THE SCOPE OF INFORMATION TECHNOLOGY APPLICATIONS IN AGRICULTURAL EXTENSION IN MAURITIUS

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ABSTRACT

A survey was carried out to identify the information needs of extension in Mauritius and the perception of the extension officers of the use of IT in their work. The possibilities and potential benefits of providing information required by agricultural extension through IT were also determined. Reaching 97% of all extension officers involved with sugarcane and other crops and livestock, the survey revealed that a wide range of information (on crop and animal husbandry practices, results of research, new technologies developed locally, market, individual farmer profiles) can be stored on a computer, and updated when necessary. Moreover, IT can provide information required for decision-making and planning locally improve the information flow within the agricultural community; information required for their work with increased efficiency of the agricultural extension. Extension officers generally possess basic skills required to use a computer and are keen to make use of IT in their work. However, the introduction of IT in extension will largely depend on the commitments of the institutions involved to provide further training and the necessary infrastructure.

Keywords: information technology, extension, technology transfer, Mauritius

INTRODUCTION

With the integration of its economy in the global trade systems, Mauritius has to improve the productivity and competitiveness of its economic and trade sectors. The agricultural sector is faced with the challenge of its modernisation. It lags behind other economic sectors with the gradual erosion of its resource-base in favour of new sectors like industry, tourism and services, and the advent of a harsher and more competitive external trade environment.

Agriculture has thus to develop through technology improvements and increased efficiency at all levels. (MEPD 1993). However this transition from a resource-based to a technology-based system of agriculture places greater responsibility on agricultural extension, which acts as a vital

conduit of new agricultural information and technologies to farmers, as well as, feedback to researchers and policy-makers of farmer's problems, needs and concerns (Kleps and Absher 1997). Generally, extension aims to bring up-to-date and reliable information about farming to those who need it, in a way that is understandable as well as useful to them (Jacobsen 1987). Therefore, an efficient extension service which provides the appropriate information at the right time to farmers, will no doubt, help to increase the productivity of farmers in Mauritius. However, extension officers must understand farming as a whole, be able to identify appropriate options and effectively draw on different sources of information or assistance, to play their role fully.

The development of computers and improvements in telecommunications offer many new opportunities to obtain technical and economic information quickly and to use it effectively for decision-making. Furthermore, in formulating a National Information Technology Strategy Plan, the government is aiming to turn Mauritius into a nation where information technology (IT) will be fully exploited to improve business competitiveness, quality of life, and to generally encourage IT diffusion at the national level. Thus, much effort is also being placed on encouraging the adoption of new technology in agriculture. Information and communication technologies can help this modernising process by improving information flow among the concerned parties. However, to date, the agricultural sector has been slow to adopt the use of information technology despite its potential to improve efficiency of planning and decision making (Bheenick 1998).

A study has been carried out, at the end of 1997, to examine the potential of information technology applications in agricultural extension. The study was based on a survey of extension officers in Mauritius, to determine their perception of how extension is carried out in Mauritius, which information are useful to extension and their information sources, the format in which the information is provided to farmers, the usefulness of IT in extension, the kinds of information which can be stored in IT applications and the computer skills of extension officers. The information thus gathered has then been used to determine whether IT has a role to play in the future of agricultural extension in Mauritius.

METHODOLOGY

The organisation of extension as it is carried out locally can be categorised into three fields namely crop, livestock and sugarcane. The Agricultural Research and Extension Unit (AREU) is responsible for non-sugar crop and livestock extension. Officers of the Mauritius Sugar Industry Research Institute (MSIRI) and managers of the Farmer's Service Corporation Centres around the island deal with sugarcane extension. Each of these organisation has its own objectives with respect to extension (Gya and Guness 1995; Naidu 1995; Pillay 1995; Rajkomar 1995). A list of

extension officers was obtained from the AREU and the MSIRI. The FSC Centre managers, also interviewed as part of the survey since they deal with sugarcane extension, were also categorised as sugarcane extension officers. Thus, the survey involved 14 extension officers from AREU, 5 extension officers from MSIRI and 10 FSC managers representing all extension officers in office except one (96.7% of the population). Background information on extension locally was gathered through contacts with resource persons at Agricultural Research Extension Unit, Mauritius Sugar Industry Research Institute and the Farmers' Service Corporation as well as with those who had previously worked as extension officers. The survey questionnaire was tested with a group of persons who had previously worked in agricultural extension, and was finalised in the light of the feedback received. A copy of the questionnaire is available elsewhere (Brizmohun 1998). Most of the survey was carried out as personal interviews but some officers preferred to answer at their own convenience either because of a busy time schedule or because they felt more comfortable in the absence of the interviewer. In the latter case, the survey questionnaire was collected a few days later and any clarifications or unfilled items of the questionnaire were completed during the meeting. The completed questionnaires were verified and the items coded. Data analysis was carried out using the SPSS (Statistical Package for Social Scientist) software. Frequency tables were drawn for each item coded and cross-tabulations were worked out to investigate the relationship between items.

RESULTS

Profile of extension officers

Age and experience

Most (90%) of the extension officers are males and their age group varies largely. About two-thirds of extension officers are below the age of 45 years while a small percentage (3.4%) is above 50 years old. Sixty two percent of extension officers have less than 10 years experience in extension while 13.8 % of the extension officers have more than 20 years experience in extension.

Access to computers and use

Extension officers may have access to computers either at home, at office or both. Fifty percent of extension officers have access to computers at the office. However, while 80% of sugarcane extension officers have computers in the office, the majority of livestock officers (75%) have no access at all (**Table 1**).

Table 1 Access to computers by extension officers %

Field	Home	Office	Home & office	No access	Total
Crop	33	11	11	44	100
Livestock	25			75	100
Sugarcane		60	20	20	100
Overall	*14*	*36*	*14*	*36*	*100*

Eighty nine percent of extension officers having access to computers use the computer. Extension officers use the computer primarily for word processing (81), while 63 also make use of spreadsheet applications. Sugarcane extension officers also access SIRITELL (6), an information system developed by the MSIRI, through the computer.

Formal training

More than half of extension officers (59) have followed a course in information technology while 55 of extension officers are willing to follow courses in information technology (**Table 2**). Thus, about half of the extension officers (47) who have already followed courses in IT are eager to further improve their computer skills. Most of sugarcane extension officers (80) have followed a course in IT. The majority of extension officers (75) who are interested in following a course in IT are below the age of 45 years, 17 between 46-50 years and the rest (8) above 50 years.

Table 2 % of extension officers having followed or interested in following courses in IT

Field	Have followed	Willing to follow
Crop	40	70
Livestock	25	75
Sugarcane	80	40
Overall	*59*	*55*

User computer skills

About two thirds of the extension officers have the basic skills required to use a computer, i.e., they can click on and move objects on the screen. Moreover, these extension officers can enter data onto a computer to create a document and save the file onto a disk (**Table 3**).

Table 3 Computer skills acquired by extension officers

Computer Skills	Frequency %
Using the mouse to click on and drag objects on the screen	66
Copy files from a diskette to hard disk	62
Opening a file which has been saved as a Word Document	69
Typing a letter and saving the file to disk	72
Making a graph on the computer	59
Printing a document	66
Protecting a document from unauthorised access	24

Use of the internet and electronic mail

The internet and use of e-mail are relatively new to extension officers as the majority of extension officers have neither used the internet (86) nor e-mail (68). Three quarters of those extension officers using the Internet have access to computers at office, while one third of extension officers using e-mail have access to computers only at home.

The practice of extension: interaction with farmers

Extension officers interact with farmers in several ways, namely through individual meetings; group meetings including workshops, seminars and training sessions; mass media (radio talks) and through publications. In all three fields of extension, individual meetings constitute the most important method of extension. Extension officers carry out individual meetings 65 of the time while, on average, group meetings are carried out 26 of the time.

Individual Meetings

The frequency of visits of extension officers to farmers varies depending on the field of extension (Figure 1). The majority of crop extension officers (90) carry out visits fortnightly while three quarters of livestock extension officers visit farmers at intervals longer than monthly. In sugarcane extension, the frequency of visits by extension officers varied with 47 carrying out visits fortnightly and 40 visiting sugarcane planters at monthly or longer than monthly intervals.
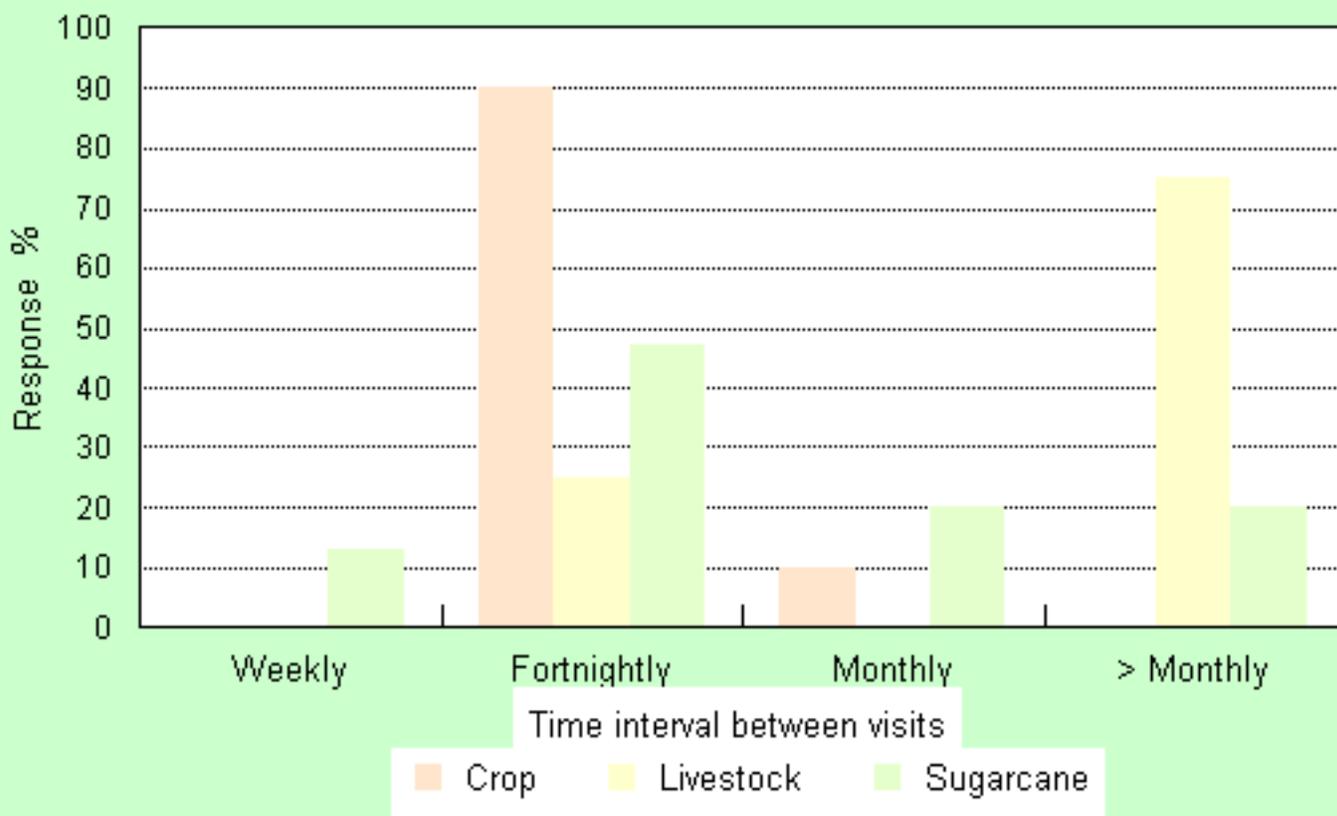
Group Meetings

The frequency of group meetings and the size of the groups vary depending on the field of extension. Crop extension officers tend to organise group meetings either fortnightly (40) or on a monthly / longer than monthly basis (Figure 2). Sixty percent of the time, the group size comprises 5-10 farmers or else it is a larger group. Half of the livestock extension officers hold group meetings fortnightly while the other half organise meetings at monthly or longer than monthly intervals. The average size of the group is often (75) between 5-10. Sugarcane extension officers generally organise group meetings monthly (53) and the number of sugarcane planters attending these group meetings is almost always (93) greater than 10.

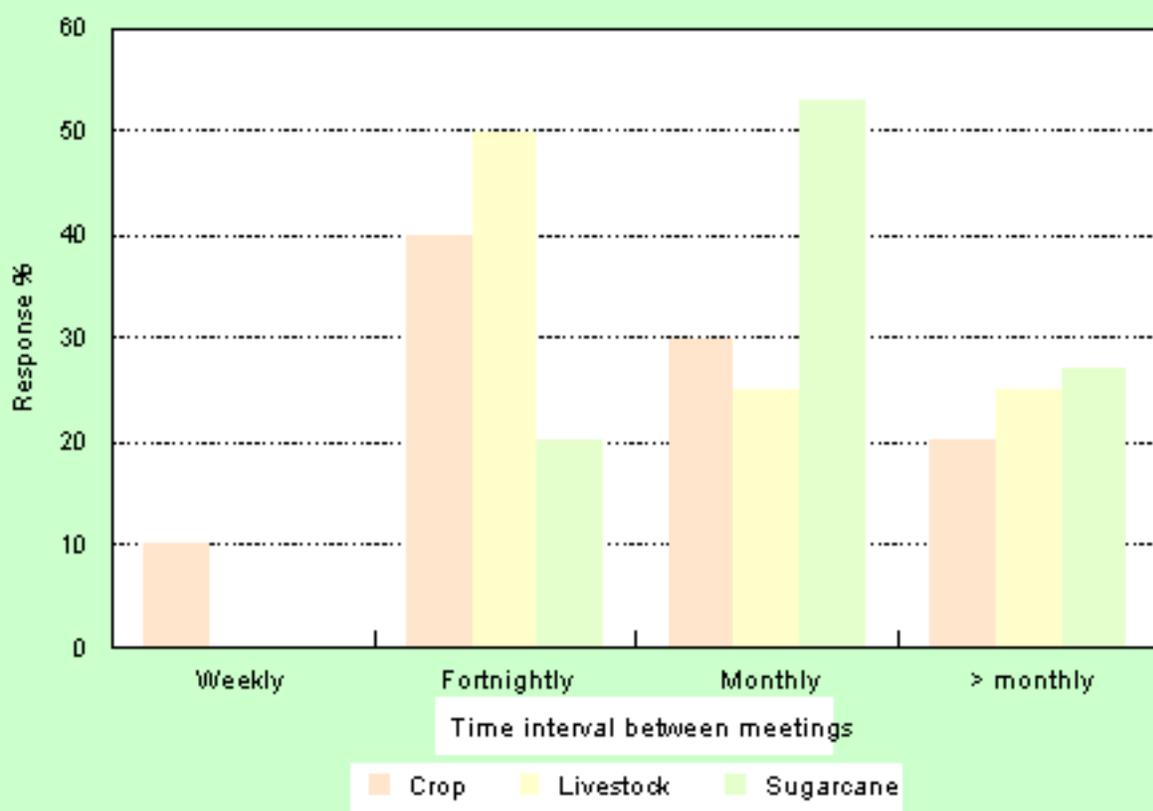## Success rate of meeting farmers during visits

Extension officers generally manage to meet 40 - 80 of the farmers regularly. However the success rate varies among the fields of extension. In crop extension, most (80) of the extension officers are able to meet an average of 60 of farmers. Similarly, in the livestock sector, three quarters of the extension officers generally meet 60 of farmers while in sugarcane extension, 53 of extension officers meet 40-60 of the sugarcane planters.

Figure 1 Frequency of visits to farmers for individual meetings by extension officers

The primary reason (90) for not being able to meet farmers is because the latter are part-time farmers, while 56 of extension officers believe they are not able to meet farmers because of the latter's lack of interest.

Figure 2 Frequency of group meetings in extension

Farmer-initiated meetings

Meetings also take place upon the initiative of the farmers when they are faced with a problem. Farmers generally contact extension officers by visiting the latter personally at the office or else they contact extension officers by telephone or by sending letters to the extension unit. Crop growers mostly (90) visit the extension officers at the office, phone in (80) or send letters (70) to the extension department. All livestock farmers come to the office when faced with problems, alternatively they use the phone (75) or mail (50). Sugarcane planters usually phone the extension

services (67) when help is required or they visit the office (60) to obtain information

Research, extension and farmer linkage

Extension is generally viewed as providing the link between applied research and the problems faced by farmers in the field. Therefore it is expected on one hand, to help in determining areas of research to solve agricultural problems locally, and on the other hand transfer the results of research to farmers. Several areas of research in each field have been determined locally as a result of extension officers being in contact with farmers and the feedback provided to researchers (Table 4). Most crop extension officers (88) state that extension has helped to guide the direction of research in pest and disease control, while the main area of research determined by extension in the livestock sector is to find solutions for the shortage of fodder. In sugarcane extension, the main area of research determined by extension has been in selecting varieties adapted to particular regions. Pest and disease problems and to a lesser extent weed management and the use of ripeners in sugarcane fields are also research issues determined by extension, following their interaction with farmers.

Table 4 Main areas of research determined by extension

Field	Area of research	Response of Extension Officer %
Crop	Pest and Disease Control	88
	Choice of varieties	12
Livestock	Problem of fodder shortage	67
	Growth monitoring	33
Sugarcane	Choice of varieties	73
	Pest and Disease Control	12
	Weed management	6
	Use of Ripeners	6

On the other hand, extension has also transferred the results of research to farmers; on new varieties of crops (60), methods of pest and disease control in crops (20) and new technology, including post harvest technology. Livestock extension has transferred research results in the area of animal nutrition (with respect to silage production and feeding of molasses) as well as demonstrated and taught farmers how to use flytraps to control flies. Sugarcane extension officers have most often disseminated information on soil amendments and fertiliser requirements of sugarcane (73) and new varieties of sugarcane released (66). Weed control and irrigation methods are among the other issues on which the results of research are transferred to farmers.

Transfer of information to farmers

Different types of information are usually provided to farmers. Advisory type of information, that is, information, which supports farmers in solving problems related to their profession, is most often (35) provided by extension officers. Information on agricultural practices, economic and market situations in agriculture (informational type) is the second most popular (24) type of information provided, while dissemination of information on the application of latest technology and, educational information, aiming to supplement and increase the professional skills of farmers are less popular (20). The majority of extension officers (93) rank personal communication as the most important format in which they provide information to farmers. The other formats used are publications (86), audiovisual means (70) and conducted tours / demonstrations (58).

Information needs of farmers (as viewed by extension officers)

The issues commonly raised by farmers give an indication of the type of information required by extension officers (Table 5). In the field of crop extension, the issues commonly raised deal with control of pest and diseases; seed availability and market information, while livestock keepers are commonly faced with the problems of lack of animals for purchase and untimely artificial insemination. Fodder unavailability is also an important issue raised by livestock keepers. In the sugarcane sector, the majority of sugarcane planters require information on weed control and fertilizer application from extension officers. Sugarcane extension officers also have to provide advice on choosing a sugarcane variety suitable for a particular region as well as solutions to the problems of water shortage.

Table 5 Classification of the issues raised by farmers

Field	Issues	Frequency %
Crop	Control of pest and diseases in crops	70
	Seed availability	60
	Market information	50
Livestock	Lack of animals for purchase	75
	Veterinary services / artificial insemination	75
	Fodder shortage / irregular supply of feed	50
Sugarcane	Weed control and fertiliser application	53
	Choice of varieties	47

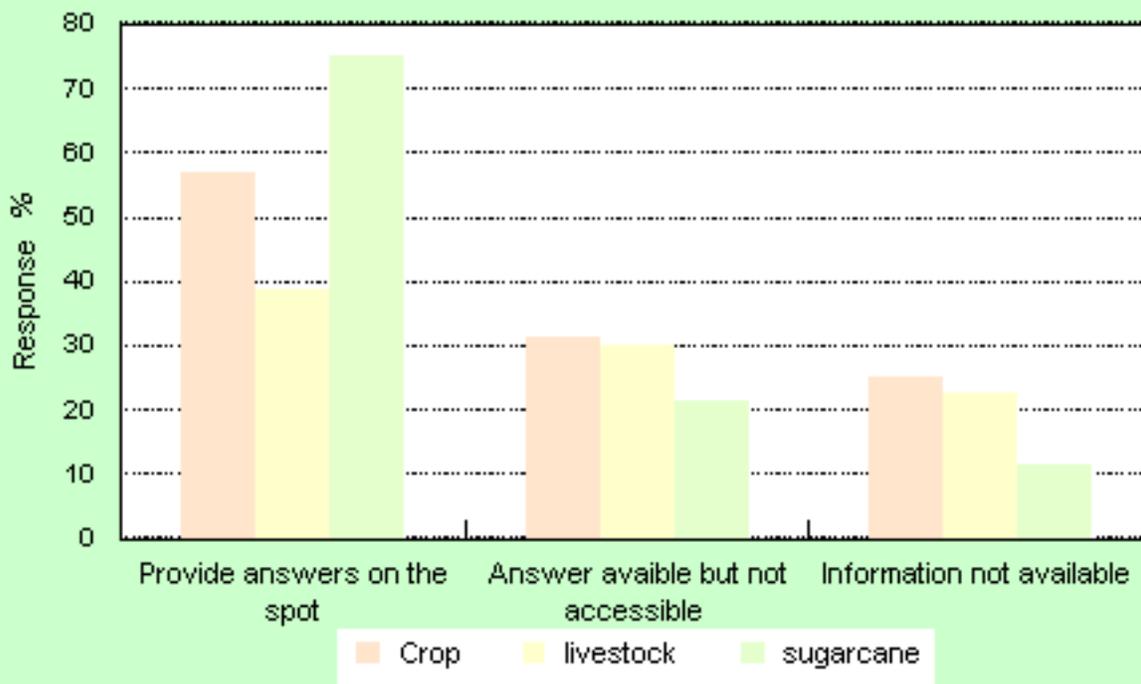|	
Irrigation problems	47
Cost of production	40

Response to information needs of farmers

Generally, extension officers provide answers to queries by the farmer on the spot. However, the extent to which this is possible varies among the areas of extension. In the case of sugarcane, extension officers provide information on the spot to issues raised by sugarcane planters 70 of the time while this percentage is lower in crop (50) and livestock extension (42) (**Figure 3**).

The answers to the queries raised by farmers are sometimes available but not readily accessible. In sugarcane extension, this occurs 20 of the time while in crop and livestock extension, around 30 of the time, extension officers do not have the information at hand to provide to farmers.

However, it does occur that information required by farmers is not available when requested and research should be carried out. This occurs 10 of the time in sugarcane extension, 22 in crop extension and 25 in livestock extension.

Figure 3 Response of extension officers to information needs of farmers

Sources of latest information for extension officers

Extension officers are usually required to provide latest and up-to-date information to farmers.

Ninety six percent of extension officers obtain latest information from their own reading. Other ways of accessing latest information are through official meetings with researchers (89.3) and through interactions with officers of the same grade (82.2). Information is also obtained from local extension publications (80.7) or from specialists in the division (77.8) while farmers themselves (60.7) often act as a source of information. Suppliers of inputs are not often used as a source of information while very few extension officers (21.7) presently obtain information from the Internet.

Perception of IT applications in extension by extension officers

A majority of extension officers consider information on husbandry and management practices and information on new technology as the most important broad areas in which information which can be provided to them through IT (**Table 6**). Information to be used for decision-making at farm level is ranked next in order of importance.

Table 6 Extension Officers' ranking of six broad areas, which can be provided through IT

Information on:	% Respondents		
	Very Important	Important	Least Important
Husbandry and management practices	69	21	10
New technology	69	10	21
Decision-making at the farm level	57	32	11
Reports on research findings	55	21	24
Market requirements	43	29	28
Decision-making at the national level	39	21	39

Further investigation into the perception of extension officers on the use of IT shows that they agree that IT can be used to obtain a variety of information ranging from information on crop husbandry, animal breeding, information on pests, information on land suitability to guidance information for new farmers (**Table 7**).

Table 7 Extension officers' perception of the use of IT in obtaining information

Information on:	% Respondents		
	Agree	*Not Sure*	Disagree
Management and crop / animal husbandry	100		
Occurrence of injurious insects	89	11	

Land suitability	89	11	
Animal improvement and breeding	86	9	5
Guidance information for new farmers	86	7	7
Governmental and statistical information	84	12	4
Marketing of fruits and vegetables	81	11	8
Research titles and topics in national research centres	77	15	8
Milk production and testing	75	25	
Rural area and production	67	29	4

Perception of sector-specific applications of IT in extension

After obtaining a general idea of the information requirements of extension officers, the latter ranked the importance of specific information that could be made available to them through IT applications such as a database and an information system.

Perceptions on a database / information system in field of crop / sugarcane

All extension officers considered a database containing such information as: name of planter; crops grown in a particular season; acreage under crop/sugarcane production; varieties of sugarcane/ crop grown; planting date; amount of fertiliser / manure applied; pest and disease encountered; chemicals used to control pest and diseases be provided to extension officers, either as essential (52) or very useful (48).

All crop and sugarcane extension officers consider the results of research in agriculture as important and useful to have on a computer. 88 of extension officers would like to have information on new technologies available on computer (**Table 8**)

Table 8 Importance of information in crop / sugarcane extension and its usefulness on an information system

	% Respondents		
Information on	Useful to have on computer	Acquired by working experience	Not required
Results of research carried out locally and abroad	100		
New technologies	88	8	4
New agricultural products available on the market	79	17	4

Prices of inputs	77	14	9
Varieties grown in particular areas	67	33	
Soil and climatic requirements	67	29	4
Cultural practices: fertilisation; irrigation; pest and disease control	61	39	
Places where inputs can be obtained	57	38	5
Land preparation and planting methods	27	73	
Expected yield in a given region	21	71	8

Information on new agricultural products, information on prices of inputs, varieties grown in particular areas, soil and climatic requirements of crops and cultural practices are important information which over half of crop and sugarcane extension officers consider important, but a large share of the extension officers also believe that these information can be acquired with work experience. Land preparation and planting methods as well as expected yields are important but generally not considered as useful to have on a computer.

Perceptions on a database / information system in field of livestock extension

All livestock extension officers considered a database for the livestock sector be created containing information such as: name of livestock keeper; number of heads of livestock; age of animals; breed; feeding practices carried out by farmer; rearing system adopted; pest, disease and other problems encountered; monitoring of pregnancy in cattle and calving rate; and vaccination programs followed as database as either very useful (50) or essential.

Information on feeding management of livestock and results of research carried out locally are important information which all livestock extension officers find would be useful to have on an information system while 67 of them consider information on diseases affecting livestock as important and would like to have such information on a computer. However, information on housing condition of livestock, prices of inputs including feed, breeds of animal and knowledge of the sources of feeds and other inputs are often acquired through working experience(**Table 9**).

Table 9 Importance of information in livestock extension and its usefulness of an information system

Information	% Respondents		
	Useful to have on computer	Acquired by working experience	Not required
Feeding Management	100		

Results of Research carried out locally	100		
Diseases	67		33
Housing conditions	50	50	
Prices of feed and other inputs	50	50	
Breeds of animal	50	25	25
Places where feeds and other inputs are obtained	25	75	

Immediate applications of IT in extension

All extension officers recognise the use of computers in their work as a tool to store, process and retrieve information, with a range of objectives more pertinent to the field of extension and the main issues raised by farmers (**Table 10**). Thus, crop extension officers would presently use computers to access information on new technology and research findings, especially on pest and disease control. Sugarcane and livestock extension officers see the immediate applications of computers in their work as accessing a database on the individual farmers and as a means of speeding up the flow of information and communication.

Table 10 Currently envisaged potential applications of computers in the extension officer's work

Immediate applications of computers in the extension officer's work	Response %
Crops	
Store, access and retrieve information required for work	30
Information on pest and disease control	20
Comparison of yields in different areas	20
Information available on new technology and research findings can be accessed easily	20
Information on crop production can help to analyse and plan market demand and supply	10
Timely and up to date information for decision making may be obtained	10
Livestock	
Keeping records of visits carried out by extension officers	25
Data information flow between research and extension is facilitated	25
Follow up of farmer's activities	25

Sugarcane	
Data processing	53
Accessing databases of individual planters	47
Rapid method to manage information in an efficient way	40
Availability of latest information	20
Essential tool	20
Input and output of data for proper decision making	20
No need to keep bulky files	6

Importance of computer networking in extension

All extension officers believe that a computer network linking extension offices is useful. The various groups of extension officers illustrated the applications in their field of extension. Crop extension officers believe that computer networking may improve the extension process itself, for example, through more rapid and efficient information flow among researchers and farmers, eliminating a lot of paper work. Access to up-to-date information such as pest and disease attacks would also be improved, while the collection of information through networking could easily provide an overall idea of food crop production, as well as comparison of yields in different areas.

Livestock extension officers would be able to compare activities of farmers in different regions as well as the problems faced by farmers. Linking computers through a network would help officers put ideas together to bring solutions to problems at farm level. All livestock extension officers agree that it is important for them to be connected through a computer network to other extension offices, the central office, and other divisions such as Dairy Chemistry Division, Veterinary Division and the Agricultural Marketing Board.

The majority of sugarcane extension officers (93) are of the opinion that a computer network linking extension offices (FSC and MSIRI) is important to them. The main aim of this network will facilitate information flow, that is, extension officers will have ready access to information on sugarcane and they will also be able to share information and experience among themselves. A computer network will also help the extension officer give advice to a sugarcane planter growing sugarcane in different areas of the island since all the information on that particular farmer will be available on a computer. Furthermore, extension officers will be able to compare sugarcane production data in different regions of the island.

Perception of constraints to the application of IT in extension in Mauritius

Extension officers ranked the constraints that might hinder the application of IT in extension. Training of extension officers constitutes the most important constraint (89) to be overcome

before IT can be applied in Extension. Other constraints include lack of familiarity of extension officers with computer and lack of infrastructure (Table 11).

Table 11 Obstacles to application of IT in Mauritius

Obstacles	% Respondents		
	Agree	Not sure	Disagree
Training of extension officers	89	11	
Lack of familiarity with computers	60	25	15
Lack of infrastructure	59	22	19
Lack of information to create a database	41	4	55
Lack of legal framework	35	42	23
Financial Constraints	7		

DISCUSSION

The practice of extension in Mauritius

The survey of the extension officers at the end of 1997 confirms that the target audience for each institution is clearly defined. It has also been established that extension officers are predominantly male, two-thirds below the age of 45 years. However, a recruitment exercise was under way at the time of the survey at the AREU, in line with the role it is expected to play in promoting agricultural diversification in Mauritius and in increasing agricultural productivity at the national level (MANR 1995a), dealing with around ten thousand livestock keepers and a similar number of food crop growers.

The Extension Division of the Mauritius Sugar Industry Research Institute and the Farmers' Service Corporation, being the two organisations involved in sugarcane extension, while the Agricultural Research and Extension Unit is responsible for extension in the non-sugar crop and livestock sectors. The latter institution is expected to play an important role in modernising and revitalising agriculture locally. The frequency of visits to farmers by extension officers varies depending on the field of extension. Thus, crop extension visits are mostly (90) carried out on a fortnightly basis while livestock extension officers (75) visit farmers at intervals longer than monthly. This can be explained by the fact that most vegetable crops are short cycled and therefore farmers require more frequent visits of extension officers whereas rearing of livestock does not necessitate frequent visits of extension officers unless the farmer is faced with

difficulties. Sugarcane extension officers visit sugarcane planters either fortnightly or at longer interval depending on the cultural practices adopted and the time of the year.

Individual meetings are the preferred method of carrying out extension rather than group meetings. Information is most of the time provided as personal communication. This ensures that the farmer receives the correct information from the extension officer in an appropriate form. Publications are also given to farmers; however, this format is not appropriate to farmers who are illiterate, hence reinforcing the importance of personal communication. Group meetings are also effective to disseminate agricultural information. Thus, in the sugarcane sector, large group meetings are held on monthly basis, possibly as a strategy to satisfy the 35000 small sugarcane planters.

In addition, farmers especially crop growers and livestock breeders, usually call at the office to meet extension officers when faced with a particular problem. Moreover, a larger number of farmers are now using the phone to get in touch with the extension officers, also demonstrating that farmers are adapting to the development in communication technology.

Information exchange in extension

Extension is playing its role of providing the link between the researcher and the farmer whereby the results of research are communicated to farmers as well as feedback on the problems faced by farmers to researchers, examples of both having been found during the survey. Extension officers have to deal with a wide range of types of information and therefore have to be well informed on technical, economic and social aspects of farming to advise farmers. They generally obtain such information through their own reading, their peers and through publications but only a small proportion (22) currently obtains information from the Internet. This is expected to rise in future.

Generally, extension officers are in a position to answer queries of farmers on the spot and sometimes the answer to the query may be available but is not readily accessible. However, extension officers cannot provide answers to the farmers 10 and 22 of the time, in sugarcane and crop extension respectively, until further research is carried out. The lower figure in the case of sugarcane extension may be due to the fact that research in sugarcane has been geared towards the needs of farmers while crop extension has to deal with a larger array of crops.

Scope of information technology applications in extension

Extension officers are also aware of the potential of information technology to provide a variety of information ranging from information on crop and animal husbandry practices, information on pest occurrence to information on current research projects. Overall, they have a positive attitude towards IT applications in their field of work.

Half of the extension officers have access to computers at the office. However, these are mainly sugarcane extension officers at the MSIRI and the FSC, which demonstrates a difference in the exposure to information technology at the level of the institutions in Mauritius. Furthermore, the extension officers who actually use the internet are those having access to computers at the office, possibly indicating that exposure to the technology leads to further exploration of its uses and applications.

More than half of the extension officers have already followed courses in IT and about two-thirds already have the basic skills required to use a computer. Therefore, these extension officers would be able to use an agricultural information system developed around the concept of the World Wide Web, which uses a graphical user interface, as proposed by Bheenick (1998). Such a system allows up-to-date information to be obtained rapidly and often simply by making use of relevant keywords. The web also has the ability to link up relevant information located on the Internet. Therefore, the ability of IT to provide information rapidly to a large audience makes it an appropriate tool to facilitate communication in extension.

Furthermore, fifty five percent of extension officers are interested in following courses in information technology. Further training, especially of the younger generation, will allow extension officers to use information made available to them through IT. Moreover, these extension officers would be able to evolve together with the new technology being developed as well as contribute to the information system during their career.

Information technology can have a major role in communication and exchange of information in extension. Generally, both extension officers and farmers need convenient access to a wide range of scientific publications (Jones 1990). Such publications are costly to print and take up valuable storage space and therefore electronic publications provide a good alternative. Additionally, electronic publications reduce the dissemination of out-of-date information (Tennessen et al. 1997); dynamic information, such as pesticide information, needs to be updated often and delivered quickly to farmers from researchers. Moreover the advent of CD-ROM technology allows a large amount of information to be stored in compact discs enabling extension officers equipped with portable computers to provide information to farmers in the field.

While extension officers get access to up-to-date information from researchers to provide to farmers, it is also essential that researchers obtain feedback information from farmers via extension officers. Bheenick (1998) proposed that all agricultural institutions set up local area networks (LAN) to improve internal communication and that extension offices and other relevant agricultural institutions be linked through a computer network to further improve communication such as sharing and exchanging of information among extension officers. Therefore, an information system developed together with the user-friendly interface will help manage

information in agriculture and hence allow sharing of ideas within the agricultural community possibly even bridging the link between farmers and researchers.

The setting up of an integrated agricultural information system will be helpful not only to extension officers but also to users of agricultural information including farmers, cooperative societies, governmental organizations, researchers, students and policy makers. Progressive farmers who are willing to use this integrated information system will, no doubt, benefit from such a system. They will have access to the appropriate information at the right time, allowing the right decisions to be made, which will consequently lead to an increase in agricultural productivity.

An eventual use of e-mail for communication could allow information to be received even in the absence of the computer user and stored until the user reads its, hence ensuring that the information is transferred to the individual, whether he is a researcher, extension officer or farmer. In addition, through the networking of computers, data entry concerning agricultural production for different regions made in different extension offices around the island can provide an overall idea of agricultural production and enables comparisons of production within different areas in Mauritius.

Therefore, the study seems to indicate that there is already an opportunity and a lot of potential for the use of IT by extension officers in Mauritius. In fact, the survey has also established that information technology could be of use in satisfying the information requirements of extension officers and farmers in their field of work in the short term. The specific examples of applications in extension are discussed below.

Scope of IT applications in crop and sugarcane extension

The most important information required by crop and sugarcane extension officers and which can also be provided by IT is information on crop husbandry and management practices. The commonly raised issues by crop and sugarcane growers include control of pest and diseases, weed control, land preparation and other cultural practices. Furthermore more than half of crop and sugarcane extension officers would like to have such information on a computer. Information on these aspects of sugarcane is available through the SIRITELL information system developed at the MSIRI, with new modules to be added in future.

Information on crop husbandry and management of non-sugar crops grown locally is already available in printed form (MANR 1995b) and also in publications of the extension unit of AREU. This information could be made available to extension officers electronically, through an information system, making it readily accessible and easier to be kept up-to-date.

Having access to information on new technology developed for the agricultural sector and reports of research findings are very important to most extension officers. One of the roles of extension officers is to transfer new technology from research to farmers. Therefore, it is essential that extension officers have quick and ready access to such information to be able to give the necessary information to farmers. Crop and sugarcane extension officers would like to be provided with results of research (96) and information on new technologies available (84) through an information system.

Extension in Mauritius does not provide market information (demand, supply and prices of food crops) to farmers, as is practiced elsewhere (Kleps and Absher 1997). Hence, it is difficult to plan crop production, resulting in prices of agricultural products fluctuating according to demand and supply. In some cases, farmers are not able to recuperate their investment if prices fall too low. Crop growers often raise this issue with extension officers (50) implying that farmers require such information. Given that extension officers are in contact with farmers, a database containing information on crops grown by farmers can be used to predict yields of different crops at any one time. In this way, crop production can be controlled to satisfy the market demands. However, this will require the collaboration of farmers, as they will have to provide correct information such as area under cultivation and costs of their production.

One of the roles of an extension officer is to assist farmers in decision-making at the farm level. The extension officer should therefore master technical, economic as well as social issues so as to be able to provide sound advice to the farmer. Moreover, crop and sugarcane extension officers mention that a potential use of computers in extension would be to provide timely and up-to-date information for decision-making. Therefore a computer database containing information on the farmer and the previous practices adopted by the farmer and an information system containing important aspects of crop husbandry, results of research and new technologies will help extension officers provide the correct information so that farmers take proper decisions.

Information technology is concerned with the storage, processing and dissemination of information. Information plays an important role in planning and decision-making. Hence the availability of a large amount of reliable information will assist in planning. For example, one of the problems currently faced by many crop growers is the lack of seeds and planting material. Therefore, it is essential that authorities take the proper steps to ensure that the amount of planting material that will be required by growers is available. To be able to achieve this, the authorities should have basic information such as the number of growers in Mauritius and the area under cultivation of specific crops. Such information can be stored and made available rapidly through IT to facilitate planning.

Scope of IT applications in livestock extension

Although there are only a few livestock extension officers, they provide an insight of the information needs of extension officers and farmers in this field. Fodder shortage is one of the major issues raised by cattle keepers as well as a major area of research locally. A better planning strategy can help to solve the problem of fodder shortage. Moreover, extension officers deal with a range of livestock animals including cattle, poultry, goat, pig and sheep, each having its own specificity as far as feeding is concerned. To be able to recommend appropriate feeding management, extension officers require information on types and quantities of feed so as to be able to plan for adequate feed supply. Hence, it is beneficial to have such information on an information system. Moreover, any results of research concerning feeding of livestock can be updated when available on an electronic format on the computer. A similar approach could be used to solve the problem of a lack of animals for purchase, following importation by government services.

Livestock keepers rarely ask extension officers for information on diseases affecting livestock but 67 of livestock extension officers find it useful to have such information on an information system. This may be because problems of diseases in livestock are usually dealt by the veterinary services of the Ministry of Agriculture. However, extension officers would at least need to identify diseased animals so as to recommend the advice of veterinary services. Information on diseases of livestock such as symptoms of common diseases is already available in local publications of the livestock extension and can be supplemented with the help of veterinary services so that it can be provided in electronic format on a computer to extension officers. In addition, coloured graphical displays, illustrating the disease symptoms, can be made available on a computer

Half of the livestock extension officers consider information on housing conditions of livestock important and believe it should be provided to them through an information system while the other half have acquired such information through working experience. Thus new technology developed or results of research in this subject can be made available to the extension officers through an information system and such information on housing conditions would be beneficial to newly recruited extension officers who have not yet gained such experience. Information on housing conditions for different livestock is already available locally in publications of the Livestock Extension Unit and can be used as a basis to create such an information system.

Information on prices of feed and other inputs are considered by half of the livestock extension officers as important information, which can be provided by a computer. The other half of extension officers do not consider places where inputs can be obtained as an important information for extension officers as farmers do not ask them for such information. However to achieve a higher agricultural productivity, it is essential that farmers invest in inputs such as feeds. Therefore, the extension officer's role is to provide information on sources and prices of inputs to farmers to encourage them to consider these options. Hence information technology can

be used to store such information so that it can be made available to farmers by extension officers.

Obstacles to IT applications in Mauritius

The survey has shown that the information required by farmers and extension officers locally can be provided by information technology applications, especially those that are in greater demand, such as information on husbandry and management practices, information on research carried out and new technology available to farmers, market information, and information for decision-making at the farm level. However, even though the government is committed to introducing information technology at the national level, the introduction of IT in extension in Mauritius will depend largely on the commitment of the institutions involved. Therefore, these institutions will have to devise Information Technology strategies to overcome current obstacles dealing with issues such as training, infrastructure, appropriate human resources, and the adoption of a policy on information sharing.

Training of extension officers is necessary before IT can be applied locally; 89 of extension officers believe that they need training to make good use of a computer, of which 53 also lack familiarity with computers. However, a graphical user interface (GUI) that makes use of the 'point and click' concept to issue commands does not require much computer skills and extension officers will not find great difficulty to use a GUI. In fact, some of the extension officers who have access to a computer at work are already using the Internet to obtain latest information.

In addition, a proper infrastructure is required to apply IT to the extension unit. Extension offices will have to be provided with a computer, a modem and a phone line to be able to be linked to other computers, or even to the World Wide Web. Furthermore, the pace of development in this area is fast. However, it will be of no use waiting any further to adopt the technology and make it generally available. Financial constraints can no longer be considered as important as the technology is getting cheaper and the decision to invest in the equipment depends on the benefits the institution expect to derive from the adoption of IT.

As the rate of adoption of IT in the agricultural sector increases, human resources will be required to develop appropriate systems, as well as for the maintenance of these systems. However, training institutions such as the University of Mauritius can provide the multidisciplinary approach required in the development of a common, user-friendly interface for the information systems and train the necessary human resources. However, the major obstacle to the application of IT remains the adequate exchange of information among institutions. Databases that will be developed may contain a lot of personal information on farmers, which may be a concern for the individual citizen. Therefore, the process of applying IT in extension will require a policy decision on behalf of the institutions and the Ministry of Agriculture as well as to provide a legal framework for such information exchange.

CONCLUSION

The survey has shown that most of the information required by extension officers, and eventually farmers, could be made available through IT. The information ranges from information on crop and animal husbandry, results of research such as new technology developed, to market information. Moreover, IT can provide information for decision-making both at the farm level as well as at the policy formulation level. Most of the information required for the creation of an information system is already available but is not currently in a structured electronic form that can easily be accessed. For example, information such as market information is not presently accessible but the creation of a database with the collaboration of farmers, providing up-to-date information regularly could provide information on the demand and supply of crops. Furthermore, information on research carried out locally and new technology can be updated and disseminated rapidly when available on a computer.

Information technology offers the advantage of providing up-to-date information required by extension officers rapidly, increasing the efficiency of the extension services. Hence, IT applications will help extension officers and farmers make good decisions. IT also offer the ability to link up the information held up at different agricultural institutions so that a wide range of information is available at any time. The evolution of information technology in extension can also, in the future, lead to the development of expert systems and decision support systems in the form of simulation models.

Moreover, this survey has shown that extension officers are interested to use IT applications to improve the information flow between researchers and farmers. About two-thirds of the extension officers have a computer literacy level which would allow them to use an agricultural information system with a graphical interface. Therefore, there is scope for the application of IT in extension in Mauritius. However, training will still be required not only for new users of computers but also as their skills in applying IT in their area of work evolves.

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