Enhancing the agricultural sector with *m*-agriculture

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Sri Lanka is a predominantly agricultural nation with a rural population of approximately 85%. This constitutes a large community engaging in agricultural activities. Information *and* communication technology can play a vital role in improving this sector which, despite a handful of noteworthy efforts, has largely been untapped thus far. Once this lingering inertia is defied, and a sector upon which a large proportion of the populace rely themselves is integrated and improved, the nation would experience extensive development that was hitherto on stand by. This paper is conceptual in nature and attempts to devise a mechanism by which the agriculture sector is integrated and agro-services are provided to farmers via mobile devices. The ubiquitous mobile phone has become the quintessential tool of the small man to get connected. By using the mobile platform to disseminate services and facilitate operations, a larger dimension of the farming community can be reached and a multitude of services can be provided and monitored. This paper additionally focuses on the instruments required to realise the aforementioned mechanism.

***Index Terms*— Agro-advisory system, m-agriculture, m-commerce, social-networking**

I. Introduction

Even though Information *and* communication Technology has made significant inroads to our society lately, it appears that the supremacy of IT is unbeknownst to agriculture sector. This paper however does not attempt to discount the numerous efforts made thus far; it simply underscores the inadequacies of undertaken endeavours as opposed to other sectors. Nevertheless, the apathetic commitment to a vital sector of our country is in fact a great tragedy. The fascination spawned by many industry opportunities in other sectors might have had an effect on this inertia. Neighboring countries like India has made momentous progress with regard to agricultural sector. This paper explains the structure of a mobile-based agro-advisory system (referred to as *MAgroS*), the instruments required, and its future potentials.

The model which will be explained in this paper is not only aimed at facilitating operations by using communication technologies but also management and future requirements by the use of Information technology; thus the deliberate separation of the term Information and Communication technology in this paper. That is, operational activities requires advanced communication technologies such as mobile telecommunications, email services, etc. managing information and respond future queries require advance information technologies such as database management, expert systems, etc.

The main virtue of ICT is the possibility to directly address individuals rather than generalised communities. This advantage is materialised in areas like e-governance, C2C, social-marketing etc. This system applies the same principle to usher in a new era of agriculture and empower the farming community.

Since the liberation of the north and east, huge amounts of hitherto unutilized verdant land is going be incorporated into our national agriculture grid. By managing information and facilitating communication between the once separated two communities will also realise other long term goals.

The scope of this paper is limited to paddy cultivation owing to the fact that it constitutes the majority of the agricultural sector. However that does not limit its uses and its potential as an agriculture system.

II. Overview

The proposed system basically revolves around an IT agro-advisory system in addition to encompassing several other components. Therefore, the main objective of the system is imparting timely bespoke advices to farmers. The information gathered during this advising process would be the raw materials for the residual components. As the first step, farmers are registered under this system and will have an account that is accessible through their phones or PCs based on their preference and convenience. Services are offered through mobile service providers who have direct contact with the control centre of the system. Mobile operators therefore act as intermediaries, facilitating communications between farmers and the control centre. A downloadable interface is made available by service providers to users' mobile phones through which related interactions would take place.

A. Structure of the system

The proposed system is envisaged to encompass the entire country upon full implementation. Divisions and the hierarchy of the system (at this conceptual state) resemble those of the agricultural administrative layers.

MAgroS is a centralised system having a control-centre at the helm and consisting of many sub-stations called regional centres. The scope of these regional centres can vary according to the nature and complexity of the crop in question. The layers between the main control centre and the regional centres can also vary on the same bases. Such regional centres can be situated in the main cities in every district or even drill down to cover smaller segmentation and to see to local matters. The entire system is connected through the Internet and is hence centralised.

The above mentioned geographical based structure, i.e. the physical structure, is imposed to accommodate administrative and operational functions. However, in a conceptual point of

view, the system is structured on the bases of crops that are grown with the eye of improve system efficiency. As Fig. 1 illustrates, the final node of the system, i.e. a regional centre, performs all activities segmented on different crops such as rice, fruits, etc. A conceptual model of such nature was formulated in order to facilitate highly specialised service delivery.

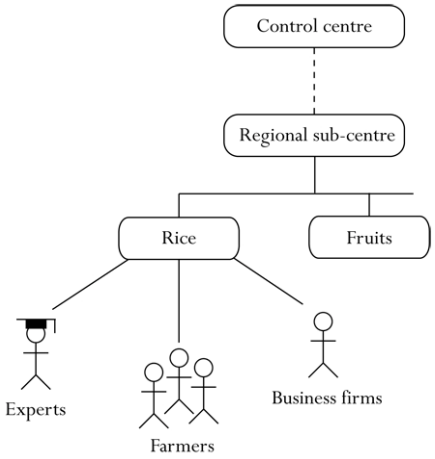

Fig. 1. - The administrative structure of the system

The control centre holds all the data on servers that are securely housed inside the premises. Mobile service providers are given an access to the advisory system through which interaction between farmers and experts take place. Activities, enquiries and responses, are all logged in the system and used for further processing. Subsequently, BI tools (business intelligence) like OLAP are used to extract patterns and valuable insights from the recorded data. Automated advices for queries can be generated by means of the resulting knowledge base of past data. Tasks carried out by the control centre (or regional centres) are co-ordinated and monitored using GIS (geographic information systems).

B. Services provided

In order to make this argument concise, the scope of the model is compacted to incorporate only a handful of services. However, the model can be used to delivery a myriad of services provided that the necessary infrastructure is available.

The core unit of this system is an agro-advisory system which offers vital advices to farmers regarding harvest, cultivation, remedy to crop diseases etc. and responds to enquiries. The system achieves these enquiries and forms a knowledge base that is set off against farmers for future references. Hence the system has a dual purpose where the availability of a history for each farmer can be used to provide effective and personalised guidance. A more profound explanation of its operations is given in a subsequent chapter.

In addition to saving enquires, services provided to farmers and their performance are also saved in the system. During the paddy harvesting period for instance, farmers' output and production volume are recorded alongside their resource consumption to identify their effectiveness and weaknesses. The availability of all the necessary data and also the ability of manage these information would eventually lead to smooth operations when, for example, distributing seeds and fertilizers.

The system is also able to facilitate monetary transactions of farmers regarding agricultural activities. By connecting farmers with business firms, a farmer can greatly benefit by securing direct links with the prospective buyer and engage in selling. The lack of intermediaries would ensure a more successful transaction. By the induction of mobile banking systems, farmers are given the opportunity to engage in m-commerce. Prospects of such measure are described in following chapters.

Furthermore, the integration of mobile interfaces and internet technologies within a regulated environment of MAgroS, farmers are given a platform to involve in web 2.0 activities. By engaging in interactive learning, discussion sand social networking farmers' informational value and competence in the current electronic world would greatly enhance.

C. Mobile Interface

Mobile phones have currently taken the role of an ornament or an instrument of modernity in rural communities. Given the fact that these devices are affordable and ubiquitous, low income levels would not impede farmers of possessing a mobile phone. At present, more than half of the population owns a mobile phone, and almost all of them are capable in skillfully operating the devices.

A device of such characteristics suits exactly to the requirements of a device reaching the final node, i.e. the farmer. Their proficiency in mobile phones would render initial training costs associated with system implementation redundant. Additionally, given the itinerant nature of farmers and harsh conditions under which they labour, the device that they use to communicate and interact should be mobile and portable.

Mobile service provision is an extremely competitive market in Sri Lanka; so much so, our nation boasts of one of the lowest call rates in the whole world. Thus, operating a mobile phone would not incur a rural farmer an exorbitant rate. Services are accessible from almost any part of the island. The selection of mobile phones over PCs is down to the fact that the PC sector has not reached to the depths of the rural community. The prospect of setting up the infrastructure and training the population a new technology cannot be construed as an economically feasible option.

III. User Registration

The importance of information management underpins the success of any IT enabled system. Hence, the registration process is the preliminary task of *MAgroS*. Farmers, experts in the particular crop, business firms, etc. can be incorporated into this system based on its scope. In addition to registering personnel, agricultural land, livestock etc has to be documented and recorded. The process of registration is carried out and controlled by the main control centre given the privacy and operational issues.

Registering farmers for instance does not merely entail maintaining records of farmers or similar activities.

Implications thereof reach far beyond the scope of the current usages of information management.

Mobile services can be used to assist the registration process by which regional officers go from village to village organising seminars thereby gaining access to all farmers. Hence, in such setup, initial know-how can be imparted in addition to a regular registration. All the necessary details such as personal details, region, type of cultivation, size of land utilised etc are provided upon registration. User information can be grouped on the bases of region, crop type etc. to further organise farmer data and facilitate future operations. Since the system runs on a mobile platform, a user's mobile account will be treated as the user account for this system. Consequently, the system can be accessed simply by providing the password through the downloaded interface of the mobile phone. All activities, enquiries, transactions, services consumed etc. will be entered against a user's account thus providing a clear profile of each farmer.

In addition to farmers, specialists in various crops are also registered in the system so as to organise the advisory function. Independent specialists can be employed besides internal full-time experts. This measure unequivocally allows a pool of skilled practitioners to be maintained in the data base.

IV. The IT Agro-advisory System

An IT agro-advisory system involves an IT based agricultural extension service that provides customised agriculture related advices to farmers. This system is powered by modern mobile and web technologies to enhance accuracy and speed of advices and manage information.

A. A Case in point

Since Indian rural community is reminiscent of local agricultural sector, and India has made significant progress in ICT, examples of Indian background are given priority in this paper. An IT agro-advisory system called e-sagu [1] is already implemented in India and has proven extremely effective. The system is based in Hyderabad India and covers villages in the region. The entire operation is controlled from a centre in the main city which houses experts in agriculture field as well as computer specialists. They have dispatched regional officers who possess mobile phones equipped with cameras to local farming communities. These personnel are required to respond to enquiries by farmers related to diseases, miscellaneous details, guidance on cultivation and harvest etc. In the case of diseases, the officer takes snaps of the troubled crop using his mobile phone and from the regional station, sends the picture along with the details in a CD to the main headquarters in Hyderabad. Experts attempt to decipher the problem and find suitable solutions that will be delivered to the farmer's door step in a timely manner. More importantly, the eSagu system is capable of analysing collected data so as to extract important patters and information [2].

B. Information Dissemination

There have been significant interests in agricultural extension services during the recent past due to the ability of ICT to disseminate information to farmers effectively and efficiently and various economic benefits [3]. The cyber agriculture extension of the department of agriculture is an admirable endeavour aimed at offering knowledge to rural farmers through IT centres [4]. Additionally, the *Nava Goviya* project, a public, private community collaborative on e-agriculture development, conducts virtual online classes on various agricultural issues [5]. However the emphasis of an extension service is on delivering advises *directly* to the individual. Using terminals set up on IT centres for this purpose would not be effective as farmers won't be interested in listening to podcasts after a day's toil. A study focusing on rural farmers in Nigeria showed such limitations of broadcasting information [6].

Hence, although the crux of *MAgroS* is agricultural extension (advisory service), its focus is on one-to-one delivery of information in a more interactive manner while providing an extended business model.

C. Extended advisory system

The same system can be adapted such that mobile phones (or any mobile or electronic device) be the main medium of communication, transaction and interaction. Such a system can be further elaborated by the integration of supportive activities and making those services available to farmers from one virtual outlet, i.e. mobile interface. Since all regional stations are interconnected, the necessity of filed trips by officers is eliminated. One-to-one communication opportunities - be it verbal or SMS based – are enabled between farmers and the station operators through mobile interfaces. Photographs can also be taken of plant specimens and be sent along with the enquiry if the phone is equipped with MMS facilities and obviously a camera.

The farmer is given the opportunity to isolate the problem using an interactive interface thereby alleviating both the control centre and experts from an influx of enquiries. Hence, an enquiry can be channeled to the correct sub-division (based on the type of crop, disease etc.) without inundating the main control centre with requests. General tips, remedies for trivial crop diseases, etc. can be posted on the interface thus providing the farmer with basic details without the requirement of calling a specialist. As a result of this, training on the mobile interface should be given to the recipients of this system.

Since experts are registered, enquiries can be filtered and directed to them based on their competence and availability as depicted in Fig. 2. Consequently, their full potential could be used without intruding on their valuable time. Each enquiry an expert receives is treated as a session which remains open until the outcome is logged. Experts initially make contact with the control centre via the mobile phone or through the Internet (in the case of a PC), not directly with the farmer.

Since an enquiry comes through a user account, relevant information such as farm size, type, etc. are also displayed to the expert thus facilitating his consulting process. Should the problem persist, experts can engage in direct communication with the relevant farmer using their mobile phones (as though in a regular call). Conversely, based on the availability and the consent of the expert, a farmer will be given opportunity to initiate a phone call with one of them as to interactively

engage in solving the problem. Upon finding the solution, the specialist logs the results in his/her account before the sessions is deemed concluded.

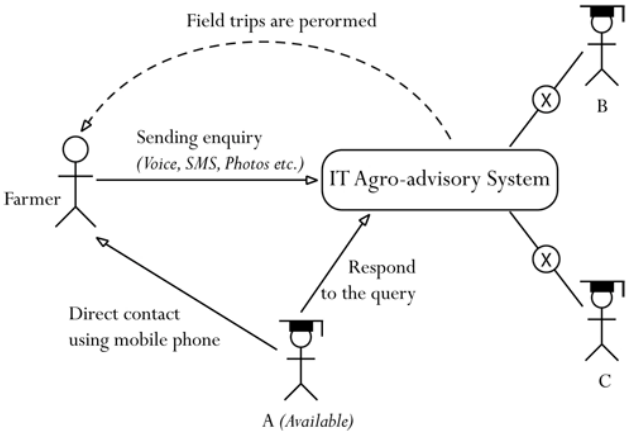

Fig. 2. - Model of the extended IT-advisory system

By maintaining an information archive alongside the provision of advices, consequent long-term benefits of an advisory system will definitely be noteworthy. This core element of this system is therefore, an extended version of an IT agro-advisory system.

V. Other Types of Interactions

In addition to the *farmer-expert* relationship in the extended agro-advisory system, there are other types of associations based on services provided. Following are the residual interactions that take place in *MAgroS*.

A. Farmer & the relevant authority

The full spectrum of activities related to various agriculture facets can be organised, co-ordinated and controlled using such a system. SMS news alerts can be sent to farmers on various activities, awareness programmes and so on.

Having the farmer community registered, managing various related tasks would be generally straightforward and less time consuming. For instance, when authorities face the problem of dispatching water to fields during dry season, having the necessary particulars about water requirements of each farm, the process would be highly efficient and effective.

With the aid of GIS, critical events can be managed confidently and economically. Areas that require urgent assistance can be effectively zeroed down and supplies can be dispatched efficiently.

B. M-commerce for farmers

Buyers are able to secure direct communication links with farmers by means of this system. Interested buyers have to register with this system. Prices of various buyers can be conveniently compared through the system. In the case of purchasing, farmers are able to successfully evaluate selling prices of different firms. On the same time, buyers can find prospective sellers given that details of farmers are available to them. As in every virtual service, the all round availability of accessing information is anther vital virtue. A similar mechanism called *farmer production database*, albeit on a web interface, is available through the website of the department of agriculture. The department of agriculture website is a website worth mentioning for its remarkable features.

The induction of the m-commerce and mobile banking facilities further extends the usages of the IT agro-services system. More to the point, besides being a communication or an entertainment device, mobile phones start to take the role of a payment device. Orders can be placed on-line and payments can be made through the phone. Since *MAgroS* maintains user accounts for each registered farmer, m-commerce operations can be better regulated and monitored. Farmers are hence not required to have credit cards to experience such far-reaching benefits of IT. Home-delivery mechanisms can be introduced with the aid of business firms, opening farmers to new avenues in the modern cyber world. However, this paper does not intent to expound on the technical fundamentals of mobile baking or m-commerce concepts.

If business firms are registered in the system, they are in a position to engage in direct marketing with farmers. A sound interaction can exist between the system and business firms to exchange data insofar as they are permitted to be shared. For instance, by analysing farmers' enquiries, various market segments can be identified by firms. Additional business opportunities can be created by allowing firms to post advertisement on networking sites. However, this feature should not hinder the process of expert advising. Business firms can resort to unscrupulous practices by spreading false messages to beguile the poor farmer. Incorrect advices can lead to destructive circumstances thus causing irreparable damage to the reputation of the system. Therefore, it is extremely important to control such issues.

Ultimately, a lucrative new business model can be created of *MAgroS* where farmers, firms and mobile service providers would profit alike. By providing an effective platform on which various parties can interact and form relationships, the business value of such a system would grow even further. Such an extension shall augur new prospects in the horizon for the proposed system.

VI. Farmer Interaction

Having mentioned that a large database of farmers is maintained, the possibility of farmers engaging in social networking would come to fruition rendering additional benefits. In order to facilitate such interaction, bespoke platforms can be created exclusively for farmers' usage; catering to local needs and accommodating global involvement. Present excitement of social-networking can be channeled towards enabling the farming community. However, the performance in a social-networking domain hinges on the availability of Internet connection.

A. *Participatory Learning*

This area addresses a learning method where farmers participate and engage in interactive learning. Participatory learning not only helps novel farmers but also allows seasoned farmers to improve their knowledge. By lending itself to borderless discussions, farmers all around the world can get together and share their knowledge through Internet based media. This might look slightly contradictory to ingrained local hereditary learning method in which knowledge disclosure was not the norm. However, the current status quo forces us to change our thinking paradigm and adopt a knowledge sharing stance. There are such fora for discussions such as *e-agriculture.org*.

More to the point, a planned agro-advisory systems would subsequently be rendered superfluous should individuals posses the necessary knowledge and ability to share them. In fact, an outcome of such nature is exactly what should be anticipated by the introduction of such a system.

B. *Making their voice heard*

Internet technologies have proven its prowess of carrying the voice of masses. An immediate benefit that stems from the social-networking and blogging tools is the ability to engage in protests, group themselves in demonstrations etc. Farmers would therefore have an unprecedented capacity to make their voice heard.

VII. CHALLENGES

Various challenges that have to be surpassed are elucidated in this part. This discussion goes mainly along the following lines: socio-cultural, political and economic and technological aspects. However, for the sake of clarity, some categories are broken down so as to address specific issued pertaining to such labour.

A. *Standards of instruments*

Given that the main mode of interaction is mobile phones and mobile communications, the question arises as to what are the standards. There are a plethora of phone manufacturers, mobile service providers and internet service providers available. Offering services via many mobile service providers would inflate operational complexities beyond control. *MAgroS* cannot accommodate to excessive variations, especially in a project of such magnitude and with extensive objectives. Formulating a set of standards before implementation is therefore of supreme significance.

B. *Ingrained behavioural patterns*

There are some firmly established behavioural patterns that are of a disadvantage as far as the farmer is concerned. Farmers of the rural and poor community, who usually engage in low risk cultivation, are not on the lookout for information and sophisticated advices. On the other hand however, farmers with higher risks and who are high up the socio-cultural ladder, place higher value on expert advices and would resort to this sort of systems.

In the case of crop disease for instance, the *modus operandi* of a low risk farmer is simply taking a sample of an affected plant to the nearest pesticide dealer for advice. Since pesticide dealers are often bound with credit facilities provided by chemical companies, they are forced to disregard farmers' real requirements and resort to hard selling tactics. Farmers are hence deprived of their financial/economic independence and are made subjects of these dealers. Given that the major recourse for farmers in case of crop diseases are these dealers, such occurrences are destructive to the wellbeing of the farmer and the agricultural sector in whole.

C. *Political and economic aspects*

The project may initially entail extortionate costs given the scope and nature of the system. Setting up control-centres, equipping and connecting them, training control-centre users, registering farmers, experts etc. can consume high resources. Even after implementation, there is the necessity to keep the databases up-to-date, maintain hardware and software, conduct workshops for farmers that result in higher operational costs. These reasons might create unwarranted opposition from various parties due to trepidation. As far as political aspects are concerned, officers might resort to bureaucracy, corruption and other unethical activities. Hence, from an administrative point of view, the anticipated effectiveness and efficiency might not be achieved should there be no sound mechanism to thwart such acts and officers are not given adequate guidance.

In a personal level, financial limitations of rural farmers would hamper them from purchasing mobile phones with MMS capabilities to accommodate certain features of the system.

D. *Language*

Insofar as communication is concerned, language has not proven to be a stumbling block in this country. Even though standard local fonts are not readily available in electronic and mobile devices, people have got round to using the Latin alphabet to communicate in their mother tongue. Currently there are farmers, fishermen etc who expertly communicate via SMSs using the Latin alphabet. However, with regard to information management and related requirements, language plays a pivotal role in deciding the effectiveness of the model. Database management systems, programming languages and other related technologies are all based on the English language. Therefore, it is of utmost importance that this issue be addressed.

His Excellency's declaration of the year 2009 as the year of IT and English vividly illustrates the enthusiasm of the government to this effect. Given the global nature of ICT and its inherent bias towards the English language, making the community conversant in English is the most effective strategy. This measure is appropriate and resourceful compared to attempting to convert existing technologies and platforms to native languages. Once people are more

competent in English, the overall effectiveness of information management would improve by leaps and bounds.

E. ICT Infrastructure

In order to reap additional benefits of *MAgroS*, availability of the Internet is of vital necessary. Areas like social-networking require internet connectivity. A country with an Internet penetration of roughly 4%, Sri Lanka has quite a distance to cover in this regard. However, the government has evinced expectations to increase the nation's IT literacy rate up to 50% by 2010 [7].

Projects like *Nanasala* for instance, provide rural farmers with excellent opportunities to gain IT knowledge and connect to the cyber space. These stations, (currently having around 460 branches scattered around the island) provide a multitude of services for rural communities to improve their IT knowledge.

F. Privacy and safety issues

The moot point of ICT (especially in information management) is privacy concerns. Unless a sound mechanism is present to protect information integrity and counter threats to privacy related issues, there will be much prejudice against any movement related to IT. The recent introduction of cyber laws such as Computer crimes act, e-Transaction act, etc. clearly shows the eagerness of local governing bodies to embrace secure IT initiatives. Additionally the set up of the Cyber crimes division attached to the Police has given the opportunity to organisations and citizens alike to resort to legal protection against unlawful activities [8].

Securing the premise that holds all the valuable data from intentional or natural disasters is of utmost importance. Satisfactory contingency plans should be in place. Employees should be given adequate training to this regard and a sound disaster recovery system should be in stand-by.

G. Preference towards the mode of assistance

Studies have shown that preferences towards methods of receiving information are based on age, educational status, and farm size [9]. Even though this study is fairly old, propositions therein can be extrapolated to the current environment given the largely unchanged mindset of rural farmers in Sri Lanka. Generally speaking, farmers are found to be having preference towards interpersonal methods (e.g. on-farm demonstrations, tours and field trips) over computer-assisted methods. This implies that domestic farmers would expect human presence and thus one-to-one information dissemination methods should be employed by the envisaged system.

VIII. CONCLUSIONS

Globalisation has crept into the local agricultural sector thus placing framers and the sector on the whole in great danger. Domestic farmers are hence compelled to compete with the international market despite suffering major economic and resource handicaps. By disseminating expert scientific advices to farmers and empowering them to face massive competitive pressure, local agricultural sector can be saved from virtual oblivion.

The induction of farming community into the cyber space would greatly attribute to the enhancement of the image of farmers thereby prompting more are more individuals into this currently nondescript field. Achieving a level of interaction between farmers and authorities as described thus far is no less central to the betterment of agriculture sector than super highways are to transport sector. This outlines the theme of the symposium, *ICT for national development & integration*.

However, ingrained socio-cultural attitudes and other challenges have to be addressed in order that this system be effective. Additionally, awareness should be increased amongst farmers once the system is on place, to gather a substantial fervent supporter base. The reputation of the system is of paramount importance. Since the core product is advisory services, the accuracy, speed, practicality and other traits should be superior. In a country where word-of-mouth is a decisive and a powerful medium, a single wrong advice can tarnish the system's image irrevocably. Maintaining the quality of service delivery should therefore be matters of high priority.

In order to boost the image of this system, partnerships can be created with governmental bodies such as the Agricultural extension in an agricultural domain. Experts working for these institutes can be assimilated whereby the system would get additional credibility.

Information technology is essentially about managing information for the benefit of the community rather than the mere use of high-tech gadgetry. Speaking in a philosophical point of view, IT does not manifest itself in physical form other than facilitating devices such as keyboards, NICs, processors etc. Hence, benefits of IT are largely down to the management skills and conceptual abilities of end users. That is the way in which the real benefits of ICT can be *harvested*.

Going global in agriculture is important since ancient cultures without exception possess a vivid collection of traditional agricultural know-how. This knowledge can be of great importance when shared and refined. Having gone through different experiences and rode through varied amounts of perils, each culture can contribute much to the benefit of the human kind. By allowing farmers to interact, *MAgroS* could engender the enthusiasm and provide the necessary technical platform.

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