality assurance training and market information for smallholders. The company has won competitions and awards for best growers and for

commanding above-market prices for the product (Onumah, Davis, Kleih, and Proctor 2007).

Volume of commercial negotiations via mobile phones

Across the research locations in Nigeria and in Côte d'Ivoire, a significant proportion of various negotiations on availability and transportation of food produce from the countryside to urban centres is being conducted with the aid of GSM phones. However, a substantial measure of variations subsists in the extent of application and in actual volume of transactions being conducted across various research locations in Nigeria and in Côte d'Ivoire. In the case of Nigeria (Ilesha and Ile-Ife and their environs), from the stage of nurturing crops to harvest and eventual selling to urban middlemen and women (retailers and wholesalers), the use of mobile phones has become extensively and popularly established among all participants. Meanwhile, retailers and wholesalers in the cities often used their mobile phones more than rural-based food producers. The rural-based food producers naturally preferred receiving requests from prospective buyers from the cities than making calls to them. Better yet, the rural-based producers could just "flash" the prospective urban buyers, who in turn put calls across to them.

In the case of Côte d'Ivoire, individual participants in the web of the food chain from the region of Soubré (either urban-based retailers/wholesalers of food products or rural-based producers of food products) have routinely inculcated the application of mobile phones in their day-to-day activities. However, this has not been the case with the region of Korhogo, where various primordial considerations and lack of adequate knowledge of how to apply mobile phones in their daily transactional processes have continued to inhibit appropriate use of such devices in the processes of food production and distribution. Meanwhile, an only approximately 30% of the research participants in this Ivorian region claimed to have an idea of what a mobile phone is and what it does. Ostensibly, rampant illiteracy among the region's inhabitants has been a potent factor in this respect.

Sustainable livelihood approach to ICTs in support of rural poverty eradication and food security

Sustainable Livelihoods (SL) approaches and their applications have been subject to considerable debate in recent years. There is presently a considerable literature on the topic relating to both theoretical developments and, increasingly, donor and development agency experience of

implementation. As noted by Krantz (2001), donor interpretations of an SL approach commonly incorporate the following:

1. These principles specify that developmental activity should be:
- People-centred: beginning with people's own views of their priorities, opportunities, and needs, the approach works out technically and financially feasible responses. In this way, it seeks to be responsive and participatory.
- Differentiated: it recognises that the characteristics of poverty, and appropriate policy responses, differ between different groups of the poor.
- Multi-level: it recognises that poverty cannot be addressed by local action alone: approaches are needed that link local level perspectives obtained by SL into higher-level processes of designing and implementing policies that impinge on the poor.
- Conducted in partnership: between public and private sectors—both NGOs and private commercial agencies have roles to play that complement those of government.
- Sustainable: in several dimensions—economic, institutional, social and environmental—but this does not imply set patterns of livelihoods that must be sustained indefinitely; on the contrary, livelihoods are recognised as being dynamic in the sense that the poor manage complex "portfolios" of a number of (usually) part-time activities, changing the balance among them with changes in the opportunities and constraints they face.

The principles are intended as a basic guide to more poverty-focused development and encapsulate the essential aims of SL.

2. An analytical framework (providing a broad and systematic understanding of the various factors that constrain or enhance livelihood opportunities and how they relate to each other). The framework is a useful means of highlighting key aspects of the approach and the way they relate to each other but is not intended to capture all SL thinking. Rather it is one of many tools that can be employed when implementing an SL approach.

3. A developmental objective (i.e., to enhance the overall level and sustainability of livelihoods to reduce poverty). An SL approach therefore aims to bring together the lessons of "best practice" in a set of guiding principles. It also notably provides a common framework and language for analysts and policy-makers from different sectors, emphasising cross-

sectoral collaboration and providing space for different disciplines to work together towards a common goal (Ashley and Carney 1999). The potential of SL as an analytical tool is perhaps greatest in project design. A central focus of analysis is in understanding of how existing policy and resulting institutions and structures affect the livelihood outcomes and strategies of the poor. Specifically, it recognises that access to different types of capital assets, the ability to put them to productive use and to reduce risk and vulnerability are central components of growing out of poverty. Importantly, it emphasises that the poor do have assets, options, and strategies, and that they are decision-takers.

As such it provides a useful, logically consistent way of thinking through the complex issues influencing the livelihoods of the poor (Farrington, Chapman, and Slaymaker 2001).

Operationalising SL approaches

Carney et al. (1999) compared the approaches of four key proponents of SL (DFID, Oxfam, CARE, and UNDP). Variations in emphasis and interpretation are revealed but it is noted that at a conceptual level commonality exceeds variation. Elsewhere DFID stresses that there are many ways of applying livelihood approaches (there is not one single approach), but that the basic underlying principles are fundamental and common to all approaches (DFID 1999). A notable feature of the SL approach is its emphasis on multi-sectoral collaboration and coordination. As such, it encourages innovative partnerships between government departments, public and private sector, civil society, and international development agencies. Enhancing information and communication processes within and between agencies is a key area of concern.

An inter-agency forum on operationalising SL approaches, held in Siena, Italy, in March 2000, produced strong agreement on the guiding principles that underpin SL approaches (FAO 2000). However, at the same time it was noted that the tools and methods used to implement them are not specific to SL methodology. Furthermore some of the approaches, such as participation, which underpin the SL guiding principles, are already well-established in the work of agencies such as the FAO (Chapman 2001). The need to understand and facilitate effective linkages between micro-level livelihood systems and their policy environment is well recognised, but the particular role and responsibility of different agencies in interventions at different levels varies according to their comparative advantage, individual mandate, and scale of operations. For example the United Nations Development Programme (UNDP) and DFID

tend to have higher-level entry points than non-governmental organisations (NGOs) and agencies working on the ground.

However, there is clear scope for greater collaboration and complimentary activity, with different agencies building on their various existing strengths. The inter-agency forum noted the following key lessons from SL approaches:

- shift the focus from resources to people and from livelihood constraints to people's strengths;
- emphasise the relationship between people's assets and their resilience in the face of external shocks, highlighting how poverty contributes to vulnerability;
- focus on the synergy between natural, physical, financial, human, and social capital;
- stress outcomes rather than outputs;
- prioritise early diagnosis, demand-driven implementation, and the establishment of feedback mechanisms;
- emphasise project design as an iterative process involving continual learning and adaptation on the basis of feedback from unfolding implementation;
- ensure economic, institutional, social, and environmental sustainability through adoption of exit strategies in the early stages of programme implementation;
- foster interdisciplinary teamwork; stress the interdependence between "real life experiences" and the broader policy context as the basis for forging bottom-up micro–macro linkages to bring about policy changes;
- encourage innovative partnerships.

In terms of the practical implementation of SL approaches, it is important to be realistic. The SL approach does not necessarily aim to address all aspects of the livelihoods of the poor. The intention rather is to employ a holistic perspective in the analysis of livelihoods, in order to identify a manageable number of key entry points where intervention could be strategically important for effective poverty reduction, either at the local level or policy level (Krantz 2001). Identifying the most effective entry points for SL remains a key issue for further clarification, however there is no reason why priority areas should not be sector specific, provided they adequately address the needs of the poor. Large donors are increasingly changing from supporting projects towards budgetary support and sector-wide approaches (SWAps). As noted by Gilling, Jones, and

Duncan (2001), SL approaches can add value to sector-based approaches by emphasising diversity and cross-sectoral linkages and have the potential to make them more effective in reducing poverty.

The UNDP has developed a number of notable tools to facilitate the implementation of SL programmes at country level. These include:

— a manual for participatory assessment and planning for SL (PAPSL);
— a programme-support document template that can be used by UNDP country offices;
— a discussion paper on how indicators of SL can be developed;
— guides for the analysis of technology, environment, governance, community participation, and monitoring and evaluation (M&E).

Meanwhile, other literature on SL approaches has sought an increased focus on power relations, institutions, and politics. There is growing interest in the links between and relative merits of rights-based approaches and SL (see for example Farrington 2001). Rights-based approaches tend to place greater emphasis on the need to increase the power and rights of the poor if poverty is to be addressed. Moser, Norton, Conway, Ferguson, and Vizard (2001) assess the potential for fusion between the idea of rights and SL approaches to produce a "livelihood rights approach" and distinguish between a set of normative, analytical, and operational principles. It is useful to note the distinction between the "demand" and "supply" sides of rights-based approaches. SL arguably over-emphasises the "provider perspective," whereas empowerment remains a primary focus of many NGOs, for example, Save and CARE. Oxfam in particular emphasises the "right to a sustainable livelihood" but then seeks to deliver against specific objectives/outcomes on food, income, employment security, and so on. It is also increasingly concerned with value-chain analysis, markets and livelihoods, and issues of power and powerlessness in markets and trade (Hussein 2002).

ICTs in the context of SL

Information and communication issues currently receive only limited treatment in the literature on SL approaches but are central components in the framework in that they provide the linkages that maintain its dynamic structure. The framework serves to highlight the processes that contribute to a set of livelihood outcomes and is not a static map of the structures alone. In order to achieve desired livelihood outcomes information must

be communicated throughout the framework to inform decision-making at every level. Through a process of iterative diagnosis and feedback, information generated within the SL framework should contribute to a constant learning process that influences project design and contributes to poverty focused institutional and policy reform (Pasteur 2001). SL thinking illustrates that there are many different livelihood strategies that can be developed by working with the assets, policies, principles, and institutions in each context to affect positive change. In each and every case, information and communication are central driving forces of change.

Understanding the local level information needs of the rural poor, as the ultimate beneficiaries, is centrally important to the development of effective projects, programmes, and policies in support of SL. The particular role of information at the livelihood level can be usefully conceptualised in terms of a livelihoods information wheel. In order to help define the role of information in support of SL, related information is categorised into two (A and B). These categories are not intended to represent two completely distinct types of information but rather the dual role that information can play in support of sustainable livelihoods over time. A represents the information for long-term capacity building involving education, training and technical support appropriate for the livelihood development of individuals or groups. This core information contributes to the enhancement of an individual's knowledge. It improves understanding of the systems and processes that can affect the way that assets are used in the longer term, and assists in the planning of livelihood strategies. B represents information for short-term decision-making that is used to maximise the potential of a particular asset at any one time, reduce vulnerability to shocks and respond to immediate needs.

These two types of information can support any one or all of an individual's assets but the relative importance of information relating to a particular asset is largely context specific. The typology (A+B information to support long-term livelihood strategies and short-term livelihood activities) is not intended to be comprehensive in its representation of the role of information in support of SL but is indicative of a systematic and differentiated approach to information needs assessment that can usefully inform the design of more people-centred policies and programmes in support of SL. The livelihoods information wheel provides a reference point to help focus project design on differentiated information needs.

Participatory approaches underpin SL and a particular value of the approach lies in the inclusive, non-threatening process of designing poverty interventions that it encourages, in addition to whatever improved project/programme outcomes it achieves (Farrington et al. 2001).

Information and communication initiatives are keys to enhancing the benefits of this process. A people-centred approach can also help the poor to use information and communication technologies for their own needs rather than just receiving information in the form of messages from external sources (Norrish 1998). This requires enhanced two-way information flows between beneficiaries and policymakers. For example, the Farmer Field Schools developed by FAO as part of an Integrated Pest Management project in Indonesia use a methodology that helps focus on local knowledge and experience and ensures that the participatory learning process is one that is shared between the farmers (Coldevin 2000).

The lessons from Farmer Field Schools are being integrated into other sectors such as community forestry and are a good example of how many of the principles of SL are already being applied by organisations such as the FAO. SL thinking, however, can further help reveal the types of information that might best contribute to FAO's food security and poverty objectives, either by providing for the information needs of the poor directly, or by enhancing the quality and quantity of information available to institutions responsible for making decisions that affect the poor. It emphasises the importance of a detailed assessment of the needs of target beneficiaries and stakeholder groups to identify the most appropriate institutions and policy processes for effective programme implementation. Debate regarding new ICTs centres on the identification of opportunities for the poor to use ICTs to manage information that is appropriate for their different needs. This requires "local appropriation" of ICTs by communities so that they can be adapted to their own social, economic, and cultural processes (Michiels and Van Crowder 2001).

SL approaches focus attention on the relationship between people's assets and their resilience in the face of external shocks, in particular the relationship between poverty and vulnerability. This can usefully inform a differentiated approach to information that needs assessment by highlighting the potential role of information in enhancing the different livelihood assets. A direct relationship exists between, on the one hand, the supportive role that information plays in sustaining the livelihood assets of the poor and, on the other hand, how ICTs can improve the flow of information to support sustainable livelihoods of the poor.

SL approaches aim to be flexible, responsive, and participatory, prioritising early diagnosis, demand-driven implementation, and the establishment of effective feedback mechanisms. The design and management of SL projects is an iterative process involving continual learning and adaptation on the basis of feedback from unfolding implementation (Pasteur 2001). Information in support of SL therefore has

a dual function: to supply the information required by the poor in order to pursue sustainable livelihood strategies; and to supply information required by institutions responsible for making decisions that affect those strategic livelihood options. Information relating to market prices, for example, if packaged correctly can respond to the immediate needs of farmers. However, a multi-level approach will both deliver information on market prices to the village level in an appropriate format, and incorporate information (on yields, market prices, and farmers' incomes) from the local level into national productivity and vulnerability assessments, for example poverty reduction strategy papers (PRSPs). SL provides a holistic perspective that can assist in the identification of priority activities and appropriate entry points, based upon an improved understanding of the potential synergies between targeted interventions at different levels.

It is evident that effective promotion of sustainable livelihoods requires changes in institutions and attitudes, knowledge and information levels, processes and skills. An improved understanding of skills at different levels enables the identification of appropriate systems and institutions for the delivery of information in support of SL. The role of information in decision-making will therefore be discussed in the following section, exploring the importance of information for the information needs of individuals and institutions at different levels and for developing strategies and policy-making.

Enhanced information for enhanced productivity

Information is a basic and fundamentally important element in any development activity. Finding ways to harness it more effectively to assist those making decisions affecting the sustainability, productivity, and profitability of their livelihoods is a priority concern (DFID 2000, 2002). Information about food and agriculture is vital for both individuals and institutions in developing countries in order for them to make effective decisions on issues ranging from household-level food security to local, district, and national rural development strategies.

Better information and information systems can greatly assist decision-making at all levels and enable the information that is available to be used more effectively where it is needed within the system. The goal of the FAO's World Agricultural Information Centre (WAICENT) Outreach Programme is:

> . . . to enhance the ability of individuals and communities in Member Countries to improve the efficiency, quality, and relevance of information and knowledge exchange among the various stakeholder groups involved

> in agricultural development and food security, with a focus on the most vulnerable and deprived groups. (FAO 2000, 1)

The effective provision of information on food and agriculture is therefore fundamentally important as it informs both the livelihood strategies of the rural poor themselves, and the policies and strategies of agencies and institutions responsible for reducing rural poverty and food insecurity. In each case, it is only through improved information that individuals and institutions can make informed choices about the opportunities and constraints associated with agricultural development strategies.

In order to prioritise information programme activities and effectively target different information needs, it is important to identify different stakeholders. A recent assessment of stakeholder participation in FAO Field Programmes, by FAO's Informal Working Group on Participatory Approaches and Methods to Support Sustainable Livelihoods and Food Security (Warren 2001) identified more than 25 different stakeholder types. Primary stakeholders include community and societal actors in projects and programmes. Secondary stakeholders include local governance institutions and "interface" institutions such as technical services, NGOs, and private sector organisations. Tertiary stakeholders include national-level development agencies, national NGOs, policy-makers and international support agencies. Evidently these various stakeholder groups have highly differentiated food and agriculture information needs. The distinction between stakeholders at the government, decision-making level and the more local-level stakeholders helps illustrate the diversity of information requirements. Further analysis of information needs differentiated by gender also follows logically from the people-centred focus of the SL approach. However, a differentiated approach to information needs on the basis of gender should also recognise that most people fall into multiple stakeholder categories according to their livelihood options and assets. In this regard the policymakers and farmers discussed below represent comparatively distinct stakeholder groups, although, needless to say, they refer implicitly to both men and women.

Meanwhile, improved access to information is necessary but not sufficient for improved decision-making. Decision-making is a political process and stakeholder participation in decision-making processes is crucially important. Enhancing the quality and quantity of information therefore also relies on attention to the flow of information, such as the means of communication, format, and content. Information can potentially have a catalytic role but must be reliable and relevant to the needs of the particular user group. Improved information can enable people to better

defend their interests and articulate their needs; and it increases their bargaining power and ability to influence decision-making processes that affect them. Transparency is equally important if information is to empower people to make better decisions. Improved communication systems can enable individuals to organise themselves, use information to hold institutions accountable and put pressure on relevant authorities to deal with their problems (CTA 2001). However, identifying appropriate type, quality, and quantity of information depends on understanding the capacity of decision-makers at different levels

Enhanced information accessibility and improvement of rural livelihoods

Some three quarters of the world's poor live in rural areas and, according to projections, a majority of the poor will continue to live in rural areas well into the twenty-first century (IFAD 2001). The rural poor depend primarily on agriculture and related activities for their livelihood; agriculture provides the bulk of their income and their main source of nutrition. A complex range of information is required by rural people and community organisations to pursue individual and collective livelihood activities and formulate sustainable livelihood strategies.

Richardson (1997) in a report for the FAO stresses the need for an integrated approach to information for rural and agricultural development. An approach that "begins with the needs of rural people and grassroots agricultural organizations and works to establish vertical and horizontal channels of communication" is consistent with a participatory, people-centred, SL approach to information management. Richardson notes that "participatory development is fully dependent upon communication and information sharing processes" and that in order to deal with the unprecedented challenges of food insecurity and poverty, people at all levels of society "must be able to access critical information and communicate" (1997, 7).

Understanding the information needs of these primary stakeholders is an essential starting point if higher level policy and planning processes are to effectively support sustainable livelihoods in rural areas. Promotion of sustainable rural development strategies, including sound management of natural resources, is a central concern of agricultural information systems. Smallholder farmers in many parts of the world reach productivity levels that are only one third of the potential yield under optimum conditions (IFAD 2001). Principal reasons for low productivity include weak (or non-existent) extension services, lack of competitive markets and lack of

suppliers for seeds, fertilisers, and rural financial services. Together these factors reduce either the possibilities or the incentives for increasing agricultural productivity. The lack of information available to the rural poor is a major constraint to increased agricultural productivity. Agricultural extension, education, and training can help many farmers maximise the potential of their productive assets. Farmers need up-to-date information on the sources, availability, and cost of agricultural inputs, and also on the potential of different techniques and technologies used for the production and processing of agricultural goods. Smallholders can substantially increase their yields by adopting better methods, seeds, and fertilisers while delayed adoption of new technologies among poor farmers can lead to exclusion from market opportunities.

Tripp's (2001) assessment of future agricultural technology policies for rural development emphasises that most of the new technologies that will become available to farmers will be "information intensive," that is, requiring increased levels of knowledge for appropriate management. In addition to basic technical knowledge, rural poor people need to be able to operate in increasingly sophisticated input and output markets. However, it is not sufficient to focus on production and crop-specific information alone. The information required by the rural poor on agricultural techniques includes that relating to forestry, fisheries, and livestock. In addition, information on rural off-farm activities is increasingly important in many areas. In most situations, the information that is most relevant to improving support to livelihoods is wide-ranging information that informs diverse household-level strategies. Effective information systems need to integrate the productivity based needs of rural communities with information to support broad-based rural development strategies, including diversification of household activities both within and outside the farm sector. For appropriate choices to be made at the local level, information regarding rural development strategies also needs to incorporate issues of environmental and not just economic sustainability.

Strengthening developing country capacities for research and development of more responsive extension services is a key concern in order to support farmers to make better decisions relating to overall household strategy. Extension of agricultural information has evolved beyond merely transmitting messages (although this is still important). It is becoming more open, more participatory, and more demand-driven, involving interactivity, negotiation, and two-way information exchange between extension agents and farmers. There is new emphasis on the acquisition of information; farmers need to be able to request information specific to their particular livelihood needs and the options available for

building more diversified activities. Information communication systems must therefore be designed to facilitate dialogue and questioning (Jafri, Dongre, Tripathi, Aggrawal, and Shrivastava 2002). It is also important to note that the impact of increased information flow is dependent on its effective translation into a format and language appropriate to the intended users and their local context, and also on the capacity of farmers to analyse and act on it.

Information about the role and responsibilities of different institutions in the provision of key services is equally important. Rural poor people require better information about rural development programmes supposedly designed to benefit them. Farmers also need to know where to go and who to ask for different types of information. Law, for example, is a crucial topic for the rural poor—key questions concern inheritance, women's rights to land, and relationships between crop-raisers and herders (Mundy and Sultan 2001). Agricultural credit is another crucial topic. Legal and financial disputes are common because rural people do not have access to basic legal and financial information. This creates a climate of distrust, which constrains investment in agriculture. Longer-term strategies will be increasingly dependent on information relating to international markets, to determine opportunities and potential challenges to sustainable livelihoods.

Globalisation and continuing liberalisation of agriculture has substantially changed the policy and institutional environment in which poor farmers operate. Previously the cost of inputs and output market prices were fixed and known, but now smallholders are increasingly exposed to the vagaries of the open market. Most poor farmers are ill equipped to cope, they do not understand how markets work or why prices fluctuate and are vulnerable to rapid changes in market conditions. Accessing information on market conditions, prices, and quality of produce from physically remote locations is extremely difficult. Groups of poor farmers are often isolated from each other with little collective organisation, limited experience of market negotiation and little understanding of ways in which to influence the terms and conditions under which they enter the market. For example, rural producers commonly sell cheaply during the glut immediately following harvest and then buy at higher prices in the lean season, thereby losing out twice. The lack of information means that poor farmers are ultimately passive rather than active players in the market and are vulnerable to exploitation by others. As a result they often fail to realise the full potential value of their produce. Farmer groups or associations can help overcome this problem. Where rural producers are able to communicate better, enabling them to organise themselves and

gain access to up-to-date market information, they are able to develop strategies to achieve better and more stable prices. Improved systems for the management and communication of agricultural information can help poor farmers organise as groups, manage production jointly, exchange experiences, obtain technical and economic information, and make appropriate livelihood choices.

Strategies for information in support of SL-friendly policy-making focus primarily on enhancing the quality and quantity of information available to institutions responsible for making decisions that affect the poor. It is important to note that information needs at different levels of government decision-making (local, district, national, and international) are highly differentiated. However, two broad types of information can be usefully distinguished:

— information on the status of agriculture and poverty as the basis for policy and regulatory decision-making (including population, productivity, poverty and vulnerability, etc.);
— information to support management and implementation of policy interventions (monitoring and evaluation, constraints analysis, micro-macro links, diagnostic feedback, etc.).

Adoption of an SL approach can provide policy-makers with a changed perspective. The further an SL approach underlies the collection of information on the status of agriculture and poverty, the better the quality of the information flowing up to policy-makers. It follows that improved understanding, among policy analysts and decision-makers, of the diversity and complexity of livelihood opportunities facing the poor is likely to lead to more appropriate policy choices. SL approaches to information collection and analysis can certainly enrich quantitative and economics-based frameworks commonly used in assessing and designing policy and programme interventions. In particular, participatory approaches to eliciting more relevant information in support of decision-making are fundamental to improved understanding of livelihood issues. It is however important to be pragmatic. As noted by Krantz (2001), successful application of the approach depends less on, for instance, a particular definition of vulnerability and more on the interpretation of reality against the principles underlying the approach. At the government level, information needs refer to both the quantity and quality of information that is required by decision-makers to formulate effective policies.

Heeks (1998) (cited in Kenny, Navas-Sabater, and Qiang 2000) prioritises four main types of information required for governance institutions:

- information to support internal management, including staffing and budgeting accounts;
- information to support policy and regulatory decision-making, including population, economic, financial, and other data;
- information made publicly available, including laws, statistics, and health information;
- Information to support public services such as education, health, and transport.

It should be further noted that enhancing approaches to information collection and analysis is necessary but not sufficient to realise SL objectives. Thomson (2000) argues that the best possibility for achieving a sustainable improvement in livelihoods policy is to allow for greater civil society and stakeholder participation in the setting of priorities and formulation of policy. However, the extent to which different stakeholder groups engage in policy debates on food and agricultural issues depends largely on their ability to access relevant information. Governments therefore require improved information on the nature, extent, and distribution of food insecurity and poverty, but also, crucially, on the complex linkages between policies designed to solve these problems and actual livelihood outcomes. FAO has a number of specialised information systems and tools (e.g., Global Information and Early Warning System [GIEWS], Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases [EMPRES], GeoWeb), but it is important to examine the ways in which this information is actually used by policy-makers, as well as if and how it translates into targeted policy interventions.

In an evaluation of FAO's policy assistance (FAO 2001), it has been shown that it is widely appreciated by the countries and international partners, and that its technical quality is as good as, or better than, that of other agencies, making considerable contributions to the policy-making processes. However, significant areas for improvement were found, including the integration of multi-disciplinary input. The report also recommends that, in the light of the Strategic Framework, FAO's policy assistance should be oriented towards rural development policy rather than just agricultural policy. FAO has been effective in introducing more consultative approaches into policy-making between government departments, but this could be still further strengthened. It is

recommended that FAO continue to encourage participatory modes of policy formulation that include not only other line ministries, but also NGOs, the private sector, and other UN and bilateral agencies. There is a particular need to increase the capacity for more rapid flexible responses to the information needs of policy-makers. This is partly a question of improved targeting of government information needs and partly a question of supporting and training governments in information management and analysis for policy-making.

CHAPTER SEVEN

SPECIFIC LIVELIHOOD OUTCOMES OF THE APPLICATION OF ICTS IN AFRICAN AGRICULTURE

Raising the productivity of smallholders is a necessary condition for increasing incomes and improving livelihoods among the rural poor in most developing countries. This increased productivity is essential to both household food security and to agriculture-based growth and poverty reduction in the larger economy. Smallholder productivity is limited by a variety of constraints including poor soils, unpredictable rainfall, and imperfect markets, as well as a lack of access to productive resources, financial services, or infrastructure. It is also critically limited, for example, by lack of information about market prices, available crop varieties, production techniques, and methods of disease management—information that pertains specifically to local conditions. Smallholders also lack timely information sources such as news reports or early warning communications about weather, pest outbreaks, and other seasonal risks, and about services that could help address them.

The smallholder agricultural economy is in crucial ways an information and service economy. The physical isolation of smallholders imposes high information costs that compound the high transport and transaction costs of obtaining inputs and marketing outputs. Improving the information, communication, transaction, and networking resources available to farmers—and to the markets, organisations, and institutions they interact with—is essential to making smallholder agriculture more productive. The appropriate deployment and use of information and communication technologies (ICT) is central to this improvement.

Information and communication technologies are also vitally important to commercial and large-scale agriculture, and to agriculture-related services and infrastructure such as weather monitoring and irrigation. This note focuses on the sometimes less-obvious importance of ICT in improving the information, communication, transaction, and networking elements of smallholder agriculture in developing countries.

Improving smallholder agriculture is an information- and communication-intensive process throughout the value chain from farm to market and beyond. Smallholders face higher information costs, both as producers and sellers, because of their typically greater isolation and the poor state of rural information and communication infrastructure. They require information to make informed decisions at each stage of the production cycle, from crop selection, to planting, to harvesting, to selling. Timely information about prices and consumer preferences not only informs production decisions about crop mixes and the need for inputs, but enables farmers to balance their investment of family labour in farm and non-farm activities during the growing season.

Crop quality and yield also depend heavily on producers' access to information and networks. Given the diverse agro-ecology of smallholder agriculture (particularly in Africa) and the growing diversity of national and global food product markets, the information and advice that farmers need is increasingly diverse and context-specific.

At harvest, this same knowledge helps farmers negotiate a better price from traders and other middlemen, and even to access a wider variety of markets, middlemen, and transport opportunities for their products. The ability to pool output and increase negotiating leverage through cooperatives and producer associations, for example, can also help farmers earn higher incomes.

The costs of searching for information can represent a substantial proportion of farmers' total costs, and a substantial majority of their transaction-related costs. In Sri Lanka, for instance, de Silva and Ratnadiwakara (2008) documented evidence that these information costs can represent 11% of farmers' total costs, and up to 70% of their transaction costs. Because the cost of information does not vary with the size of a farmer's crop, smaller farmers are particularly burdened by high information costs.

This information will increasingly come not only from traditional sources such as national agricultural research systems and agricultural advisory services, but also from fellow farmers, the private sector, and other local sources. As agricultural innovation systems adapt to meet more diverse information needs, ICT can play a key role in strengthening the more complex and time-urgent pathways of information and knowledge-sharing on which this new form of agricultural innovation depends.

Mobile phones, rural ICT kiosks, and ICT-equipped intermediary organisations can all serve as pathways for this information exchange and collective action. In particular, mobile phones have recently enjoyed increasing attention because of their availability, affordability, and

versatility, as platforms for a broad range of information and transaction services.

Many agricultural cooperatives, producer and trader organisations, extension agencies, and other intermediaries and service providers are subject to the same impediments as the farmers they serve. Improving their ability to aggregate and share information and knowledge, and to connect people and foster collective action will increase their effectiveness in serving members and communities. Recognising the importance of these intermediaries, donors such as the Gates and Rockefeller Foundations are increasing efforts to expand and support networks of rural agro-dealers. Providing appropriate ICT tools and connectivity to these networks, and building their capacity to use ICT should be an important element in developing vital links in the rural service economy.

ICT can extend the reach of financial services in rural areas in two ways. It can help traditional financial institutions reduce the costs and inefficiencies of reaching, assessing, and servicing rural clients. In Ghana, for example, ICT has helped an extensive network of independent rural banks, to both increase their efficiency and extend their services to a wider population. ICT can also facilitate new business models for providing financial services to the poor, helping them to afford higher-quality inputs and to secure prompt payment for their outputs.

ICT can serve a similar function in strengthening public services for the rural poor, from land registration, extension, and advisory services to health and social services, and public support payments. Yet the poor often have very limited information about those services, or about their own eligibility to access them. Even among those who are aware, accessing public services often entails considerable time and money to travel to towns where the responsible institutions are located. Local government services are, moreover, often prone to corruption.

ICT can increase information about government services, and facilitate collective action to increase effective demand for them. It can make services and the institutions that provide them more efficient and transparent, and decrease opportunities for corruption. A trailblazing example took place during the Bhoomi project in Karnataka, India. The project involved the computerisation of several million land records which were documented and made publicly available through a network of rural ICT-linked kiosks. This process reduced opportunities for corruption, eased farmers' access to documentation needed for land transactions and loans, and demonstrated that farmers are willing to pay higher use fees for quicker, more reliable access.

Consumption patterns among urban populations are changing and generally diversifying. Demand for meat, fish, dairy, horticultural, and processed products in particular is increasing. Here too, ICT can play an important role in enabling smallholders to produce high-value commodities and to capitalise on opportunities to participate in these markets. Supply chains leading to these urban and global markets are highly integrated, and require timely information and impose exacting quality standards. ICT can be instrumental in improving smallholders' access to information about these markets and what is required to produce for them. It can also greatly facilitate networking among smallholders, and provide new ways to communicate with institutions that are involved in carrying out transactions in these markets.

Extending affordable access to ICT will depend on innovation in technological and business models, including a variety of shared-use models that have already shown great promise. Perhaps the best-known shared-use model is the Village Phone model first launched in Bangladesh, wherein micro-loans enable women in poor villages to purchase a mobile phone and re-sell phone service at per-call rates to their neighbours. The increasing affordability of mobile handsets and pre-paid service, combined with innovations such as multi-account mobile phones, are permitting greater local innovation in sharing phone service among those who cannot afford their own phone. Technical innovations such as cell phone signal amplifiers are extending the range of mobile services, and many telecommunication providers are extending communications infrastructure further into rural areas to respond to new market opportunities.

The competitive markets needed to stimulate this innovation and expanded access will require effective legal, policy, and regulatory frameworks. Government policies, regulations, and (where appropriate) public investments, can create incentives for private investment in adapting ICT tools, infrastructure, and service models to those in low-income, isolated, and often-rugged environments. Governments and donors can play a vital role in encouraging innovations appropriate for local conditions, among other things by improving the investment climate for new businesses. In addition to their role as facilitators of extended information and communication networks, governments also use these networks to improve and extend public services. These "supply-side" initiatives need to be complemented by measures to stimulate demand for ICT among farmers and the organisations and institutions that serve them. Part of this "demand-side" work entails raising awareness of the ICT services and resources that are available, and showing how they can be

used to improve farmers' livelihoods and the operations of local organisations.

It is important to distinguish between access to ICT and access to the services, resources, networks, and capacities that ICT enables. In many cases, the most sustainable and transformative impact of ICT in rural areas will come from its effect on the markets and institutions with which the poor interact. Improving the capacity of these institutions to use a broad range of technologies, including web-based technologies, will increase their effectiveness as sources of local service delivery. At the same time, increasing rural access to newer ICTs should not obscure the continued value of more established communication tools such as radio. Some of the most creative and sustainable innovations for information, communication, and transaction services in rural areas will come from integrated mixes of technologies that are adapted for local contexts. The Developing Countries Farm Radio Network (www.farmradio.org), a pioneer in using radio to support farmers, is now exploring how content can be distributed creatively through a variety of technologies ranging from radio and mobile phones to portable audio players.

The specific character of local demand for ICT, and the local economic, social, and physical context, will determine the mix of technologies and services that are most appropriate and most likely to be sustainable. Detailed assessment of this demand and context and of any factors that might impinge on the local agricultural information economy is, therefore, an early priority in the design of ICT interventions. In general, ICT-for-agriculture interventions should be embedded in, and subordinate to, locally appropriate strategies for improving the agricultural information economy more broadly.

Across various categorisations—urban or rural, male or female, producers or buyers—actual "call-making" has been the most preferred application of the mobile phones in the processes of food production and distribution in all of the study locations in Nigeria and in Côte d'Ivoire. Time consideration and illiteracy (especially, in the case of rural Côte d'Ivoire) have been the determinants of this development. Through adequate sensitisation programmes by the governments at various levels, in partnership with the GSM service providers, individual participants within the web of the food chain could be encouraged to explore other possibilities of mobile telephony, for instance through making advertisements and business contacts via the internet.

Evidential ICT outcomes

In both Nigeria and Côte d'Ivoire, the sale of agricultural products within the food chain has been considerably enriched by the capacity of truckers. In all cases, the use of mobile phones has ensured timely establishment of contact and delivery of farm produce compared with the pre-mobile phone era. Initially, in Côte d'Ivoire, available trucks for conveyance of farm produce from villages to the urban centres were very few in number. They, however, reached optimal growth in numbers from the years 1996 onward because of the law on imports of vehicles in Côte d'Ivoire that allowed many carriers to acquire the KIA vehicle brand. These vehicles have contributed massively to the expansion of points of collection of farm produce hitherto reachable not by vehicles but only by cart.

Moreover, the advantage of using these types of KIA trucks is twofold: on the one hand, the amount of collected food products has now grown tremendously. Approximately 135,000 tons of farm produce were conveyed in 2014 alone, according to data sourced from the Office of Vivriers Marketing of Products in Ivory Coast (OCPV). According to this government agency, the level of accessibility of food products by the population inexorably depends on the quality of transport of food products and their networks with leaders of different markets. Indeed these two dimensions were revealed during field investigations that led to the production of this research report. Ostensibly, the introduction of mobile phones has facilitated the exploration of new areas of communication in enhancing agricultural production and food security in both Côte d'Ivoire and Nigeria. Although the introduction of truck drivers had assisted the process of linking rural areas of food production with urban areas of food consumption, the use of mobile phones has been very visible. Indeed, most road networks in Côte d'Ivoire and Nigeria are very bad. Most food producers have tended to be in close proximity to areas of high food consumptions in the cities. Of course, in improving the speed of access to food produce, the usefulness of mobile phones has been central. The extent of collaboration between farmers and buyers of food produce has indicated that it will continue to reflect a familial pattern of interaction that leads to financial support from both parties, even in the case of the death of a member of the family of participants (buyers and producers). This partnership had indicated that the crops are planted and distributed in collaboration between food producers, transporters, and buyers (wholesalers and retailers).

The processes of production and distribution of food produce had caused improved relations between producers and buyers within the food

chain. Ostensibly, the high demand from Nigeria and Ivorian markets has enabled the emergence of large-scale cooperative outfits, which in most cases have easy opportunity to obtain financial support from wholesale buyers, especially for the purpose of unobstructed accessibility to food produce distribution. We consider the trading circuits of food produce excluding transfers fields to camp or village for consumption. The marketing (or distribution) is carried out through different circuits that allow for the passage of the food produce from the rural production stage to that of the urban consumption stage. To understand this essential function and to input constraints and strategies related to marketing, we first present the economic players and distribution channels they animate by their intervention, with the mobile phones playing a central role. Many economic actors (referring to intermediaries) are involved in the marketing of food products, which makes it difficult to establish a precise typology. To simplify the presentation, we adopted a transversal approach in relation to locations of food production and consumption in Nigeria and Côte d'Ivoire; we studied together the main economic actors found within the produce chain, according to their degree of involvement in the distribution processes and their functions. This presentation is based on our personal field surveys and monographs used during our research in Nigeria and Côte d'Ivoire. In investigations, we followed a process that led us from the production area to the market for the reasons explained in the introduction to this report. To be consistent with this choice, we present the actors from the stage of production where local farmers initiate flows of food produce toward the urban consuming areas. For the purpose of selling farm produce in Nigeria and Côte d'Ivoire, the markets where the initial middlemen (buyers) receive produce are usually located close to the rural food producing areas; as such there are no elaborate structures of distribution in place. Meanwhile, the rural farmers are now able to be in touch with the urban buyers through the mobile phone medium. It is worth noting that the producers are the first players within the chain of marketing food produce. They, therefore, constitute the starting point of the marketing channel. Their presentation is limited by their characteristics and their understanding of their mode of intervention in the marketing of food products. The descriptions of various producers and producers in a cooperative (that is, small producers and large producers) are presented as follows

Small producers

Generally, small producers in both Côte d'Ivoire and Nigeria have very limited financial resources and are therefore limited to the exploitation of fields of limited areas with the help of their families. The main concern is to ensure the subsistence of the family. But preserving crops is often performed in precarious structures. They routinely expose produce from their farms to undue decay (for instance, produce like yam, cassava, and plantain are most vulnerable) and do not allow for long-term storage to meet the needs of the family throughout the year. Meanwhile, small-scale producers of crops in both Nigeria and Côte d'Ivoire who have functional mobile phones are able to link up with prospective buyers from the urban consuming areas in good time. Under these conditions, farmers are forced to sell part of their produce (often from 100 to 150 kg) improperly called a "surplus," although originally prepared for their households' consumption. This scenario equally plays out in the production of traditional or local rice (popularly called *Ofada* in Nigeria), which can be kept for a comparatively longer period when compared with other perishable produce. Small producers often sell part of their stored rice produce in the build up to the resumption of school by their wards in order to meet school fees and other associated expenses.

Women smallholders may need to purchase products from the markets during the lean season or period of scarcity. Some small-scale food producers have sufficient resources (while equally engaging in the practice of retailing crops). In such cases, there is always the extant need to appeal to agricultural extra manpower to assist in food production and distribution. They could, therefore, have larger surpluses; estimated at a few tons of produce that could be retailed in the local markets, often to bring greater income to meet their needs and also cash to feed the family. It is expedient to note that throughout the processes in Nigeria and in Côte d'Ivoire, the application of mobile phones, from the production stage to the final consumption stage is paramount.

Large producers

Whether specialised in food production for local consumption or in increasingly growing export produce for international consumption (for instance, cotton, coffee, and cocoa), large producers in Nigeria and in Côte d'Ivoire require substantial human and financial resources in order to invest in the exploitation of larger areas. Often, they exceed 10 hectares. It is interesting to note that education or the level of literacy of individual

farmers has been a significant determinant of the extent to which ICTs are applied in the processes of food or crop production and distribution in both Nigeria and Côte d'Ivoire. For instance, those farmers that have not received education beyond the elementary stage have restricted themselves to production for local-level consumption and, indeed, the usage of mobile phones (call-making) for marketing and networking. However, those farmers who have been privileged to receive education beyond the elementary stage have naturally been involved in cultivation and marketing of crops for international consumption and, of course, in the application of varying ICT applications in their daily routines. Such ICT applications have ranged from the use of mobile devices for call-making to internet searches and internet discussions with their business partners, who are spread across the globe. But very often the fields are not in one piece and thus we meet producers with two or three scattered fields.

Producer groups

In fact, the producer groups do not generally intervene directly in the production process. Their roles have focused on bringing together members of the producing groups to ensure optimal sales for them or to assist them in commercialising their produce by providing, if necessary, the vehicles of the cooperative body for conveyance of their produce. The cooperative body is rarely the owner of the produce or the farming land. It only assists in selling produce on behalf of the producing members, and sometimes acts as the intermediary between the producers and the traders. In all the entailed interactions, the use of mobile phones is significant.

Merchants

In both Nigeria and Côte d'Ivoire, the marketing of food crops involves a multitude of varying important traders. It is not easy to establish a typology of these economic actors. The classification of two women to be found in the production area of paddy buying or plantain as wholesalers or detailing proves to be a high-risk exercise involving errors. The same is true of the distinction between a mere intermediary in the grouping of a yam or plantain batch sufficient to achieve a load of 10 tons, as the wholesaler and owner of the lot sometimes appears disinterested. To overcome these difficulties, our typology calls first, to a logical grouping according to the functions they carry out in the marketing unit, and second, to a logical classification based upon features in organisational and business practices of these economic actors. On this basis, it is possible to

distinguish intermediate (collectors or trackers), wholesalers, and retailers who are the economic actors animating private marketing channels. The use of mobile phones among participants has been very central.

Intermediaries

In Nigeria and Côte d'Ivoire, intermediaries are generally found in both local producing areas and urban consuming areas, but they are more common within the urban setting. They play an essential role in marketing food products. Positioned in trade relations between producers and wholesalers, middlemen are responsible for ordering farm produce from wholesalers and retailers, and sometimes for sourcing of farm implements on behalf of local producers. They are also involved in sourcing for produce by crisscrossing various villages on motorcycles. In this role, they are called collectors or trackers. Whatever quantity of food produce he or she is able to collect would be made available to the wholesalers in places already agreed on and easily accessible to vehicles (roadside, farm gate, possibly with the opening of an access road, village, and so forth).

Usually located within the precinct of the food production area, the collectors (that is, the middlemen) do not own the produce they order. They operate on behalf of the wholesalers who are responsible for their mobility and remuneration. In most cases, they are provided with some capital in order to finance their operation, which is sourcing for farm produce and collection of such and making it available for the wholesalers. It is especially at these levels that collectors play a key role. They ensure that the length of stay of the wholesalers is reduced to the barest minimum since they would have done all of the necessary sourcing and packaging of food products before the arrival of the wholesalers and, indeed, the conveying vehicles. The action of the collectors is therefore actually an acceleration factor of the transfer of the farm produce from the stage of production to the stage of final consumption. It is imperative to note that across the board (in Nigeria and in Côte d'Ivoire) mobile phones are used to connect the middlemen with the local producers, the middlemen with the wholesalers, and the wholesalers with the transporters, and, of course, to connect the urban final consumers, in limited cases.

Linked to the fragmentation of supply of food products, the grouping of time necessary to obtain specific produce varies with the time of availability of the product and the marketing calendar. Meanwhile, the time taken by the middlemen (that is, the collectors) to get a load (in tons) of produce is dependent on the type of produce and the marketing period of the produce (for instance, peak or low period).

Table 12. Produce by period of marketing (Côte d'Ivoire).

Produce	Period of marketing	Time consolidation
Yam	Abundant	Maximum 2 days
	Scarce	3 to 7 days
Plantain	Abundant	2–7 days
	Scarce	4–7 days
Paddy rice	Abundant	2–3 days
	Scarce	4–5 days

Source: Fieldworks, 2015

Table 13. Produce by period of marketing (Nigeria).

Produce	Period of marketing	Time consolidation
Yam	Abundant	2–8 days
	Scarce	2–9 days
Plantain	Abundant	4–9 days
	Scarce	2–8 days
Paddy rice	Abundant	2–10 days
	Scarce	2–5 days

Source: Fieldworks, 2015

From Tables 12 and 13 above, it is very conspicuous that both Nigeria and Côte d'Ivoire present similar dynamics in respect of periods that certain produce are available for selling and distribution. However, either during the period of surplus or scarcity, the role of up-to-date information exchange vis-à-vis the availability of specific produce is expedient. This is where mobile phones have played a particularly significant role.

Wholesalers

Wholesalers are traders who buy goods in relatively larger quantities, generally involving the use of heavy-duty vehicles for the conveyance of purchased food items. The use of mobile phones is very popular among wholesalers. They usually sell goods they source from the producers, or, in most cases, from the middlemen located in various rural centres, to retailers located in urban market centres. Due to the often high volume of food produce involved, the wholesalers routinely provide the function of item conservation (that is, storage in their various stores in urban market centres). The wholesalers function is as specialists in identifiable food

items; as such, their business is geared towards trading in specific food items.

Table 14. Wholesalers' specialisation by produce (Korhogo and Soubre, Côte d'Ivoire).

Number of products sold	Level of specialisation	Korhogo			Soubre		
		Yam	Banana	Rice	Yam	Banana	Rice
1 product	Wholesalers (%)	96	98	60	100	100	100
2 products	Wholesalers (%)	3	2	40	0	0	0
3 products	Wholesalers (%)	1	0	0	0	0	0

Source: Fieldwork, 2015.

Table 15. Wholesalers' Specialisation by produce (Ile-Ife and Ilesha, Nigeria).

Number of products sold	Level of specialisation	Ile-Ife			Ilesha		
		Yam	Banana	Rice	Yam	Banana	Rice
1 product	Wholesalers (%)	92	96	75	85	100	95
2 products	Wholesalers (%)	6	4	25	10	0	5
3 products	Wholesalers (%)	2	0	0	5	0	0

Source: Fieldwork, 2015.

From Tables 14 and 15 above, it is observable that the majority of the research participants in Korhogo and Soubre (in Côte d'Ivoire) and in Ile-Ife and Ilesha (in Nigeria) are wholesalers who sell one product at a time. Across the board in Côte d'Ivoire, an average of 92% of single produce wholesalers is recorded, while it is 91% in Nigeria. This analysis has factored in all relevant data from the viewpoint of tonnage sold. All the outcomes of our investigations provided useful information. When selling local rice for instance, the wholesaler involves other products from the same family, for instance cereals, such as maize, millet, and groundnuts. If the wholesaler in question trades in imported rice, then items like sugar, salt, and/or flour would be included as part of commodities of business.

A gender-based analysis of the wholesalers' functioning has shown that more women are involved in the sale of plantain in both Nigeria and Côte d'Ivoire (that is, an average of 72% in Korhogo and Soubre in Côte d'Ivoire and an average of 80% in Ile-Ife and Ilesha in Nigeria). For the yam market, more men are involved in both Côte d'Ivoire and Nigeria

(that is, an average of 72% in Korhogo and Soubre in Côte d'Ivoire and an average of 80% in Ile-Ife and Ilesha in Nigeria). Meanwhile, for rice, the profession is practised 7% by women. In all cases, however, the use of mobile phones has been central to trading activities. Of course, in all the study locations in Nigeria and Côte d'Ivoire, the lowest application of mobile phones in trading activities recorded is 90%. Although trading in plantain seems to be a relatively difficult task, particularly as it requires collection from various points on the farm, the business has been largely dominated by the womenfolk in Nigeria and Côte d'Ivoire. A great impetus in this respect has been the availability of mobile phones to network across the length and breadth of areas of interest. Nevertheless, at this level, the work requires:

i. Endurance: the long walks in the bush to retrieve goods from various points could sometimes be frustrating, especially for women. It should also be noted that upon arrival in the urban consuming centres, the women wholesalers may need to wait and sleep onboard the trucks until daybreak. But, the great respite lies in the capability of the women and their clients to continue their negotiation, intermittently, over their mobile phones all through the night.
ii. Availability at the household level: Women wholesalers are often unavailable to attend to their various household responsibilities because they may have to spend several days on a single trip. While their mobile phones could still provide leverage by linking up with home front, an extant vacuum continues to be noticed whenever they are away from their homes for trading purposes.

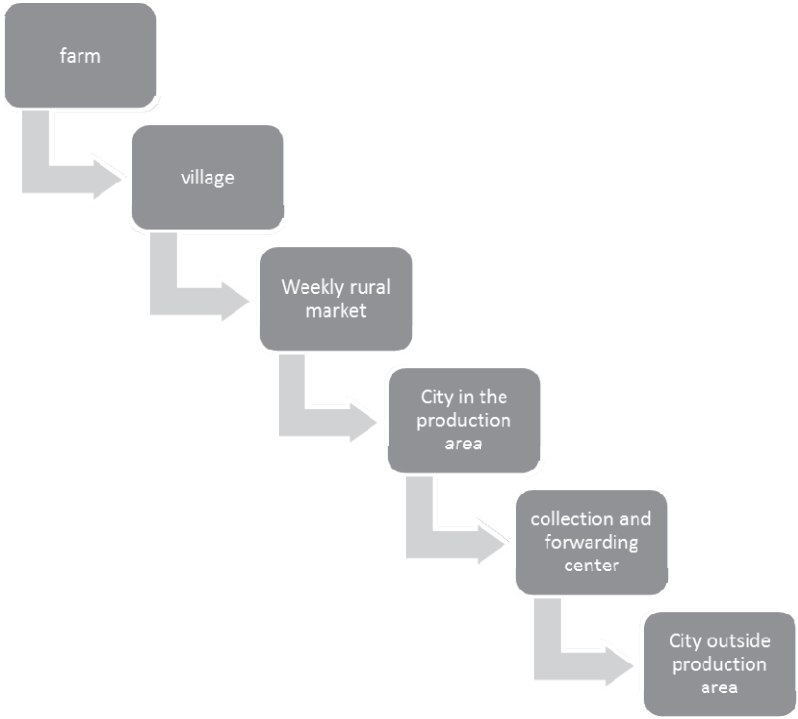
However, depending on whether they operate within the production areas or in consuming urban locations, the wholesalers are categorised as either shipping wholesalers or unbound wholesalers. Of course, the pattern of wholesalers' categorisation has emanated from the viewpoint of their supply logic. Shipping wholesalers usually reside within the production zones, very close to the food/crop producers. In addition to trading in food produce, they are also carriers and/or planters, buyers of produce (for instance, coffee and cocoa), and traders of processed products. Subsisting sedentary nesting allows the wholesalers to have relatively large amounts of cash dedicated to trading food products. They can buy full truckloads, and fill up their stores with products like yam and plantain. They could sometimes sell either at distant urban markets, where they deliver their food products to other wholesalers, or at the local urban markets (not quite

distant from the production areas) to retailers. Unlike food trading along the streets by retailers, which are often characterised by relatively modest financial outlay, possession of warehouses is imperative to the work of the wholesalers. They routinely crisscross weekly rural markets (HRM) to buy food produce of interest, with the average quantities (of 1 to 2 tons), which they thereafter convey to their various warehouses. It is worth noting that in all the entailed processes, for instance to connect all participants within the food chain, the use of mobile phones has remained central.

Unbound wholesalers are traders settled in urban centres. They go up the chain from the urban centres to the production areas for where they are able to collect various food supplies from either the producers or the middlemen (see Figure 16 below). They often buy from the field. But in times of scarcity, especially in respect of yams and rice, they would comb all nooks and crannies of the different villages, since they have a good knowledge of the calendars of these markets. Since most of the wholesalers engage the services of one or more middlemen, they spend less than a day in the bush regardless of the period of the year. As soon as they are informed of the availability of specific produce, normally through mobile phones, they swing into action to collect the goods from various designated points. The use of manifold points induces additional cost. But the benefit lies in the capability to increase the capital turnover rate with time savings at the primary collection and transport.

For the settlement of their purchases, unbound wholesalers in Nigeria and Côte d'Ivoire must have substantial liquidity of at least N50,000 (US$280) and 500,000 CFA (US$250), respectively, for a load of goods worth 8 tons). In Côte d'Ivoire, it requires between 250,000 and 300,000 CFA (about US$150) to buy sufficient quantity of plantain (about 8 tons) and ensure its evacuation from sources in the rural areas to various trading points in the urban centres. According to our observations, in Nigeria and in Côte d'Ivoire, wholesale trading in plantain seems to be an exclusive activity of the womenfolk, while trading in yams has been dominated by the male folk. In all cases, the gender distribution of the supply of traditional food products from the rural producing areas to the urban consuming centres has shown that most of the difficult tasks are being performed by women. Examining associated economic variables, the financial incapacitation of the womenfolk vis-à-vis the required capital to enter the profession could explain this situation. It is difficult (despite following the analysis) to conclude that women are poorer than men, because it has been observed within the traditional farm setting in Nigeria and in Côte d'Ivoire that production and marketing of such produce as

Figure 16. General scheme of the transport chain of traditional food products (yam, plantain, rice craft).



Source: Authors' Conception, 2015.

plantain, has always been undertaken by the women peasants. It is a cultural fact. And more generally, in such rural societies, all aspects of the food production and commercial distribution have routinely had women at the epicentre.

The yam and rice businesses, usually dominated by men, require more capital: about N100,000 (US$540) in Nigeria and 1 million CFA (US$500) in Côte d'Ivoire. On a general note, these men do have easy access to disposable capital (Often, credit). The main wholesalers (of yam and plantain) typically sell to other wholesalers located in the urban centres. In all cases, they sell for cash, allowing them quickly to recuperate invested cash. The number of visits undertaken is relatively high, that is, 2.8 on average per week in times of surplus production for the plantain and 2.3 on average, in respect of yam, over short distances of supply.

When engaged exclusively to retailers, selling is often done on credit and the payment period varies from 2 to 5 days for plantain and 3 to 7 days for yam in all the study locations in Nigeria (that is, Ile-Ife and Ilesha) and in Côte d'Ivoire (Korhogo and Soubre). The rotations (that is, the process of shuttling between the rural producing areas and the urban consuming centres) are low since it takes about a week for the wholesaler to replenish their capital base (see Tables 16 and 17 below):

Table 16. Average number of rotations made by the originating wholesalers per months depending on the mode of settlement and the marketing period (Korhogo and Soubre, Côte d'Ivoire).

Produce	Marketing Period	Distance Travelled			
		D ≤ 100 km		D ≥ 100 Km	
		Payment method		Payment method	
		Spot	Credit	Spot	Credit
Plantain	A (September–January)	11.2	9.0	9.3	4.0
	S (May–August)	7.6	4.0	5.6	2.9
Yam	A (August–February)	8.4	5.4	9.0	4.8
	S (April–June)	4.0	3.8	4.0	3.2

Source: Fieldwork, 2015.

Table 17. Average number of rotations made by the originating wholesalers months depending on the mode of settlement and the marketing period (Ile-Ife and Ilesha, Nigeria).

Produce	Marketing Period	Distance Travelled			
		D ≤ 100 km		D ≥ 100 Km	
		Payment method		Payment method	
		Spot	Credit	Spot	Credit
Plantain	A (September–January)	10.8	8.4	7.5	5.0
	S (May–August)	10.6	6.1	6.2	4.3
Yam	A (August–February)	9.2	5.2	7.2	5.2
	S (April–June)	5.0	2.3	2.2	2.4

Source: Fieldwork, 2015.
Guide: A: Abundant; S: Scarce; D: Distance.

Credit practice has proved to be very inimical to the sustainability of the wholesalers' business activities in the sense that even in times of plenty, the pace of business (as reflected in the number of rotations engaged in) decreases to about half the normal rate obtained when sales

are made in cash. Of course, our analysis of the supply logic showed good operating knowledge of production schedules on the part of the originating wholesalers. Wholesalers that supply produce such as yams and bananas, will source a priority in areas of proximity in times of plenty. In terms of turnover, this period is characterised by shorter stays in the bush (a day or two at most) regardless of the product and longer sales periods in urban markets (that is, between one and two days). This practice does not, however, incorporate the dynamics of related distant areas of production.

Meanwhile, the period of scarcity is usually marked with instant turnover in urban markets. Nevertheless, the time spent in the rural producing areas to source for commodities is routinely longer and the process of collection of food items from various designated points becomes more difficult, which in turn limits the number of monthly rotations made by the wholesalers. The wholesale business in the urban centres is dominated by women in the case of plantain and men in yam and rice. Unbound wholesalers themselves take over the organisation of primary transport and mainly transport their produce to urban markets. Usually located within the precinct of urban markets, urban wholesalers receive various produce from the originating wholesalers (most often) or from the producers who deliver the produce by themselves to the urban centres. They rarely move within the bush. Some of them are involved in transport business as well. In such cases, the driver, aided by two employees of the merchant-carrier performs bush tours to buy from the rural producers (or to collect sourced produce from the middlemen). During the flow time in inventories, the vehicle is rented to other traders.

A main feature of the urban wholesalers is that they have at least one store apiece where they offer storage facility for various acquired farm produce. Yam is often subjected to weighing during transactions. Plantain is not weighed. The sales unit of the urban wholesaler is typically saddled with conduct of transactions between the originating wholesalers and the urban (unbound) wholesalers. The retail food market, mainly dominated by women, has many small participants who supply consumers in urban markets and primarily have their retail outlets on the roadside (particularly applicable to rural women producers) in both Côte d'Ivoire and Nigeria. Interestingly, they rely on the use of mobile phones to obtain up-to-date information on the movement of different law enforcement officers who might intend to confiscate their goods for engaging in street trading. We focus on retailers operating in urban markets who represent the bulk of retail participants. Two main actors are distinguishable in the case of urban retail market functioning: the associate and the independent. Associated detailing is exclusively comprised of women traders, who engage in the

retail of food products. They usually transit between rural locations of food producing areas and urban locations of food consuming areas. An associated retailing group (of between three and five operators) is usually constructed on the basis of ethnic or familial affinity. They buy directly from producers on the field or at the weekly market locations, of which they determine their calendar. The purchases are often made in cash. The business association usually plays a significant role in the procurement process, which is carried out by one or two members of an associated group. After a particular trip, purchased food products are distributed to each member of the group, each fully responsible for sales. Such an associated partnership has been common with yam and plantain business in all the study locations in Nigeria and in Côte d'Ivoire. For instance, in the case of yams, this organisation is common in Korhogo (Northern Côte d'Ivoire) and in Ilesha (Southwest Nigeria). In all cases, the process of associated detailing facilitates substantial price reductions on all commodities (between 15% and 20%) in Nigeria and in Côte d'Ivoire. The purchases take place either on the field or during weekly rural market days.

In the case of plantain, associated detailing groups purchase exclusively from producers in two or three production areas. In general, they are connected to these producers in measures of good business relations. For instance, it is not unusual for members of an associate detailing group to carry items like soap, sugar, and milk as gifts to their partner located in various rural producing areas in order to retain them. Meanwhile, this pattern is less common in the case of yam supplies and is often done over long distances. Such a feature may explain the need for use of heavy-duty vehicles for the conveyance of yams. Transactions, which are done by tons of truckload, peak between May and October.

Independent retailers

Various groups of independent retailers are usually identified according to specific gender categories and specific food produce. The use of mobile phones is very common among all groups across all the research locations in Nigeria and in Côte d'Ivoire. Men are mostly found in the official retailing of white rice. They are also found in the retailing of yams, which they sell in leased stores, but they are absent from plantain retailing. Women are in a dominant position in the retail of imports and local rice, yam, and plantain. Usually installed in urban markets or in the immediate vicinity, independent retailers can be divided into two classes across

gender categories and according to their size measured by their capital base.

Small independent retailers are by far the most numerous. With very limited financial means and limitedly equipped, small independent retailers source their general credit from wholesalers. In the case of yam or plantain, purchases are made in small quantities (100 to 200 kg for yams, and for plantains 40 to 50 tons or about 400 to 500 kg) or in stores from the wholesalers, who are established around the market. Interviews with small independent retailers show that it is relatively easy to set up as a retailer compared with setting up as a wholesaler. In general, a retailer requires little or no financial base because of the common practice of credit supply (for instance, such accounts for 49.4% of retail food crops in Soubré, Côte d'Ivoire, and as high as 62.5% at Ile-Ife, Nigeria). The maximum amount needed to commence business as a retailer is found by considering the period of shortage where prices are highest: 3.52 for plantain, 1.14 for yam (Klingle), and 1.43 for local artisanal rice (or husked rice winnowed) in Côte d'Ivoire. The estimated results for batches of 100 kg are: plantain, 11,900 FCFA; yam, 13,760 FCFA; local artisanal rice, 19,700 FCFA.

The largest independent retailers generally have substantial financial resources and are equipped with a rocker (yam and local artisanal rice). They are installed in small shops in the same market or nearby and occasionally need to manoeuvre (yam, plantain). The role of the latter is to unload vehicles (truck 5 or 10 tons) during deliveries to help customers get the products (street-edge aggregation) for purchases of large quantities. But retailers who have gained relative prosperity in the profession and can thus support cash payments and long-distance transport costs, prefer to individually operate in the production area. This practice can be observed both at retailers' locations in the production area and in large urban centres. They often buy full truckloads of 1 or 2 tons (of plantain and rice) and truckloads of 5 or 10 tons, corresponding to 8 to 15 tons of yam. Overall, purchases are made on credit (except purchases from producers) and are paid for during the following supply of between three weeks to one month (in cases of rice and yam) or three days to one week (in the case of plantain). Their customers mainly comprise consumers. But they also sell to other retailers who then pay cash, which probably explains the large quantities handled by transaction. These sales are especially frequent in times of shortage and enable retailers sourcing by this circuit to avoid stock-outs.

The results of our surveys in Côte d'Ivoire and in Nigeria indicated that, overall, retailers of all types who sell in urban markets (neighbouring

production areas) record low daily turnover (about 100 kg of plantain, 50 kg of yam and artisanal rice) because of low volume purchases made by housewives who usually buy the bare necessities for the needs of the day. Inventories are generally broken into small-scale units, which consist of tuber (yam), or plantain or artisanal rice, and after three to seven days (bananas) and two weeks to one month (yam, rice). The types of retailers other than the large independents (who own shops) occupy a confined space within the markets where products (banana, yam) are exposed on the ground, outdoors, and sometimes in precarious hangars serving as shelters. As the market closes, the remaining products are covered in heaps of bags, palm branches, and so on, and placed under the supervision of a guard for the night, who is usually paid 500 CFA (about US$10) per week in locations in Côte d'Ivoire and N5,000 (about US$13) in locations in Nigeria. The guard can simultaneously serve several retailers (three to five) within neighbouring outlets.

Although, various human carriers or loaders of food stuff provide a vital function in terms of transfer of food crops from different collection point into vehicles for onward movement to the cities, it has been noted that the poor state of most of the rural roads in Nigeria and in Côte d'Ivoire has often tended to make the entailed process unduly tedious and to some extent unproductive. Indeed, the poor state of most rural roads causes intermittent and huge maintenance costs to vehicles, thereby impeding the timely collection and delivery of food crops along the food chain. Of course, the costs on the part of other participants aside from the transport operators, for instance, wholesalers, retailers, middlemen, and farmers, have been quite massive. The difficulties of accessing fields for collection—the dispersion of supply of food products in the supply space—causing long tours of collection areas and sometimes prolonged immobilisation of vehicles in the production area has been very costly.

In such situations, it follows that an insufficient supply of vehicles during the milking period of export products causes inflation in transport prices; and that the means of motorised transport is not always suitable, for example, in the transport of plantains, the very fragile product is transported primarily by trucks that are closed or often equipped with tarpaulins. In all the cases, however, the use of mobile phones has been quite helpful in disseminating timely information about related obstructions within the food chain and, of course, offering feasible and immediate solutions in the form of provision of alternatives for getting the food chain moving.

On a general note, the medium carrier artisans in Côte d'Ivoire (professional traders-carriers or carriers) are characterised by the absence

of a classically trained professional type. The only existing training is that which is practised on the job (-m- learner driver-carrier) and has shown its limits with under-qualification and lack of generalised guidance regarding management and vehicle operation. Awareness of this situation led the transport union to initiate, three years ago, a training action framed by the National Regulatory Fund (FNR). But for now, carriers do not participate in such exercises themselves, preferring to enrol their sons or other family members, calling them to take over. Given the antiquity of the occupation (28 of 41 carriers operated prior to 1970 and 7 after 1980), youth trained under this programme could quickly reach the business (if the operation is growing). In this case, certain conditions are met to raise the level of the profession and allow the emergence of companies operated and managed better with the help of modern ICTs, such as the mobile applications.

Analysis of transport chains in Nigeria and Côte d'Ivoire

The distribution channels are made by economic actors that are related to a producer to distribute his products to consumers. It is clear from this definition that a distribution circuit procedure can be established in considering only the actors within the transportation chain. However, the operations of modern transport chains in both Nigeria and Côte d'Ivoire have been built around the use of mobile phones. With the release of the official white rice considered a "strategic product" and that of other products (artisanal rice, plantain, and yam) considered "traditional products" in both Nigeria and Côte d'Ivoire, we have distinguished two flow paths in food production: private and public channels.

The establishment of the transport chain of food products in Côte d'Ivoire is based on surveys of producers, traders, and transporters. The observations and information obtained was complemented by the exploitation of monographs available on the relevant products. It is clear from these investigations that the transport chain comprises product concentration points, which constitute the nodes. The products are grouped into one of these nodes as presented below and are elements of trading; inter-nodal movements are involved.

Dovetailing from one nodal product to another, these routes or links are characterised by the following variables: the nature of the infrastructure, distance, means of transport (motorised or not), and the actors that ensure the flow of products. The investigation and the exploitation of monographs identify the main points where the products are usually loaded and unloaded. Hence, we distinguish the following focal/nodal points:

— The scope: it is the starting point for the flow of goods (excluding white rice). The field holds a place of prime importance in the marketing of food products. An important part of interregional traffic of food products originates from the field.
— Village: peasants hold stock at the village where they await the passage of traders to sell the products being brought from the fields.
— The weekly rural market (WRM): part of the stock from the town is sold on the WRM.
— The city market located in the production area: the market is supplied from the field, village, or WRM.
— The forwarding centre in Bouaké, Côte d'Ivoire, and Ile-Ife, Nigeria: these nodes characterise the flow of plantain and yam respectively. It is an important step because of the geographical position of Bouake and Ile-Ife as a commercial crossroads.
— The market in the remote town of production or final consumption in the urban centre: it is the culmination of the transport chain, which is the main outlet for food production.

Meanwhile, the lack of local supply often leads:

— Future foreign wholesalers to stock an empty vehicle rented in the city where they are installed.
— To discouraging peasants in a remote area to pick up a vehicle, which takes time and discourages their initiative to go to an urban market to sell.

There are two other factors hindering the flow of food products within the food chain: competition from other agricultural products and bad roads/competition from other unregistered transport operators (usually using small vehicles of between 5- and 10-ton capacity). For instance, various transport operators prefer to convey yams and plantain to the detriment of such perishable and low turnover stuffs as vegetables, peppers, okra, tomatoes, and so forth. In Korhogo, Côte d'Ivoire, carriers are turning away yams (a leading product in this part of the country) to devote themselves to transporting shea nuts (May–July). The main reason for this is the regularity of the transport that allows multiple consecutive trips a week. It is the same in Bouaké, Côte d'Ivoire, and in Ilesha, Nigeria, during the orange peak season. In the central west (Daloa) and southwest (San Pedro, Soubré), Côte d'Ivoire, coffee and cocoa mobilise the bulk of small trucks that carry the collection and supply of plants at the

expense of yam and plantain. This competition of coffee and cocoa, in transportation, is lower in Bondoukou, Côte d'Ivoire, and in Ile-Ife, Nigeria, where these products are not grown considerably, if we limit ourselves to the local trucks on offer.

The second factor is the poor state of most local roads, which become impassable during the rainy season. During this period, local carriers sometimes refuse to go into the bush. It then relies on carriers from surrounding areas to ensure the shipment of food products from the fields. According to the peasants and "tonics wholesalers," this leads to major difficulties in finding vehicles. In the north of Côte d'Ivoire (Korhogo) and the central area (Bouake), competition does not play out in respect of cotton that ships with large trucks and articulated vehicles so that the transport of yams produced in large amounts in these areas is undertaken by vehicles of 5 to 10 tons. We distinguish various logics followed by the carriers to find a load of food products. We present the four most common.

a. In smaller urban centres like Soubré, Côte d'Ivoire, and Ile-Ife, Nigeria, vehicles are parked in a vacant lot (undeveloped) outside the headquarters of the local union carriers where farmers and traders can hire vehicles. The local distributes transport applications under the terms of the registered vehicles. This principle of alignment is required for transport outside the department because the local union does not intervene in intra-departmental transport, which is the subject of a contract and direct negotiation between carriers and shippers. During high yam season (August to December), the waiting time to get a load is two days. But the vehicles are rarely at the Union office at that time; thus, carriers are often contacted directly at home by shippers. In this case, carriers must move to the office of the union for the issue of an exit ticket upon payment of a fee of 2,000 FCFA (about US$1) in the case of Côte d'Ivoire and a fee of 150 Naira (about US$1) in the case of Nigeria. The peak periods (April to July) cause long delays. It could take up to a week to find a load because at that time all vehicles are engaged.
b. In the large urban centres of exporting areas, both transporters and commodity exporters enter into long-term alliances. In most cases, the vehicle owners equally assist their clients in sourcing loads of commodities to purchase for export. Thereafter, the client then pays for both commodity and for mobilisation to the transporters. This practice ensures that both transporter and

exporter stay in business. That is, the subsisting relationship is mutually benefiting.

The availability of fields and villages

One of the major problems faced by economic actors in the flow of food products lies in the difficulty of accessing fields or villages. As a local measure of the ease of access from one point to one or more points in space, for reasons related to a need, and a means or set of means of transport, the accessibility concept can account obstacles to the development of food products marketed and the development of activities in production areas. It is clear from this definition that the distance (following the routes of the roads and tracks used) and means of transportation used are very important factors in the accessibility of villages and fields.

Cultural practices of food products generally lead farmers to install camps far from the villages. Fields then created around settlements are not only connected to remote villages but also to the major roads. Recall that the reason for the removal of fields include stray animals from the savanna, which can loot nearby fields, and the tendency of farmers to settle in the wake of the opening up of logging roads in the forest area.

Approximately 74% of the farmers surveyed for this investigation have at least one field located more than 3 km from their village. They often travel by bicycle, motorcycle, or on foot. In the latter case, the importance of travel time, the difficulty of walking, and the lack of accessibility leads farmers to stay for three to five consecutive days at the camp to work in the fields before returning to the village. When the field is located less than 3 km (maximum accessibility) away, farmers also have recourse to the modes of locomotion used previously. They can even open paths to access the field.

The accessibility of villages in the production areas is determined by their nearness to the cities and towns of consumption areas. Thus, large villages are connected to these cities by dirt roads that integrate public programmes for road maintenance. As these cities are connected in turn by busy roads, mostly paved, large villages are thus connected to the national roads by a good level of service network. This link between the accessibility of the main grouping of food products and the hierarchy of the road transport system promotes village centres. These village centres result from the structuring of the Ivorian countryside around collective-interest facilities (markets, health centres, schools, etc.). These devices are well within the reach of rural populations in village centres with good accessibility.

This is particularly the case of the villages of Bouna, both large producers of paddy rice and yam. These villages are connected to Bouna by a track that is cut off for up to one month during the rainy season. This causes some irregularities in the passage of traders who struggle to find vehicles to stock up outside these villages. According to local carriers, this characterises the network of trails in Bouna, which mainly has problems related to the existence of many rivers and high rainfall. Indeed, on the slopes, the works that are provisional are often carried away by the rains, causing traffic interruptions. But with the economic crisis, local officials for road maintenance pay more attention to the main roads in areas that support more traffic, by assigning most of the limited resources at the expense of village roads.

Difficult travel conditions did not allow us to go to these villages during our investigations. Thus, we had to content ourselves with interviews with the economic actors and local administration officials involved in the transportation of food products, to account for the situation of these villages. Wanting to illustrate the apprehension of carriers about serving the villages outside the main roads during the rainy season, a driver did not hesitate to tell us about a case of vehicle immobilisation. Following a rental vehicle, the vehicle went to a camp on a clear day to load yams. On the second collection day, heavy rain fell for three days in the area. A section of road having been washed away, he had to wait a week to "get out of the bush" following a deviation made by the Public Works Department to open up the area, which lengthened the route.

The conditions of poor accessibility for farmers are even more severe for producers in Korhogo, which is underserved, remote, and problematic relative to large urban centres. Foreign traders are rare. Another clue limiting the dynamism of villages and linked to poor accessibility is, if not the absence, at least the irregularity of extension agents. The lack of viable roads and displacement means that agents rarely visit remote villages that are as hard hit by the free distribution of seeds provided by cooperatives.

Before discussing the organisation of the transport chain, it is important to present the two nodes that determine the course and transfer activities taking place there.

Besides the production, harvesting, and consolidation of fields, roads mobilise farmers, their families, farm labourers, and associated groups of farmers. The operations of collection and consolidation of the field that make a crucial node in the product marketing, provide substantial income to rural areas (dividends paid to the GVC, collection, and consolidation costs paid to the collectors and other local intermediaries).

The harvest is of yam tubers out of the earth mounds. This sometimes results in breakage and injury to the tubers, which rapidly spoil and devalue. But the harvest is less urgent compared with other products. It can be delayed for several weeks after the yams mature and will keep well in the ground (for one month). What is at stake here for the farmers is the possibility:

— To defer marketing (no storage costs) when most growers harvest.
— To be less subject to the problem of irregular passages of traders in certain areas, as these two points can contribute to increasing farmers' income. At this level, the problem is the downtime of vehicles for harvest: when to present a buyer.

The fragility of bananas poses enormous difficulties in harvesting. The fruit ripens on the plant a few days after maturity. Now the market value considerably decreases as the banana ripens, resulting in the decline of peasant bargaining power; thus, the farmer often gets a low income. The farmer is obliged to cut loses quickly and promptly find a sometimes unpredictable market (traders with irregular schedules, difficulties for the farmer transporting himself to the urban production market). But harvesting techniques are artisanal and generally cause significant damage to bananas. These injuries accelerate the ripening process after harvesting, which helps the importance of losses estimated at 35% in trade channels including 10% from the producers. The collection can be considered as integrated transport in the sphere of agricultural production. In the collection operations, transfer, grouping, and / or storage inside the field, the collection has an important function that allows products to enter the market system. The collection involves producers, intermediaries (collectors or trackers, independent or mandated), or buyers themselves. Depending on the size of the vehicle (van, truck of 5 or 10 tons), and period (abundance or scarcity), the collection may take one to seven days.

For plantains, a highly perishable product that requires quick evacuation, collection mobilises all available people (children and women of the producer, movers, collectors, buyers, and sometimes drivers and apprentices) and saturates all the artisanal transport. Thus, some do the collection by carrying on the head (with a bowl or similar) or shoulders (on wood), with the load varying for children, men, and women. Others use wheelbarrows, bicycles, or mopeds with a higher loading capacity: 70 to 100 kg, 7 to 10 trips on average.

After the collection, the products are grouped either in the field or at the edge of the field, still on the edge of the road, depending on

accessibility. Producers sometimes open the trails with machetes to allow products to be carried out (portage, NMT) and put the products in piles along roads (near fields) to be loaded onto vehicles. In savannah areas where the terrain is more consistent, producers often make new rural roads to allow access for field vehicles. The dispersion of fields and their small size causes carriers painful and lengthy collection rounds. The average distances indicated by carriers and traders range from 30 to 40 km depending on the area. In addition to agricultural activities taking place around the village, the village provides areas for activities such as crafts, fishing, trade, and livestock. Depending on the level of development and population size, the villages have public facilities (health centres, schools, markets, water supply, and so forth). The large villages in the most significant exporting areas host storage facilities belonging to the economic players. Thus, producers have access to facilities for the storage of their products (yam, rice) that they bring in small quantities from the fields. Elsewhere, people use attics and homes for storage until buyers pass or the product can be sold at market. In terms of the first link (field -> village), transport conditions will be analysed through transport supply (infrastructure and transport) and transport demand (economic actors). The nature of the road infrastructure linking the village and the field is the corresponding pathway at the bottom of the hierarchy of the Ivorian transport system. Indeed, the transportation of field products to the village and the delivery of fertilisers from the village to the field are generally made either (1) on trails made mostly by farmers themselves, or through major works (in the forest south), whether as a result of frequent walking or wagons (north savannah region); or (2) on seasonal earth roads with traffic interruptions (one week to one month) during the rainy season as a result of flooding of low points, lack of upkeep, or destruction.

The means of transport are related to the level of infrastructure service. Thus, trails that provide field–town links up to 10 km are often used to for carts, bicycles, and mopeds. The last three means of transport are more common in the savannah than in the forest zone. The dirt roads carry traffic between small villages and fields, over distances of the order of 10 km. We met mostly porting (walking), bicycle, motorbike, and cart pulled by oxen (in the north) but also traditional road transport: the bush taxis that perform mixed transport (cargo-passenger) in vans. The first players with significant transportation needs between the field and the village are obviously the producers (individual or grouping). Both are found on the trails on dirt roads. The method of delivery of products typically used by producers is porting. The difficulty of this mode significantly reduces the

unit load as we have already indicated. But these movements are also made with bicycles, mopeds, carts, and tractors.

Local and foreign traders (retailers and wholesalers), transporter traders, and collectors hold stocks in the villages before making shipments over short distances (to the VZP) or even over long distances (to urban centres). This ability to group products makes the village an important place in the organisation of transport. It improves the efficiency of transport to the village then provides a grouping function and burst of products. To reach the village, the products (from the field) are carried on dirt roads on small freight vehicles (truck, 5-ton capacity) or mixed transport (bush taxi). For nearby fields (3 to 4 km) and low tonnages (several hundred kilograms), producers provide themselves with their own transport using bicycles, mopeds, and carts. Sometimes the cart is rented. This practice is common in the north where one encounters artisans very skilful in cart construction. For medium quantities (that is, 1 to 2 tons), economic actors in the village typically employ transport for hire or reward. The vehicles used are bush taxis, vans, and trucks of 5 tons.

From the village, as we shall see in the following link, loads sometimes break (if the producer sells locally) and vehicles are larger and more loaded. For some villages, accessibility issues limit the use of this function. Some major problems remain:

— inadequate and low service level of rural transport infrastructure, creating poor accessibility to the fields on the road network;
— inadequacy of the commercial vehicle fleet;
— absence of extended use of means of transport.

This organisation represents all products. However, it is worth mentioning the specificity of the transport of the official local rice in rural areas. For removal of this rice (official collection), there are collection centres located in production areas that belong to the industrial mills. These collection centres are not actual storage infrastructure with physical existence as the paddy is not stored, but they are points of concentration of the paddy, created when the distances between factories and silos or collection areas are important. Rice collected through the fields arrives on small vehicles before shipment to the silos or factories. Collection centres play an essential role. They allow the achievement of tensile ruptures in the supply silos or plants and avoid shipments over long distances in small vehicles. They also allow (1) transport upstream to ensure a rapid turnover of vehicles; (2) transport downstream to consolidate flows towards paddy

silos or factories using large vehicles; articulated vehicles, for example, in 1986 sent nearly 46% of the paddy tonnage.

The rural market access problems are similar to those in villages. Indeed, the rural market is necessarily a part of the villages in the area of production. We will present the characteristics of the node directly posed by the WRM and of arranging transportation between the village and the WRM. As its name suggests, the WRM is characterised by periodicity. It is held once a week, at a fixed date for a given village. In rural areas there are two or three villages, depending on the size of the production area, which locate a WRM to be held at the market sessions. The immediate consequence resulting from this organisation is the lack of daily food sales at the WRM. But this corresponds to the osmosis between this type of market and business logic of the players attending the WRM. The WRM leads to low unit transactions. But it does not exercise less of an important function. Indeed, on the side of rural populations, the WRM offers, first, flow merchant opportunities for producers who can, by selling small amounts individually, obtain some financial resources. This allows them to release some of the stress formed by irregular passage traders to fields and villages in some areas. On the WRM, women producers are the main sellers. Then, farmers have the possibility to source necessities. Local traders come from the city in charge of products (soaps, milk, oil, etc.) that they sell at the WRM. Finally, the day of the WRM is also an opportunity for farmers to meet and visit relatives. The WRM transcends market exchanges to ensure a social function for the strengthening of social relationships and the animation of the villages that house the market.

As for buyers of food products and carriers, the WRM significantly reduces the time spent “in the bush” and avoids long and painful primary collection routes dreaded by carriers. The WRM area of influence extends not only to the surrounding villages of the area of production but also to nearby cities. This attraction led merchants and traders-transporters to crisscross the WRM and to keep in stock small quantities in order to acquire sufficient stock before making a shipment. The marketing is generally done by women producers for all products. The evacuation of the products is undertaken by bush taxis when trucks are scarce or otherwise occupied. In this case, the vendors move batches of a few tens of kilos. When the village is close to a city and has a relatively large stock (in the case of yams and paddy or artisanal white rice), the producer sometimes makes an appointment with a carrier who will remove products on market day. This transport is generally provided by vans. But this way of seeking a vehicle is difficult because it often requires several trips to town, discouraging producers. This practice is not common. In general,

carriers do not roam the villages on market day in search of cargo to supply the WRM. Crops 2–3 km from the WRM are transported by portage; this operation is performed by women using large basins (tens of kg of product). But for lots of around a ton, transportation is sometimes done by cart. For yams and rice that are stored relatively closer to the village, the weakness of lots offered may be explained by the lack of vehicles (locally) which therefore constrains the flow of the WRM.

Agenda setting

Adequate engagement of all possibilities offered by ICT is critical to the attainment of the goal of food security in Africa. Inferring from the findings of the study, the following are recommended as agendas for mainstreaming ICT frameworks into the processes of food production and distribution, and, of course, in the drive towards realisation of food security on the continent:

i. The centrality and usefulness of ICT in the processes of food production and distribution should be presented to all participants (food producers, middlemen and women, transporters, wholesalers, retailers and even the final consumers) by both mobile operators and governments at various levels.
ii. Through appropriate sensitisation programmes, centring on the significance of ICT in the processes of food production and distribution, the current volume of produce being traded via mobile telephony could be improved upon.
iii. Specific interventions could be facilitated for those participants who are currently discouraged from using ICT in their daily routines. For instance, in the case of poor women farmers in rural areas of Korhogo, Côte d'Ivoire, the problem of illiteracy has to be addressed through adult literacy programmes. Equally, they could be empowered to own mobile phones through various promotional efforts from service providers.
iv. In order to explore other possibilities offered by ICT aside from the routine mobile telephony, adequate sensitisation programmes from various ICT service providers are desirable for all participants in the web of the food chain (that is, food producers, middlemen and women, transporters, wholesalers, retailers, and, even, the final consumers).
v. Both governments (at all levels) and the service providers in Nigeria and in Côte d'Ivoire should be prepared to executive

functional policies that would serve as a form of impetus for those who are involved in the web of food production and distribution (that is, food producers, middlemen and women, transporters, wholesalers, retailers and, even, the final consumers).

CHAPTER EIGHT

CONCLUDING COMMENTS

On a final note, the outcomes of our investigations have validated our conceptual study's postulate that "an ICT framework is only useful for an individual for the use it is applied." Various interactions and information gathered from our fieldwork in Côte d'Ivoire and in Nigeria have suggested that without adequate and sustainable awareness campaigns and training programmes on the possibilities derivable from the applications of mobile phones in the processes of food production and distribution, the realisation of the goal of food security could be impacted negatively in the two countries. Policymakers and members of agricultural extension systems need to be aware of how appropriate ICT-based instruments can help influence agricultural practice and assist in the fight against malnutrition. Increased knowledge of food production systems through learning applications and access to best-practice data will enable international expertise to trickle down to local levels. Where the regional and local representatives of organisations are not involved in such processes, effects will be reduced. Henceforth, decision-makers should provide necessary resources to build capacity for technologies to integrate regional and local intermediate organisations because they are the crucial link between ICT programmes and the rural population.

For food distribution and marketing, the role of information is essential. Empirical researches have suggested that ICTs do have a positive impact on farm-household incomes. It is also important to remember that food shortages are not exclusively a distribution problem. ICTs can, however, lower the hurdle for markets to emerge and improve the effectiveness of early warning systems and relief activities. To raise awareness of the importance of ICTs, further research is needed to identify more precisely their prospective benefits as public goods, specifically their ability to generate network externalities. Negative outcomes should also be considered to avert the unnecessary repetition of mistakes, and more importantly, innovative private-sector and donor involvement will be needed to generate funding for socio-economically desirable, yet financially unsustainable initiatives. Positive and negative lessons from

past experience underline the importance of ICT-related capacity building and suggest the need to maximise the power of the market with a minimum of external resources. Nevertheless, civil society and the public and the private sectors need to cooperate in order to set the rules of ICT development and integration in agriculture. To facilitate such collaboration, governments should provide:

i. a sound, market-oriented regulatory framework;
ii. universal access regulations and mechanisms that motivate operators to serve regions where it is economically infeasible but socially desirable for them to do so;
iii. incentives such as a sound business and taxation environment to encourage investor and donor involvement in ICT infrastructure development in Africa;
iv. the preconditions for inter-African collaboration through, for example, the introduction of common standards, cross-border trade liberalisation, ICT-based monitoring, forecast programmes, and so on;
v. support to research institutions and other non-profit participants who help safeguard the demand driven implementation of ICT tools that assess and transmit commodity prices, thereby allowing markets to emerge;
vi. support for ICT use to increase the efficiency of knowledge systems for agricultural production, and support for intermediate organisations in terms of transferring knowledge from global or national to local levels, which in most countries will begin with the integration of agricultural extension services into knowledge systems; and
vii. leadership in combining existing media channels, such as rural radio stations, with ICTs to match potential local demand with global content and distribute the gained information widely in the relevant languages.

The private sector's role should be to engage governments constructively and take advantage of any existing pro-ICT policies. Organisational, as well as, technological options exist to reduce access costs and eventually support the increase of available information. In terms of retail services, for instance, the private sector should:

i. be aware of the socioeconomic dimension of activities related to the ICT sector;

ii. take advantage of the lessons learned from franchise systems that have been successful business models in many developing countries, including Senegal, Gambia, and Bangladesh; and
iii. aim toward the stepwise extension of phone shops to more sophisticated telecentres using knowledge transfer, capital availability, and, if need be, ICT infrastructure support schemes, such as universal access funds compensating for potential losses.

In terms of technological options, the private sector should also develop low-cost access technologies that work off-grid and require a minimum of maintenance, thus making them more profitable; fixed wireless technologies and solar power panels have proven effective in this regard.

Eventually, civil society's main activities should be to ensure that ICT-related activities are developed for those parts of society that require particular care: the poor, the malnourished, the isolated, and those suffering from discrimination. By improving the efficiency and impact of NGOs, the availability of new information flows and network opportunities can improve livelihoods in Africa. Addressing such issues can help promote the spread of ICT availability and open opportunities for farmers that they would not otherwise have. There is a general consensus that missing such opportunities will be costly and increase the digital divide where it is most visible, at the subnational level between the urban elite and rural smallholders.

As a matter of significance, the suggestions itemised below are deemed expedient in order to optimise the plethora of opportunities offered by various strands of the ICTs, especially mobile telephony, in the drive towards the attainment of food security in West Africa, even sub-Saharan Africa. Of course, the recommendations are aimed at enabling policy makers, regulators, and the international development community to: obtain insight into the benefits of ICT-led interventions in their respective countries or regions of operations; implement interventions that would have a tangible outcome; develop multi-country cooperation procedure and feasible best practices; and prioritise interventions that would be most beneficial in the process of connecting ICTs with agricultural productivity, and food security.

i. Build synergies between different parties within the agricultural value chain:
   In many African countries, synergies between different parties within the agricultural value chain are not exploited optimally.

Hence, forums have to be set up to encourage dialogue, interaction and promote knowledge related to use of ICT in agriculture, such as the World Bank's ICT in Agriculture e-Sourcebook, which is essential in the case of Côte d'Ivoire and Nigeria. Specific partnerships should be identified and be built between stakeholders for identified eAgriculture projects with targeted outcomes, working with established partners, such as NEPAD or CAADP. Such partnerships can play an invaluable role in the research, planning, problem-solving, review of operations, and training of relevant government functionaries; for instance agricultural extension officers, in the use of ICT in agriculture.

ii. Establish an agricultural hub

Leadership, communication, and creative thinking are required to initiate and sustain e-Agriculture projects that will have a significant impact vis-à-vis the attainment of food security. A purpose-built management and support structure would enable communication between the private sector and the government and drive the strategic agenda of the state, significantly in West Africa. Designed to be non-bureaucratic and nimble, an agricultural hub would drive agricultural diversification, mega-projects including e-Agriculture projects, and initiate and coordinate opportunities in the agricultural sector. These e-Agriculture projects would in turn stimulate commercialisation, diversification, and job creation.

iii. Implement legislation and regulations to govern specific opportunities

Legislation and regulations relating to ICTs must be revisited, to ensure that, among other concerns, information security is protected, the cost of communications infrastructure (e.g., broadband) is reduced, and ICT infrastructure is accessible even from remote rural agricultural producing areas. Some programmes, such as national irrigation schemes and traceability programmes may require new, strong legislation and regulation. National legislative bodies together with Ministries of Agriculture and Ministries of Communications need to coordinate to ensure timely enactment of laws and regulations that would enable appropriate coordination of ICTs and agricultural practices in order to attain sustainable food security.

iv. Consider adoption of traceability systems at a national level
Traceability systems have the potential to bring about conspicuous improvement in the well-being of large numbers of people on the African continent as export markets can be created when traceability systems are implemented correctly. Systems should address full traceability, from first contact to market destination, since systems that do not cover the whole lifecycle create gaps in traceability, which may be detrimental to the industry and the consumer. It is essential that legislation and regulations are enforced and will also apply to other agricultural products.

v. Empower women in agriculture
On average in Africa, women perform nearly 70% of all activities within the agricultural sector. Not only do these women often have little access to finance, but they also have little free time to devote to their own interests or to rest and are physically at a disadvantage. Women in rural communities, and particularly those moving from subsistence farming to small-scale farming, can benefit greatly from the application of ICTs in their daily routines, as these can save time and physical effort and equal access can be monitored. Governments need to provide incentives to telecommunications service providers to expand money transfer services to rural communities as these would enable rural women farmers to have enhanced level of control over their finances. Content providers need to provide health, nutrition, and educational advice on eAgriculture web pages. Active monitoring of the eAgriculture programme by the government is necessary to assess the extent to which these programmes take the interests of women into consideration.

vi. Implement irrigation solutions in Africa
ICTs can be used to reduce water consumption significantly using modern irrigation techniques and as a result enhance the quality and productivity of land and eventually increase farmers' incomes. Technology that has been used for a number of years in Egypt with great success may still be deemed "new" in many other African countries; consulting with and learning from experts and those with extensive experience in ICT is therefore suggested.

vii. Implement integrated e-Agriculture plans
Implementation of a comprehensive, integrated, long-term e-Agriculture Plan for each country should involve all stakeholders and hence increase stakeholder ownership, bring about economies

of scale, and ensure that there is political and executive commitment to e-Agriculture with the necessary budgetary allocation. The plans facilitate the design of single technology frameworks for each country into which new hardware and software components, addressing different functionality and features, could slot. Single-window services and one-stop shops naturally result from such plans. There is also a need to strengthen African research and training institutes in the agricultural and environmental field, including those that play a role in monitoring climate change.

viii. Focus on community ownership
Well-established community ownership assists projects to survive after donors move on and reduces long-term dependency on an external champion. Thus, programme designers and implementers of community-based projects should include community members in decision-making early in the project and progressively hand over leadership and operation of the project to them. As community owned projects are often resource-scarce, it is best to adopt approaches that make adequate use of the existing infrastructure.

ix. Make e-Agriculture technology robust and accessible
Systems are only valuable if they are used, but this can only occur in e-Agriculture projects if the end users find the systems easy to use and the technology is cheap, available, reliable, and can be run off-line when necessary. Backup and disaster recovery plans, as well as alternative work processes that can easily be linked into the primary system, need to be implemented so that systems are useable even if there are some hitches with the technology. Systems' designers and developers need to design system access through commonly available technology devices, such as mobile devices, and include alternative communication options in order to include the largest possible number of end users. Voice is often a better option than text because users are often not fully literate. Multi-purpose telecentres not only allow internet and ICT access but are important points for learning, listening, and stimulating ideas. Initial donor financial support is needed until the number of users reaches a critical mass.

x. Build human capacity in rural communities
Rural communities urgently require basic education opportunities, including basic farming skills and business management skills. Complete reliance on e-Education is not recommended in

communities made up primarily of smallholders or subsistence farmers but the internet can be a very valuable resource for teachers who provide classroom tuition. Donors and funders are urged to ask for an educational-use component to be made a funding eligibility requirement for all projects. A good model here is the African Leadership in ICT (ALICT) component of the Global e-Schools and Communities Initiative (GeSCI), based in Nairobi, Kenya.

xi. Encourage environmental responsibility through country agriculture strategy maps

Country specific agriculture strategy maps, using a variety of ICT tools but primarily imaging tools such as GIS and satellite technologies, can be used to encourage environmentally responsible farming, as well as, commercially astute practices. Donors are urged to assist in developing the e-Agriculture plan recommended to policy makers and regulators in "suggestion vii" above by providing access to the necessary technology and international experts required for developing country specific agriculture strategy maps.

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