USE OF INFORMATION TECHNOLOGY IN SOUTH AFRICAN AGRICULTURE

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Rapid developments in information technology have exposed South African farmers to the potential benefits of using these technologies in farm decision-making. Use of computers on South African commercial farms is increasing, with three studies showing adoption rates of 48 percent (1993), 64 percent (1996) and 72 percent (1998). About 38 percent of computer users in a 1998 survey of commercial maize farmers had access to the Internet. Spreadsheets and financial management software are popular amongst commercial farmers, while use of Global Positioning Systems (GPS) and Geographic Information Systems (GIS) are being used more widely in South African agriculture. Small-scale farmers in developing areas rely mainly on government and private industry extension services for farm information.

GEBRUIK VAN INFORMASIETEGNOLOGIE IN DIE SUID-AFRIKAANSE LANDBOU

Snelle ontwikkelinge in informasietegnologie het Suid-Afrikaanse boere blootgestel aan die potensiële voordele van hierdie tegnologie in boerderybesluitneming. Die gebruik van rekenaars op Suid-Afrikaanse plase is aan die toeneem: drie studies toon naamlik aanvaardingskoerse van onderskeidelik 48 persent (1993), 64 persent (1996) en 72 persent (1998). Sowat 38 persent van rekenaargebruikers in 'n 1998 opname van kommersiële mielieboere het toegang tot die Internet gehad. Spreivelle en finansiële bestuursagteware is gewild onder kommersiële boere, terwyl die gebruik van Globale-Posisioneringstelsels (GPS) en Geografiese-Inligtingstelsels (GIS) in die Suid-Afrikaanse landbou toeneem. Kleinskaalseboere is vir hulle boerdery-inligting hoofsaaklik op staats- en privaatnywerheidsvoorligting aangewese.

1. INTRODUCTION

Rapid developments in information technology have created considerable opportunities for farm businesses to adapt their operational and managerial processes to changing market requirements. Information is becoming more accessible and less costly, and markets are becoming more competitive (Thompson & Sonka, 1997). In South African agriculture, researchers, managers and advisors recognise the important role that information technology can play

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in improving the competitiveness of agricultural firms. Small-scale farmers are also increasingly being exposed to new information technologies that can provide relevant information for their farming needs.

The objective of this paper is to review the use of information technologies in both the commercial and developing agricultural sectors of South Africa. Obstacles to their use in both sectors are also identified and discussed in a concluding section.

2. USE OF INFORMATION TECHNOLOGY IN COMMERCIAL AGRICULTURE

A review of the information technology literature shows that a comprehensive range of computer software packages is available or is being developed for use by experts, extension agents, private consultants and commercial farmers (e.g. American Society of Agricultural Engineers, 1996). Generally, the objective of developing these programs is to assist advisors and producers to improve operational and management processes in firms. In South Africa, many farmers who own computers use spreadsheets to record data and to prepare farm budgets (Woodburn *et al.,* 1994a). Others use general accounting or financial management packages or similar software developed to suit local farming conditions and requirements, e.g. *SimFini*. These packages are adequate for recording data and for preparing enterprise and farm budgets. However, none of them account for firm level risk explicitly, that is, they do not provide the full range of possible outcomes of various actions and their relative likelihood. Despite the shortcomings, these software packages have gained in popularity among South African commercial farmers over the last decade, probably because they are relatively simple to use and satisfy the recording and information requirements of many farmers. Models that explicitly account for risk are relatively complex and have substantial data requirements (DeVuyst *et al.,* 1995 and Patrick & DeVuyst, 1995).

Various South African studies have shown that commercial farmers rated their own farm records/budgets as the most valuable source of information for making production, marketing and financial decisions (e.g. Bullock *et al.,* 1995 and Woodburn *et al.,* 1994b). Computers were regarded as very useful for keeping financial and physical (crop, livestock) records, for business planning purposes (preparing budgets) and for payroll preparation, and were also highly rated for providing better (up-to-date, more usable, easy to access) information and for saving time compared to traditional manual records (Woodburn *et al.,* 1994a). According to the study by Woodburn *et al*. (1994a), 60 percent of sample computer owners were using spreadsheets, while 64 percent of owners needed

advice on how to operate computers and use software effectively. Most respondents felt that courses or workshops, phone-in support and extension publications would meet these needs.

Generally, the adoption of computers by agricultural producers has lagged behind the rapid development in hardware and software technology. Several studies have shown adoption rates varying from 18 percent in Japan and 25-50 percent in Australia (Nakamura & Chamala, 1996), 37 percent among Great Plains farmers in the USA (Frasier *et al.,* 1997), 48 and 64 percent among commercial farmers in KwaZulu-Natal, South Africa (Woodburn *et al.,* 1994a and Stockil & Ortmann, 1997), 72 percent among large-scale commercial maize farmers in South Africa (Bown, 1999), to 80 percent among large-scale Cornbelt farmers in the USA (Ortmann *et al.,* 1994). According to the South African studies, computer adoption in South African agriculture appears to be increasing, which could be attributed to lower real costs of computer hardware and software technology, the availability of more user-friendly software, and more producers recognising the benefits of using computers in farm management.

Computer adoption depends on its perceived value in a business which, in turn, depends on the personal and business characteristics of producers. Results of various multivariate logit analyses, conducted in South Africa and elsewhere, suggest that farm size and farmer's education, among other factors, increase the probability of computer adoption, while factors such as farmer's age and extensive farming (e.g. beef ranching) have a negative effect on adoption (see, for example, Batte *et al.,* 1990; Stockil & Ortmann, 1997 and Woodburn *et al.,* 1994a).

Information systems being developed by researchers for solving agricultural problems often comprise expert or decision-support systems that are complex and are therefore primarily used by experts, extension agents or professional advisors. Some progressive producers may invest in these systems if they perceive the benefits of using them to outweigh the associated costs. However, many farmers may only require the interpreted results for farm decision-making. Farm advisors or experts may thus need to present farmers with the results derived from relatively sophisticated analyses in simple terms, e.g. providing them with the expected outcomes of various options without the producers themselves needing to know how the results were achieved. Harsh (1996) maintains that the use of consultants and advisors by producers has increased with the growing complexity and breadth of farm decision-making.

External information systems, such as the *Internet* and *satellite data transmission systems*, are playing an increasingly important role as valuable sources of information for agricultural producers (Harsh, 1996). Computer adoption is an

obvious prerequisite for use of the Internet, as is access to a reliable, direct telephone line. In a recent South African study of a random sample of large-scale commercial maize producers, Bown (1999) found that 38 percent of computer users (or 27 percent of all respondents) had access to the Internet, which was most commonly used for personal e-mail correspondence (82 percent of Internet respondents) and business e-mail correspondence (46 percent), and to access maize price data (79 percent) and management information (68 percent). Internet banking for personal (53 percent) and business (50 percent) uses were also important applications. Of all survey respondents in this study, 15 percent had party-line telephones, 82,5 percent direct telephone lines, 80 percent cellular phones and 64 percent fax facilities.

A 1998 survey conducted by Naspers among South African commercial farmers indicated that only about nine percent of respondents had subscribed to the Internet, although more than 30 percent of respondents were of the opinion that the Internet could be important to their businesses (Standard Bank, 1999:3). Referring to a 1995 survey in the USA, Harsh (1996) reported that relatively few agricultural producers were using the Internet (less than 12 percent of computer adopters). He suggests that producers may not know how to gain access to the Internet, what data resources exist on the system and how to locate the data. Also, producers perceive the cost of gaining access to the Internet as being high, while obsolete communications equipment in rural areas leads to slow transmission rates.

Nevertheless, the rapidly expanding Internet provides many opportunities for farmers with access to the system to obtain relevant management information. Use of *e-mail*, *listservers* (electronic mailing lists that facilitate discussion on specific topics), *newsgroups* (discussion forums organised around specific topics) and the *World Wide Web* (by "browsing" web pages) provide opportunities for producers to obtain this information. E-mail allows for quick, cheap and easy communication with other producers, experts and agribusiness firms. Most agribusiness and consultancy firms in South Africa have e-mail addresses, and many agribusiness firms have their own websites where valuable information on the firms' products and/or markets can be obtained. *Online banking* is available in South Africa and provides increased convenience and transaction cost savings to many farmers. Subscribers to such services may typically pay accounts, check account balances, transfer funds, create or cancel stop-orders and arrange for future-dated payments without leaving the farm (Bown, 1999). Thompson & Sonka (1997) report that the Internet is already the most valuable source of information for farmers and agribusiness firms with access to the Internet.

Since the abolition of controlled marketing in South Africa in the early to mid-1990s, various electronic information systems have been developed in South Africa. For example, *Agrimark Trends* (www.agrimark.co.za) specialises in the analysis and forecasting of South African and regional agricultural and market information. Its objective is "to enhance production, management and marketing efficiency within agriculture through timely and well prepared market trend analysis". Subscribers are updated daily with local and international commodity prices, while in-depth weekly market reports on some major agricultural commodities are also presented. A joint venture between Agrimark Trends, the weekly farmers' magazine *Landbouweekblad* and the agricultural division of Standard Bank has been established to expand the availability of market and price information. Agrimark Trends also provides regular spot and futures prices of agricultural products traded through the Agricultural Markets Division of the South African Futures Exchange (SAFEX). This information can also be obtained from SAFEX's website (www.safex.co.za).

Agrilink, which launched a website on the Internet in 1996, describes itself as a virtual agricultural trading and information centre (www.agrilink.co.za). It provides a commodity exchange, a classified advertisements section, a useful address database and links to various sources of worldwide market information. A chat line is also provided to facilitate discussion on various agricultural topics.

Major financial institutions in South Africa have also created websites that provide useful information for managers. For example, Standard Bank publishes *AgriReview*, a quarterly review of various agricultural topics, which is also available on the Internet (www.sbic.co.za). ABSA provides information for farm and agribusiness managers in the *AgriBusiness* section of their website (www.absa.co.za). First National Bank regularly produces analyses of trends in agricultural commodity prices in the *Farmer's Weekly*; this information is also available on the Internet (www.firstnational.co.za). Sanlam also keeps managers updated on developments in agriculture via agricultural newsletters on their website (www.sanlam.co.za).

Agri SA (formerly the SA Agricultural Union) has developed a website called *Agriinfo* (www.agriinfo.co.za) "to create a common gateway for all agricultural role players within one virtual community" (SAAU, 1999:20). Only members of organised agriculture have access to the information and specialist services available on the Agriinfo site. Services include, for example, a one to seven days weather forecast, an early warning weather system and supply of specialised management information on various enterprises. The system also enables farmers to supply information to, and interact with, Agri SA.

Clearly, South African farmers with access to the Internet also have access to information from other regions of the world. For example, James (1996) compiled a list of over 1000 Internet addresses for farm and agriculture-related information that producers can access. However, it will require good skills to locate the desired information. According to Harsh (1996), one of the most common complaints among producers is the amount of time it takes to utilise the Internet effectively and the lack of depth of information.

An external information system that is expected to be widely used by agricultural producers in the future (and is already widely used by producers and researchers in the USA) is the *satellite data transmission system* (Harsh, 1996). Data, which are continuously transmitted to the leased data terminal from a satellite, are automatically stored in the data terminal and can be accessed by a menuing process. The amount and type of data or information received depend on the options purchased by the producer. The majority of respondents in a USA study indicated that the benefits of using the system outweighed the costs (Harsh, 1996). However, use of the satellite data transmission system as a data source is still in its infancy in South Africa. Many farmers have installed satellite tracking systems in their vehicles to counteract the high incidence of vehicle theft in South Africa. Some agribusiness firms (e.g. the Kumati sugar mill in Mpumalanga province) are benefiting from vehicle identification and tracking technology which controls the movement, quantity and quality of products being delivered. *Agriforum 2000*, a weekly television programme, provides information on various agricultural topics to producers.

Precision agriculture is another area that is attracting increasing interest among commercial farmers, particularly in regard to site-specific crop management (SSCM). The potential for using SSCM has greatly improved with the availability of lower cost and accurate *Global Positioning Systems* (GPS) (Harsh, 1996). Yield monitoring and mapping systems (developed to assist in evaluating the effectiveness of alternative management practices in crop production) appear to be finding the greatest acceptance. However, a concern with these systems is arriving at the correct inference of what causes yield variations since a large number of factors are involved (e.g. pH, soil structure, planting date, variety planted, nutrients applied, crop-protection chemicals used and rainfall). Although a *Geographic Information System* (GIS) could be used to capture the large number of "data layers", few farmers have access to a GIS or are trained to use it effectively, and the costs involved in capturing and storing various data layers are substantial (Harsh, 1996).

In South Africa, a few large-scale commercial farmers have started using GPS and GIS for precision agriculture but, generally, use of these techniques among

commercial farmers is still low owing to the relatively high costs involved in incorporating them into the existing farm infrastructure. Some harvesting contractors provide this service at an additional cost to producers, but it is not widely used at present. However, crop-spraying contractors widely use GPS in crop spraying from aircraft. This has benefits for producers because of the accuracy of field measurements and the potential savings resulting from the more efficient application of crop protection chemicals. The provincial and national Departments of Agriculture in South Africa use GPS in topographical and engineering surveys (e.g. for the construction of soil conservation structures). Some provincial departments intend to use GIS to gather agricultural census data and to monitor land use patterns. Large private sugar and forestry companies already use GPS and GIS for area measurement and updating maps.

In animal farming, precision agriculture relates to, for example, computerised feeding systems where individual animals are fed a precise ration according to their production performance. This is widely applied by top dairy farmers in South Africa.

3. USE OF INFORMATION TECHNOLOGY IN DEVELOPING AGRICULTURE

Since the election of a democratic government in 1994, the South African government has withdrawn financial support for the commercial sector and has focused increasing attention on supporting small-scale farmers. These farmers currently rely largely on government or industry (e.g. sugar) extension services, hawkers and shopkeepers for agricultural information. The radio is widely used as a source of entertainment and information, and it could serve as a valuable and cost-effective source of agricultural information. At present, a radio programme dealing with agricultural development issues is being broadcast on a regular basis. However, even with effective educational (extension) programmes and other financial support (e.g. subsidised interest rates on loans), the most limiting constraints facing emerging farmers are the lack of appropriate institutions (such as secure property rights) and physical infrastructure (roads, telephones, etc.) in the developing regions (Lyne, 1996). This implies that small-scale producers experience a competitive disadvantage and are, therefore, less profitable than producers using modern information technologies (who can reduce transaction costs and respond quicker to changing economic information). The latter producers will also be able to operate at larger scales more efficiently with information technology (Thompson & Sonka, 1997).

Some Non-Governmental Organisations are using GPS to facilitate work in rural areas. For example, the Financial Aid Fund of the South African Sugar

Association, which extends loans to small-scale sugar farmers, uses GPS data to locate and measure individual producer's land areas under sugar-cane. This facilitates the extension of loans to these farmers and reduces transaction costs and risks in financing (e.g. double-financing). LIMA Rural Development Foundation utilises GPS to locate and measure individual land holdings in their establishment of forestry plantations for small-scale farmers to make contracts with timber millers possible (i.e. to reduce transaction costs and risks). In addition, this technology is helping to secure property rights to land by defining areas and boundaries of land cultivated by individual producers.

4. CONCLUSIONS

Agricultural producers in South Africa are increasingly being exposed to the potential of modern information technologies as a management tool. However, despite the real and potential benefits of using information technologies (including improved flows of relevant and up-to-date information for decision making), their capabilities have not been fully exploited. Reasons include the relatively poor infrastructure in rural areas (e.g. unreliable telephone services), the time taken to obtain information from the Internet, the perceived high cost of some modern information technologies (such as GPS and GIS) in relation to their benefits, and the lack of education in the effective use of information technologies. There is thus a need to improve the quality of electricity and telecommunication services in the rural areas, for software developers to create more efficient algorithms, and for effective educational programmes (involving courses, workshops and phone-in support) to be developed for producers who wish to adopt modern information systems. Farm advisors, including extension officers and private consultants, could make valuable contributions to educating farmers in the effective use of information technologies.

Modern information systems are expected to play an increasingly important role in future in assisting agricultural producers to become more competitive on local and international markets. Producers may expect high returns to information that is pertinent to their businesses. The challenge for producers, therefore, is how to source relevant information efficiently. "Focused" publications or newsletters, specific user-groups on the Internet, specific planning software and outside advisors dealing with specific business problems are some examples of relevant information sources. Clearly, producers would have to pay for pertinent information and compare this and other (time) costs with the anticipated benefits.

For small-scale farmers in South Africa, further educational (extension) efforts aimed at providing relevant information are crucial. However, the easing of major constraints that hinder agricultural development in the developing areas of

South Africa (such as poor infrastructure and lack of secure property rights) should be of major concern to policy-makers. In this regard, information technologies such as GPS are helping to define individual property rights to crop land.

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