Using ICT for fish marketing: the EFMIS model in Kenya

RICHARD O. ABILA, WILLIAM OJWANG, ANDREW OTHINA, CAROLYNE LWENYA, ROBERT OKETCH and RAPHAEL OKEYO

Small-scale fisheries in developing countries often perform sub-optimally owing to lack of vital market information, leading to inefficiencies, inequity, and post-harvest losses. The mobile phone, which is the fastest growing communications media in Africa, may be most suited for addressing market information gaps. The Enhanced Fish Market Information Service (EFMIS), an ICT pilot project based on mobile phones, has been implemented in Kenya's Lake Victoria fisheries for 3 years. The objective of the project is to enhance fish trade and incomes for the fisher community through improved access to market information. Through the system, data from fish landing sites and inland urban markets is continuously relayed to a central database where it is appropriately packaged into a format that users can access in real time by sending a query through mobile phone SMS. The system is automated and responds within 10 seconds. Market information is also disseminated through monthly electronic bulletins. The EFMIS model offers the potential to be adapted for application in other small-scale fisheries, drawing lessons learnt from this pilot.

Keywords: EFMIS, ICT, Lake Victoria, fish

INFORMATION COMMUNICATION TECHNOLOGY (ICT) refers to a range of devices, tools, or applications that permit the exchange and/or collection of data through interaction or transmission (World Bank, 2011). They include traditional technologies such as radio and television, modern and increasingly familiar types such as mobile phones, and more specialized applications, such as computerized record-keeping systems, satellite imagery, including the global positioning/information systems (GPS/GIS), and electronic money transfers, among others (Harrod and Jamsen, 2011). ICTs are often combined to enable rural communities to exchange information and effectively connect them to markets, input suppliers, service institutions, and other sources of information.

This report contributes to the literature on the potential of ICT, particularly the mobile phone, for marketing. It discusses the Enhanced Fish Market Information Service (EFMIS), an ICT project for fish marketing piloted in Kenya, focusing on

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its design, achievements, impacts, and implementation challenges. The report has six sections. The first section introduces ICT and its applications in the theoretical context of market competition and efficiency. The subsequent section highlights the objectives and institutional framework of EFMIS followed by a section on the technical system design. There follows a discussion of the results and impacts of EFMIS as well as project sustainability issues, leading to conclusions and recommendations.

Theoretical context

The perfectly competitive market model is traditionally used in economics as a standard for attaining efficiency and equity (Roberts, 1987). It presupposes and entails an economically efficient allocation of resources. Since each trader maximizes profits by equating the given price to its marginal cost, competitive prices correctly reflect both consumer demand and the cost of resources. The competitive market model is characterized by large numbers of buyers and sellers, low barriers to entry, product homogeneity, and complete knowledge of alternative choices on the part of producers and consumers (McNulty, 1967). An efficient market will establish prices that relate transport, processing, and storage costs respectively to the provision of services in space, form, and time dimensions. Competition should thus ensure that prices and marketing margins fully reflect the costs of resources used.

Market information is a key factor influencing sellers' and buyers' decisions and choices in the market, such as what, how much, what price and when to sell or buy. However, such information is not readily available for most small-scale producers in agriculture and fisheries, thus giving undue advantage to those with access to information. For example, players higher up the fish value chain tend to have greater access to market information, and consequently take advantage of producers at the lower end (Kambewa et al., 2007). Information asymmetries and resulting inequities in the commodity value chain need to be addressed for sustainable development of small-scale fisheries.

Applications of ICT in agriculture and fisheries

ICTs are increasingly finding use in agriculture throughout the commodity value chain. Typically farmers are faced with information gaps at all stages of the crop cycle: on inputs, planting, weather, harvesting, storage, transportation, and marketing (Mittal, 2011). Farmers can apply ICT to increase farm productivity by matching cropping practices to climatic trends, use inputs and resources optimally, and ensure good farming practices through improved soil, nutrient, and land management. ICT can also be used for weather forecasting and as a tool for early warning systems (Donovan, 2011).

The mobile phone is one ICT attracting increasing interest as a tool for quick dissemination of information, mainly through voice or short messaging services (SMS). It is an ideal technology for improving connections within farmer

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organizations and providing a wide range of services because of its versatility and portability. According to the World Bank (2011) the functions of mobile phones in agriculture can be divided into five categories, namely: 1) advice, education, and awareness – for disseminating information to farmers and extension workers about good practices, crop varieties, and pest or disease management; 2) commodity prices, market information, and trading transactions – for providing market information throughout agricultural value chains; 3) data collection – for collection and repository of data especially from large geographic regions; 4) pest and disease outbreak warning and tracking – for sending and receiving data on outbreaks; and 5) financial services – for provision of microloans, banking services, and insurance for crops and livestock.

Africa has the fastest-growing mobile phone market worldwide, which is already being applied in many ways for profitable and non-profitable ventures. The penetration of the mobile phone is far greater than that of the internet in Africa, especially in rural areas, making it one of the most accessible communication tools. In East Africa, mobile phones are increasingly being used to access agricultural information including weather, advice on inputs, reporting crop diseases, and agricultural commodity prices, among other applications. In Zambia, for example, farmers use mobile phones to access government-subsidized fertilizer and information on its usage (Harrod and Jamsen, 2011). In Botswana a radio frequency identification system is applied to prevent and treat cattle diseases (Pehu et al., 2011).

The mobile phone can also be an effective tool for strengthening extension services. There is evidence that farmers' organizations that use ICTs function more efficiently, attract and retain a wider membership, generate more funds, and provide better services to their members. The benefits of ICTs to such cooperatives include improved connections to members, better accounting and administration, and stronger collective voice (Harrod and Jamsen, 2011). The farmers share market information and technical know-how, and they remain informed about the organization's activities, thereby increasing trust between members and the overall functioning of the organization is improved. For instance the national farmers' organization in Zambia has developed an SMS-based communication service for its members, thereby strengthening the organization (Harrod and Jamsen, 2011).

The mobile phone should not be regarded as a replacement for, but rather a complement to, the traditional ICTs such as radio, television, newspapers, and face-to-face extension services in rural communities. In Uganda it has been used in combination with radio to disseminate information to farmers (Rudgard et al., 2011). A 'Village Phone' concept earlier developed in Bangladesh has been replicated in Uganda, to promote health, agricultural best practices, and gender issues among a network of women. Rural women call or send SMS messages from their phones to contribute to the discussion, which is complemented with radio programmes (Okello, 2010).

The use of mobile phones has much potential in fisheries as they can deliver information in real time to enable fast decision-making. At a global level there has been a wide range of application of ICT in fisheries, from fish harvesting throughout the fish value chain and adopting various levels of technological sophistication. For instance in Guinean waters, GPS combined with mobile phones have been

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deployed to monitor and arrest illegal fishers, leading to significant reduction in illegal, unreported, and unregulated fishing (FAO, 2007). ICT has also been applied to monitor movement of fish in traceability systems (FAO, 2013). In aquaculture ICTs have been applied for various functions, ranging from pond management to monitor fish feeding, growth, and water quality, to fish marketing (Pehu et al., 2011). FAO uses ICT to report on global fish market and price trends through the internet-based FAO Globefish bulletin (FAO, 2013). In the Kerala region of India fishers have used mobile phones to identify better auction markets for their fish, resulting in significant reduction in price disparities and post-harvest losses (Donovan, 2011).

Information constraints in Lake Victoria fisheries

Lake Victoria is Kenya's most important fishery resource, producing about 120,000 metric tonnes of fish valued at about US$70 m and earning $50 m from fish exports annually, which constitutes about 90 per cent of the country's fishery output (Abila, 2007). The lake has a multispecies fishery of which three are commercially important, namely: Nile perch (*Lates nilotics*), Tilapia (mainly *Oreochromis niloticus*), and *Dagaa* (*Ratrineobola argentea*). The lake supports over 50,000 fishers, 300,000 local fish processors and traders, seven fish processors and exporter firms, and many fisheries organizations, including 30 small fisher cooperative societies, 300 beach management units, and over 350 women fish trader associations (Odongkara et al., 2009; LVFO, 2012).

Much of the lake region is well covered by mobile phone networks; fish landing sites have access to a network that has increased from 82 per cent in 2008 to 92 per cent in 2012 (LVFO, 2012). Despite this, the fishing industry had not adequately taken advantage of this technology to market fish before EFMIS. There was no systematic means of collecting, synthesizing, and disseminating information on fish prices, demand, and supply at various levels of the market chain in a useful way. This resulted in a situation where there were significant fish price disparities horizontally between markets and vertically up the value chain. Middlemen took advantage of this to buy fish from fishers at less competitive prices. It also caused considerable inefficiencies in market operations, and when fish landings were high, especially during rains, led to substantial post-harvest losses (Abila and Werimo, 2010).

The current management plan for Lake Victoria fisheries developed by the Lake Victoria Fisheries Organization has identified increased access to fish market information as one of the best ways of improving performance of the sector and reducing poverty (LVBC, 2007; LVFO, 2008).

Enhanced Fish Market Information Service (EFMIS)

Objectives

To address information deficiencies, an innovative ICT project based on the mobile phone was developed and piloted in Lake Victoria fishery in Kenya from June 2009 to 2011 and then up-scaled to cover the whole country. The project,

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named Enhanced Fish Market Information Service (EFMIS), aims to empower the fishing community with useful fish market information to improve their bargaining position and increase incomes from fish trade. The objective of EFMIS is to enhance fish trade and incomes of the fisher community by improving their access to market information through a convenient, fast, and cheap medium. The expected outputs are transparent pricing, improved fish prices, reduced marketing costs, and reduced post-harvest fish losses.

Funding

EFMIS was initially supported through a grant under the Facility for Africa Challenge Fund programme. This is a regional technical cooperation programme supported by the International Labour Organization (ILO) and the UK Department for International Development (DFID). An up-scaled phase of the project has been supported by the EU from March 2011 and was still operational at the time of writing in 2013, which serves the entire Kenyan fisheries sector, including marine fisheries, all other fresh water lakes (Turkana, Baringo, and Naivasha), and aquaculture, as well as fish markets across the country. The EU funding is under the Assistance to Micro and Small Enterprises Program (ASMEP) in support of the Private Sector Development Strategy. ILO/DFID provided $83,951 for the initial phase while the EU provided $161,504 for the up-scaled project phase.

Institutional framework

EFMIS was conceptualized, developed, and coordinated by the authors of this paper at the Kenya Marine and Fisheries Research Institute (KMFRI). They brought together a number of institutions from government, NGOs, community-based fisheries organizations, and the private sector as collaborators, service providers, and users of the system (Figure 1). The key collaborators are: the Department of Fisheries, the Beach Management Units, Cooperatives Societies, Women Fish Traders Associations, and the Association of Fish Processors and Exporters of Kenya (AFIPEK). From the private sector two highly reputed communication firms were procured through competitive and transparent tender. Their roles are to support communication services for the project, which included the supply of low-cost mobile phones for data recorders, provision of talk time, and maintenance of the 24-hour automated SMS and internet data response system.

To get all the participants on board, stakeholder workshops and meetings were organized which were attended by fishers, fish traders, fish exporters, cooperatives, government representatives, NGOs, and the media, among others. The apex of this was a highly publicized ceremony to launch the project which drew the attention of potential users of the service. Much effort and resources were also spent on publicity so as to increase awareness about the project and how to use its services. The publicity materials included banners, wall posters, brochures, flyers, and T-shirts, which were distributed to the fisher communities and other targeted groups. In addition the project organized exhibitions during agri-business shows

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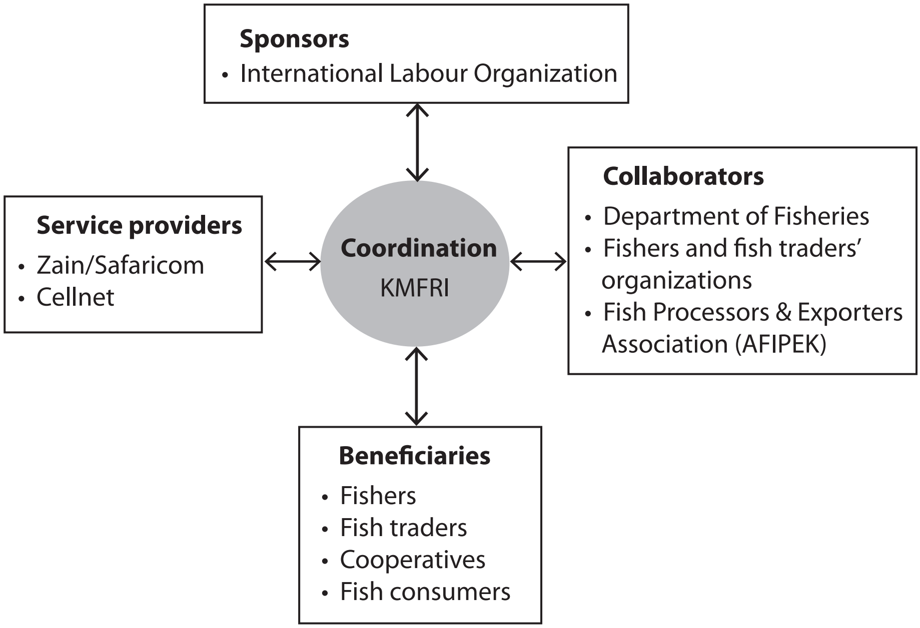

Figure 1 Institutional arrangement for EFMIS

and other forums held across the country, including the Kisumu Agribusiness Show and the Nairobi International Trade Fair. During such events EFMIS conducted 'live' shows where people were able to observe data coming in, packaging and entry in the system, and response to queries. The EFMIS data centre itself attracted a lot of interest as demonstrated by high profile visits.

EFMIS system design

Overview of the system

EFMIS is a system for generating, packaging, and disseminating key market information from fish landing sites around the lakes and marine sources and inland markets in major urban areas across the country. The system has the capability to handle data on four key variables that influence fish marketing decisions, namely: 1) fish prices at landing sites and inland markets; 2) quantities of fish at landing sites and inland markets; 3) number of fish trucks at landing sites; and 4) basic weather information (e.g. whether wet or dry).

The EFMIS system consists of three broad phases: 1) data recording, coding, and transmission from landing sites and inland markets to the data centre; 2) a central database; and 3) query and automated response system (Figure 2). In summary, data is recorded once or twice a day at each of the landing sites and inland markets, and relayed by phone SMS in a coded format to a data centre based at KMFRI in

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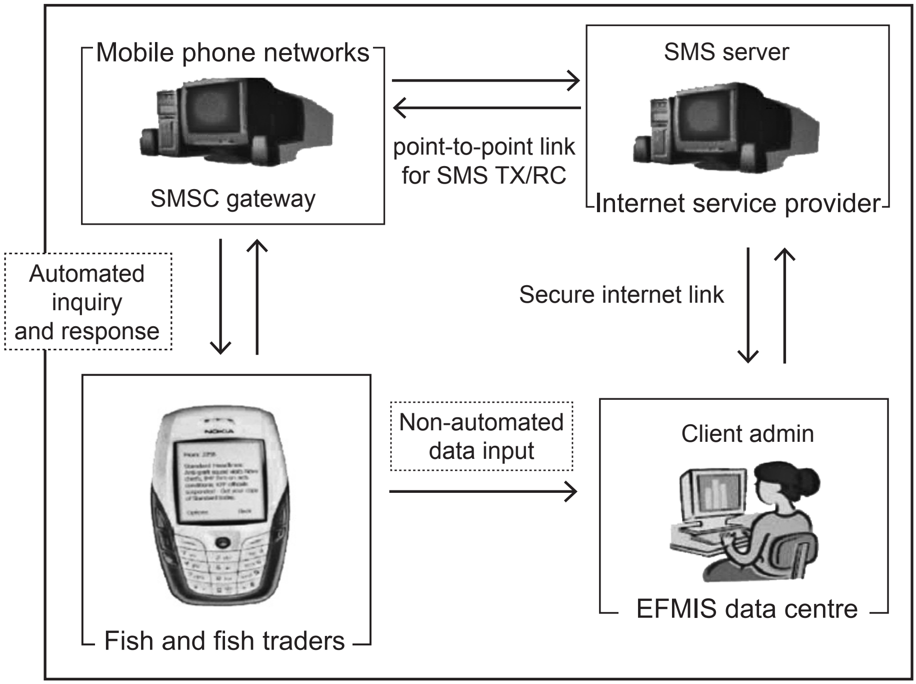

Figure 2 EFMIS system design

Kisumu City. Here it is synthesized and appropriately packaged into a database in a special format that users (mainly fishers, fish traders, cooperatives, and other consumers) can access in real time (daily, by the hour) whenever they need it.

To access the information a user has to send a query by SMS to the data centre from a mobile phone through a dedicated number (short code) and gets an automatic response usually within 10 seconds. The system is active for 24 hours every day and can be accessed from any part of Kenya where there is a mobile phone network. The database is updated daily and a summarized information bulletin containing current fish prices and trends is produced every month. The bulletin is circulated to about 1,000 stakeholders worldwide by internet and sometimes also featured in Kenya's national newspapers. The huge database containing fish market data is also useful for research and development studies.

Data input phase

The data input phase consists of three key stages of data recording, coding, and transmission from landing sites and inland markets to the data centre in Kisumu. This segment is managed entirely by data recorders at the markets and the project

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staff based at the data centre using normal direct phone communication without involving external service providers.

A core principle of EFMIS is that the fisher community supplies data which is then appropriately packaged for use by themselves and everyone else. This dual supplier-user approach ensures that the community owns the process and its outputs, and that the information disseminated is relevant for users. The project therefore depends on fishers to record data at landing sites and fish traders at inland markets. At each of these points two personnel were identified and trained on how to determine weights and prices of fish, record data in a standard format, and code and transmit it to the data centre. Data recorders are not compensated for their services to the project; however they get about $12 of talk time per month for communicating data and were each provided with a low-cost mobile phone at the start.

The database

The data centre at KMFRI in Kisumu is equipped to receive data from the markets and appropriately package it into an active database. Six personnel at KMFRI were trained on data management, including how to retrieve, synthesize, and enter data in the database. The set up of the data centre network consists of a phone connected to a computer, enabling it to display data from markets. Data is then retrieved and transferred manually from the display into a data sheet built on Excel and structured with columns for entering each of the following variables: market, time, date/month, fish species, quantity landed, price, number of trucks, and basic weather.

Data output phase

The data output phase comprises two main components, query and response. This phase is largely automated and managed with support of an external service provider. A special short code was leased from the SMS/internet service provider which is linked to the database through a server and dedicated entirely for use by the project. Queries sent by SMS through the short code are routed to the database. The server has software with the capability to pick out the specified data and automatically respond to the sender with information, usually within 10 seconds. A user querying the system only specifies the name of landing site or market and receives back all the latest information available for that site in terms of: the price of each of the three commercial species, quantity of fish available, number of fish trucks at a landing site, and basic weather (wet or dry). Using this system one can access market information all the time on any day from any part of Kenya where there is a phone network.

An additional information outlet is the electronic *EFMIS market bulletin* produced monthly and distributed via the internet to over 1,000 people across the world. The bulletin presents market trends for the three commercial fish species with simple charts and figures and brief discussion of the prevailing factors.

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Results and impacts of EFMIS

Framework for monitoring and evaluation

The project put in place an elaborate plan for continuous internal monitoring and independent external evaluation. Objectively verifiable indicators (OVIs) for monitoring project progress and impacts were identified through a participatory process involving the fisher community and other stakeholders. At the start of the project a baseline survey was conducted on the key performance variables, which were then regularly monitored and progress reports prepared during project implementation. An independent evaluation of the project was conducted towards the end of the pilot phase by an outsourced consultancy firm. This report presents the results and impacts of the pilot phase.

Performance indicators

The project log frame had the following OVIs for monitoring progress and evaluating impacts:

Progress monitoring OVIs. These indicators were designed to measure achievement of key milestones in project implementation. They included:

- number of fisher organizations and markets participating in the project and providing data on a regular basis;
- database established and fed regularly with market data and information;
- number of inquiries for market information made to the database;
- types and frequency of market data and information disseminated by various media; and
- quarterly and annual reports produced in time.

Impact monitoring OVIs. These indicators were designed to measure the impacts of the projects. They included:

- fish prices at landing sites and inland markets;
- incomes to fishers, fish traders, and processors;
- percentage of post-harvest losses;
- cost of marketing fish;
- quantities of fish landed and sold at landing sites.

Results

The following were the results of the key progress indicators:

Number of fisheries organizations and markets participating in the project and providing data on a regular basis. For the purpose of this OVI, participation was viewed from the aspect of an organization providing data to the EFMIS system. The fisheries organizations participating in the programme comprised beach management units, cooperatives, and fish traders associations who were based at various landing sites or inland fish markets cooperating with the project. In total 165 fish markets participated in

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the project, comprising 150 landing sites and 15 urban-based markets. This was above the target of 150 markets.

Database established and fed regularly with market data and information. The market information database was developed in the first quarter of the project and fully functioned throughout the pilot. Data from the landing sites and inland markets were fed into the system daily and queries received automated response throughout. At the end of pilot, the system was taken over by the up-scaled national project phase in full working order.

Number of queries for market information made to the database. From zero at the beginning, a total of about 20,000 SMS queries for market information were submitted to the database by different users and got feedback. A number of telephone call inquiries were also made to the data centre but the system did not record these; hence actual usage of the system was higher than stated. Besides, this was a drawback as details of the callers were not retained in the database for future reference

Impacts

Despite the increasingly important role of ICTs in rural development, it is difficult to accurately measure their impact on incomes in isolation from other factors such as performance of complementary media, improvement in other infrastructure, better market facilities for inputs and outputs, and increase in demand, among others (Kantiza, 2012). Nontheless there is much literature on how ICTs benefit rural people, including: increased choices of input suppliers and commodity markets, improved bargaining position, reduced post-harvest wastage, enhanced commodity prices, and increased producer incomes. Producers also benefit from reduced transaction cost, lower cost of transportation, provision of accessible platform for service delivery, and reduced cost of information (World Bank, 2011; Grahame and Jayaraman, 2011). In Asia ICT has produced quantifiable impacts, such as improved yields and incomes, as well as non-quantifiable gains in terms of improved communication, education, and health (Mittal, 2011). Furthermore, positive gains from ICT are more significant in areas and commodities where information asymmetry was initially very high or markets were not well developed.

In analysing impacts of EFMIS, the link between market information and project impacts is built on a number of assumptions. With information beforehand (on prices, fish quantities, and number of fish buyers at various markets), the beneficiaries (fishers, fish traders, and cooperatives) will make informed decisions on the most cost-effective markets and avoid unnecessary transport costs. In the same manner, knowledge of comparative fish prices at different landing sites and inland markets will allow fishers to bargain for higher prices. Middlemen will not easily fix false prices if all players know the true market status.

By having information on the number of buyers and cold storage trucks at a landing site, fishers will avoid taking fish where it is likely to remain unsold and be spoilt. Bargaining time (before fish is stored in ice) will be reduced if fishermen have information on comparative prices in other landing sites. Weather information will

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enable fishers to make decisions avoiding inaccessible landing sites. The impact OVI targets and end-project status are as follows:

Fish prices at landing sites and inland markets. The target set for this OVI was that the project would contribute to increased fish prices by 30 per cent at the end of the project. There was a sustained increase in average fish prices in markets covered by the project. In the 21 months of the pilot phase, the price of Nile perch rose by 25 per cent, tilapia by 91 per cent and dagaa by 137 per cent. However all the changes cannot be attributed to EFMIS alone as other external factors might have also contributed to this significant increase in fish prices.

Incomes to fishers and fish traders. The target for this OVI was to contribute to increased incomes of fishers and fish traders by 30 per cent at the end of the project. The gross income to fishers and fish traders is a factor of price and quantity of fish available for sale. Complete assessment of this impact has not been undertaken; however, the above significant price changes should have a strong positive influence on incomes.

Post-harvest losses. The target for this OVI was to bring the post-harvest fish losses down by 40 per cent at the end of the project. A baseline survey conducted at the beginning of the project put the level of post-harvest losses for Nile perch at about 5 per cent on the landing sites. Although the post-harvest situation at the end of the project has not been determined, an assessment conducted in June–November 2010 on some of the landing sites reported post-harvest losses at about 4.5 per cent (Abila and Werimo, 2010).

Sustainability issues

Application of ICT in rural development has largely expanded with the increased pervasiveness of telecommunication networks. These have ensured speedy, reliable, and accurate information exchange through text, voice, and other applications between farmers, input suppliers, buyers of their products, and other stakeholders (Rudgard et al., 2011). The World Bank (2011) attributes the phenomenal growth of ICT for agriculture in developing countries to five main drivers, namely: their low-cost and pervasive connectivity; they are increasingly adaptable and more affordable tools; advances made in data storage and exchange; innovative business models and partnerships taking advantage of ICTs; and the democratization of information, including the open access movement and social media. These factors will undoubtedly continue to shape prospects for using ICT effectively in agriculture in the developing world. Rudgard et al. (2011) point out that for ICTs to make major impacts in the agricultural sector, policy change and collective action (among research institutions, extension agents, governments, and farmers) will be critical.

The success of ICT depends on the availability of supportive infrastructure such as electricity and reliable telecommunication networks, transportation facilities and financial services, among others. The mobile phone alone may not achieve the desired impacts unless there is additional investment in facilities such as roads, market outlets, and readily available sources of agro-inputs. Kenya's fisheries sector

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is relatively well placed in terms of these factors, thus creating ideal supportive conditions for EFMIS to operate. However, the system may only be sustainable if the costs of data collection, packaging, and transmission are maintained at a level that is manageable.

Financial sustainability would mean that EFMIS is able to generate adequate revenue from the services offered to cover its costs. However, the project serves a sector dominated by a relatively poor and disadvantaged population who cannot afford to fully pay for information services. Inevitably EFMIS has a large public good component that justifies external support presently but in the long term it should be supported through public–private partnership. This means that the project has to operate cost-effectively and its capacity has to be enhanced to generate revenue from its users. Sustainability of the project has therefore been analysed on the basis of cost-effectiveness of implementation and its capacity to generate revenue.

Cost-effectiveness of project implementation

The budget which had been committed for running the pilot project in one year was extended for another year. This was attained by greater involvement of fisher communities providing information on a voluntary basis. Analysis of expenditure shows that 34.2 per cent of the budget was spent on talk time credit, 14.6 per cent was for holding consultative meetings with stakeholders, while 10.7 per cent was spent on installation and maintenance of the short-code leased for the 24-hour automatic response system. The next highest cost, at 10.1 per cent, was on purchase of equipment, including mobile phones for the fisher organizations participating in the project. Travel by project staff to various landing sites and markets for identification and training of data collectors took 7.8 per cent. The remaining significant costs were for collection and storage of market data, which took care of database operations, and internal and external monitoring and evaluation (7.4 per cent). The rest of the costs were less than 5 per cent of the overall costs and did not have a significant bearing on overall project expenditure.

Sustainability of the system

A key issue is the potential of the system to sustain itself beyond donor support. The expenditure structure outlined above demonstrates that much of the costs went towards establishing the system, including personnel mobilization and capital equipment, while the operational costs took less than half the budget. For sustainability, effort should be made to reduce further the operational costs and raise revenue from information services.

The potential for the system to raise revenue was investigated during the pilot by charging users a small premium price above the cost of SMS sent to the data centre. A mechanism was put in place to automatically charge a user fee for the SMS query. Based on 20,000 SMS queries, the project raised a total of about $2,500 in revenue, which was shared out in a structured way (Table 1). The revenue base is directly related to the number of queries; therefore greater use of the service would ultimately enhance revenue.

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Table 1 Revenue from SMS charges

	Revenue structure	
(a)	No. of SMS	25,000
(b)	Cost of SMS (Ksh)	0.125[1]
(c)	Total generated by project SMS [(a)*(b)]	2500
(d)	Cost to mobile phone companies and government tax @ 60.3 per cent of (c)	1508
(e)	Balance after tax	993
(e)	Payment for code lease and database maintenance services @ 50% of (d)	496
(f)	Revenue available for project activities @ 50% of (d)	496

1 Ksh1 = US$0.01

With greater sensitization and incorporation of additional information packages, the number of users and resulting revenue can substantially increase. However, it is unlikely that this source alone would suffice to sustain the system in the short term. Besides user fees, it would be necessary that the fisher organizations play a bigger role, for instance by meeting part of the talk time costs. There is also potential to incorporate other private sector business ideas, for example, mobile money transfer services and commercial adverts targeting the fisher community as way of raising revenue. Kenya has well-developed mobile phone money transfer services operated by different phone networks which have created new opportunities for small businesses as money agents (Donovan, 2011). There are good prospects for fisher communities to establish these agencies at the landing sites to complement their incomes and improve their capacity to pay for EFMIS services. In consideration of the project's public good functions, it may be necessary to negotiate with the authorities for tax exemption on equipment and usage.

Implementation challenges

Development of ICTs in rural areas faces important challenges. Telecommunication networks and electricity are not well provided in such areas as they are in urban areas; consequently ownership and use of mobile phones is much less among rural populations. Furthermore some applications will not work for rural populations because of infrastructure, connectivity, accessibility, or affordability (Rudgard et al., 2011).

Other bottlenecks include the relatively high costs of handsets, limited capacities of rural people to use mobile devices beyond standard voice and SMS, and the functional limitations of the basic handsets/software available in developing countries. Where the basic infrastructure is not well developed and/or users are few and scattered, the costs of delivering information through ICT might be prohibitive. Besides, packaging information for SMS or radio dissemination requires expertise and time so that it comes out in a format that can easily be understood by the farmers to ensure that information is not distorted and is carefully targeted to their needs (Rudgard et al., 2011).

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Socio-economic and cultural factors can also have a significant effect on access to and use of ICTs (Manfre, 2011). This is not only determined by the availability of the physical infrastructure but also socio-economic factors such as knowledge and skills, which are often mediated by gender, class, and race (Manfre, 2011). Rural women are disadvantaged in terms of access, ownership, use, application, and control of ICTs compared with men because of low literacy, income levels, and heavier work load in the village. Greater consideration of socio-economic and cultural factors during planning and project implementation will enable women to benefit directly from ICT, through greater access to information and services, or indirectly, by improving the efficiency and transparency of systems already in place.

Many times traders, rather than producers, are the main beneficiaries from ICT-driven improvement in logistics and reduction of transaction costs (Grahame and Jayaraman, 2011). Furthermore there are important challenges on how these innovations can be replicated, up-scaled and made to work for diverse populations in a sustainable manner (World Bank, 2011). Most of these general challenges also apply to the fisheries sector in Kenya and affect EFMIS. However, there have been a number of internal specific challenges facing project operations.

First, despite the service being available and functional it has not been fully utilized. This could be due to inadequate sensitization or the user charge built into the system that fishers could not regularly pay for.

Second, the project could not expand at a faster rate than wanted by some stakeholders due to limitations of resources. The project had planned and budgeted to start with 20 markets and gradually increase by adding a similar number per month until reaching the target of 150. However, more markets and fisher organizations wanted to participate in the project sooner than was planned and budgeted for, thus straining the resources.

- Meeting the high expectations of the different stakeholders for market information has been an important challenge. Various stakeholders (fish farmers, traders, fish processors, and consumers) have diverse information needs sometimes beyond what the project could provide. To address this issue a second package was attempted which allowed fishers to use the mobile phone to find out the availability and cost of fishing nets and other gear in different shops. This, however, has not been fully developed.
- Lack of cooperation by some stakeholders, particularly the fish processing and exporting industry, has been another challenge. Most fishers are keen to find out factory gate fish prices paid to middlemen; however factory owners have been reluctant to declare this information publicly since they regard it as their ‘business secret’. It has been equally difficult to get consistent information on wholesale/retail prices in the export markets, which is of great interest to the fishing community.
- Finally, lack of proper standardization on fish quality and pricing units is an important constraint; for example, fish prices may be reported as low because of poor quality rather than unfavourable market conditions.

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Conclusion and recommendation

Modern ICT has great potential for improving fish trade and incomes in the sector. This is demonstrated by the EFMIS project which has improved the level of transparency in the fisheries industry by enhancing access to up-to-date market information for the fisher community. The project has managed to disseminate market information to various users using modern technology, particularly the mobile phone SMS service and internet bulletins. There is good indication that EFMIS has made a contribution to improved fish prices and incomes for the fisher community and, potentially, a reduction in marketing costs and post-harvest losses. The successful implementation and positive results of the project has attracted a lot of interest and there are opportunities to replicate its design and software systems for other fisheries in the region.

This system is relevant as it uses the mobile phone, which is the fastest growing media for communication and therefore in line with the current development trend. Despite the outlined challenges in setting up and operating the system, it is a valuable tool for enhancing competitiveness of trade in small-scale fisheries in developing countries where access to information is a big constraint. This model can be adapted appropriately for application in other small-scale fisheries, paying attention to the lessons learnt from this pilot. The establishment of the system, however, needs to take into account the level of ICT skills available and put in place mechanisms for sustainability.

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