E-MANDI

ICT as a tool to empower Indian farmer by improving market access

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1.0 Introduction

Agriculture today is facing a range of modern and more complex challenges, particularly in developing countries like India. Exposed to price shocks, climate change, and continued deficiencies in infrasture in rural areas, there is need of information accessibility to the smallholder farmers with limited monetary & social cushions. With improving reach and better affordability of modern day communication technologies, many of these challenges can be effectively addressed.

In this report we propose for a mobile/tablet based virtual marketplace named E-Mandi developed to provide real time and accurate information on crop demand and prices, directly to the farmer and thus helping him make an informed judgement on strategy and marketability. The proposed platform can parallely be use for building online farmer communities to exchange knowledge & also access credit.

1.1 Understanding the context for employing ICT services in Agriculture:

1.1.1 Agriculture & pro-poor livelihoods

· Under-nourishment and hunger remain the biggest risks to health today, greater than malaria, HIV-AIDS and tuberculosis combined. Rising food prices have pushed over 40 million people into poverty since 2010, more effective interventions are essential in agriculture (World Bank 2011). Agriculture accounts for the vast majority of the poor's livelihood activities, it is also the sector that holds the most promise for pro-poor economic growth. In fact, agriculture is around four times more effective at raising incomes among the poor than other sectors (World Bank 2008).

1.1.2 Wastages & Agriculture inefficiencies

The world is still reeling under the combined impact of the recent rise in food grain prices, commodity speculation and the havoc from extreme weather patterns. One-third of the food produced annually for human consumption is wasted in a world where 870 million, or one in eight people, go hungry every day as per United Nations Food and Agriculture Organisation report. As much as 1,94,502 metric tonnes of food grain worth crores of rupees was wasted in India due to various reasons between 2005 and March 2013.The Food Corporation of India (FCI) has given this information in reply to an Right to Information (RTI) query sought by a Delhi based activist Om Prakash Sharma[1] recently.

1.1.3 Increasing demand of agricultural produce:

The growing global population, expected to hit 9 billion by 2050, has heightened the demand for food and placed pressure on already-fragile resources. Feeding that population will require a 70 percent increase in food production (FAO 2009). High volume of food wastage that occurs right through the food supply chain exerts an adverse impact on land,water, biodiversity and climate change. Food that is produced, but not eaten, occupies close to 30% of the world's agricultural land, says the report. Such an extremely unproductive use of land is hard even to contemplate given the current scramble for fertile and wetlands in Africa and parts of Asia. Clearly, the judicious use of available food ought to be a critical global priority.

1.1.4 The Indian agrarian crisis

Agriculture in India is often attributed as gambling with monsoons because of its almost exclusive dependence on precipitation from monsoons. The failure of these monsoons can lead to a series of droughts, lack of better prices, and exploitation of the farmers by middlemen, all of which have led to a series of suicides committed by farmers across India.More than 17,500 farmers a year killed themselves between 2002 and 2006, according to experts who have analyzed government statistics.[2]

1.2 Information & Communication Technologies for solving agriculture challenges

Information and knowledge is the basis of the entire crop production process, right from crop selection,planting strategy, buying good seeds and fertilizers and fetching correct market price for the produce. Everything depends on the availability of information. The challenge actually lies in conveying the most updated, & localised information to each producer / farmer.

The benefits of the green revolution greatly improved agricultural productivity. However, there is a demonstrable need for a new revolution that will bring lower prices for consumers (through reduced waste and more-efficient supply chain management), contribute to "smart" agriculture, and incentivize farmers (for example, through higher income) to increase their production.

1.2.1 Drivers of ICT in Agriculture

ICT is increasingly finding foothold even in poor smallholder farms and in their activities. Following five main trends have been the key drivers of the use of ICT in agriculture, particularly for poor producers:

(1) Low-Cost And Pervasive Connectivity:The pervasiveness of connectivity—to mobile phones, Internet, and other wireless devices—is due to a number of factors, including decreases in costs, increases in competition, and expansion of last-mile infrastructure. Several trends, working in tandem, are making ICT devices and services more affordable in ways that also extend access to small-scale producers

(2) Adaptable And More Affordable Tools: The proliferation of adaptable and more affordable technologies and devices has also increased ICT's relevance to smallholder agriculture. Innovation has steadily reduced the purchase price of phones, laptops, scientific instruments, and specialized software. The intuitive design of many technologies and their capacity to convey information visually or audibly make them useful to people with limited formal education or exposure to technology.

(3) Advances in data storage and exchange: Greatly increased data storage capacity and the ability to access data remotely and share it easily have improved the use of ICT in agriculture. Sharing knowledge and exchanging data have created opportunities to involve more stakeholders in agricultural research—involvement facilitated by a

(4) Innovative business models and partnerships, : Unlike other development strategies, which often struggle to survive or be scaled because the public sector cannot fund them, development strategies featuring ICTs have benefited from growing private sector interest and public demand

(5) The democratization of information, including the open access movement and social media: Vast quantities of information held by institutions and individuals are becoming visible, publicly accessible, and reusable through the open access movement.The expansion of open access software also enables grassroots community organizations to share knowledge with one another. Social media, once used purely for entertainment, has great potential to be used for knowledge sharing and collaboration even in agriculture.

1.2.2 Opportunities of using ICT in different segments of ICT value chain:
What is ICT ? - ICT is any device, tool, or application that permits the exchange or collection of data through interaction or transmission. ICT is an umbrella term that includes anything ranging from radio to satellite imagery to mobile phones or electronic money transfers.

Goal-Based Typology of Mobile Agriculture Services

GOAL	METHOD
Education and Awareness	Information provided via mobile phones to farmers and extension agents about best practices, crop varieties and pest management.
Commodity Prices and Market Information	Prices in regional markets to inform decision making throughout entire agricultural process.
Data Collection	Applications that collect data from large geographic regions.
Pest and Disease Outbreak Warning	Send and receive data/warnings on outbreaks.

Source: Hellström, 2010

Figure 1: Mobile Agriculture Services

Source: Mobile Agriculture, Jaime Loucky, 2012

ICT is increasingly gaining traction even in impoverished regions.The increase in affordability, accessibility, and adaptability have resulted in their use even within rural homesteads relying on agriculture. New, small devices (such as multifunctional mobile phones and nanotechnology for food safety), infrastructure (such as mobile telecommunications networks and cloud computing
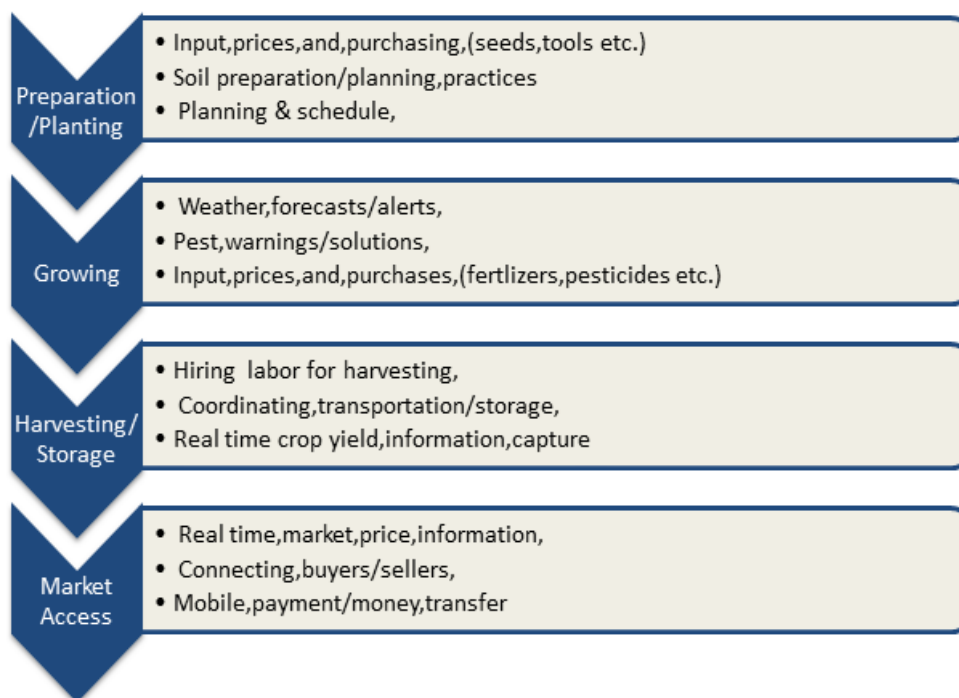
Preparation /Planting
- Input,prices,and,purchasing,(seeds,tools etc.)
- Soil preparation/planning,practices
- Planning & schedule,

Growing
- Weather,forecasts/alerts,
- Pest,warnings/solutions,
- Input,prices,and,purchases,(fertilizers,pesticides etc.)

Harvesting/ Storage
- Hiring labor for harvesting,
- Coordinating,transportation/storage,
- Real time crop yield,information,capture

Market Access
- Real time,market,price,information,
- Connecting,buyers/sellers,
- Mobile,payment/money,transfer

Figure 2: Opportunities of ICT interventions across agriculture value chain

facilities), and especially applications (for example, that transfer money or track an item moving through a global supply chain) have proliferated. **Figure 1, 2 and 3** show different goals of application of ICT in agriculture and methodologies to be adopted in order to achieve them.
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	ACCESS	PRODUCTIVITY	MARKETS	INSTITUTIONS
	Innovations to improve the technology access	**Innovations to improve on-farm productivity**	**Improving market access and value chain through ICT**	**Innovative ways to strengthen public service mechanisms**
THEMES	✓ ACCESS & AFFORDABILITY ✓ MOBILE APPLICATIONS	✓ INCREASED PRODUCTION ✓ AGRI- INFORMATION SYSTEM ✓ FARMERS ORGANISATION	✓ Markets & price information ✓ RURAL FINANCE ✓ Supply chain management ✓ Risk management ✓ Tracebikity & food safety	✓ Rural governance ✓ Land administration ✓ Forest governance
Examples	✓ PUBLIC INNOVATIONS IN UNIVERSAL ACCESS TO TELECOMMUNICATIONS. ✓ DELIVERING CONTENT FOR MOBILE AGRICULTURAL SERVICES	✓ WEATHER FORECASTING REDUCES AGRICULTURAL RISK IN TURKEY ✓ ICTs HELP TO CHARACTERIZE FIELD CONDITIONS, SOMETIMES AT A VERY FINE LEVEL OF DETAIL, AND HELP FARMERS IMPROVE SOIL AND LAND PRODUCTIVITY. ✓ PREVENTING YIELD LOSSES THROUGH PROPER PLANNING AND EARLY WARNING SYSTEMS. ✓ WEB-BASED GIS FOR PRECISION FARMING, ✓ WSN CAN HELP MONITOR THE QUALITY OF PASTURES ✓ FARMER NETWORKS AND KNOWLEDGE SHARING	✓ THE USE OF ICT-ENABLED FINANCIAL SERVICES IN THE RURAL SECTOR ✓ VIRTUAL AGRICULTURAL MARKETPLACE. ✓ MOBILE MONEY MOVES TO RURAL AREAS ✓ SUPPLY-CHAIN MANAGEMENT (SCM) SOFTWARE RUNNING ON NETWORKED COMPUTERS AND HANDHELD DEVICES	✓ BUILDING PUBLIC SERVICE PROVISION THROUGH INTERNET APPLICATIONS ✓ USING BIOMETRICS TO PROVIDE RURAL SERVICES ✓ COLLECTING DATA TO PROTECT LOCAL KNOWLEDGE AND ECOSYSTEMS ✓ ICT FOR LAND ADMINISTRATION AND MANAGEMENT

Figure 3: Application of ICT in agriculture

2.0 Solution

As mentioned earlier, E-Mandi uses ICT to empower farmers in 2 ways:
a. Improving productivity
b. Improving market access and value chain

We will now discuss how E-Mandi achieves these two goals.

Figure 4 gives an overview of the E-Mandi platform. It provides three services to farmers:

1) Virtual Marketplace

E-Mandi provides a virtual marketplace for farmers. First, an account is created on the E-Mandi servers for every farmer. After the creation of an online profile, farmers are entitled to use the three services of E-Mandi. The virtual marketplace is analogous to a farmer's market. It allows farmers to showcase their harvest to all the potential buyers (Section 2.1) and farmers registered on the E-Mandi network. In a similar way, buyers can post their requirements on the marketplace. Virtual market brings both the demand (potential buyers) and supply (farmers) close to each other. The knowledge of demand, market price and opportunities to interact with other farmers and companies enables farmers to market their crops effectively. For instance, if the farmer observes that a company is ready to pay $5/kg for rice to another seller, he can decrease his price marginally to sell his produce.

Benefits:
a. Creating online identities for digitally anonymous farmers
b. Associating these profiles with services which directly impact their occupation (Agriculture)
c. Narrowing the gap between buyers and sellers
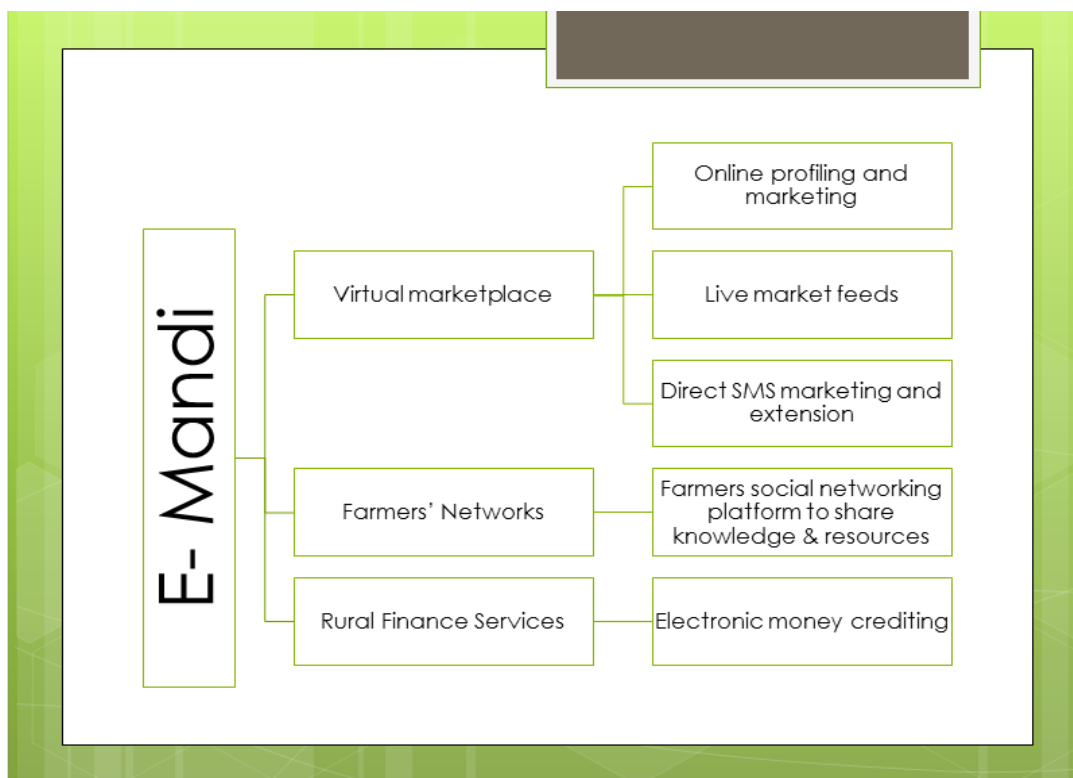d. Knowledge and awareness for effective marketing

Figure 4: Overview of E-MANDI services

2) Farmer Networks

E-Mandi allows farmers to interact with each other. The primary aim of Farmer Networks is to increase communication and information sharing among farmers. One major outcome of this functionality would be collaborative farming wherein farmers would be aware of various crops being harvested across the nation. They can collaborate to harvest specific crops that sell at a better price when sold together or crops which sell better in bulk.

Benefits:
a. Exchange of knowledge and information
b. Collaborative farming and marketing and other such marketing strategies

3) Finance services

One of the services offered by E-Mandi is an integrated payment gateway. Integration of such a service makes monetary transactions transparent. Also, since business is done directly with the buyers, margins lost with middlemen are significantly reduced. Further, integration of financial services within the E-Mandi framework allows farmers to take loans on their quarterly anticipated produce (QAP) (Section 2.1.1) since they seldom own any assets which can be leveraged otherwise.

Benefits:
a. Direct payment (Without the intrusion of Middlemen)
b. Insurance and Loans through E-Mandi contracts

2.1 Detailed Solution with Interface Design

E-MANDI enables farmers to sell and market their agricultural produce on a virtual market place. It also enables potential buyers to keep track of the current stock of a crop and its anticipated harvest at various locations in the country. In this section we will discuss the interface design and functionality for both the *Seller's Account* as well as the *Buyer's Account*. In the following subsections we will discuss each of the two accounts separately.

E-MANDI provides 2 types of accounts:
(a) Seller's Account
(b) Buyer's Account

The Seller and the Buyer accounts differ in that both have different functionalities which will be discussed separately in the later subsections. **Figure 5** shows high level view of E-MANDI components. E-Mandi servers would run two different web services. The seller web service (Figure 5) would allow farmers fetch news feed data (Section 2.1.1), maintain their account and inventory (Section 2.1.1), access Farmer Networks (Section 4.0) and use the marketplace (Section 2.1.1) to sell their harvest. The buyer web service (Figure 5) would allow companies to search for availability of crops (Section 2.1.2), their location, quantity and post requirements on the marketplace (Section 2.1.2). All the information consumed by these web service is stored on the E-Mandi database (Figure 5).
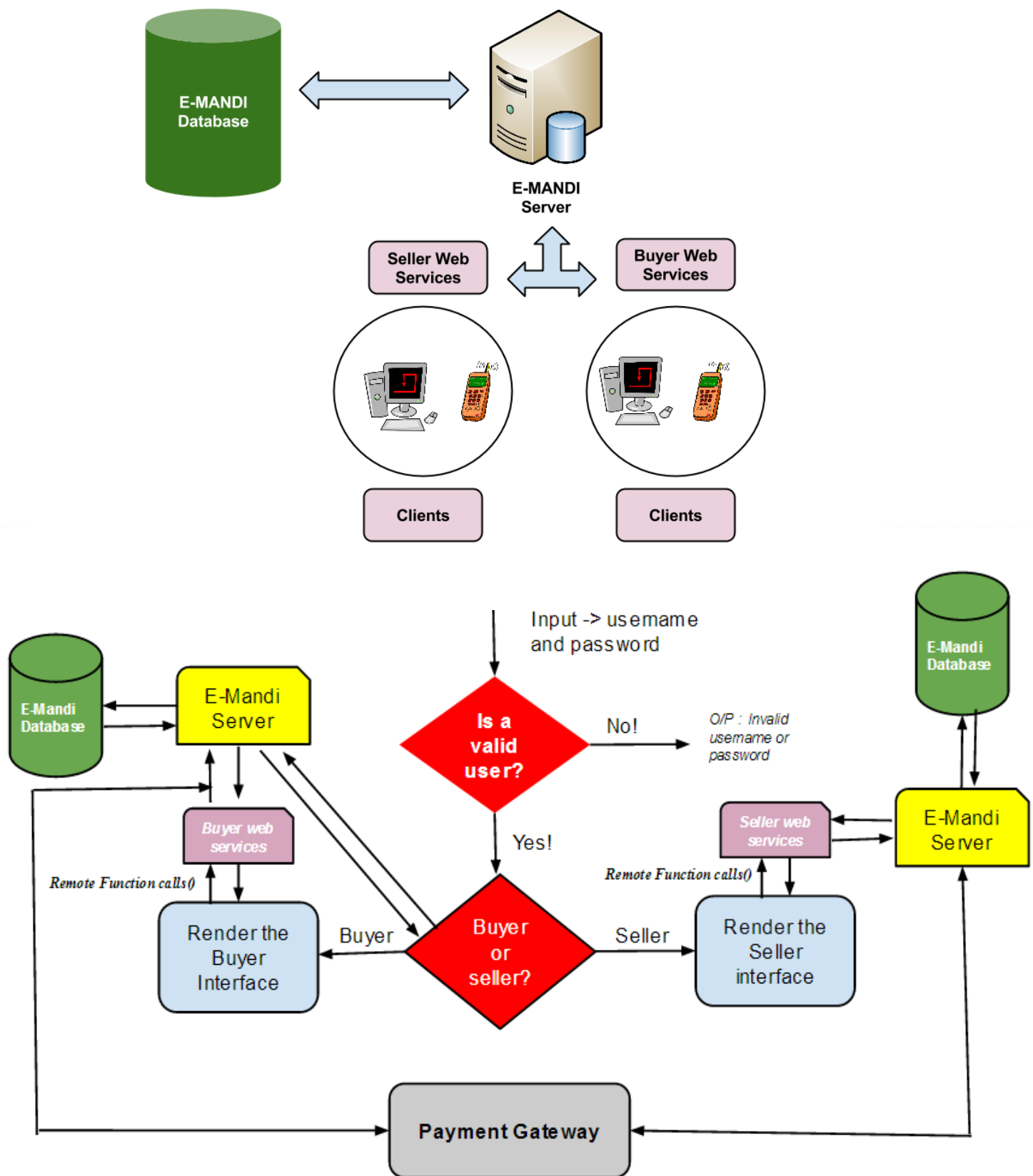
Figure 5: High Level view of E-MANDI

In the following subsections we will discuss each of the two accounts separately along with their interface, component level view, database view and functionalities.

2.1.1 The Seller Account

The Seller UI consists of the following screens:

1. Login screen
2. My Account
3. Mandi
4. Messages
5. Inventory
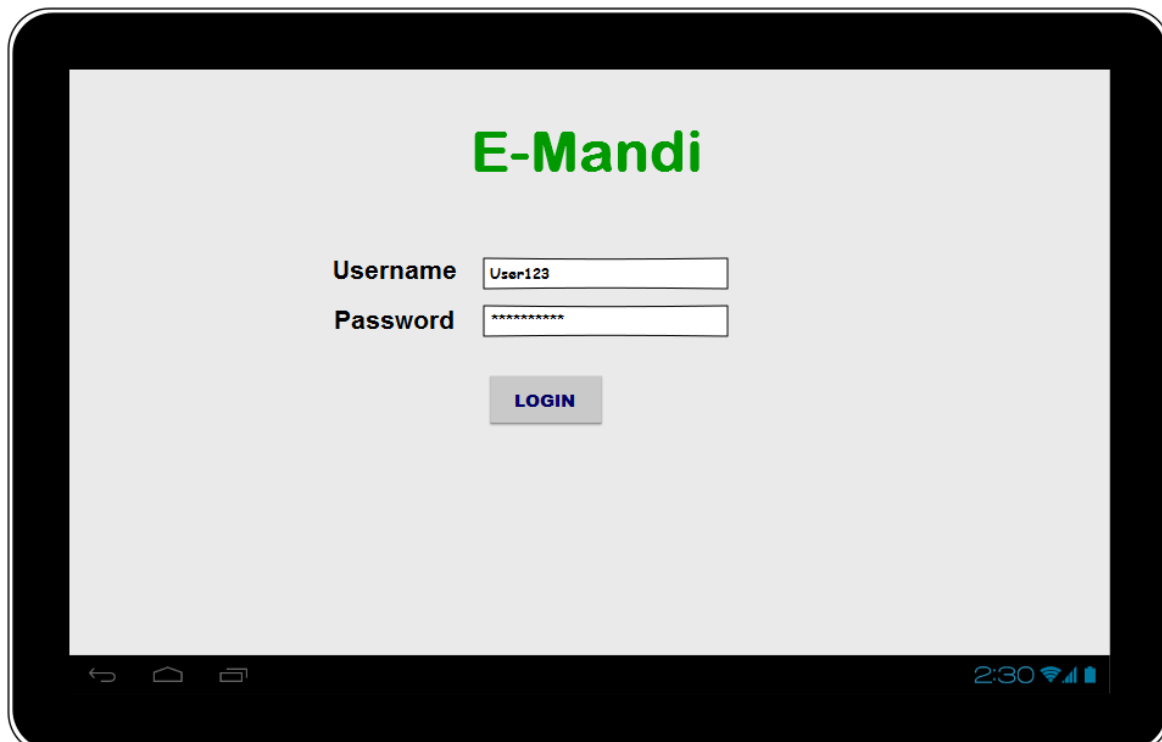6. QAP (Quarterly Anticipated Produce)

Figure 6 : The Login Screen

A. The Login Screen

The login screen is a common screen for both the seller and the buyer interface. In this report we will describe all the interfaces using a Tablet client. In section 3.0 we will discuss why Tablets are a smart choice for mass distribution. The login screen acts as the front door to the E-Mandi servers. It allows all the registered users to sign into their accounts and access the E-Mandi services. **Figure 6** shows the E-Mandi login page for a Tablet. It has 2 input fields namely the "Username" (text field) and "Password" (password type). Upon clicking the "Login" button, the user is verified with the E-Mandi database and directed to his home page.

B. The Home Page

The Home Page is the default page the user sees after successfully logging in. **Figure 7** shows a typical home page. The home screen is divided into three parts: The left hand side of the Tablet UI of E-MAndi has a sidebar which is used to navigate to other screens (Section 2.1.1). The top most part of the UI consists of a picture of the user along with E-Mandi display name. The profile picture and the name is the public identity of the user.The third part of the Home Page is the news feed section orthogonally placed between the sidebar and the page header.
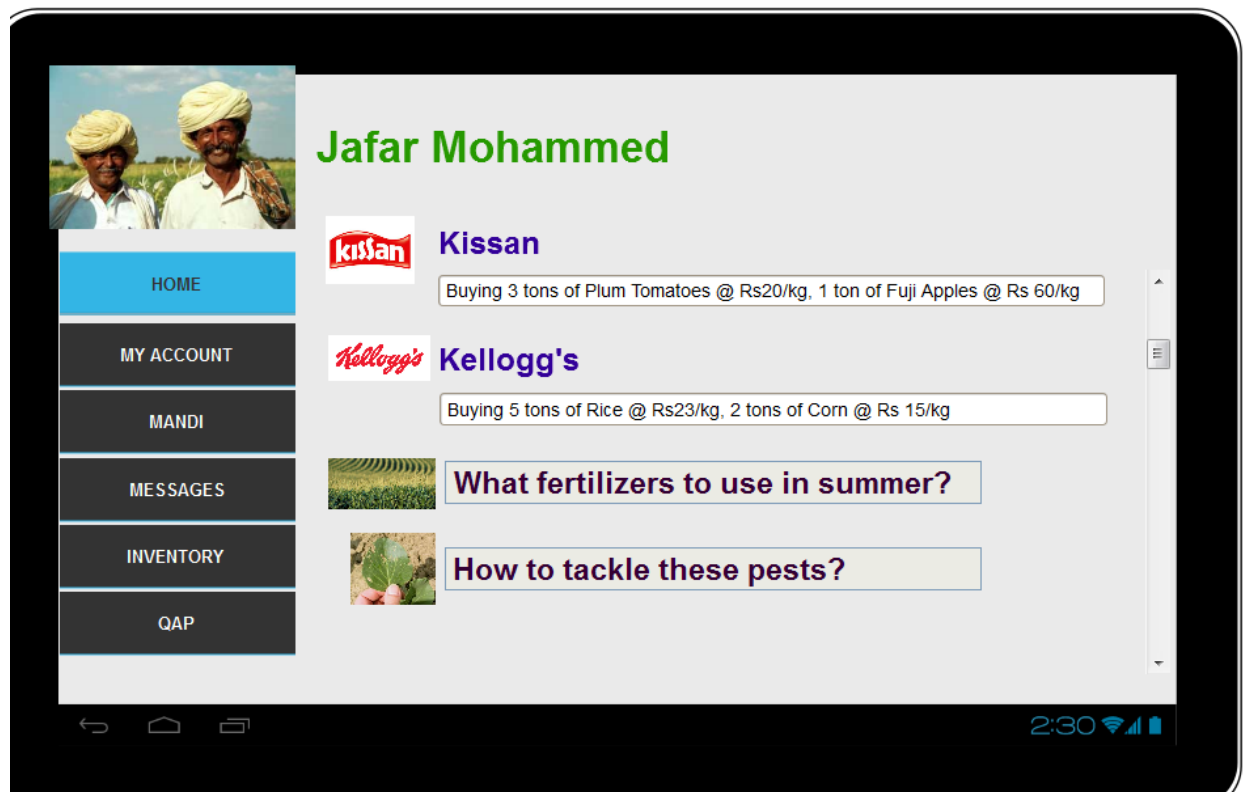
Figure 7 : Home Page

The news feed displays three things:

(1) Information articles
These articles will provide valuable information to the farmers related to agriculture and government policies. This serves one of the main goals of E-Mandi i.e. increasing awareness in rural areas.

(2) Latest requirements posted by a company
Farmers will be kept abreast of incoming demands from buyer's account. Having up to date knowledge about requirements will enable the farmer to make better decisions regarding what crops to harvest and at what price to sell. This information can also be accessed on the MANDI interface.

(3) Latest completed transactions and stock updates
The news feed will also display the posts showing recently completed transactions and any new item which has been added to the marketplace sorted by date and time of publishing. This information can also be accessed via MANDI interface.

C. MY ACCOUNT
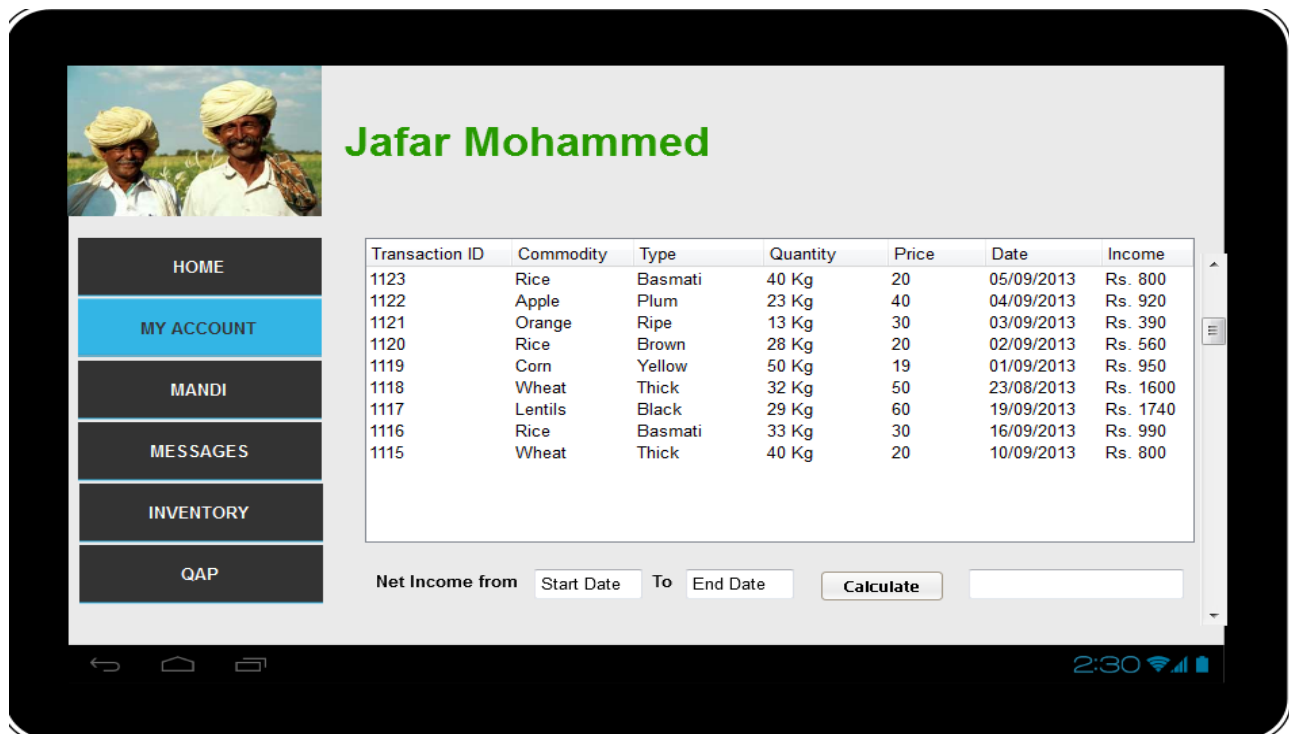
Figure 8 : MY ACCOUNT

The My Account feature allows farmers to keep track of their previous transactions all at one place. **Figure 8** shows the My Account interface. The table displays attributes such as the transaction ID, commodity name and type, quantity sold, selling price, transaction date and the net income from the transaction.The transaction ID uniquely identifies each transaction on the E-Mandi network. For instance, consider **Figure 9** which shows the Mandi interface. We observe that both the transactions listed have a unique transaction ID associated with them. User can click this ID to get the detailed information about that particular transaction.

D. MANDI

"Mandi" is the Hindi word for farmers' market. This serves as the virtual marketplace as discussed in Section 2.0. The Mandi interface has 2 functionalities. First, it provides a search option wherein the user can search crops for sale, available quantities and advertisements/demands posted by the buyer's account. The Mandi interface fetches its data from the E-Mandi database (Figure 5).
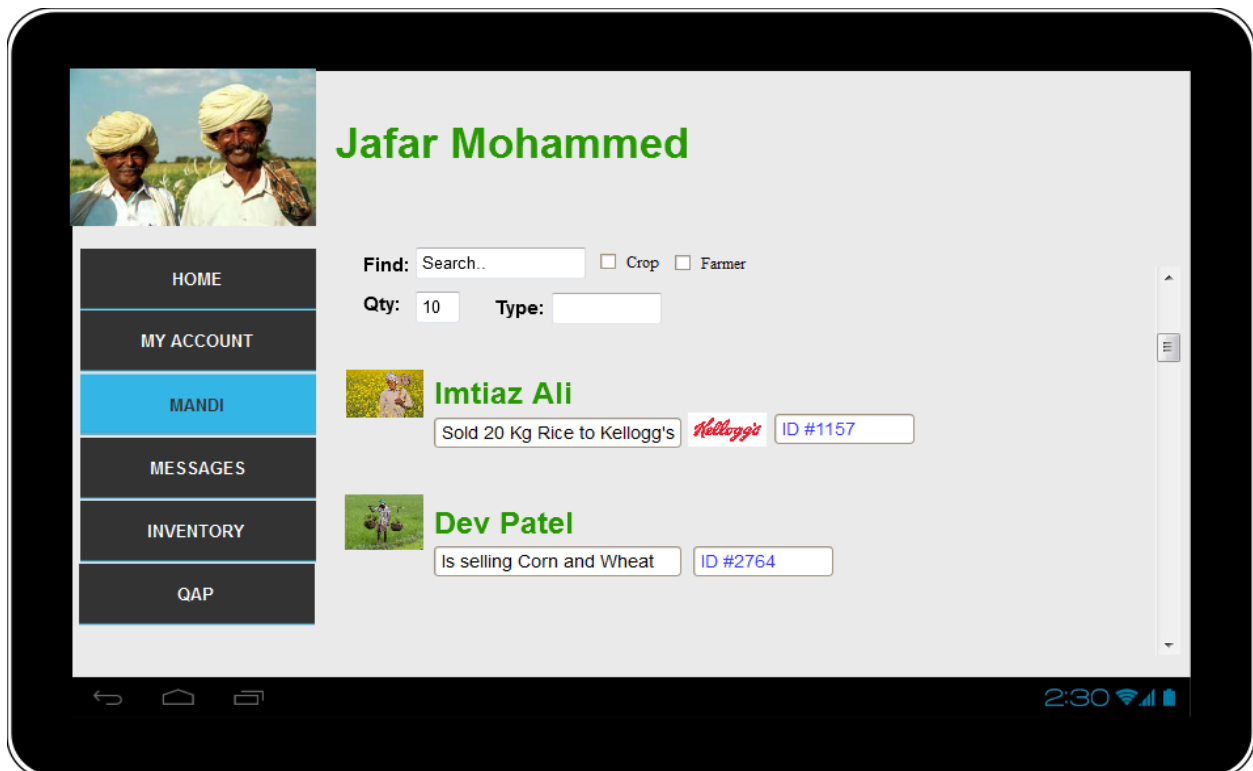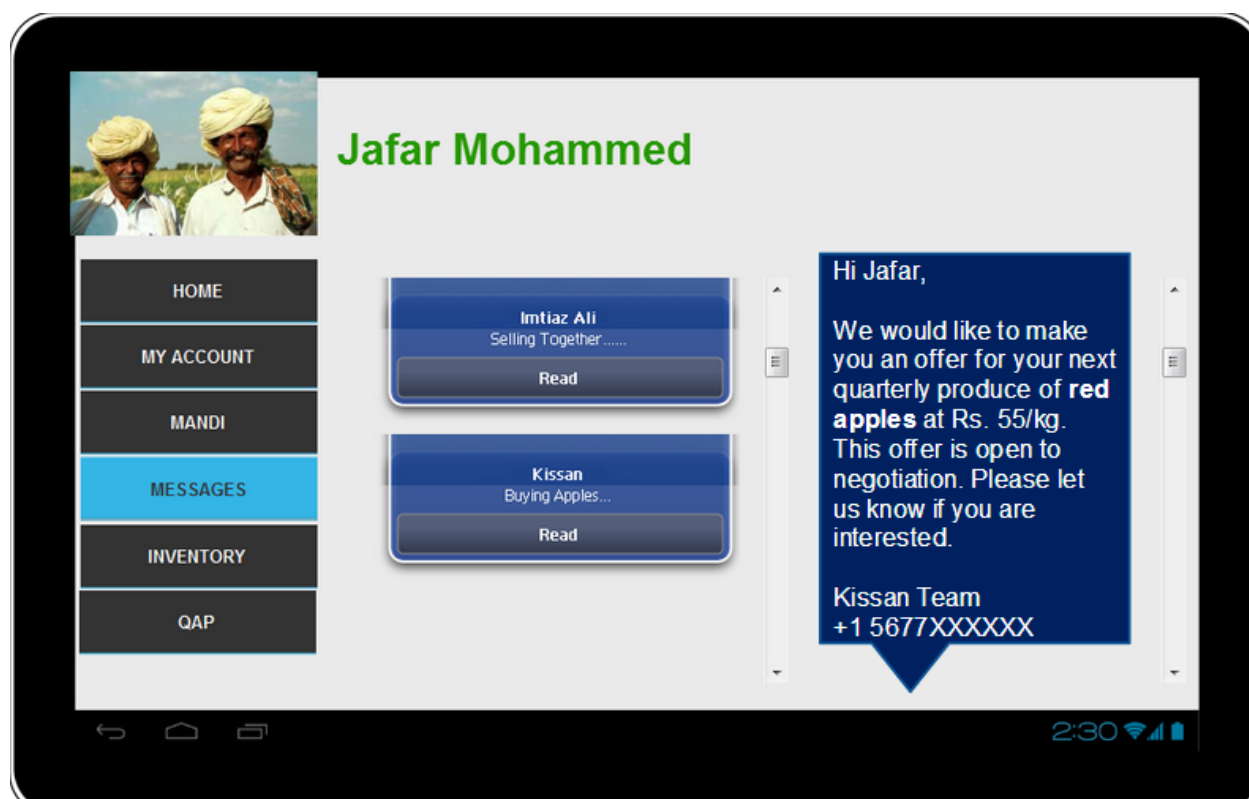

Figure 9 : MANDI

Figure 10: MESSAGES

E. Messages

Farmers can use messages to communicate with other farmers and with buyers. **Figure 10** shows the message interface. Once a buyer is interested in making a deal, he can message the seller to discuss the future course of action.

F. Inventory

The Inventory is like a digital store room for users. Farmers can add resources to their inventory list. **Figure 11** shows the inventory list. Every commodity on E-Mandi has a commodity ID associated with it. This commodity ID will act like a HashTag in that all information related a commodity will be accessible through this ID). User can add new commodities and update existing commodities. Each commodity can be directly put up for sale using the sell button.
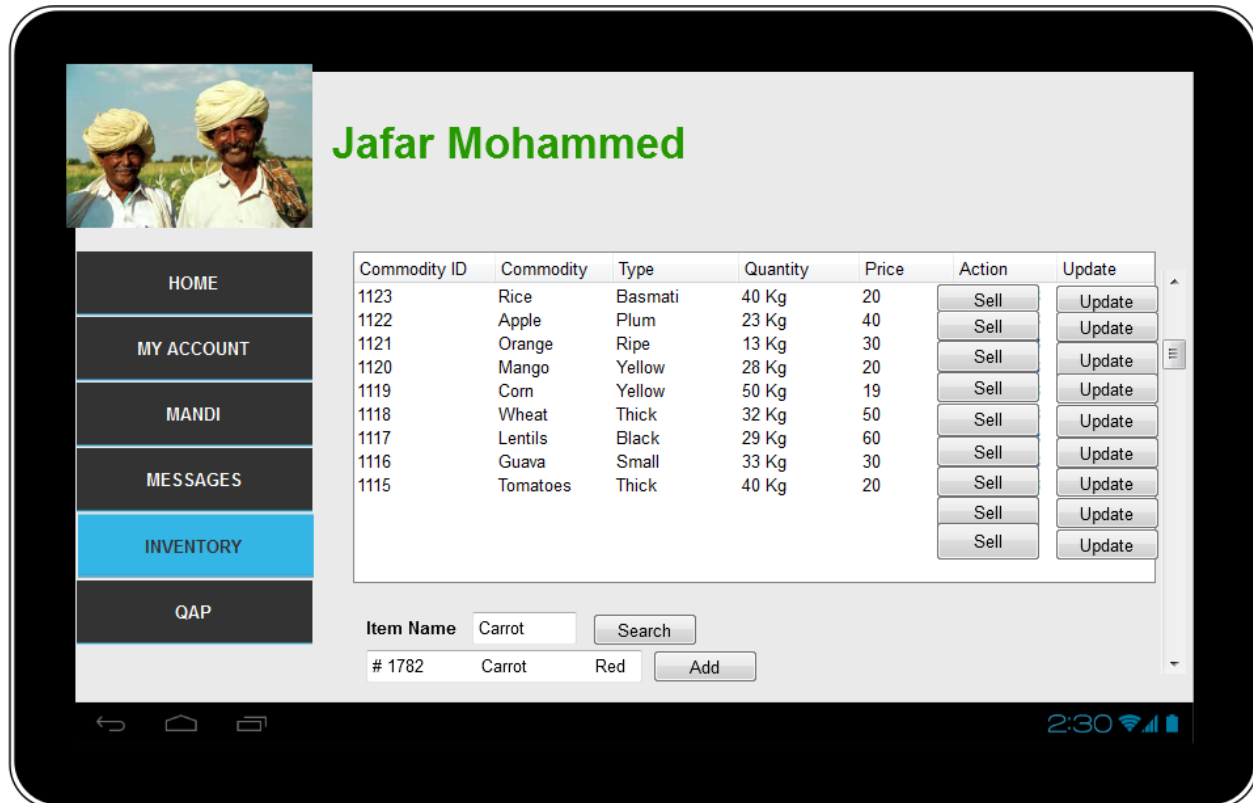
Figure 11: Inventory

G. QUARTERLY ANTICIPATED PRODUCE (QAP)

Farmers can sell their anticipated produce. This means that they can sell their future harvest and can get loans based on these harvests. Moreover, selling the crops in future i.e. selling the anticipated produce will significantly reduce wastage of food as the harvest can immediately be dispatched to the buyer upon harvesting. In addition, having the knowledge of anticipated produce, buyers can plan ahead and optimize their business processes. **Figure 12** shows the QAP interface. This interface, by default, will be visible to the public. The period attribute in the table shows the date of the anticipated harvest.

G. QUARTERLY ANTICIPATED PRODUCE
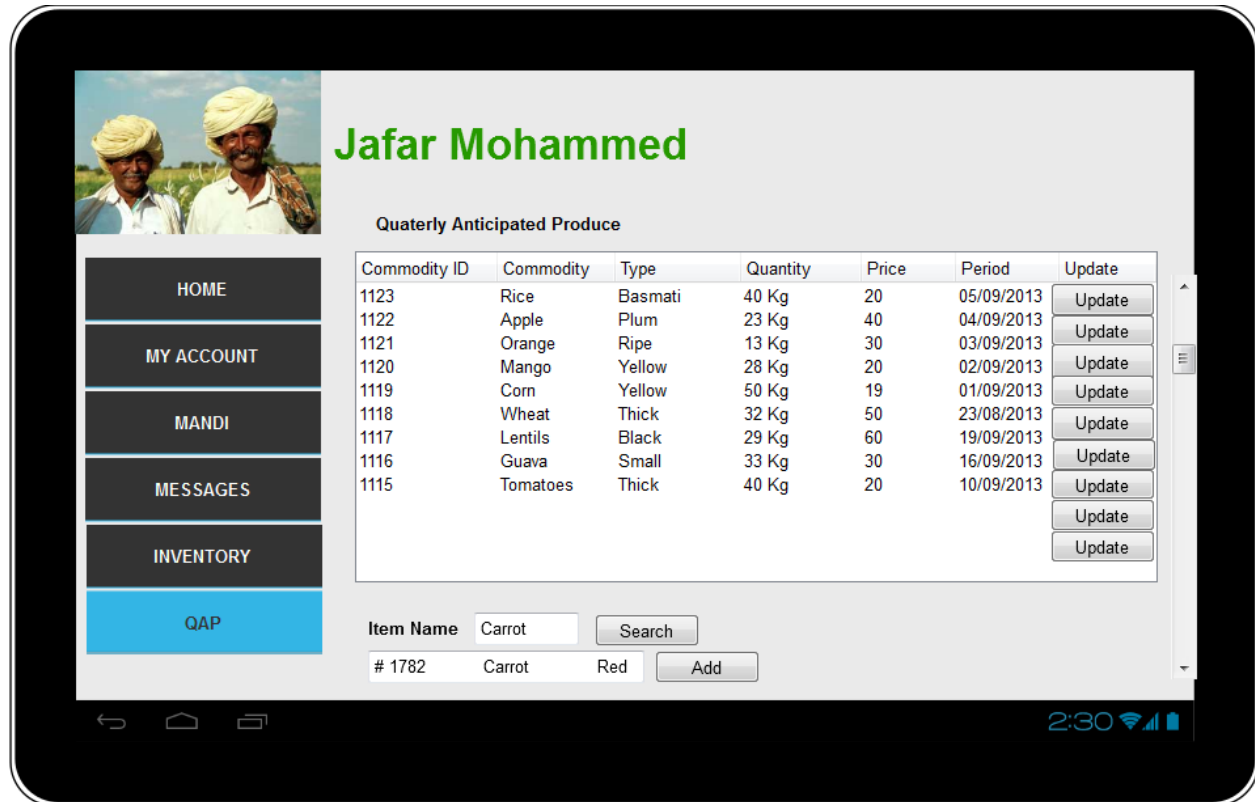
Figure 12: Quarterly Anticipated Produce

2.1.2 The Buyer Account

The Buyer account is used by companies or potential buyers to search for available crops and post requirements on the virtual market i.e. the Mandi. Buyers are eligible for a different set of services as compared to the sellers and hence communicate with the E-Mandi servers through the "Buyer web services" **(Figure 5)**.

The Buyer UI consists of the following screens:

1. Search
2. Mandi
3. Messages

Figure 13: The Search Screen

A. Search

The search screen is also the default screen for the buyer account. **Figure 13** shows a typical search screen. The search screen can be used to search a particular crop or a particular farmer. As discussed earlier Section 2.1.1, commodities are searched by their commodity ID . The search results show the availability of the crop at different locations. After obtaining the search results, the buyer can message the seller or even buy the product using the "Buy" button.

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Figure 14: Mandi

B. Mandi

The Mandi service allows the buyer to post requirement on the marketplace**. Figure 14** shows the Madi interface for the buyer account. We notice again that the "post" is associated to a commodity ID. Hence, all the information related to a particular commodity can be accessed through this commodity ID. The post by the buyers is visible to all the farmers registered on the E-Mandi servers.
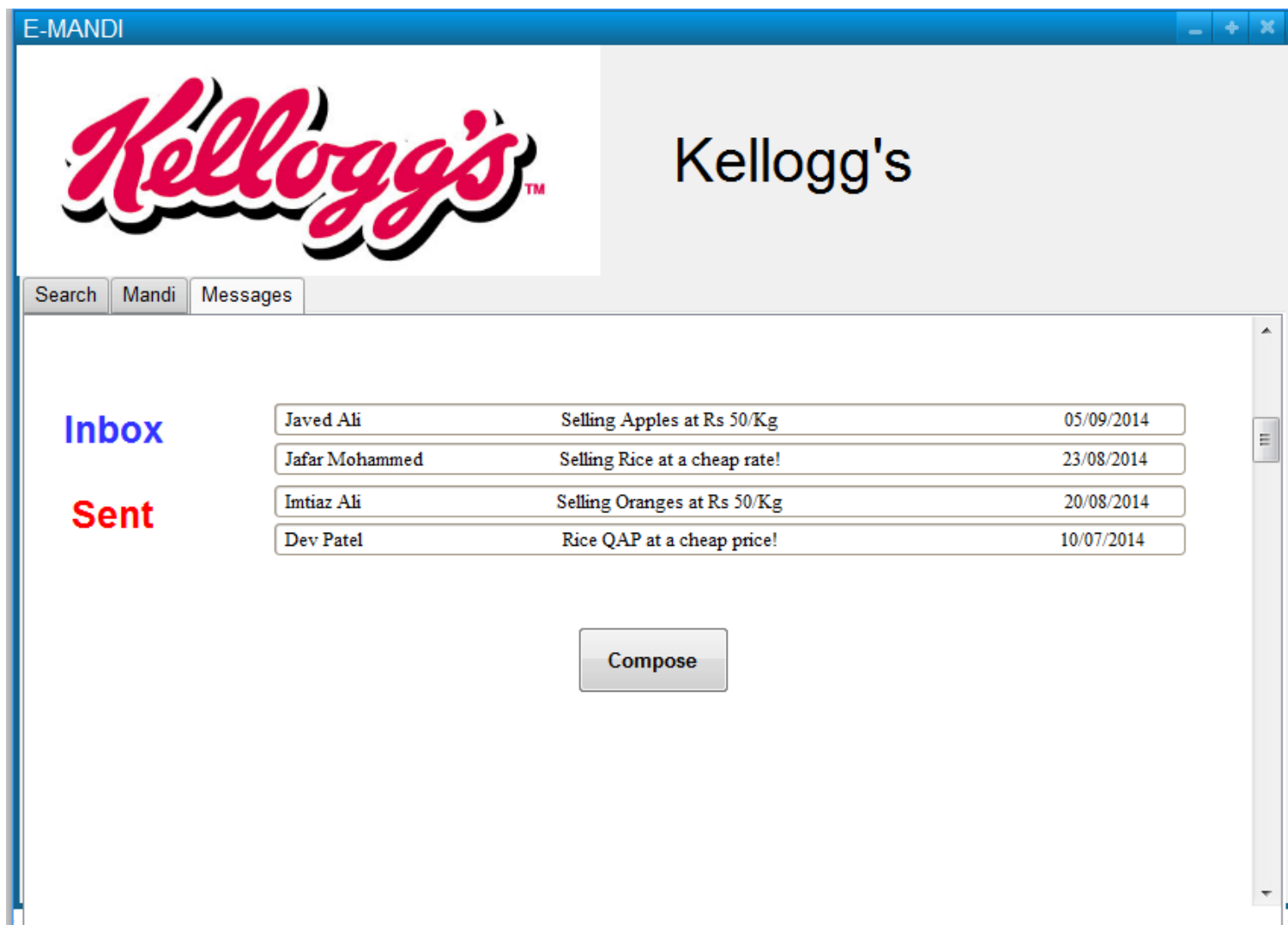
Figure 15: The Message Screen

C. Messages

The message interface allows buyers to communicate with farmers directly. For instance, if Kellogg's is interested in buying 50 Kg of rice from Jafar Mohammed then it can directly communicate with him to discuss the further course of action. **Figure 15** shows the message interface for the buyer. We will discuss in the later in section 4.0 that how we can leverage SMS services in absence of Internet connectivity.

3.0 Challenges in technology deployment & usage[1]

(1) Inadequate peripheral Infrastructure: Creating affordable ICT services in rural areas is a complex challenge. To supply ICTs and related services in rural areas, the main challenge is the high level of capital and operating expenses incurred by service providers. On the demand side, rural adoption of ICTs in developing countries is curtailed by low availability of complementary public services, such as electricity and education, and by the relative scarcity of locally relevant content.

(2) Adapting technology to local preferences & intuition : It is important to develop solutions by engaging local stakeholders and build systems as per their preferences. In designing ICT interventions, it is necessary to research and understand local information and communication practices, barriers to ICT-enabled empowerment, and priority information and communication needs of end users. Using conventional information and communication tools to address the needs of those who cannot access the ICT because of limitations related to literacy, isolation, and social norms is often required.

(3) Appropriateness of the technology : The attractiveness of the newest ICTs can lead to a preference for the latest technologies at the expense of older technologies (such as radio), yet the newest, most elaborate, or most innovative technology is not automatically the most appropriate one. Moreover, an innovative mix of technologies (for instance, radio programs with a call-in or SMS facility for feedback) can be the most cost-effective solution. Well reasoned assessment of the tradeoffs between the added cost of a technology or service and benefits relative to other options (technological and other) is important

(4) Ownership Issues: Focus on affordable Access and Use, Not Ownership. As the costs of ownership of ICTs have come down, the affordability and accessibility divide has improved, especially for individual user services. However, it also may be that in some cases,learning is better facilitated through shared access than individual access facilities, Peripheral infrastructural development and electricity supply.

5) Initiatives to create digital literacy at all levels: An aggressive drive to impart basic digital literacy among rural population should be initiated. Youth and children should be on priority made comfortable with technology usage.

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[1] ICT in agriculture,e-sourcebook, World Bank, 2011

4.0 Defence

As discussed in the previous section, introducing ICT in rural areas faces several challenges. Creating peripheral infrastructure to effectively integrate ICT tools in agriculture is essential. One such step taken by the Government of India is the $10 (Subsidized rate) Aakash tablet. Aakash comes with a 7-inch touch screen, ARM 11 processor and 256 MB RAM running under the Android 2.2 operating system. It has two universal serial bus (USB) ports and delivers high definition (HD) quality video. For applications, the Aakash has access to Getjar, an independent market, rather than the Android Market [6][7]. Power consumption of the tablet is 2 watts, and there is a solar charging option. This is one of the reasons that we stress on leveraging these portable, handheld, powerful smart devices to run applications such as E-Mandi. E-Mandi is one step forward in leveraging technology to empower farmers and promote agriculture as a profitable occupation. While it is true that creating digital literacy is important in order for such applications to effectively function, we cannot let that be an impediment in creating life changing software. Initiatives to spread digital literacy amongst the younger generation is an effective solution. For the older generation it can be hard to adapt to rapidly changing technology and hence the best way they can learn is through their kids. Out of the vast spectrum of application of ICT in agriculture (Section 1.2.1), E-Mandi focuses on empowering farmers by providing a platform where they can market and sell their harvests at the best prices. E-Mandi thrives to bring more business to farmers empowering them financially. It also serves as information sharing platform where they can network and communicate with other farmers. E-Mandi envisions a nation with strong independent farmers who make smart, well-informed decisions.

5.0 Future Work

In this report we discussed the seller and the buyer accounts in detail**. Figure 4** shows various goals of E-Mandi. SMS marketing and Farmer networks are two features that can be integrated with the E-Mandi platform in the future. SMS marketing involves leveraging already existing infrastructure to transfer messages and share information. This is possible by using web based SMS APIs. These web based APIs use standard internet protocols to route messages using HTTP PUSH to one or more registered URLs.The advantage of using such services is that they are significantly cheaper and relatively faster than normal SMS services. **Figure 16** shows the description of a SMS web service offered by M-Science.com. A similar web service can be deployed on the E-Mandi servers. This will ensure that even if the farmers are unable to receive internet connectivity for some reason, they can still receive news feeds and updates via SMS. Thus, if a farmer does not own a smart device or does not know how to use a smart device, he can receive information via SMS on his basic phone. Another addition to E-Mandi would be Farmer networks. As discussed in Section 2.0 farmer networks can allow farmers to actively network with each other. This would open more channels for communication and such an interaction would help in spreading knowledge and awareness rather quickly.
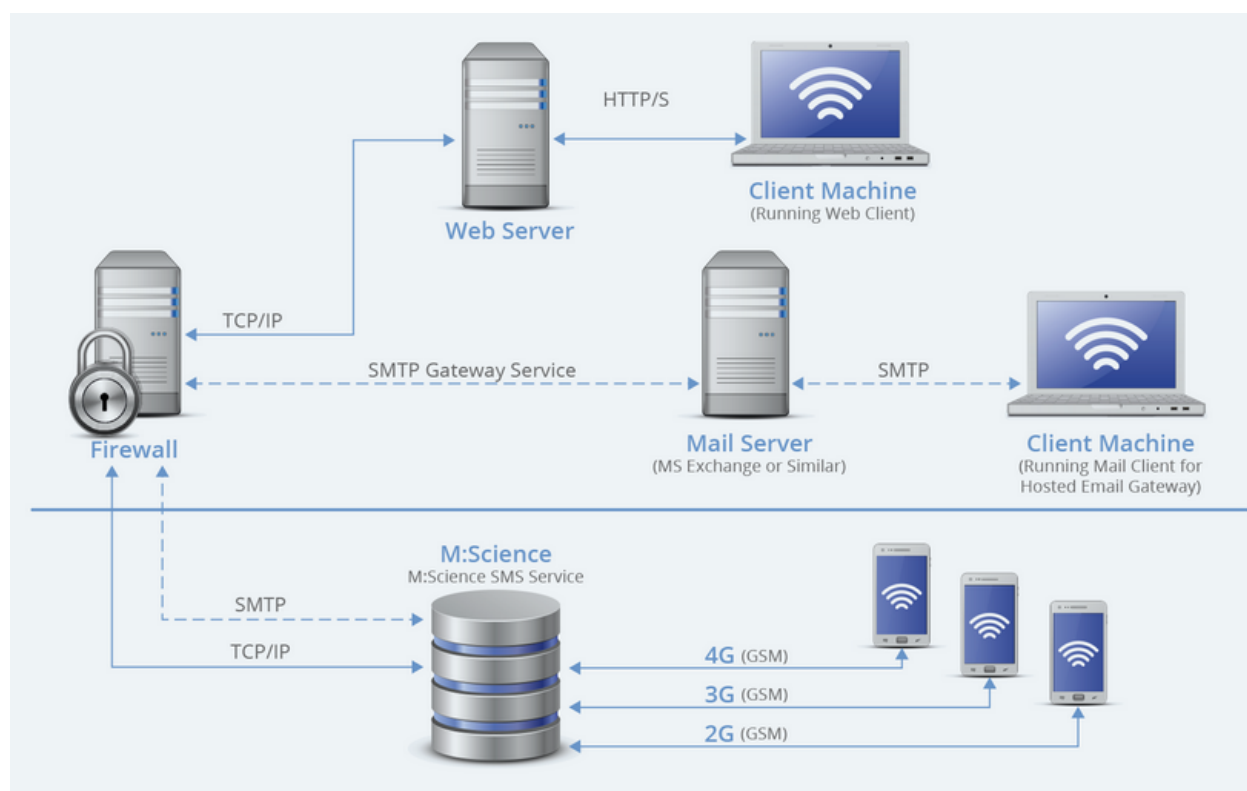
Figure 16: Working of a SMS web service
(http://www.m-science.com/products/sms-integration/sms-web-service/)

6.0 Conclusion

E- mandi is one of the many possibilities to reduce market inefficiencies and empower farmers to make more informed decisions about their produce. It can to some extent improve market access and resource planning. There may be limitations to the use of such interfaces due to challenges of network & technology access , affordability and rural illiteracy but with increasing scale and proliferation of networks and technology the cost & access issues will dampen overtime. a combination of ICTs such a community radios, television, voice based information systems can be used to overcome the education paralysis on a short terms. For a long term though ,aggressive digital literacy drive , especially among younger generation is needed to be undertaken.

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