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Research Article

Cell phone- A decision support for sustainable crop protection

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SUMMARY : Use of cell phone would be the need of the hour in respect to decision making power of the farmers. The objective of this work was to disseminate regular crop advisory, crop monitoring, crop pest surveillance and crop pest forecasting to farmers for sustainable crop protection through mobile based programmes comprising of SMS alert and direct contact between crop doctors and beneficiaries. Two hundred numbers of progressive farmers/rural youth from farm families and twenty resource persons were trained up as beneficiaries on different aspects of integrated crop management options before starting this study. The beneficiaries were expressing more interest to update themselves. Based on the foot falls along with other farmers to KVK had been significantly increased for obtaining more information against a specific problem. The other important findings of this study among the targeted beneficiaries were (i) the dependency on others for pest or crop management had been reduced, (ii) the decision making power for pest management had been significantly improved, (iii) the skills and attitude towards bio-intensive pest management was developed, (iv) the entrepreneurship development among resource persons by providing various services to farmers was successful.

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BACKGROUND AND OBJECTIVES

The district South 24 Parganas of West Bengal belongs to complex, diversified and risk prone area. Most of the geographical area of this district is characterized by salinity in both soil and water, heavy and prolonged rain (1700-1800 mm/yr) along with poor drainage system accompanied with natural calamities like cyclone, tidal ingression, embankment breaches, flood etc. About 70 per cent of the total land is low lying (Maitra *et al*., 2008) in nature where more than 3 ft water gets stagnated during rainy season. Aman paddy is the main crop for the low and medium land conditions here. The upland as well as land embankment surrounding low and medium lands serve for some vegetables cultivation like okra, bitter gourd, tomato, chilli, cowpea, French bean, dolichos bean etc. and in some cases mustard also. During *Rabi*-summer season, cotton, green gram and sunflower are grown in the partially irrigated as well as rainfed low land situation. In the irrigated medium to uplands, vegetables like okra, French bean, tomato, cole crops, cucurbits, chilli and brinjal are grown. Thus, agriculture along with animal husbandry and fisheries are the main stay of occupation.

Effective completion of any enterprise requires appropriate knowledge or information on the subject. Success in agriculture also demands information on weather, soil and nutrient, crop variety, seed, pest and disease, time and process of harvesting, market demand and market price. Information can be gathered from different sources like experts, books, leaflets and pamphlets, electronic media like radio and television, print media and mobile phone and internet. The other sources have already been used effectively till date. The latest mode of information technology is the internet and mobile phone (Murthy, 2009). Mobile phone may provide necessary information at the right time in a crispy way in the form of SMS or through verbal contact with experts. Unlike other methods of information collection, it is the least time consuming, more specific to the day to day field problem, cost effective and very much

farmers' friendly.

In the context of climate shifting, the disease and pest problems of crops are increasing day by day affecting the crop production. It has also increased the farm spending considerably for getting optimum production and productivity. In many cases, the farmers are facing losses from their crop production due to lack of appropriate information backed by technologists and consequently lack in decision making power for sustainable crop protection/management. Farmers generally use pesticides indiscriminately without knowing the specific problem and right solutions for that problem. They use to move to their nearby input dealers for information with respect to the status of their crop pests, type and doses of pesticides and fertilizers. The Government machinery comprising a network of Agricultural Extension Officers and supporting staffs and agricultural programmes on TV and radio could hardly meet the timely information required by the farmers affecting with the compounding problems. Sometimes unsuitable weather conditions triggers the occurrence of a particular disease/pest and if it is predicted in time then it can be effectively controlled by informing the farmers about the specific control measures to be adopted soon through mobile alert system. Today most of the rural people are having mobile phones. Any SMS alerts reaching to a farmer having a mobile phone may be used to communicate the vital message to his neighbouring farmers who do not have a mobile phone. Thus, cell phone, a most effective mode of information technology has become the crucial need of the hour.

Use of cell phone technologies for the empowerment of marginal farmers is not a new phenomenon. The IIT, Bombay had developed farmers' friendly software where registered farmers can have their queries answered on a mobile phone. They developed a multilingual portal called AQUA (All Questions Answered), where farmers can ask questions on crops or livestock through SMS either in Marathi, Hindi or English. As a pilot project, the IIT, Bombay has also installed 36 numbers of weather-cum-disease forecasting stations in and around Nashik and farmers are alerted via SMS about a probable crop disease or rainfall likely to hit the crop with the implications and possible precautions (Mihika, 2007). Renee *et al.* (2006) studied the social and political challenges related to the implementation of ICT-Kiosk projects for rural development in India and opined that the widening of telephone network and lowering of telephone rates revolutionized the rural economy. According to Paul and Tapan (2006), use of mobile phone technologies and information systems on the rural front reduced the inefficiency and enhanced the supply chains.

Keeping these advancements of information technology in mind, one disease forecasting unit has been established at KVK, Nimpith in 2007 after which this mobile SMS-4-IRM Page 4 1/19/2012 measures. The objective of this study was about regular crop advisory, crop monitoring, crop pest surveillance and crop pest forecasting services through cell phone to farmers in resource-constrained environment for sustainable crop protection and to achieve scientific bio-intensive integrated pest management with minimum use of only eco-friendly chemical pesticides at proper dose along with proper method of application and at proper time.

RESOURCES AND METHODS

Hypothesis:

The study had tried to find out the hypothesis as proposed by Mittal and Tripathy (2009) that the mobile phones would help in reducing the specific and particular information gap related to plant protection aspect in agricultural sector and would be helpful in improving the farm profitability. There would be a positive impact on farmers' profitability by reduction in (i) costs of plant protection inputs (ii) time saving on necessary information collection and (iii) travel cost. Moreover, timely and better decision-making on preventive, protective and curative management strategies to eradicate the crop stresses from pests, diseases, soil nutrient and weather could also increase farm profits. The timely use of superior quality, advanced and eco-friendly plant protection inputs would deliver better yields and profits. The ultimate vital sense behind the study was that the information received through mobile phones could play a complementary role to extension activities and would have a better impact on plant health management than the other conventional information technologies.

Methods and data sources:

A Decision Support System (DSS) for better cost effective plant protection means the integration and organization of all possible types of timely and applicable information transfer required for development of farmers' skills, self-confidence and decision making power in their own farm to manage the harmful crop pests. Magarey *et al*. (2002) created a conceptual diagram (Fig. a) of such a DSS for pest management which was adopted for the present study. Each component can be thought of as a method with a set of associated tools. For example, the data component is associated with the collection method, through different tools including automated weather forecasting stations, site-specific weather products and field scouting of pest and diseases. DSS tools vary in complexity which include rules, schedules of management, equations, combinations of decision aids, and expert systems. The type of DSS to be adopted is determined by the combined efforts of a multi-disciplinary team comprising of knowledge specialists as well as the technical and financial resources available, the degree of support from industrial organizations and the expectations of the end users. The selection of an

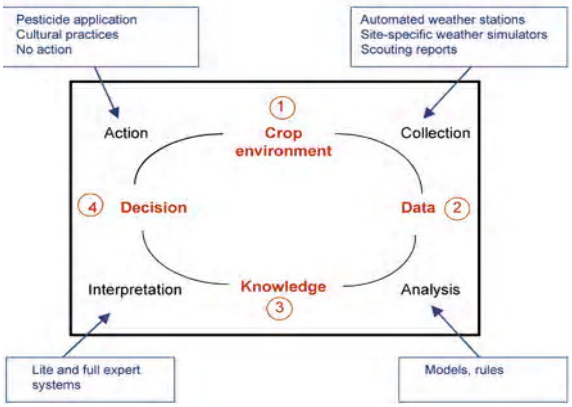

Fig. a: An idealized decision support system for plant disease management showing components methods and tools (modified form of Petersen *et al.*, 1993)

Fig. b: Process of SMS alert system on plant protection advisory through cell phone

appropriate DSS for a given cropping situation often depends upon the pathogen–pest complex as it interacts with the crop and the growers preference factors.

Clients:

The main clients were the farmers of the South 24 Parganas district of West Bengal and the community resource persons who were directly or indirectly linked with agricultural activities. KVK experts are also benefited by learning to use new Information and Communications Technology (ICT) tools for insect pests and disease forecasting and receiving regular feedback from the farm side.

Process of SMS alert system on plant protection advisory through use of cell phone:

The Ramkrishna Ashram KVK (RAKVK), Nimpith, situated in the South 24 Parganas district of West Bengal, has set up an automatic weather forecasting unit (Micro Metos MCR-300) in November, 2007. Here, the different sensors help in collecting the prevalent climatic conditions of the region at hourly basis. It records data on wind speed, atmospheric temperature, relative humidity, rainfall, solar radiation and leaf wetness. After collecting, analyzing and verifying the data with the manual meteorological unit of the KVK, suitable crop protection measures are designed for a particular disease or pest of a particular crop which otherwise may flare up in the coming days. For immediate communication of these measures to the ultimate beneficiaries - the farmers of the district, the RAKVK has set up one computer based software (E2C) comprising of a unique method of mobile SMS alert system and creating provisions for two ways round the clock direct contact between the crop doctors and farmers or community resource persons either through cell phone or direct contact. To conduct this programme in a systematic manner, two hundred numbers of progressive farmers/rural youths from different farm families and twenty community resource persons from the farm science clubs of the district were taken as sample population. All the 220 persons were trained up on different aspects of bio-intensive and other eco-friendly pest management practices before starting this programme. Crop based detailed database along with contact number of the trained persons is maintained with the KVK.

Direct plant protection advisory through cell phone:

The RAKVK had created provisions for both ways any time direct contact between the KVK crop doctors and the trained community resource persons or farmers through the cell phone.

OBSERVATIONS AND ANALYSIS

The results obtained from the present investigation have been discussed in the following sub heads:

Supporting preventive, protective and curative (PPC) measures for crop pests and diseases:

The automatic weather station collects weather data at hourly interval. On the basis of these data, forecasting of possible insect or disease attack was forwarded to the targeted farmers from the KVK. After collecting the weather data, it is plotted in an excel sheet. According to the weather parameters (temperature, relative humidity, sunshine hour, wind direction, wind velocity, leaf wetness and rainfall) it is predicted, either there is any chance of sudden insect and disease occurrence or not. As for example when there was any chance of a sudden rainfall, farmers are supported with the immediate SMS alert of applying PPC measures like spraying of *Trichoderma viride* and *Pseudomonas fluorescens* in the root zone of the plant to

prevent soil and seed borne diseases in the highly humid condition. Similarly, in case of controlling red mites of vegetables when there is any possibility of dry spell along with the hot humid weather condition, targeted farmers are advised through SMS alert to spray bio-based acaricides as PPC measures to eradicate the chances of high infestation under most favourable environmental conditions. It was observed that by adopting proper PPC measures at right time, the targeted farmers used to manage the specific problem very easily and confidently in a much better way than the non-targeted farmers. So, more practical applications as a plant disease and pest warning system involving all the useful new generation plant protection chemicals and bio-pesticides had also been prototyped.

Reducing dependency on local input dealers and improving the decision making power of the farmers for pest management of their crops:

The other important finding from this study among the targeted beneficiaries was the reduction in dependency on input dealers for their crop management. There is no doubt that local input dealers are playing an important role for agricultural development in the country after independence. They act as a local friend for the farmers to guide them in every aspect of the crop production by putting main emphasis on types of pesticides and fertilizer to be applied in their field. But, the absolute dependency on the dealers is one of important reasons for collapse of the decision making power of the farmers regarding the pesticides and fertilizers scheduling into their crop fields that indirectly led them to indiscriminate use of the same causing environmental pollution as well as resistance development against the major insect pests and diseases. On the other hand, unnecessary cost involved for excessive use of pesticides and fertilizers is increasing day by day. Table 1 revealed that the dependency on the local dealers for taking ultimate decision on crop-pest management significantly reduced along with better success in plant protection.

The development of skills and attitude towards bio-intensive pest management (BIPM):

To get optimum success in bio-intensive pest management, farmers should have adequate knowledge about the proper time and method of application of bio-pesticides and bio-agents to keep the pest population below ETL. In this regard, they were always repeatedly advocated with the methods of bio-intensive pest management either through bio-message in their cell phone or during their visit to KVK. The skills and attitudes towards the using of BIPM among the targeted farmers had been significantly improved during the study period (Table 2). Now, more than 60 per cent targeted farmers have fully adopted the vaccination of the crop plants through *Trichoderma viride* and *Pseudomonas fluorescens* based biological seed treatment, nursery bed treatment and soil treatment to manage seed and soil borne plant diseases. Moreover, more than 40 per cent projected farmers have been convinced about the need of vermicompost, neem based pesticides and bio-fertilizers for eco-safe successful management of multiple problems of their crops.

More footfalls of farmers to KVK:

After getting regular plant protection services through use of cell phone, the benefited farmers are expressing more interest in getting more updated information related to farm production system. The farmers who had earlier received information through SMS are spreading the information to their fellow farmers. Based on this, their footfalls to KVK along with other farmers have been significantly increased for gathering more information. The ordinary problems related to plant protection are solved through SMS alert or direct contact through cell phone. But to solve the complex problems, the farmers use to visit KVK more frequently for taking timely advice on plant protection measures. It increased their footfalls at KVK from 26.33/month in 2007 to 65.33/month in 2010 (Table 3).

Increased interaction with experts and improved decision making ability:

Use of mobile phone had increased the frequency of farmers interactions with KVK experts, while also saving their valuable time and expenses on transit. Quite often they used to depend on the mobile phones to gather various plant protection information for the entire crop growing season.

Table 1: Reduction of dependency on local dealers and improvement in decision making power of target farmers

Observation along with solution	Year							
	2007		2008		2009		2010	
	B	S	B	S	B	S	B	S
Problem solved by self	13.00	16.80	15.50	17.50	16.50	20.50	17.30	21.80
Visit to pesticide dealer	78.50	54.20	71.33	56.20	52.50	60.20	45.80	67.50
Visit to KVK after pesticide dealer	3.70	78.30	6.67	79.50	7.50	80.30	9.50	82.60
Visit to KVK without going to pesticide dealer	7.20	86.70	12.50	87.80	27.30	89.50	35.50	91.80
Ph call to KVK	1.50	71.90	7.50	73.20	19.20	74.10	32.20	74.20

B= Percentage number of beneficiary, S= Success percentage

Table 2: Percentage of farmers using bio-inputs and its sale at KVK

Bio-inputs	Year							
	2007		2008		2009		2010	
	P	Q	P	Q	P	Q	P	Q
Trichoderma viride	2.50	36.60	4.50	41.75	20.00	192.60	60.50	462.90
Pseudomonas fluorescens	1.50	25.25	4.00	32.35	19.50	143.80	60.00	312.50
Vermicompost	2.00	2630	5.50	3790	15.50	12040	28.00	18950
Neem based pesticides	3.50	72.30	5.00	82.50	18.50	265.30	46.00	525.10
Bio-fertilizers	1.50	21.50	2.50	29.80	14.00	175.25	23.50	242.35

P= Percentage of farmers using bio-agents; Q=Quantity of sale of bio-agents from KVK (kg)

Moreover, they sometimes invite the KVK experts or local resource persons for tackling the critical plant protection problems. The increased interactions with the crop doctors made more than 60 per cent of the targeted farmers to realize that their appropriate decision making ability with respect to plant protection efforts have been improved significantly fetching him higher returns. So, the purpose of using information technology through cell phones to provide optimal decision support for farmers on plant protection was achieved.

Table 3: Increase in farmers' footfalls (in crop protection sector) to KVK

2007	2008	2009	2010
26.33/ month	28.54/ month	43.67/ month	65.33/month

Savings in the cost of plant protection measures and increase in benefits:

Among the targeted farmers, almost all reported some cost savings from their crop protection activities by using their mobile phones as basic communication to seek information on plant protection input availability along with the particular management process including proper dose and timings for application etc. These farmers adopted the necessary plant protection strategies in time against the probable insect-pests and diseases after receiving the message from KVK. The targeted farmers also made valuable use of the information provided by the KVK experts on planting techniques (seed treatment, seedling treatment, soil treatment, bio-fertilizer use, crop rotation, crop intensification and crop diversification) to make changes in their traditional farming practices. It is noted that, they were shifted from imaginative to scientific and practical action in cultivation practices which ultimately contributed a significant increase in their annual earnings. The extra earnings of about 10-20 per cent have been achieved by cost savings through reduced sprays for plant protection. The trained farmers managed to reduce their plant protective sprays by at least 50 per cent or more per crop season, which resulted into the savings of both input and application cost. Moreover, there was a greater impact on both the quality and quantity of the produce that helped the farmers to fetch better market price. This experience varied from farmer to farmer but could be worked out through his actual production history (APH).

The entrepreneurship development among village resource persons:

The resource persons were employed as village plant doctor for the targeted and neighboring farmers. On the basis of a regular contact through cell phone with the KVK, they offered their voluntary service to the farmers for identifying the actual reasons for the crops failure. On the other hand, they earned some money by receiving reasonable commission through the provision of various services to the farmers like arranging soil testing, timely supply of bio-products to their fields etc. So, the cell phone would go a long way as sustainable equipment for integrated pest management (IPM) by creating continuous awareness among the farmers about it.

Taking a chance on new information:

The KVK experts and the resource persons have regular direct and/or indirect contact with different pesticide companies (either through mobile phones or visit of company representatives to KVK). This helps in getting information about the new generation eco-safe pesticides or newly innovated technologies for pest management. Sometimes, the internet and various journals on plant protection also serve the same purpose to the KVK experts. Whenever any new information reached to the resource persons or KVK experts from any reliable source, the much needed information used to percolate to the targeted farmers either through SMS or direct contact.

The results of this present mobile based decision support service (DSS) model accurately timed plant protection measures and reduced the cost of application without affecting the yield. There is no doubt that the growers were able to save money at various stages using this DSS model depending on the season, type of cultivar, plant protection techniques and the respective cost. Several such earlier models by numerous workers have also been developed and applied which are also more or less similar with the present structure. Jensen and Thysen (2003) applied a push and pull type warning system

where up-to-date and local agricultural information was communicated by SMS to the farmers whenever they needed and wherever they were. Laurenson *et al.* (2002) and Sasaki *et al.* (2002) developed mobile-phone based applications to access weather database so that farmers can always check the weather conditions in their fields. More practical application of a pesticide warning system has also been prototyped. Its easier interface than the computer and its mobility to fields have been welcomed by farmers. Sugawara (2001) developed a mobile phone based farm-working journal to collect field data. The software is web-based and it can directly upload the farming data to a database from the fields. Now, the proper implementation of the systems is as important as the development thereof. The challenge that lies ahead is to change the attitudes of growers, in order to encourage the use of such DSS. Kouno and Machida (2001) developed an integrated database system called "PaDB" for the purpose of supporting actions against crop diseases and pests.

Conclusion:

This study has provided a first hand look at the potentiality of mobile phones for the plant protection service as a whole. Use of cell phone was comparatively better for gathering information on plant protection services than the existing or traditional sources of getting information. The mobile phone had been found to be the most interactive ICT tool for enjoying easily acceptable plant protection service.

As per the feedback from the benefited progressive farmers, the cell phone enabled initiatives in plant protection were required at a larger scale through the Government initiative or the private players to improve the accessibility, content and timely information. There was lack of requisite skills among farmers for better adoption of the cell phone based plant protection technology. Conventional extension services and capacity building efforts can be supplemented by information dissemination via mobile phones and associated services to accelerate the adoption of new agro-techniques. However, in case of poor farmers facing significant constraints, it was found that there were still some opportunities to realize the benefits gained from the adoption of cell phone based plant protection services to mitigate crop production losses.

Information should flow in time and in a reliable manner through local language which is easy to understand. In the present study only the simple SMSs were used as a medium for communication (such as the alarming ones, needing quick action) between the KVK experts and the farmers with decision support for plant protection efforts. A sequence of related SMSs (as dialogue communication) consisting of requests and response between the user and the supplier may be developed. The available mobile technologies as described above would go a long way in alleviating the distress of the farmers living far and near and help them to compete with the global markets. The disease forecasting services model using the DSS system can be replicated across the country using the network of KVKs'.

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