Journal of Agriculture in the Tropics and Subtropics
Volume 102, May 2001, pp. 53 - 58

Intellectual Capital Management in Agricultural Research Efforts and the Role of Smartcard Applications in enabling Knowledge Exchange

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1 Introduction

Modern agriculture requires an innovative capacity which exceeds the individual research scientist, farmer, industrialist or consultant. In order to flourish, agriculture needs to utilise the vast wealth of information that is available to decision makers to improve productivity, efficiency and progress. Research teams could reach their goals faster if a convergence of information flow were available to them and to external parties applying previous years' research outcomes.

This challenge has long being posed in the pharmaceutical's industry where intellectual property is the pivot point around which business is driven. It is also increasingly apparent in management consulting firms where prior learning experiences of research teams are assigned a value in attempting to resolve new problems and tackling new projects.

It is ironic that whilst agriculture, as a biological discipline, is one of the highest data-generating activities in the economic climate, it is at the lower end of the spectrum when it comes to managing its knowledge bases. The mere development of a new wheat variety, for example, generates and consumes many thousands of pages of information. Is this information considered knowledge? How would the lack of this information affect the research outcome, ie what value does this information have? And how can agricultural research efforts be coordinated in a more streamlined fashion by converging knowledge management?

This paper attempts to address the influence of Intellectual Capital Management (ICM) on agricultural research activities and a method with potential in bridging the ICM gap.

2 Information and Knowledge Basics

There is a difference between *information* and *knowledge*. *Information* is merely data until it is processed and analysed by which time it becomes *knowledge*. This knowledge is the basis on which numerous industries are established and represents the "useful" part of information. The difference in value between information and

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knowledge is the same as the difference in value between crude oil and airplane fuel, respectively. Scientists seek to gain information by way of research, but this information becomes knowledge once it is applied and used to discover further information and so on.

Knowledge can be managed. This encompasses storing knowledge, accessing knowledge and passing it on. The key words are *accessing* knowledge and *passing it on.*

Knowledge is the primary resource we draw upon when designing agricultural, horticultural or biological experiments. The nature of knowledge as a resource is so different that we have seen a phenomenal growth of attention to knowledge management (ALLEE, 1997).

Let us explore the plant-breeding example mentioned earlier. Information on the genetic background, phenotypic, environmental and breeding history of lines of plants is intellectual property. It is IP that is owned by the companies and organisations that produced this information by way of gathering it, accumulating it or researching it. However, the plant breeders who have worked on these lines for extended periods of time are the ones capable of transforming this information into knowledge. This combined information can be utilised in such a way that new varieties and cultivars are bred and brought to existence. The value of the IP, then, is not merely in the information that resides on the organisation's database, but in the ability to use it (KADER, 2001).

Knowledge can be managed. Managing it encompasses storing knowledge, accessing knowledge and passing it on. These three functions, from a technology perspective, are achieved by hardware and software that stores and disseminates the content of a knowledge database. There is one tool, though, that appears to stand out in terms of its ability to deliver "end-to-end" knowledge and ICM solutions. This is the smartcard.

3 Smartcards

Smartcards have been in existence for many years. The first smartcard was developed in Germany in 1968 by Juergen Dethloff and Helmut Groetrupp, with considerable advancement being made since.

A smartcard is essentially a credit card-sized plastic card with an embedded chip. This chip is the factor that makes the smartcard "smart". It is, in essence, a compact computer placed inside a plastic coating that looks like a normal card.

There are various clones of cards depending on the power of the processor, storage capacity and the way in which the card interfaces with the outside world. Smartcards could, thus, be contact cards, contactless or dual interface. Contact cards have to be inserted into a reader in the same way as one would access a bank's ATM. Contactless cards can be waived infront of a receiving reader that communicates with the card remotely, and dual interface cards incorporate both contact and contactless technology. The main uses of smartcards have been in automated fare collection in public transport, toll payments on motorways, health cards and ID cards. Mobile phones also utilise smartcards in the form of SIM. However, smartcard applications have started to penetrate other areas of science and technology. Smartcards are used to capture biometric data, provide an extremely secure store of information and are used in e-commerce. The potential for usage in agricultural research is significant.

4 Smartcards and Intellectual Capital Management in Agriculture

Consider a multi-disciplinary research organisation catering for various agricultural sciences. Within the organisation may be a team looking at various lines of salt-tolerant sorghum varieties, a team investigating the influence of seed priming treatments on germination of sorghum under drought, and a team researching the impact of cultural practices in reducing evapotranspiration in sorghum stands. The tissue culture and biotechnology department may be looking at identifying genes responsible for expressing ABA production in stressed plants and the influence of this on growth under stress.

These teams may frequently meet and discuss their findings. Seminars and publications provide a platform for exchanging information, views and new ideas. However, in the strict definition of Intellectual Capital (IC), this is merely information. The way in which this information is exchanged is relatively streamlined, but lacks coordination. An individual researcher must access numerous sources of data to obtain *parts* of what is required to assist her/his research effort.

The smartcard has the capacity to store a profile. This profile can be of the cardholder or of her/his preferences. These preferences could range from the preferred seating on an airplane to identifying a recessive gene. The cardholder could interface with the card via a normal desktop computer and alter this profile (if the smartcard application is programmed to allow them this level of access). In the case of the interdisciplinary organisation above, consider that the team looking at salt tolerant sorghum varieties was seeking a specific piece of information. It would post this request on the smartcards of its members. The same would apply to all other teams who would enter the information they are looking for and the results they have reached onto their smartcards in keyword or abstract format.

By swiping or waiving the card infront of a reader, the card can identify that an individual within the organisation has the information that another team member is looking for. It could automatically send an email request to the information holder for that information, or it could automatically send a request to the library for that article to be sent.

The card, with a sufficiently powerful processor, could also update the system so that if the entered profile covers already existing information, that information is immediately brought to the attention of that research team. The card can perform automatic dial-in to the system so that no login and password is required and the application could request the computer to send short results to a mobile phone, personal digital assistant or Internet-based e-mail address. The applications in this area may include notification of exceptional ranges of readings etc. This functions in wire and wireless environments, so experiments in the field could be conveyed live via mobile telephony or stored offline on the card until the information can be downloaded the first time the card accesses a reader.

The IC of this particular organisation whilst still stored on disparate databases within each department has now become instantly accessible and more importantly *relevant*. Only the specific information pertinent to a particular research topic could be specified or a range of parameters could be specified. This depends on the user's requirements. This will greatly increase the speed with which IC is developed, the accuracy of experimental reporting and the commercial and developmental relevance of information being exchanged.

Within one legal entity IC exchange does not pose an Intellectual Property concern. However, the boundaries between commercial secrecy and IC become more apparent in profit-based organisations. For these organisations an elevated level of security could be incorporated into the card like biometric parameters and cryptographic signatures etc.

The open aspect of smartcards is that the same smartcard used as a search engine could be used as a driver's license, health card or electronic purse. Many applications can run separately on the card in the same way that various separate applications run on our computers.

5 Future Trends

Agricultural businesses and even research institutes have lost their locks as purveyors of information and knowledge. Meanwhile, information has become the primary asset of many of these organisations either directly or indirectly. A collection of data is not information. By the same token, and as discussed above, a collection of information is not knowledge. Finally possession of knowledge does not mean wisdom. Knowledge, then, from an agricultural standpoint, is information on direct and indirect inputs that influence the outcome of an agricultural activity directly or indirectly. This information has been found, acquired or otherwise, has been processed, distilled and packaged in such a form that is useable by the human mind. There can be a person responsible for this in an organisation- a knowledge worker. This individual may not necessarily *contribute* information that is turned into knowledge, but has the role of *processing* information to turn it into knowledge. The knowledge worker is not to be confused with the knowledge user who merely uses this to perform his or her job.

As people relocate, change careers or otherwise, a wealth of knowledge and subsequently IC is lost (Drucker, 1999). Some of this is replaceable, in the short or long term, and some is irreplaceable. By managing knowledge through computer and communications or through the efforts of a dedicated knowledge worker, many of this information is retained and converted into IC. This applies not only to research-related information, but to the know how farmers have, traditional production methods, seed varieties, and cultural practices. (think of what the Grimm Brothers did to preserve, otherwise lost, tales)

Currently, many formulas attempt to place a monetary value on information and knowledge, but this is beyond the scope of this paper. The general idea is that IC is of value to an enterprise, university or seed bank. Various international consulting firms have established divisions that consult on knowledge management and how to transform it into IC, IP and subsequently monetary value to the business. Many International pharmaceutical companies pay millions of dollars a year in accessing sources of information and spend additional millions of dollars transforming it into knowledge. The business cases for this have so far been solid and returns have been sound.

At the conservation level of agricultural research, the value of Human Capital in the bio-production cycle is enormous. The potential IC each individual has is of value to the overall effort to conserve plant and animal species, whilst maintaining a sustainable level of agricultural production. Ten farmers, for instance, may collectively have a combined knowledge span of 200-300 years.

The near future will see convergence of laboratory devices with mobile telephony products and smartcards. Wireless technologies have already influenced the way in agricultural scheduling takes place. Enhancements in the smartcard arena will see a diversity of applications serving the growing Intellectual Capital space.

5 Summary

The transformation of information into knowledge and subsequently Intellectual Capital is of significance in agricultural research programs. Both from an interdisciplinary team effort and the conservation of scarce natural resources points of view, knowledge management has potential in advancing world agriculture.

An array of hardware and software solutions exist today to manage knowledge, but one that is small, convenient and fast is the smartcard. Smartcard applications have the potential to increase the speed and efficiency of agricultural research and to apply these to the well being of sustainable agricultural development. This article provides a brief overview of this application.

6 References

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