ICTs and Food Security

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Food security and hunger are global concerns. This Technology Watch Report examines some of the main ways in which Information and Communication Technologies (ICTs) can be used locally and globally to address the problems of food security and hunger and reviews the relevant ITU standardization work.

Telecommunication Standardization Policy Division
ITU Telecommunication Standardization Sector

International Telecommunication Union

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- Identifying candidate technologies for standardization work within ITU.
- Assessing their implications for the ITU Membership, especially developing countries.

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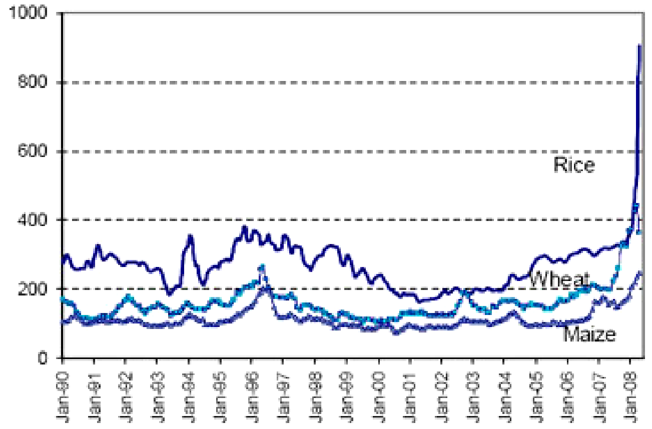
ICTs and Food Security

I. Introduction

Famine and hunger have plagued mankind throughout history and remain critical problems. Most recently, attention has been focused on the problem of food security[1], which has become one of the main issues on the global agenda. Concerns over food security have been prompted by the impact of climate change, sharp rises in food prices in many countries, and energy policies, in particular the issue of biofuels. In this report, the term 'food security' refers to the availability of adequate food supplies and access to it.

Figure 1: Grain Prices $/ton from 1990-2008



Source: World Bank, http://go.worldbank.org/DKQVYDJ7H0

The impact of climate change on food security has drawn great attention. Extreme weather events can have an immediate, adverse impact on food availability [2], while shifts in weather patterns can increase crop vulnerability to infection, pest infestations, and choking weeds.[3] The increased use of agricultural lands to produce biofuels instead of food, global population growth, loss of agricultural land to residential and industrial development and growing consumer demand in developing countries have also been cited as reasons for rising prices and shortages.[4]

The magnitude of the problem of hunger and food security is alarming. Every six seconds, a child dies from hunger and related diseases.[5] The Food and Agriculture Organization (FAO[6]), a specialized agency of the United Nations, estimates that more than 860 million people in the world today suffer from hunger. Of those, about 830 million live in developing countries, the very countries expected to be most affected by climate change.[7]

Sharp recent increases in the price of food have raised special concern and calls for global action. Food prices rose by nearly 40 per cent in 2007 and further large increases took place in the first part of 2008 (see Figure 1). For the poor, higher food prices mean a reduced ability to purchase staples such as rice, maize, wheat, and dairy products. Lack of affordable food can cause long-term, irreversible consequences for health, productivity, and well-being.

The reduction of extreme poverty and hunger is the first of the eight United Nations Millennium Development Goals (MDG).[8]

As the lead UN agency for ICTs, the International Telecommunication Union (ITU) is playing a key role in promoting the use of ICTs to address emergency situations and food security. Increased access to and use of ICTs can be beneficial to farmers and the agricultural industry. Nonetheless, efforts to date to employ these tools have not been uniform or sufficiently widespread. There are many factors (policy, legal framework, technology, knowledge, markets, research, etc.) to be considered when addressing food security, but in all of them information and communication technologies (ICTs) can act as catalysts.

This report presents examples and initiatives, which make use of ICTs to improve food security, and describes how ITU work can help to address the problem.

II. Using ICTs to address food security

A. Globally: Monitoring and early warning

The systematic monitoring of world food supplies is a first and necessary step to address food security. This includes mapping agricultural production and food shortages and establishing comprehensive data bases. Monitoring can be greatly facilitated by more effective use of ICTs, including:

- Remote sensing infrastructure: monitoring of agriculture and water resources by the use of high resolution radiometers and moderate-resolution imaging spectrometers, general placed aboard aircraft and satellites.

- ICT equipment: PCs, PDAs[9], servers, mainframes, network databases and software are used for food security analysis, including statistics, modeling and mapping. In particular geographic information systems (GIS) can help to establish cross-sectoral communication - by providing powerful tools for storage and analysis of statistical data, and integrating databases of different sources in the same format, structure and map projection.[10]

- Communication infrastructure: relevant information can be distributed via the Internet and other communication channels to farmers and consumers, and can be presented on web portals, interactive maps, etc.

International organizations dealing with food security collect and analyze the data and provide statistical services. FAOSTAT (FAO statistical services[11]) provides mapping and monitoring of famine and agricultural production for many countries. In countries subject to recurrent food security crises, the UN World Food Programme (WFP) conducts a comprehensive food security and vulnerability analysis (CFSVA), providing a complete picture of the food security situation in each country (this incorporates household level data and analysis with GIS information).[12]

Mapping and monitoring of vegetation productivity, yield forecasts and global weather patterns are also used by organizations to issue early warnings to alert those concerned of potential problems of food security. Different early warning systems are presented in Box 1. They can make it possible for governments to take preventive actions in areas at risk of a food crisis.

B. Locally and Globally: Emergency communications

To be able to coordinate and to rapidly provide food supplies in emergency situations and crises affecting basic food access, the WFP is making use of emergency telecommunications services, including UHF/VHF/HF radio networks and satellite phone services.[22]

Box 1: Food Monitoring and Early Warning Systems

- **GIEWS** - FAO Global Information and Early Warning System[13]
- **FEWS Net** - USAID Famine Early Warning System[14]
- **GMFS** – Global Monitoring for Food security[15]
- **VAM** – World Food Programme Vulnerability Analysis and Mapping[16]
- **MARS FOOD** - Monitoring Agriculture with Remote Sensing (EC/JRC)[17]
- **EARS** - Environmental Analysis and Remote Sensing[18]
- **AP3A** - Alerte Précoce et Prévision des Productions Agricoles (CILSS/Agrhymet – Sahel, only in some African countries)[19]
- **SADC -** Regional South African Early Warning System for Food Security[20]
- **DMC** - Drought Monitoring Centers (SADC/IGAD) in East Central Africa[21]

Source: GMFS, http://www.gmfs.info

The Inter-Agency Standing Committee (IASC), a UN forum for inter-agency coordination of humanitarian assistance, established the “cluster approach” and designated lead agencies in eleven key areas of humanitarian activity. One of these areas, the Emergency Telecommunications Cluster (ETC) [23] was established to ensure the availability of predictable, robust and reliable ICT infrastructure and services, which are critically important to the successful functioning of the humanitarian community and to ensure the personal security of humanitarian workers. Its main tasks include:

- Providing inter-agency telecommunications infrastructure and services, for both data and security communications;

- Providing standard, interoperable ICT platforms and procedures to avoid duplication and ensure cost effective services; and

- Ensuring a smooth transition to the post-emergency reconstruction.

Technical standards are vital to safeguard interoperability of different systems for monitoring, early warning and emergency communications.

ITU plays a major role in developing the technical and regulatory background for further evolution of remote sensing and early warning systems, and has a strategic function in ensuring global interconnection and interoperability of telecommunications networks at the onset and during emergency and disaster situations through its standards (ITU Recommendations).

The Radiocommunication Sector (ITU-R) allocates necessary radio-frequency spectrum through its World Radiocommunication Conference and provides regulatory protection to remote sensing systems. ITU-R also carries out studies and develops Recommendations, reports and handbooks on remote sensing.

The data sensed remotely is disseminated using different alerting technologies based on telecommunication networks. In 2007, the Telecommunication Standardization Sector (ITU-T) published Recommendation ITU-T X.1303, which defines the XML-based Common Alerting Protocol (CAP). CAP is used for exchanging public warnings between different alerting technologies and associates emergency event data (such as public warning statements, photographs, sensor data or URIs) with basic metadata such as time, source and level of urgency, and with geographic locations. Application of the protocol is not limited to rapidly generate and exchange weather alerts, seismic events, etc., but it could also be used to spread "food alerts".

To facilitate communication in disaster relief activities a special country code (888) has been assigned to UN OCHA (Office for the Coordination of Humanitarian Affairs) and adopted in ITU-T E.164. This separate, alternate naming and addressing system will remain in operation until normal telecommunications can be restored. ITU-T E.106, a Recommendation approved in March 2000, describes an international emergency scheme for the preferential use of public telecommunications by national authorities in emergency and disaster relief operations.

ITU-D, the development arm of ITU, assists developing countries in the use of ICTs for disaster prediction, detection and mitigation. This includes infrastructure development, and the establishment of enabling policy, legal and regulatory frameworks. In the immediate aftermath of disasters, ITU-D deploys temporary ICT solutions to assist countries affected.

The use of remote sensing and associated technologies is not limited to situations caused by natural disasters, but can also be applied to related scenarios, for instance to monitor food supplies.

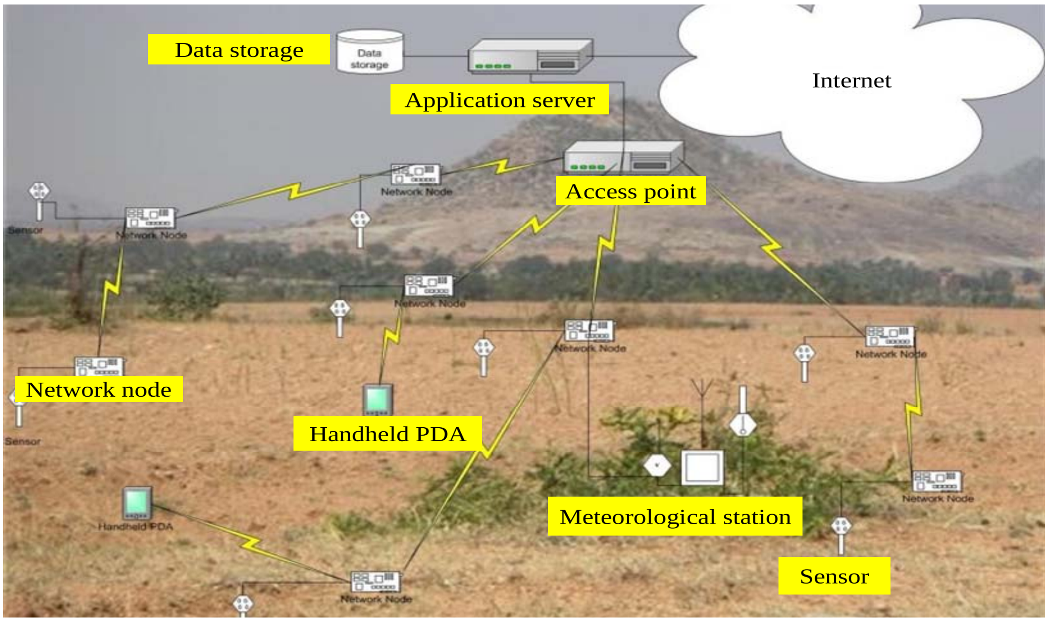
C. Locally: Monitoring agricultural conditions

Monitoring environmental and soil conditions can make farming more profitable and sustainable, for instance, through better water management and pest and disease control (It is estimated that the overall efficiency of water use for agriculture is less than 30 per cent). Improved operation and management of water for irrigation can lead to significant savings and to a more sustainable use of water resources, as well as enhanced soil productivity.[24]

ICT tools in agricultural and soil monitoring include:

- Stand-alone sensors, which measure air temperature, atmospheric pressure and humidity.
- Ubiquitous sensor networks (USN), whose sensor nodes are deployed on the field and transmitting data to a base station. This data can also be uploaded to global systems.
- Telemetry units transmitting air temperature, humidity, leaf wetness data, solar radiation, wind speed, and soil moisture, using cellular networks.

Figure 2: Example of a wireless network scheme to monitor agriculture parameters



Source: COMMON Sense net, http://commonsense.epfl.ch/

The deployment of ICTs in the field can help to improve food yields and enable farmers to better forecast crop yields and production. The use of ICTs to share data increases the number of farmers profiting from the information.

One example is provided by the COMMON Sense Net project (Community-Oriented Management and Monitoring of Natural Resources through sensor network). COMMON Sense Net is used for agricultural management in the rural semi-arid areas in Karnataka, Southern India (See Figure 2). The project consists of a wireless network of ground-sensors that periodically record the state of the soil (measuring salinity and humidity), the air temperature, the volume of precipitation and other parameters. A second network of subterranean sensors is used to monitor the level and quality of ground-water.

A different example of soil mapping is provided by a new project of the African Soil Information Service. This project combines remote satellite imagery and soil science to produce the first detailed digital soil map of sub-Saharan Africa.[25]

A number of limitations in the technology still need to be resolved, e.g., the limited lifetime of sensor nodes and the reliability of multi-hop communication.[26] Different approaches and protocols have been proposed to increase the lifetime of sensor nodes. These include synchronized communication protocols, and efficient sleep/wakeup cycles.

However, the deployment of sensors and networks is costly and requires technical knowledge and trained personnel. Today's installations mostly serve research purposes in the developed world (e.g., "Vineyard Computing"[27]), rather than being used to safeguard food security.

More effort must be made so that the technical design is appropriate to the geographical, cultural and socioeconomic situation of the end-users. Finding technology appropriate solutions is a critical need in developing countries.

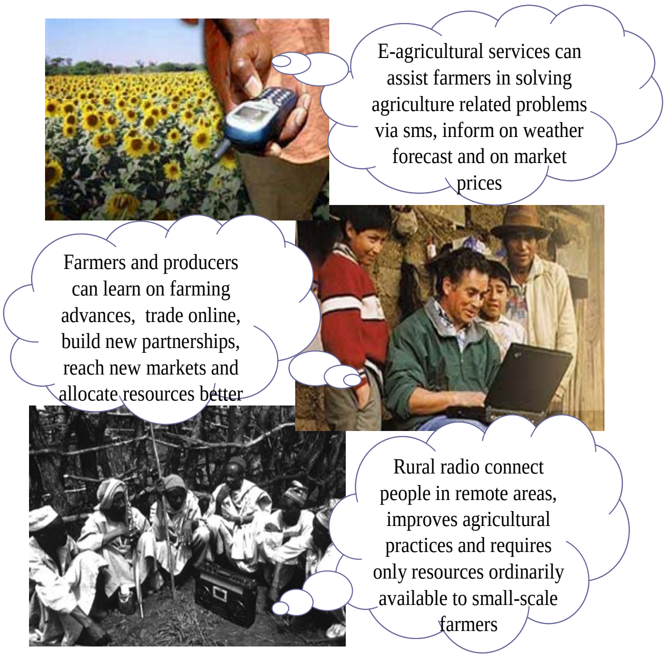
D. Locally: ICTs to enhance sustainable agricultural development

At the local level, ICTs can provide farmers with useful and beneficial information, such as new farming techniques, weather reports, and crop prices. This is also referred to as e-agriculture and the following are some practical examples of this use of ICTs:

- Rural radio. Information and knowledge play a key role in addressing food security. The radio has a fairly wide coverage and is a relatively inexpensive communication medium that can provide farmers with information about farming conditions. FAO Rural Radio in Africa has a food security channel with programs on food production and productivity.[28]

- SMS. Farmers can use mobile phones to receive text messages with market information on commodities (market price, supply and demand). In some countries, these types of services reach millions of farmers every week.[29] For example, e-Choupal[30] in India and Tradenet[31] in Ghana offer mobile phone and web based services that help farmers achieve better yields and secure better prices by allowing them to receive accurate weather forecasts and local price information direct to their mobile phones, and in their local language (see Figure 3).

Figure 3: Some ICT applications helping farmers



Sources: www.techgadgets.in and www.e-agriculture.org

Similar services are used by coffee producers and fishermen to quickly respond to market demand and to avoid waste. A study in Kerala, India, showed that fishing profits grew by 8 per cent while fish prices decreased by 4 per cent, after mobile phone services were introduced in the market. This improvement was equivalent to an increase of 2 per cent in per-capita GDP.[32] [33]

Mobile phones are rapidly becoming widespread in developing countries (more than 70 per cent of the world's mobile subscribers were in developing countries at the beginning of 2008, see Figure 5). The use of mobile phones to distribute food market information offers great advantages for consumers and food producers.

- Telecenters. In rural areas, information can also be made available to farmers through community telecenters.

  These centers provide the rural population with access to the Internet, to telephone and fax services connection. Farmers can use these services to enhance communication with potential buyers and to access information on improved farming techniques. With the assistance of ITU, telecenters providing these services are being set up in a number of rural communities.[34]

- E-learning/training. Rural education is a key resource in the fight against poverty and hunger. In addition, where access is available, the Internet can help farmers to reach new markets and better allocate resources. Several partnership initiatives offer online toolkits to train individuals and support institutions and networks world-wide in the effective management of agricultural information.[35]

However compared to mobile telephony, Internet access in rural communities is quite limited in most developing countries, whereas global mobile penetration surpassed 50 per cent in 2008.

The World Summit on the Information Society (WSIS), organized by the ITU, recognized the importance of ICTs for agriculture and adopted an Action Line on e-agriculture in the Tunis Agenda.[36] Two leading initiatives are the FAO Programme for Bridging the Rural Digital Divide (BRDD) worldwide, and the First Mile Project (FMP) organized by the International Fund for

Agricultural Development (IFAD) in Tanzania.[37] BRDD aims to establish networks for exchange of information and communication on agriculture and rural development at a global scale.[38] FMP seeks to connect the rural poor – at a regional scale - to relevant information, knowledge and key people in the market chain (including processors, traders and consumers) by making use of mobile phones, the Internet and e-mail.[39] In 2006, FAO and others launched www.e-agriculture.org to guide efforts in this area, and to enhance sustainable agricultural development and food security by promoting the use of ICTs and associated technologies to support rural development.

III. RFIDs: ICTs and supply chain logistics

ICTs can be used to improve the supply chain of food products and thereby enhance food security. Manufacturers, as well as farmers, can make use of ICTs to boost food output and monitor inventories.

The tracking of food supplies and inventories can be improved with the use of radio frequency identification (RFID) tags. An RFID tag is an electronic device made up of a chip and antenna. It allows the identification and tracking of shipments (including food products) using radio-frequency communication.[40] To date, this use of RFID is largely limited to some developed countries.

RFID tags can store larger amounts of data than bar codes and can be used to identify single objects. These systems can offer benefits in the food supply chain by increasing automation and reliability. RFID systems also can help to ensure that perishable products, such as meat and poultry, are maintained in optimal conditions benefiting both the seller and customer. Information about the origins of the food product and its ingredients can also help to avoid poisoning and food-borne illnesses.

The European Union is gradually introducing individual traceability of animals to improve the health and protection of consumers. All animals born after 31 December 2009 will be given a tag recording individual animal movements (individual tracking). This could be extended to packed meat and other animal products.

Sensor tags (sensors with RFID tags) and wireless sensor nodes can be integrated in the food supply chain, for instance to monitor temperatures and humidity information. USN services enable that sensed information is transmitted to food management systems through the communication infrastructure.

In some field tests USNs have been used for cattle monitoring. The sensors respond to RFID tags in collars that store the identity and health status of each animal with their location.[41] The costs of this technology are still relatively high for developing countries, as the implementation requires a large start-up investment.

Another current drawback of RFIDs is its incompatibility among different countries (e.g., not all RFID tags in the USA are compatible to those in Europe or Japan). Standardization activities can play an important role to overcome this obstacle.

ITU-T published a technical paper on RFID[42] in 2005 and USN[43] in 2008. Food traceability, the tracing and tracking of food and the related information at each stage of the food chain, including production, processing, distribution and sales ("from farm to fork"), is described as one application of RFIDs or barcodes in ITU-T F.771.[44] Other ITU-T Recommendations for tag-based applications and services have been approved[45], and further are under preparation.[46] ITU-R allocates radio-frequency spectra for remote sensing and RFID, and the Joint Coordination Activity on Network Aspects of Identification Systems (JCA-NID) coordinates ITU work on this field including RFID and USN matters. Ensuring the security of sensed data becomes a critical function in USN. Therefore, three ITU-T Recommendations on USN security, X.usnsec-1-3, are currently under development in ITU-T Study Group 17, the lead study group on telecommunication security.

There are many other standardization bodies involved in work on RFID, including ISO/IEC JTC 1, ETSI, and IEEE. The ISO 22000 series provides global standards for safe food supply chains.

IV. Conclusion

In the past few years, sharply rising prices and shortages of food and agricultural commodities, particularly in many developing countries, have led to global concern about food security. This problem is linked in large part to the impact of climate change on agriculture.

There are several ways in which information and communication technologies can address this problem at the local and global level. ICTs are used by many international organizations for mapping and monitoring world food supplies, early warning systems, and to respond when disasters strike. In this area, ITU's work on telecommunication and radiocommunication standards is essential to the functioning of the humanitarian community.

In developing countries, the use of ICTs by farmers and the rural population to overcome hunger and food security remains in early stages. The mobile phone revolution, especially the growth of mobile penetration in developing countries, offers new opportunities to benefit farmers and agricultural production. Better access to weather, market and price information can have an impact on the incomes of farmers and fishermen. However, the full potential of ICTs to address food security has yet to be realized.

In developed countries, ubiquitous sensor networks and radio-frequency identification applications are leaving the university and research labs to be deployed in the fields and food supply chains. Standards for the better design and implementation of USN using wired and wireless sensor networks could increase ICT use in agriculture. To lessen the risk of unsafe food, RFID tags and further standardization in this area can heighten compatibility between tags in different countries, which would ensure an effective global use of the tags for food tracking.

Glossary of acronyms

AP3A	Alerte Précoce et Prévision des Productions Agricoles
BRDD	FAO Programme for Bridging the Rural Digital Divide
CAP	Common Alerting Protocol
CFSVA	Comprehensive Food Security and Vulnerability Analysis
COMMON Sense Net	Community-Oriented Management and Monitoring of Natural Resources through Sensor Network
DMC	Drought Monitoring Centres
EARS	Environmental Analysis and Remote Sensing
ETC	Emergency Telecommunications Cluster
ETSI	European Telecommunications Standards Institute
FAO	Food and Agriculture Organization of the United Nations
FEWS	Famine Early Warning System
FMP	IFAD First Mile Project
GDP	Gross Domestic Product
GIEWS	Global Information and Early Warning System
GIS	Geographic Information System
GMFS	Global Monitoring for Food security
HF	High Frequency
IASC	Inter-Agency Standing Committee
ICTs	Information and Communications Technologies
IEC	International Electrotechnical Commission
IFAD	International Fund for Agricultural Development
ISO	International Organization for Standardization
ISO/IEC JTC 1	ISO/IEC Joint Technical Committee 1
ITU	International Telecommunication Union
ITU-D	ITU Telecommunication Development Sector
ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Telecommunication Standardization Sector
JCA-NID	Joint Coordination Activity on Network Aspects of Identification Systems
IEEE	Institute of Electrical and Electronics Engineers
MARS	Monitoring Agriculture with Remote Sensing
MDG	United Nations Millennium Development Goals
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
PDA	Personal digital assistant
RFID	Radio-Frequency Identification
SADC	Regional Early Warning System for Food Security
SMS	Short Message Service
SG	Study Group
UHF	Ultra High Frequency
USN	Ubiquitous Sensor Network
VAM	Vulnerability Analysis and Mapping
VHF	Very High Frequency
WFP	United Nations World Food Programme
WSIS	World Summit on the Information Society

Notes, sources and further reading

[1] The UN Food and Agriculture Organization (FAO) defines the term food security as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." See "Trade Reforms and Food Security," FAO, 2003, http://www.fao.org/docrep/005/y4671e/y4671e00.HTM.
[2] See "Climate Change and world food security: a new assessment" by Parry, Rosenzweig, Iglesias, Fischer and Livermore, Global Environmental Change.
[3] FAO Director-General's statements for 2007, "Climate change, food security and poverty reduction". Conference organized by SIDA (Swedish International Development Agency).
[4] See "Biofuels and Grain Prices: Impacts and Policy Responses" by Mark W. Rosegrant, Director, Environment and Production Technology Division, International Food Policy Research Institute, May 2008, http://www.ifpri.org/pubs/testimony/rosegrant20080507.asp.
[5] See the World Food Program website http://www.wfp.org/.
[6] The Food and Agriculture Organization of the United Nations leads international efforts to defeat hunger. See more on global hunger situation at http://www.fao.org.
[7] This number increased by 40 million compared to 2007. See "Hunger on the rise," FAO, September 2008, http://www.fao.org/newsroom/common/ecg/1000923/en/hungerfigs.pdf.
[8] High prices may set back by seven years any progress towards the 2015 MDG. See ICAD 2008, http://www.kit.nl/smartsite.shtml?ch=FAb&id=24342&Part=InDepth.
[9] WFP also uses PDAs for household level data collection, which improves the quality of data gathered and reduces the time needed for data entry and analysis.
[10] A Geographic Information System (GIS) integrates hardware, software and data, and is used to collect and analyze geographically referenced information, which creates models that associate attribute data with specific aspects of physical spaces. This is a key for consulting and analyzing Earth resources in agriculture. Additional information on GIS at http://www.ccdmd.qc.ca/en/gis/, and on the website of the Food Insecurity and Vulnerability Information and Mapping Systems Organization, at http://www.fivims.org.
[11] http://faostat.fao.org/
[12] The CFSVA incorporates household level data and analysis with GIS information. See http://www.wfp.org/food-security/reports/CFSVA.
[13] http://www.fao.org/giews/english/index.htm
[14] www.fews.net/
[15] www.gmfs.info/
[16] http://www.wfp.org/operations/VAM/about_vam/index.html
[17] www.mars.com/
[18] www.ears.nl/
[19] http://www.case.ibimet.cnr.it/ap3a/
[20] http://www.sadc.int/fanr/aims/index.php
[21] www.dmcn.org
[22] See more at http://documents.wfp.org/ict-emergency/ETCServices/Standards/index.htm.
[23] See http://www.humanitarianreform.org/humanitarianreform/Default.aspx?tabid=82.
[24] See "Wireless Sensor Networks for marginal farming in India" by Jacques Panchard, École Polytechnique Fédérale de Lausanne, Switzerland. http://commonsense.epfl.ch/Resources/thesis.pdf.
[25] The program was launched on 13 January 2009 by the Center for Tropical Agriculture (CIAT) and is supported by the Bill & Melinda Gates Foundation and the Alliance for a Green Revolution in Africa (AGRA). See http://www.africasoils.net/about/overview/overview.html.
[26] Multi-hop data collection refers to several nodes forwarding data packets to the base station. This is necessary due to the limited radio range of wireless sensors. In this process, with a low density of the network and present standard multi-hop protocols, lifetimes of wireless nodes can decrease rapidly and package delivery may fail.
[27] "Vineyard Computing: Sensor Networks in Agricultural Production" by Jenna Burrell, Tim Brooke, and Richard Beckwith, Intel Research, http://people.ischool.berkeley.edu/~jenna/burrell_pervasive_computing.pdf.
[28] http://www.fao.org/sd/ruralradio/en/24516/index.html
[29] See "The un-wired continent: Africa's mobile success story" by Vanessa Gray, ITU http://www.itu.int/ITU-D/ict/statistics/at_glance/Africa_EE2006_e.pdf.
[30] http://www.itcportal.com/rural-development/echoupal.htm

[31] http://www.tradenet.biz/
[32] "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector" by Robert Jensen, John F. Kennedy School of Government, Harvard University 2007. Also see "The GSMA Development Fund Top 20", Research on the Economic and Social Impact of Mobile Communications in Developing Countries, http://www.gsmworld.com/documents/GSMA_development_fund_top20_print.pdf.
[33] See http://www.ftpiicd.org/files/publications/IICD-agri-impact-2006.pdf.
[34] See http://www.itu.int/ITU-D/cyb/telecentre/index.html.
[35] See for instance the Information Management Resource Kit (IMARK), at http://www.imarkgroup.org/, the learning resource center of the Consultative Group on International Agricultural Research (CGIAR), at http://learning.cgiar.org/, or the Global Development Learning Network (GDLN), at http://gdln.org/.
[36] WSIS took place in 2003 in Geneva and in 2005 in Tunis. http://www.itu.int/wsis/basic/about.html.
[37] International Fund for Agricultural Development, http://www.ifad.org.
[38] Digital Divide refers to the gap between those people with effective access to digital and information technology and those without. The programme aims to reduce poverty and hunger, by increasing the availability of information related to rural areas. See http://www.fao.org/rdd/.
[39] The First Mile project is about how small farmers, traders, processors and others from poor rural areas learn to build market chains linking producers to consumers. See http://www.ifad.org/rural/firstmile/FM_2.pdf.
[40] An RFID can be active or passive (no battery) tag. It consists in a transponder with a memory that can be used as a toll device. It is highly used as a replacement for bar code tags in tags in bookstore tracking, building access control, airline baggage tracking, and apparel and pharmaceutical items tracking.
[41] Ibis.
[42] http://www.itu.int/ITU-T/newslog/RFID+Paper+Posted.aspx
[43] ITU-T Technology Watch Report "Ubiquitous Sensor Networks", http://www.itu.int/oth/T2301000004/en.
[44] ITU-T F.771 "Service description and requirements for multimedia information access triggered by tag-based identification," August 2008. http://www.itu.int/rec/T-REC-F.771/en.
[45] For example ITU-T X.668 "Procedures for the Operation of OSI Registration Authorities: Registration of Object Identifier Arcs for Id-Based Applications and Services," and ITU-T X.1171 "Threats and requirements for protection of personally identifiable information in applications using tag-based identification," both ITU-T SG 17, http://www.itu.int/ITU-T/studygroups/com17/.
[46] For instance, Draft Recommendation ITU-T H.IRP "ID resolution protocols for multimedia information access triggered by tag-based identification" describes a protocol for the resolution of multimedia information for a given ID (whether it is a bar code, an RFID tag, etc.). ITU-T SG 16, http://www.itu.int/ITU-T/studygroups/com16/.