ICT Enable of Agricultural Innovation Systems: Implications Environment, Population and Food Production

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Abstract. ICTs is ideally suited to enhance interaction between enterprises and individuals focused on bringing new products, new processes and new forms of organization into economic use, together with the institutions and policies that affected their behavior and performance. This Model recognizes that an interaction of people and ideas catalyzes innovation. And that technological advancements consist of generating, accessing utilizing and managing knowledge. To this end ICTs can expand communication cooperation and ultimately Innovation among the mushrooming assortment of actors in agriculture. This paper will demonstrate that ICTs especially mobile phone can and would drive participatory communication including consultation with those on the margins of traditional research-extension processes, and they are often the key instrument of organizations that used to deliver to larger number of rural people than they could reach before. Telecommunications networks have increased the speed, reliability, and accuracy of the potential of nanotechnology to revolutionize Information and communication technology, as well sustainable agricultural production via information exchange—through text, voice, and applications—between farmers and other stakeholders. Low-bandwidth networks have also started to trickle into rural areas in developing countries, creating opportunities for farmers to connect with extension workers, agribusiness, researchers, and each other.

Keywords: sustainable agriculture, mobile phone, cloud computing, advanced technology, food production, policy maker

1 Introduction

It is widely held believe that Smallholder farmers would be responsible for feeding the billion hungry populations. In his book 2012 "One billion Hungry: Can We Feed the World?" Sir Gordon Conway indicated that the many interrelated issues critical to our global food supply from the science of agricultural advances to the politics of food security.

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It is believed that 500 smallholders with less of 2 hectares of lands in sub-Saharan Africa and Asia are responsible for feeding one third of the World population. In Africa the dependence is higher, where small farms produce about 80% of the food consumed (Vittorio Calao, CEO Vodafone, "The Role of Mobile in Driving Efficacy and Sustainability in the Food and Agriculture Value Chain."

To achieve Global sustainable agriculture demands appropriate policies to foster open access to timely, cost-effective, innovations, research, advanced technologies and applied technology transfer, services and storage, essential information on market prices and Market Channels.

Understanding and addressing global agricultural developments-both positive and negative –are critical to improving smallholders' livelihoods. This paper presents a comprehensive review on Information Communication Technology (ICT) that can improve smallholder farmers' incomes, reduces water scarcity, decrease CO2 emission and increase agricultural productivities both in qualities and quantities

The Author will demonstrate that the prevailing, expanded and increasingly affordable connectivity and tools, especially mobile phones, as well as advances in data storage – Cloud Computing and open access, have made ICT significant ino Agricultural Production Systems. Mobile phone and wireless Internet end smallholders isolation therefore prove to be the most transformative Technology of economic and agricultural development of our time.

2 Sustainable Agriculture

Sustainability underlines the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. Therefore, stewardship of both natural and human resources is of prime importance. Managing and administrating human resources includes consideration of social responsibilities such as working and living conditions of laborers, the needs of rural communities, and consumer health and safety both in the present and the future. Governorship of land and natural resources involves maintaining or enhancing this vital resource base for the long term.

Sustainable agriculture interlaces three main goals--environmental health, economic profitability, and social & economic equity. A variety of philosophies, policies and practices have contributed to these goals. People in many different capacities, from farmers to consumers, have shared this vision and contributed to it. Despite the diversity of people and perspectives, the above themes commonly weave through definitions of sustainable agriculture.

Systematic methodology is essential to understanding sustainability. The system is envisioned in its broadest sense, from the individual farm, to the local ecosystem, and to communities affected by this farming system both locally and globally. An emphasis on the system allows a larger paradigms and more orderly understanding of the

consequences of farming practices on both human communities and the environment. A system approach gives us the tools to explore the interconnections between farming and other aspects of our environment. A system evaluation implies interdisciplinary efforts in research and education. This requires not only the input of researchers from various disciplines, but also farmers, farmworkers, consumers, policymakers and others stakeholders.

Transforming to sustainable agriculture is a process. For farmers, the transition to sustainable agriculture mandates a series of small, realistic steps. Family economics and personal goals and education influence how fast or how far participants can go in the transition. It is important to realize that each small decision can make a difference and contribute to advancing the entire system further on the "sustainable agriculture continuum." The key to moving forward is the will to take the next step.

The strategies for realizing sustainable agriculture are grouped according to three separate though related areas of concern: Farming and Natural Resources, Plant and Animal Production Practices, and the Economic, Social and Political Context. They represent a range of potential ideas for individuals committed to interpreting the vision of sustainable agriculture within their own circumstances.

3 Major Actors in Sustainable Agriculture

Policy Makers are critical decision makes in the process of sustainable agriculture. Policies makers must adopt policies that provide incentives to smallholders to practice sustainable agriculture. In addition, the policy makers must pave the roads to create appropriate technical infrastructure including building Institutional complexes and technical information centers, establishing appropriate educational & technical colleges and extension resources. Policies that provide; adequate energy, water supplies, transportation systems, and ports. Establish Incentive and balanced policy to promote imports & exports.

Multidisciplinary Researchers: An agricultural sector encompasses soft and hard sciences. Therefore researchers must collaborate in their efforts to bring about comprehensives advancements in agricultural sustainability.

Institution & Educators are the key in trickling down/trickling up information to and from the famers and smallholders.

Farmers and smallholders are the executive that implement and practices sustainable agriculture. They are major decision makers and their roles in developing and enduring sustainable agriculture s of paramount important.

Innovators: Smallholders and social actors actually do to innovate their practices can be understood as networking: social actors in search of relevant ideas, knowledge, information and experiences, continuously build and manage relationships with others which, by some standard, they consider relevant to innovating their practices

Investors: Agriculture is very risky investment. However, sustainable agriculture drives down risk factors.

Postharvest /Primary Processors and Packagers: Technological advancements are available to prevent postharvest loses. Protecting commodities at the farmgates preserve commodities quality and prolong its shelflife. As such it is significant value added

Transporters: Refrigerated and appropriately cooled trucks are are value added

Marketers & Traders, understanding market opportunities, and prices mechanisms both at the local and international level are crucial to increase income revenues and profits

And on the demand side is the Consumers that utilize the commodities.

Factors to be considered in Practicing Sustainable Agriculture:

Farming and Natural Resources, in Specific non Renewable resources:

water, (b) soils and (C) energy

2. Plant and Animal Production Practices,
3. Innovations and Advanced Technologies
4. Macro and Micro Economic,
5. Social and Political milieus

4 Advanced Technologies

Traditionally the Smallholders often can't easily access new and advanced technologies such as Genetically Modified Seeds (GMS) and Nanotechnology. These technologies prove to increase productivities, control losses and manage risk. GMS first and second generations produced drought & disease resistant seeds, high yields varieties that can be mechanically be harvested and meet consumer expectation.

On the other hand, Nanotechnology applications are gaining momentum in all aspects of food production system. Both GMS and Nanotechnology research are considered private properties and remained in the multinational corporations and private research institution domain.

5 ICT and Sustainable Agriculture

ICT is an Umbrella term that Includes: Anything ranging from Radio to Satellite Imagery to mobile phone or Electric money Transfer

ICT no longer is considered luxury for Developing Countries (DC.) In fact, many of the ICT innovations are emerging from DC. They are creating new ways of communicating, doing business and delivering services. Through extending access to ICTs

A linear approach can exclude other stakeholders in the agricultural sector such as universities, agribusiness, traders, and nongovernmental and civil society organizations. It does not reflect the many well-documented ways that agricultural innovation actually occurs, such as experimentation by individual farmers, informal networking among farm communities, private sector participation, collaboration among extension workers interested in a particular idea, collaboration between researchers and farmers, and the adaptation by all of these actors of knowledge and practices from domains outside agriculture.

6 Key that Drive ICT in Agriculture

ICT in agriculture, particularly for poor producers:
Ø low-cost & Pervasive Connectivity
Ø Adaptable and more affordable tools
Ø Advances in data storage and exchange,
Ø Innovative business models and partnerships, and
Ø The democratization of information, including the open access movement and social media. These drivers are expected to continue

7 ICT and Agriculture

ICTs appear ideally suited to the task of enhanced interaction because they can expand communication, cooperation, and ultimately innovation among the growing array of actors in agriculture. ICTs, especially mobile phones, can and do drive participatory communication, including communication from those on the margins of traditional research-extension processes, and they are often the key instruments that organizations use to deliver services to larger numbers of rural people than they could reach before. ICTs are fundamental to the Sustainable Agriculture, smallholders and "farmers," public and private—extension agents, consultants, companies contracting farmers, and others—emerging to stakeholders device, knowledge, collaboration, and interaction among groups and communities throughout the agricultural sector.

Numerous electronic tools increase interaction among the actors involved in agriculture. On a macro level, e-Science (e-Research) draws on increasingly connected and extensive digital infrastructure to facilitate collaboration and knowledge exchange nationally, regionally, and globally. On a micro level, m-Agriculture, powered by increasingly affordable mobile digital devices such as phones, laptops, and sensors, how much processor, bandwidth, and storage capacity are needed? The required resource is made available immediately

8 Cloud Computing-- (CC :)

For the Smallholders cloud computing is a form of outsourced IT services. Enabled smallholders and farmers to store their information and data with little upfront costs, does not require purchase or maintenance of significant hardware and scale down to the need of the farmers or smallholders without purchasing new software or hire new personnel.

The advantage of cloud computing is that it offers pooled and elastic resources on demand over the Internet (Porcari 2009) National Institute of Standards and Technology (NIST.) More specifically, cloud computing has been described as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell and Grance 2009 NIST)

Over the years Cloud Computing eased the data collection and aggregation process, which is critical for research, extension, and education. Smallholders often lack access to timely, cost-effective, and personally relevant information on improved practices, markets, prices, inputs, weather and impending disasters, Smallholder farmers, who still provide a significant portion of the world's food, need to level the plain and access information, technology, innovation and market channels to advance their production to feed the world.

The need to Access essential information on prices, markets, varieties, production techniques, services, storage, or processing underscores growth in Food production. ICT is changing the above scenario as the types of ICT-enabled services useful to improving the capacity and livelihoods of poor smallholders are growing quickly.

9 Mobile Phone

v Around three-quarters of the world's inhabitants now have access to a mobile phone and the mobile communications story is moving to a new level, which is much about the phone but how it is used.

v The number of mobile subscriptions in use worldwide, both pre-paid and post-paid, has grown from fewer than 1 billion in 2000 to over 6 billion now, of which nearly 5 billion in developing countries.

v The mobile phone has evolved from a simple voice device to a multimedia communications tool capable of downloading and uploading text, data, audio, and video—from text messages to social network updates to breaking news, the latest hit song, or the latest viral video

v A mobile handset can be used as a wallet, a compass, or a television, as well as an alarm clock, calculator, address book, newspaper, and camera. Mobiles are also contributing to social, economic, and political transformation. Farmers in Africa obtain

pricing information via text messages, saving time and travel and making them better informed about where to sell their products, thereby raising their incomes (World Bank 2011a, 353).

The Mobile phone impacts on stallholders and farmers in four major areas:

· Improving access to financial services,
· Providing Agricultural information
· Cultivating data conspicuousness for supply chain adeptness, and
· Promoting access to Market

Short Messaging Service (SMS)

v SMS is now enabling mobile phones to be used as a platform for agricultural information exchange.
v SMS enable the smallholders to exchange technology advancement
v SMS will enable the smallholders to access innovation
v SMS enable smallholders to enhance the implication, adaptation & adoption of Technologies advancement.
v SMS enable the smallholders to communicate their best practices

10 Mobile Phone Opportunities and Constraints

v Mobile phone can link farmers and smallholders to finance, education, nutrition & health, prices and market channel
v Monitors resource, track processing, control quality and production
v Collect data on biodiversity
v Access research and advanced technology from available public information centers:

Such as FAO, UNIDO UNDP, the World Bank, the Coherence in Information for Agricultural Research for Development (CIARD) Formally, Consultative Group on International Agricultural Research (CGIAR) that funded the 15 International Agricultural Research Centers

12 Conclusions

In conclusion Sustainable Agriculture and ICT are integral part of food production chain. Both are multidisciplinary & convoluted sectors. Therefore demand collective support and coordination of all main actors, policy makers and decision makers in Food Production. ICT networking provide upstream/downstream movement as well as backward/forward collaboration and cooperation,

The Author underscored critical achievement factors include the development of local stewardship and understanding, testing solutions and methodological regulatory participation. These fundamental elements can ensure that the content and methods of delivery are designed to both market and crop type. Therefore, not only the smallholder and farmers benefit from increased incomes and revenues, but also all main actors in both ICT and Sustainable Agriculture benefit through systematic data collection and information.

The domino effects of social and economic revenues that these prospective could deliver are well beyond the food production chain.