QUALITATIVE EVALUATION OF SMALLHOLDER AND ORGANIC FARMER DECISION SUPPORT TOOL (DST) AND ITS IMPROVEMENT BY INCLUSION OF A DISEASE MANAGEMENT COMPONENT

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ABSTRACT

Historically, South Africans, particularly small-scale farmers have had little support and hence lack tools and information when faced with production decisions. Information plays an important role in enlightening people, raising their level of knowledge and in turn improving their standard of living and participation in decision making process. Research shows that Information Communication Technology (ICT) like Decision support tools (DSTs) plays an important role in systematic dissemination of information in agriculture, thus improving the quality of farmers' decisions. Decision support tools provide up-to-date data, procedures and analytical capacity leading to better-informed decisions, especially in rural areas. A body of research is emerging around issues of effectiveness of DSTs for farmers in the developed world. However, few studies have focused on issues around effectiveness of these tools for farmers in the developing world, particularly for resource-limited famers.

This study set out to evaluate the effectiveness of a new DST for organic and small-scale farmers with a group of extension officers and researchers in KwaZulu-Natal. As an extension to the DST, a crop disease management component linked to the DST was developed. The study also set to evaluate the effectiveness of the crop disease management component. Extension officers and researchers were purposively selected for this study because both groups play a major role as far as organising and disseminating information to organic and small-scale farmers is concerned.

This study identified key measures for effectiveness of DSTs and crop disease management guides using literature from the study. Two frameworks for measuring effectiveness were developed to evaluate the effectiveness of the new DST and its crop disease management component with the extension officers and researchers. Focus group discussions were used for data collection. The frameworks were used as a base for the focus group discussions. Focus groups were conducted to explore and establish whether in the light the groups (extension officers and researchers), the new DST and its crop disease management component are effective.

Results from the study revealed that extension officers and researchers felt that the DST and its crop disease management component are effective since they meet key measures for effectiveness identified in the framework. The groups agreed that the DST and its crop disease management component are relevant to small-scale farmers. They also agreed that the DST has the ability to improve access to information for small-scale farmers. Lastly, they also agreed that the DST and its crop disease management component are transparent (meaning flexible and user friendly) for small-scale farmers. Some of the areas for improvement identified by the groups included a need for information on pests and more diseases for the DST and the crop disease management component.

Although the groups felt that both the DST and crop disease management were effective, they strongly recommended a need for another study that will aim at developing a pest management component of the DST as this was clearly requested by groups in this study. Results of this study showed that half the respondents felt that the DST was easy enough to be used by small-scale farmers without help from extension officers, while the other half believed that small-scale farmers will still need the help of extension officers to show them how to use the DST. Government and other relevant institutions need to provide appropriate training for these farmers, making the DST useful to them.

DECLARATION

I, Thato Molefe declare that:

i. The research reported in this dissertation, except where otherwise indicated is my original research.

ii. This dissertation has not been submitted for any degree or examination at any other university.

iii. This dissertation does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from those persons.

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Signed: ……….…………………………………… **Date** ………………………….

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Name: Dr Joyce Chitja

As a Co-supervisor, I agree to submission of this dissertation for examination:

Signed…………………………………………….**Date**…..

Name: Dr Kwasi Yobo

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LIST OF ABBREVIATIONS

AIAEE	Association for International Agricultural and Extension Education
ARC	Agricultural Research Council
CD-ROM	Compact disc-Read Only Memory
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	Interim Science Council and Economics Program of the International Maize and Wheat Improvement Centre
DST	Decision Support Tool
FAO	Food and Agricultural Organisation
FSU	Field Service Units
ICT	Information Communication Technology
ICRISAT	International Crop Research Institute for Semi-Arid Tropics
IFDC	International Fertilizer Development Center
IITA	Institute for Information Technology Applications
IT	Information Technology
OFRF	Organic Farming Research Foundation
NGO	Non Government Organisation
NOSB	National Organic Standards Board

CHAPTER ONE

RESEARCH PROBLEM AND ITS SETTING

1.1 Introduction to the research problem

Small-scale farmers in the developing world face a complex set of challenges in decision-making. Decision-making for small-scale farmers is complex because of the close interactions between household and farming decisions (FAO, 2006). Furthermore, small-scale farming is usually not a full time occupation but is rather a part of a livelihood strategy (Makhura, 2001). Complex decision-making can be a big challenge for small-scale farmers in poor countries who, not only have poor access to resources and information, but are also faced with literacy constraints (Thamaga-Chitja, 2008). Decision making in niche areas such as organic farming where small farmers could benefit, is even more complex due to complex nature of organic farming, which requires a well developed knowledge system that promotes biological harmony encompassing biodiversity and biological cycles (NOSB, 1995). The need for new technologies for growth in areas such as organic production is crucial to support both the evaluation of potential for organic farming in South Africa and to support and guide decisions of aspirant organic farmers (Thamaga-Chitja, 2008). The introduction of information technology such as decision support tools (DSTs) for resource limited South African farmers in organic agriculture can be viewed as answers to a wide variety of farmers' decision making problems (Freyer *et al*, 1994). Many studies have investigated the role of these tools in agriculture worldwide, but most of these studies have focused on large-scale farmers in developed countries, and only a few have focused on the use of these tools by small-scale farmers in the developing world, particularly by resource-limited farmers in Africa (O'Brein *et al*, 2003).

Farming involves a relatively high level of risk and uncertainty than many other activities or businesses (Nguyen, 2002). This is because of the inherent variability of the natural environment in which it is conducted, such as climate and market conditions, which have an indirect influence on production and farmers' income (Beal, 1996). In many developing countries, including South Africa, risk is part of life for many small-scale farmers (Dercon, 1996). For farmers who attempt to access niche markets such as organic farming, they are faced with an even pronounced risk due to a number of production issues that have to be considered (Organic Farming Research Foundation [OFRF], 2001). Farmers often have to make both significant and less important farm decisions under imperfect knowledge and deal with important factors influencing farm profitability that are unpredictable and beyond their control (Nguyen, 2007). Unlike commercial farmers, small-scale farmers lack appropriate support structures to support them in decision making, especially in specialized areas such as organic production (Thamaga-Chitja, 2008). Lack of access to information increases farmers' production risk, hence, constrains them from participating in markets and converting to commercial production (Thamaga-Chitja, 2008). In such situations, DSTs can provide information to farmers that will enable them to foresee their production systems response to the possible risk and impacts, hindrances and at the same time help reduce uncertainties and risks (Kurlavicius, 2009). Tire (2006) argues that as risk takers, farmers need current information to stay informed in order to avoid and minimize risks.

Market participation is increasingly becoming essential to small-scale farmers, including organic farmers (Makhura, 2001). Farmers want to have access to good formal markets so that they can have better returns for their produce (Boughton *et al*, 2006). Moreover, farmers work in a competitive environment where in order to increase income, their farm operations need to be profitable and adaptable to market conditions (Kahan, 2007). However, few small-scale farmers have access to information about what crops to produce and when to produce them in order to meet market conditions and DSTs can help farmers by providing such information as well as other information such as who they can sell to and how they can increase the value of their produce. Information flow is an important component of farmer-market linkage, and can lead to significant increases in farm gate prices and farmers' income (David-Benz *et al*, 2004). Appropriate information, particularly information regarding production is important in decision making for appropriate extension and development of small-scale farmers, especially when considering scaling up in specialized areas such as in organic agriculture (Thamaga-Chitja, 2008).

1.2 Importance of study

Historically, South Africans, particularly small-scale farmers have had little support and hence lack tools and information when faced with production decisions (May *et al.*, 1998). According to Tire (2006), information plays an important role in enlightening people, raising their level of knowledge and in turn improving their standard of living and participation in decision making process.

Information Communication Technology (ICT) has been noted to play an important role in disseminating information to farmers worldwide (Nagarkar, 2009). Several national and international initiatives exist in the creation of information systems for farmers with the aid of modern technologies (Nagarkar, 2009). But very few studies have focused on the use of ICT by small-scale farmers in South Africa, particularly the use of ICT related DSTs. Yet, these technologies may contribute substantially and significantly in improving the quality of small-scale farmers' decisions, thereby enabling them to take advantage of market opportunities and manage continuous changes in their production systems (Demiryurek *et al*, 2008). Decision support tools have the potential to contribute solutions to farmers' production constraints and information needs. O'Brein (2004) argues that DSTs for agriculture can aid decision making in four ways. Firstly, they can make information available to farmers and advisors that may otherwise not be accessible. Secondly, uncertainties about weather, pest and disease can be addressed. Thirdly, a well designed DST can give reliable information in a consistent and timely manner. Finally, farmers' feedback and knowledge can be incorporated if appropriate methods are used, thereby making the knowledge available to other farmers.

Extension officers, which are the main source of information for small-scale farmers in South Africa, are very limited in number and often out of reach for poorly resourced farmers (Thamaga-Chitja, 2008). Worth (2009) concurs with this statement and further stated that extension officers are often inadequately trained to serve all the needs of small-scale farmers. As reported by Thamaga-Chitja (2008) in the KwaZulu-Natal province, there are up to 500 small farmers per district, with only a few extension officers. Decision support tools have the potential to fill this gap and contribute to the resources that extension workers may have.

Consequently, the aim of this study, therefore is to evaluate the effectiveness of a recently developed Excel based DST and its crop disease management component in supporting production decisions for small-scale farmers, including organic farmers in KwaZulu-Natal. The study is also intended to investigate whether the DST and its disease management component is able to assist agricultural extension officers and agricultural scientists in their technical support to organic production in South Africa and to make improvements to the tool.

1.3 Research problem

A recently developed DST (Thamaga-Chitja, 2008), was evaluated in this study. During the development of the DST, organic and small-scale farmers who were involved expressed a need for the DST to include a crop disease management component. This study has evaluated the DST from an extension and researcher point of view because these are key professionals who are in most cases, the main users of the DST.

According to extension officers and researchers (agricultural scientists), does the DST and its disease management component enhance production decisions and improve planning against and managing of crop disease for organic and small-scale farmers?

1.3.1 Sub- problems

1. Is the DST effective to both extension officers and researchers (agricultural scientists)?
2. Is the developed crop disease management component of the DST effective in guiding and improving management of crop diseases for organic and small-scale farmers?
3. How can the DST and its crop disease management component be improved?

1.4 Study limits

The study was limited to a group of extension officers and a group of researchers (agricultural scientists) in KwaZulu-Natal (Cascades and Dundee, respectively) as samples. Both groups are not representatives of the total population of extension officers and researchers in KwaZulu-Natal. The DST focuses on production decisions of farmers and does not take into account other farmers' constraints such as lack of fencing, water, compost and market. The DST can in future be modelled to include these problems.

1.5 Study assumptions

It is assumed that the selected group will answer all questions honestly, based on their knowledge of the field and being in contact with farmers.

1.6 Structure of dissertation

Chapter one of this mini-dissertation outlined the background to the research problem, the importance of the study, the research problem, sub-problems, study limits and assumptions. Chapter two gives a review of theoretical and empirical literature pertaining to issues relevant to this study. Chapter three provides a description of the study sample. It also outlines the traits of study sample. Chapter four describes in detail the methodology employed to address the research problem. The frameworks developed to evaluate the effectiveness of the DST and its crop disease management component, are presented in Chapter five. Chapter six reports the results and discussions of the study, and Chapter seven reports on conclusions and recommendations of the study.

CHAPTER TWO
REVIEW OF RELATED LITERATURE

2.1 Introduction

According to Ticha and Moulis (1997), the essence of appropriate farm management is decision making. Thamaga-Chitja (2008) explains that decision making for farmers involves a process of choosing a course of action from available alternatives. Effective decision making is crucial for the success of any business, including farming. This process is an information intensive activity, which requires accurate, relevant and timely information (Ticha & Moulis, 1997). Good decision making requires that the individual or farmer who makes the decision has the required information to make an informed choice of decisions (Jensen & Meckling, 1998). However, small-scale farmers in South Africa lack appropriate information to make better decisions regarding production (Poulton, 2004). Access and availability of information are essential to decision making. Although a sizeable amount of information is available to farmers in South Africa, this information is not consistently produced and disseminated in ways that are helpful and accessible to small-scale farmers (Stefano, 2004). Access to appropriate agricultural information is an essential component of effective and good decision making and a timely transfer of appropriate knowledge to farmers (Demiryurek *et al*, 2008). Farmers need sufficient information to be able make decisions that will enable them to take advantage of market opportunities and manage continuous changes in their production systems (Demiryurek *et al*, 2008).

Farmers' information needs are complex, in which own experience and personal collection of information is usually not sufficient and accessible to make decisions and require support (Janneh, 2001). Currently most of farmers' information is provided by extension officers through oral or verbal means and printed literature and electronic communication technologies (Meyer 2002; Morrow 2002; Batjes-Sinclair 2003). Although, oral forms of information are favoured more by rural communities of South Africa because of long oral traditions and relatively low levels of literacy (Bembridge & Tshikolomo 1992; Leach 2001), Information Communication

Technology (ICT) promises better access to information for farmers (Food and Agriculture Organisation (FAO) 1989; Van Crowder *et al*. 1998). However, due to farmers' limited access to computers or sufficient telecommunication infrastructure, and lack of computer literacy, (Morrow, 2002), ICT has been criticized by farmers for being ineffective. Nevertheless, these are very useful resources and all that is needed is to provide an easy way for farmers to navigate them (Gakuru *et al*, 2009).

One of the important applications of the service of ICT has been the evolution of decision support tools (DST), which are interactive computer based systems integrating information from different sources and scales including remote sensing and varying domains to solve complex problems (Sage, 1991; Turban & Aronson, 1998; Hayman, 2004). They are tools or decision aids, which can assist decision makers to make information clearer and better in real time (O'Brein *et al*, 2003). These tools also assess long-term implication and generate "what if" scenarios for formulating (Mahadik & Manjunath, 2008). Some applications have included pest management in grain store and arable disease control (Offer, 2003). Decision support tools have the capacity to store large amount of information, ability to retrieve pieces of required information (Offer, 2003). Their ability to assimilate and disseminate information to decision makers has opened opportunities for the development of agriculture.

Effective agricultural information dissemination and advisory services to farmers are the backbone of any practical application of information communication technology (Mahadik & Manjunath, 2008). Forecasting of information on weather and dissemination of information to farmers through agricultural technology presents an exciting opportunity for the future of agriculture (Offer, 2003). A Crop Information System in Australia has helped farmers gain relevant information about agriculture activities and its related parameters through various modules of the Information System such as Query, Display, Graphical representation, Print and Overlay modules (Mahadik & Manjunath, 2008). Decision support tools have almost become synonymous with 'extension' (Cox, 1996). Nguyen *et al* (2006) report that DSTs contribute to better farm management, by enhancing the knowledge of farm consultants and by boosting the value of information they provide to farmers. O'Brein

(2004) reinforced this point by highlighting that DSTs can make information available to farmers and their advisors that may otherwise not be accessible.

Although these DSTs seem to have many benefits to decision makers, particularly farmers, studies (Cox, 1996; McCown, 2002; Hayman & Easdown, 2002; Bontkes & Wopereis, 2003) show that the use of these tools by farmers has been low, in both the developed and the developing countries. In the developed countries, it is suggested that many existing tools do not reach the required level or are not user-friendly, whereas others are too complicated or narrowly specialized (Cox, 1996; McCown, 2002; Hayman & Easdown 2002). Although, less research has been conducted on the adoption of DSTs in the developing countries, it can be expected that the reasons could be the same or have intensified (O'Brein *et al*, 2003). With the increased number of African extension workers failing to address farmers' needs and with the low farm production and productivity in Africa's small-scale agricultural sector due to poor or inadequate information regarding production (AIAEE, 2004), DSTs can play a vital role in Africa, particularly South Africa.

This chapter presents a literature review related to decision-making for small-scale farmers. The significance of agricultural information is discussed, highlighting its role in small-scale agriculture, particularly the reasons why it is important in decision making. The literature on DSTs for farmers is presented, clearly outlining the adoption of the tools by farmers. The improvement in the development methodologies and adoption rate of DSTs are also discussed, drawing empirical studies on the success and failure of DSTs in agricultural production.

2.2 Decision making and information for small-scale farmers

Caroll and Johnson (1990) defines decision making as a process whereby a person, group, or organization identifies a choice or judgment to be made, gathers and evaluates information about alternatives, and selects from among the alternatives. At farm level, decision making is every farmer's job and a major portion of their time is spent making decisions (Ayele, 2008). Effective decision making requires accurate, timely and relevant information (Ticha & Moulis, 1997). Small-scale farmers in South Africa lack appropriate information to help them make better decisions regarding production (Poulton, 2004). Appropriate agricultural information is a critical resource for decision making, which in the hands of information hungry individuals can lead to better production decisions.

The availability and access to relevant and timely agricultural information is important in decision making (Ticha & Moulis, 1997; Thamaga-Chitja, 2008). Relevant and timely information allows farmers to make accurate decisions, while irrelevant information makes the decision making process difficult, adds to confusion and affects the performance of the farmer (Higgins, 2001). General farm management decisions include choice of agricultural enterprises, allocation of labour, land allocation, allocation of capital, acquisition of capital, and acquisition of inputs and marketing (Food and Agricultural Organisation [FAO], 2006). In organic production, the most important areas of decision making include: production, marketing, pest and disease control and certification (Thamaga-Chitja, 2008). Access to appropriate information, particularly about production and marketing is important in decision making to minimize risk and improve productivity and enterprise success (Thamaga-Chitja, 2008).

There is a sizeable volume of written and printed agricultural information available for farmers in South Africa, but only a small proportion of small-scale farmers have access to this information (Bembridge, 1997). This can be attributed to the fact that many producers of agricultural information fail to produce information that could address the true information needs of small-scale farmers (Stefano, 2004). Moreover, Thamaga-Chitja (2008) argues that those tasked with the collation and dissemination of agricultural information fail to consider literacy levels of small-scale farmers and the appropriateness of information. Consequently, such information becomes irrelevant when farmers are faced with decisions. Tire (2006) stresses that information for rural people, including small-scale farmers, should be provided in forms that meet their diverse needs. According to Stefano (2004), farmers only use information if it is accessible, credible and understandable.

Decision making in a farm is a highly complex process and influenced by many on-farm and off-farm factors (FAO, 2006). Ayele (2008) argues that the decision making process is likely to be easier and more efficient if farmers have simple objective/s. In the production systems of the developing countries, farmers' objectives have generally been relatively simple ones, almost exclusively based on production and profit maximization (Willock *et al*, 1999). All decisions made are aimed at meeting these objectives as best as possible. Higgins (2001) argues that for farmers to make sound decisions about these two objectives, they must be aware of what information they require and how to acquire it. Decision support tools are important as information providers to help make production decisions. However, in many parts of the developing world, including South Africa, farmers are not often aware of what their own information needs are or how these could be met, and so need adequate support.

2.2.1 Information needs and access of small-scale farmers for decision making

Farmers' information needs are often complex and multifaceted (Janneh, 2001). Janneh (2001) argues that they require more than personal experience or own knowledge to be able to address them. This means that most the farmers' problems and information needs require informed decisions based upon appropriate information (Janneh, 2001). The most critically needed information among small-scale farmers revolves around production and market access.

Farming involves risk and uncertainty because of several factors (biotic, environmental, and political) that render the outcomes of actions uncertain and over which the farmer does not have complete control (Ayele, 2008). Thamaga-Chitja (2008) argues that organic farming presents an even more pronounced risk due to the fact that agrochemicals are not allowed in certified organic farming. Information about organic farming is critical for the success of organic farming and creating local critical mass (Scialabba, 2007). This is particularly important in small-scale production systems, because smallholder farmers usually have limited resources and manage multiple and complex production systems than commercial farmers (Ayele, 2008).

Risk is part of farming life in developing countries (Dercon, 2000). Farmers in these countries face a multitude of risks of varying severity that originates from natural, economic and socio-political environments (Belaneh, 2002). Often, these risks arise from the inherently hazardous and risky natural environment (pests and disease and insect infestations) (Belaneh, 2002). Unless timely measures are taken, these risks can accelerate and easily trigger acute food shortages, hence, making the rural poor even more vulnerable. In such situations, information on risk minimising and risk mitigation strategies assume special importance (Belaneh, 2003).

With the increase in Africa's population and the demand for secure and sustainable food, the challenge of increasing crop production is great. For farmers, the main concern in the variability of climate relates to the inability to anticipate, respond and adapt systematically, contextually and dynamically to unfolding risks to minimize possibility of losses and its consequences (Meinke *et al,* 2001). Farmers need to be aware of the time scales that determine this variability and the possible consequences of such variability for their business (Meinke *et al,* 2001). New, quantitative information about the environment within which they operate and about likely outcome of alternative management options can reduce the uncertainty (Byerlee and Anderson, 1982). Experiences in developed countries such as Australia and the USA have shown that providing farmers with forecast future rainfall and temperature distributions can substantially manage risks and contribute to increased agricultural productivity and farmer livelihood (Meinke & Hochman, 2000).

Pest and crop disease are a major threat to small-scale organic farmers agricultural production in South Africa. They threaten the economic viability of farm production systems and the livelihoods of dependent rural communities by reducing crop yields and farm incomes (Nelson *et al*, 2002). In such environments, food security is often a major concern and agricultural production can only be improved if there are no risks (Meinke *et al*, 2001). Information about how these pest and diseases occur and how they can be controlled is required by multiple audiences such as scientists, pharmaceutical companies and farmers (Nargakar, 2009).

Moreover, good soil fertility management plays a major role in agricultural production and productivity throughout Africa, (Bontkes & Wopereis, 2003). Fertility management ensures that the soil can actually provide nutrients in sufficient amounts at all times during the growth of plants (Mubiru, 2008). However, soil fertility in many parts of Africa, is deteriorating (Mubiru, 2008). Africa's consumption of fertilizers is the lowest in the world and organic matter that could supplement fertility, is often burnt and soils left bare to the degrading effects of the sun and the wind (Mubiru, 2008). The author argues that information on how farmers can increase their yields when their soils are poor is insufficient. Effective plans to provide farmers with information to help make decisions concerning risk management is imperative.

Market participation is increasingly becoming important for small-scale farmers in Africa (Makhura, 2001). Many cooperative unions, which used to provide outlets to markets for small-scale farmers no longer exist (Mubiru, 2008). Much growth is taking place in urban markets where farm produce fetches better prices in the market places (Mubiru, 2008). Every small-scale farmer wants to have access to good export market where they can have better returns for their produce (Makhura, 2001). However, in many parts of the developing world, access to information about how farmers can take advantage of these opportunities to market their produce is limited (Demiryurek *et al*, 2008). Tools that promise to assist small-scale farmers in making decisions about what to produce, who to sell it to, how to increase its value, and ideas for solving problems with transport and communication are required by these farmers.

2.2.2 The role of information for farmers

Latest and advanced information related to market prices, weather forecasts, soil, pest and crop management is vital for professional growth of farmers (Tire 2006; Thamaga-Chitja 2008). This information can help empower farmers to make informed decision related to their profession and make better living. Most small-scale farmers in South Africa lack direct and immediate access to such information due to lack of infrastructure and appropriate information dissemination methods. Information dissemination methods that facilitate information access for South African farming population are therefore crucial.

A study (AIAEE, 2004) on small-scale farmers in South Africa discovered that inadequate information to support farmers in decision-making undermines their potential to improve agricultural production. AIAEE (2004) proposed that information for small-scale farmers needs to be reinforced so that farmers can gain valuable information to improve agricultural productivity. IICD (2008) observed that agricultural information in small-scale agriculture seeks to close the information gaps that hold back the sector and that handicap rural community's dependence on small-scale agriculture. The ICRISAT and CIMMYT (2004) shares the same sentiments by confirming that access to information makes it possible for farmers to enhance economic opportunities through increased market access, improved negotiating powers and better production methods. Moreover, the ICRISAT and CIMMYT (2004) believes that agricultural information can contribute to achieving the first Millennium Development Goal to 'eradicate extreme poverty and hunger' by raising the income of small-scale farmers and strengthening of the agriculture sector.

According to Stefano (2004), Africa's effort to improve small-scale farmers' access and availability of information has been disappointing over the years. Tire (2006) observed that South Africa has suffered a similar experience. Numerous factors have been identified that hinder the information flow to small-scale farmers in South Africa. Tire (2006) discovered that some of these factors include inappropriate packaging and format of information that is not in line with the literacy level of the target audience; lack of research on what the intended users needs are and irrelevant research issues that are not to the interest of the rural communities. Ozowa (1995) also supports this preference by asserting that much of this failure can be attributed to the fact that most current approaches to information dissemination and management fail to address the numerous problems that face farmers. There is clearly an urgent need for better tools to compliment the many already existing information dissemination methods that fail to address farmers' needs.

3. Information dissemination methods for small-scale farmers

Audiovisuals

In an effort to offer response to the information needs of small-scale farmers, a number of institutions and government organizations are helping in the creation of information dissemination methods to provide relevant information to farmers worldwide. According to Tire (2006), a bouquet of information dissemination tools exist, however, not all of these have been successful in addressing information related needs of the target audience. Some of these include printed materials such as newspapers and magazines, audio-visual materials such as CD-ROMs as sources or bases for provision of relevant information (Tire, 2006). This section provides a discussion on some of these methods, particularly the reasons behind their success and failure.

Audiovisuals play a major role in disseminating information to farmers worldwide. The same study by (Tire, 2006) revealed that farmers who are unable to read and write mostly prefer the use of audio-visuals than written materials. Audio-visual sources are usually in the form of audio and video cassettes, compact discs and slides. They provide information ranging from livestock and crop production to animal and poultry production (Tire, 2006). The study discovered that this method of information dissemination is the most popular among small-scale farmers given the literacy of these farmers. It also indicated that compact disc-Read Only Memory (CD-ROM) have proved to be most commonly used audio-visual material as it saves space, offers easy and quick access to information and has the capacity to carry large volume of data. Zijp (1994) sees the use of CD-ROM as a medium of transporting information to areas that cannot be serviced by means of highly sophisticated technology. The author identified four main advantages of using CD-ROM. Firstly, it can hold large amount of information as it contains a storage capacity of approximately 660 megabytes. Secondly, unlike paper material, the disc is resistant to dust, humidity, insects and fungi and is not affected by power fluctuations. The discs are light in weight and therefore make a good medium for transporting large amounts of data. They are low in cost, which makes them widely accessible. However, a disadvantage of this tool is that it can only be used by those who have access to computers and all other necessary infrastructure that computers require.

Radio

According to Tire (2006), radio is an effective medium of dissemination of information that can be used to reach masses of the rural farmers irrespective of age and the level of literacy. The author asserts radio broadcast is among the most commonly used methods of information dissemination among illiterate farmers. Important messages and latest findings are often publicly broadcast to reach all those who have access to this tool (Tire, 2006). In the same study, it was also discovered that farmers, extension officers, NGO’s, and research agents, all take part in identifying and prioritising topics that need to be dealt with to make a broadcast informative and better informed. Some of the topics that are often covered during broadcast include ploughing, planting, weeding and harvesting (Tire, 2006).

Advantages to radio broadcast as pointed out by the Department of Agriculture, Conservation and environment of the North West include promotion of dialogue between predominant rural clients and is also the cheapest and most powerful mass medium for reaching large numbers of people in isolated areas. Cartmell *et al* (2004) shares the same sentiment by pointing out that radio is an important tool for the rapid diffusion of important messages on new agricultural, conservation and environmental production ideas. Based on the study (Tire, 2006), an important aspect associated with the use of radio as a medium for disseminating information is that for the tool to become effective, the needs and challenges of the target audience need to be known and prioritised. This can be realized by making the target audience part of the team that decides on what forms part of the programme. Efficient as this tool maybe, Tire (2006) discovered that funding and prevalence of other competing stations always pose a challenge for effectively reaching the masses. Therefore, new thoughts are needed to move towards finding ways to overcome these obstacles.

Printed material

Print materials are another method used with the aim of disseminating information to farmers. A study (Tire, 2006), shows that print materials have a supplementary role to play over and above many other forms of information dissemination methods that exist for small-scale farmers. According to the author, this is because no sophisticated technology or infrastructure is required for distribution even up to the far flung rural areas, where most small-scale farmers in developing countries are located. Print materials are often aimed at empowering agricultural extension officers and both emerging farmers and farmers in livestock and crop management. They cover various topics ranging from animal and crop production, poultry production, horticultural production, diseases and pests to basic marketing information (Tire, 2006). Typical applications to date have included the use of crop management guides, to help sharpen the skills and knowledge of farmers and extension staff in carrying out best practices in relation to crop production (IITA, 2009). A detailed discussion on the use of crop management guides in the provision of relevant material or information for farmers is presented below.

3.1 The use of crop management guides in the provision of relevant materials and information for farmers

Crop disease is one of the major problems facing most farmers today, particularly organic farmers. The devastation of a rampant disease can be detrimental to farmer and food security, especially to small farmers (Thamaga-Chitja, 2008). Crop disease causes significant crop and income losses for many small-scale farmers throughout Africa, including South Africa. In such conditions, farmers' food security becomes a major threat. Moreover, farmer's lack of adequate knowledge on disease control forms a major constraint. Tools that assist farmers by providing appropriate information on the accurate diagnosis of the cause and control of the disease have become extremely valuable. Examples of such tools have included crop management guides.

Crop management guides are one of the many useful methods used for disseminating information about management of crops worldwide. Although very few authors have studied the use of these tools by farmers, these tools can play a major role in improving farming operations for farmers. Literature (Jubel 2009; Bufee 2010) discovered several reasons behind the use of crop management guides by farmers. Jubel (2009) found that crop management guides help build up small farmer capacities since they provide information that enables them to carry out good practices in rehabilitating old farms and starting new ones. Bufee (2010) on the other hand discovered that crop management guides help extension and development officers and colleagues train their field facilitators to help interested small farmers and farmer groups make decisions that will improve their income and their feeling of well-being. The Institute of Ecology and Resource Management (2004) identified main objectives behind the development of crop management guides for farmers:

- For use in training field extension agents and rural development workers working at the farm level;
- To assist field extension workers in working more effectively with farmers;
- To provide training materials and information that could enhance field workers capabilities

Crop management guides have become quite popular among rural South Africans (Tire, 2006). However, literacy and language forms a major barrier that prevents them from using these materials (Stephano *et al*, 2005). A study (Carter 1999; Leach 2001b) indicated that one of the reasons is because these guides provide a permanent record and important aid to memory. The same study emphasized that the use of crop management guides allows users to go back to reading them again, as compared to verbal means of communication, which can easily be forgotten. Seeking to aid the future development or design of simple guides that can be used by even illiterate or low educated farmers, several authors (Otsyina & Rosenberg 1997; Carter 1999; Morris & Stilwell 2003; Stephano *et al* 2005) have identified key criteria and key measures for success and effectiveness in crop management guides for farmers, which need to be considered during design and development of these tools. These include:

- Relevance (Work with intended users (i.e. farmers) to identify viable, beneficial solution(s); Address a real problem or need; Cover topics of interest to users
- Simple formatting (Use of pictures; Sufficient and simple text; Large print size; Easy to read; Use of simple English and Translation into a local language)

When developing an effective or useful crop management guides, Otsyina and Rosenberg (1997) states that it is important that the guide is made relevant to its intended users. This means that the guide should be able to address a real problem and need and also cover topics of interest to the users (Nguyen *et al*, 2006). Carter (1999) adds that for a guide to be relevant, users should be allowed to participate in the creation of the guides. This will enable the incorporation of users own experience and local knowledge into the materials, making it relevant to their needs. This comment confirms Morris and Stilwell (2003) view that farmers are in the best position to determine whether an information product meets their needs.

A study (Stephano *et al*, 2005) discovered that farmers considered crop management guides to be useful if they contained simple and easy formatting. This includes the use of colourful pictures; sufficient and simple text; large print size; easy to read; use of simple English and translation into a local language. Stephano *et al* (2005) discovered that the inclusion of colourful pictures makes guides look good, easy to understand, interesting and encourages readership, as compared to black and white pictures, which provides less information. Beyond the use of colourful pictures, the same study also highlights the importance of having sufficient text accompanying the pictures. Based on the findings of the study, this makes it easy for users to fully understand what is being conveyed in the pictures. Stephano *et al* (2005) asserts that where no accompanying text is used to convey what is on the picture, the guide is considered to lack clarity.

A crop management guide that includes a common language and a local language is likely to gain more popularity than one that includes only a single language. In a study conducted in KwaZulu-Natal (Stephano *et al*, 2005), it was discovered that most farmers did not use the guides offered to them since they did not include a local language (isiZulu), therefore, these material were useless to them. From various forms of information dissemination methods that exist for small-scale farmers, extension workers play the most crucial role in disseminating information. Extension officers are seen by most farmers as the most reliable information source (Ozowa, 1995). A detailed discussion on the role of extension officers in information dissemination to the farmers is discussed below.

3.2 The role of extension officers in the dissemination of information to farmers

Agricultural extension officers perform an important function worldwide in enhancing the competitiveness of agricultural production (Bernet *et al*, 2001). They act as frontline staff for the department or an agricultural institution given the nature of their work, and are therefore in regular contact with the farmers. The main goal of agricultural extension officers is to support the rural population in the process of improving their standard of living, mainly through increasing the agricultural production efficiency and increasing the farm income (Kleps & Absher, 1997). Such tasks are realized through performing four functions:

- Informational - providing farmers with information on economic and market situation in agriculture and its environment, and modern technology of agricultural production;

- Dissemination - application of the latest technology innovation to agricultural practice;
- Advisory - support farmers and their families in solving problems related to their profession and family and community resources management and
- Educational - supplementing and increasing the professional skills of farmers.

However, there has been evidence of failures of extension officers as information providers for farmers throughout Africa (Ngomane, 2004). Some studies (Anholt & Zijp, 1995) indicate that extension officers have been unresponsive to the variation in farmer needs. Van de Fliert (1998) argues that much of the information obtained by farmers is disseminated by other farmers by directly sharing knowledge and experiences with each other. Additionally, these farmers often do not get guidance or information regarding new advances on techniques in farming or tools available in the market. Farmers often criticize extension officers for being: inefficient and ineffective; lacking clear objectives, motivation, and incentives; being poorly managed and not accountable to farmers; and lacking relevant technologies to help small-scale farmers in improving production (Haug, 1999).

Most small-scale farmers operate within specific natural and socio-economic settings (Bernet *et al*, 2001). When those settings become diverse, extension officers own experience and personal knowledge usually cannot address these farmers problems spontaneously and instantaneously without research. Compounding this problem, Kahan (2007) observed that deficiencies in knowledge, skills and ability among extension officers are remarkable. In a survey conducted in 1990, it was found that about 39 percent of the extension officers worldwide had only secondary level and 33 percent had an intermediate level education (Bahal *et al*, 1992). Moreover, extension officers in their work as farm advisors are struggling to provide farmers with important agricultural information that they need in a timely manner. Extension officers who are confronted with this information struggle because they either do not understand what relevant information is needed and they do not know how to obtain it efficiently.

In South Africa, statistics from the National Department of Agriculture (2002) showed that about 80 percent of staff personnel in extension are unqualified for the job and this has a negative impact on their ability to deliver technical information (Kahan, 2007). In addition, the ratio of extension agents to farmer is 1:1500. This ratio is too high for extension officers to provide quality services to farmer training, field visits, and other services (Kahan, 2007). Moreover, it has been reported that many extension officers lack adequate transport facilities to reach farmers effectively, as a result, the resource poor in remote areas with limited access to transport, who are often more in need of information than others, are least likely to gain access to it (Janneh, 2001). All these problems have largely prevented the extension system from adequately and responsively addressing the needs of smallholder farmers (Garforth & Lawrence, 1997). Information dissemination methods such as printed material, audio-visuals, and radio can be appropriate as information providers to help farmers make decisions. It is clear that if the current extension system in South Africa is to work, then there is a need for new approaches to increase its role in assisting smallholder farmers to obtain information that will assist them in making better decisions in their farming operations.

4. The use of Information Communication Technology (ICT) in the provision of relevant information for farmers

Studies by Kahan (2007) have indicated that there is great potential in improving information flow to farmers through the use of Information Communication Technology (ICT). Kahan (2007) stresses that agricultural extension services needs to exploit this potential to strengthen their own capacities and to educate the rural populations. Since extension officers in South Africa are faced with physical distances in rural areas and the lack of transportation facilities, ICT has the potential to erase these physical barriers by developing and applying appropriate interactive information mechanisms.

Information Communication Technology plays a major role as a vehicle for information dissemination in the farming communities of the different parts of the world (IICD, 2008). However, in the rural areas of the developing world, ICT has not proved its worth for farming communities. Unlike the farming communities of the developed world, farming communities in the developing world still lag behind in the use of ICT due to certain limitations such as poor infrastructure, low levels of income and literacy (Tire, 2006). With some of the odds against the rural poor such as poor infrastructure, high level of illiteracy, and phobia around the use of technology, ICT could make a significant contribution to them in as far as dissemination of information is concerned. Farm advisors such as extension officers and consultants can help in educating farmers on how to make use of ICT. Information Communication Technology is well known for its ability to store vast information, its fast and inexpensive communication channels and the ability to link different media. One of the important applications of the service of ICTs has been the evolution of decision support tools (DST). Decision support technology is a relatively new development and may not yet be a high priority or well known among farmers, particularly in the developing world, including South Africa.

4.1 Decision support tools (DSTs)

The phrase decision support tool (DST) is frequently used in a loose sense to indicate any kind of decision aid whether computer based or not (Cox, 1996). Current agricultural DSTs are based on the notion that the performance of agricultural production systems is limited by a information shortage of the kind that professional science can provide, and by defects in the decision-making processes of resource management practitioners (Cox, 1996). These tools focus attention on a particular aspect of decision-making and help to illuminate issues or problems that are felt by the designer to be poorly understood (Loevinsohn *et al*, 2002). Such issues are generally thought to be critical to improved resource management (Loevinsohn *et al*, 2002). Decision support tools specify what has almost become synonymous with 'extension' (Cox, 1996).

Many DSTs in agricultural systems are built around an underlying simulation models (Meinke & Hochman, 2000). Simulation models are often used to predict how the components of a system interact and affect the likely outputs in agriculture (Walker and Zhu, 2000). Modeling has the capacity to assist decision-makers in quantifying complex plant-soil-environment interactions that cannot be obtained experimentally (Thornley & Johnson, 1990; Van Evert & Campbell, 1994), thereby assisting them with the diagnosis of problems and opportunities in agricultural systems (Bontkes & Wopereis, 2003).

Agricultural DSTs have been in existence since the mid 1970s (O'Brein *et al*, 2003). Examples of these tools have included SIRATAC, a cotton production decision tool, and EPIPRE, a European wheat decision support tool (McCown *et al*, 2002). None of these tools exist in the developing countries, particularly in South Africa. Today simulation has become useful means of providing valuable information for on-farm decision-making (Meinke & Hochman, 2000). Several DSTs have been developed to aid agricultural decision makers worldwide. Most of these tools are aimed at large scale farmers in developed countries, and only a few have been developed as decision support tools for farming in developing countries (Bontkes & Wopereis, 2003). The tools are important as information providers to make production decisions.

For farmers in the developed countries, there are hundreds of DSTs that are available to them (McCown *et al*, 2002). Typical applications of these tools have covered decisions relating to pest management in grain stores and arable crop disease control (Offer, 2003). However, these tools are relatively new in developing worlds and may not yet be well known or have a high priority with many small-scale farmers in Africa. In Sub-Saharan Africa, Bontkes and Wopereis (2003) observed that existing DSTs range from sophisticated computer models to simple tables that help provide answers to questions such as "what are best-bet options related to cultivar choice; use of mineral fertilizer choice and use of mineral fertilizer for late sowing of maize during the main rainy season on a degraded sandy soil"

Decision support tools for agriculture can play a number of useful roles in aiding decision-making for farmers. Rafn (2002) observed that DSTs can serve different purposes in agricultural systems. For example making provision and assessments and fostering of knowledge management for food and agriculture, which enables farmers to use fertilizer in a correct way and improving the environmental performance of fertilizers. O'Brein (2004), Sekyewa (2005) and Nguyen *et al* (2006) have identified numerous reasons behind the effectiveness of these tools in supporting farmers' decisions:

- Allows faster delivery of information;

- Makes information available to farmers and their advisors that may otherwise not be accessible;
- Addresses uncertainties and risks about production;
- Gives reliable results in a consistent and timely manner;
- Involves users in the development process;
- Presents a wider and faster dissemination of information to people hitherto unreached or under served, and a deeper geographic penetration, especially to rural areas;
- Improves access to information worldwide, hence fostering capacity building of individuals in the area;
- Provides rare opportunities and challenges for government to provide services to the rural populations.

In developed countries like Australia, the use of DSTs in agricultural systems is more common among extension officers than farmers (Nelson *et al*, 2002). Nelson *et al* (2002) argues that perhaps this is because the role of extension officers as advisory service providers is highly information intensive and requires them to learn, filter, organize and disseminate a large amount of information to farmers in the particular industrial context in which they work (Nelson *et al*, 2002). Farmers expect them to supply relevant advice on significant issues. Clearly for them, the use of DSTs has the potential to assist in the acquisition and management of such information. Offer (2003) claims that the use of computer systems to assimilate information and provide advice to farmers offers an exciting opportunity for extension officers in their work as farm advisors in this information intensive environment.

In developing countries, the role of DSTs in agricultural systems, although rarely documented, is increasingly being acknowledged to aid decision-making for farmers (Bontkes & Wopereis, 2003). Currently, farmers' information is provided mostly by extension officers, libraries or via websites (Gakuru *et al*, 2009). Considering the limitations or drawbacks of using libraries and web-based solutions by small-scale farmers (for example poor infrastructure, low literacy and limited language use), such tools of information delivery have the potential to be largely ineffective by giving farmers access to information in local languages about crops and agricultural market prices (Nagarkar, 2009). Moreover, with the number of farmers increasingly going up while extension officers are going down, and deficiencies in knowledge, skills and ability among extension officers, there is a need for such a tool to address this gap (Thamaga-Chitja, 2008). Furthermore, Gakuru *et al* (2009) adds that the development of these tools as a horizontal transfer of knowledge to farmers is becoming crucial particularly when viewed in the context of declining resources in governmental extension agencies, increasing demand for food and new challenges like climate adaptation.

Equipped with information, farmers can make better decisions. Farmers, who are supplied with direct information, can better manage revenues and farm costs (Ayele, 2007). With computer models and user-friendly tools becoming more common, farmers can now turn to DSTs to provide them with information that will assist them in making better decisions.

5. Adoption of DSTs by farmers

Although DSTs seem to have many benefits to farmers, evidence from literature suggests that a high percentage of these tools have failed to fulfill expectations (Walker, 2002) and therefore are not widely taken up by farmers (Cox, 1996; Lynch *et al*., 2000; Hearn and Bange, 2002). A number of issues have been raised about the development and adoption of DSTs in agricultural production systems (Newman *et al*, 2000). Many scholars have presented evidence and have commented on the slow rate of adoption and the lack of success in implementing these tools in agricultural decision-making (Nguyen, 2007). Assessments of this failure consistently identify the same issues (Walker, 2002). Campbell (1999), Lynch *et al* (2000) and Nguyen *et al* (2006) have examined barriers behind the low adoption rate of DSTs in the developed world. Some of the barriers include:

- Complex design and considerable data input;
- Limited computer ownership among producers;
- Unrealistic requirements for monitoring data;
- Irrelevance and, inflexibility of the DST;
- Lack of field testing;

- Mismatched objectives between developers and users
- Poor marketing of decision support tools;
- Lack of user-involvement;
- Farmers' fear of using computers and
- Time constraints.

In a survey conducted by the International Fertilizer Development Center (IFDC-Africa) to investigate reasons behind the limited use of DSTs in Sub-Saharan Africa, Walker (2000), Bontkes *et al* (2001), Matthews and Stephens (2002) summarized constraints with the widespread use of DSTs in agricultural development as follows:

- DST's often fail to capture sufficiently the complexity of small-scale farming;
- Some require data that are often not available or that are poor in quality;
- Lack of knowledge to use DSTs, which has prevented the widespread and inability to address the complexity and diversity of small-scale agriculture;
- Institutions promoting the use of DST's in Sub-Saharan Africa often emphasize the use of one particular tool, which does not address the complexity and diversity of small-scale agriculture;

There are many suggested reasons to explain the slow uptake of DSTs by farmers (Nguyen *et al*, 2006). Decision support tools have been criticized for not being well designed and focused on appropriate farmers' issues and so they do not really reflect how farmers make decisions (Nguyen *et al*, 2006). In a study of farmers' decision making processes, Ohlmer *et al* (1998) found that farmers do not use linear decision models, which are usually implemented in agricultural DSTs, but rather use non-linear decision models. As a consequence, these tools did not fit farmers' needs (Olmer *et al*, 1998). Failure of DSTs to meet actual requirements has led to irrelevance, inaccessibility and inflexibility of the tools (Walker & Zho, 2000).

One of the biggest challenges in developing a successful DST is making it relevant to the farmers' needs and decision-making processes (Nguyen *et al*, 2006). Farmers' decision-making process is often complex and multifaceted, and requires flexible, problem-oriented approach (Bontkes *et al*, 2001). Walker & Zho (2000) argues that most DSTs seek to mimic real decision-making processes and challenges, and therefore contribute to poor adoption. This reinforced the point made by Cox (1996) that decision support tools in agricultural systems usually impose structure on decisions that correspond poorly to decision style of farmers and the context in which they operate.

Compounding this problem, McCown (2002) pointed out that DSTs were not successful because they focused on the production component of the farming system and failed to address the subjective/social dimensions of the management system. Robertson (2005) reinforced this point by stating that these tools have been unable to compete with simple, more efficient, and more attractive systems of supporting decisions (for example; farm consultants). Moreover, Nguyen (2007) argued that developers of these tools rarely build flexible, easily used or comprehensive tools intended for farmers. Consequently many DSTs have had little relevance to farmers and have contributed to poor adoption (Cox & McCown, 1993). Perceived ease of use and usefulness of DSTs are key determinant of whether the DST will be accepted (Newman *et al,* 2000). Both these measures determine how well a DST will enhance a farmers' decision-making capability. This refers to the amount of time it might take to perform a certain task (Newman *et al*, 2000). The aim is therefore to develop a tool that rates high in ease of use and usefulness.

In a study on DSTs in Australian agriculture, Nguyen *et al* (2006) found that DSTs failed to get significant uptake because farmers believed that they can make good decisions without them. In addition, the study also found that DSTs were not widely used because they had not been well marketed, hence, most farmers do not know that they exist or what they can do (Nguyen *et al*, 2006). In another study Hayman (2004) noted that limited computer ownership among farmers was one of the major reasons for low uptake of DSTs in Australian agriculture. Although, less research has been done on the adoption of DSTs in the developing countries, it can be expected that issues related to computer ownership would be intensified (O'Brein *et al*, 2003).

Nevertheless, Nguyen *et al* (2006) argued that farmers are not computer-literate, which may lead to problems with the use of these tools by farmers. Cox (1996) reinforced this view by arguing that because DSTs are computer based, there is therefore a poor correspondence with the decision-making style of most farmers who, unlike model developers, do not generally use computers. For this reason, many farmers are not comfortable or lack confidence about the reliability of the tools and their outputs (Nguyen *et al*, 2006; Walker, 2000). Therefore, if farmers were to become more confident and proficient in model application, DSTs would also become increasingly useful and important to farmers Meinke *et al* (2001).

In the survey investigating the widespread of DSTs among farmers in Sub-Saharan Africa, Bontkes *et al* (2001), Matthews and Stephens (2002) and Walker (2002), commented that one of the reasons behind the low adoption of DSTs in Sub-Saharan Africa was that there are currently many single-issue DSTs, which fail to capture sufficiently the complexity of farmers' agriculture. In support of this view, Bontkes & Wopereis (2003) adds that individual tools are often unlikely to attain acceptance because they fail to address the complexity and diversity in agricultural production systems. The challenge for developing a DST is therefore to design and implement a tool that addresses a sufficient range of production issues in order to be useful to the farmers (Walker & Zho, 2000).

Ideally, farmers are important in development process of DSTs, from assessing the need for, to design and testing of these tools (Nguyen *et al*, 2006). This is because they are capable of providing feedback concerning design issues, relevance, needs and perceptions (Nguyen, 2007). However, in reality, farmers have often not been involved as much as they could be in many cases (Nguyen *et al*, 2006). Newman *et al* (2000) argues that many of the problems associated with the development and the low adoption of these tools can be traced back to farmers' involvement from the start of the development process. Nguyen *et al* (2006) proposes that close involvement of potential farmers at all stages in the DST development process will ensure that the final product will be well accepted. In cases where researchers, advisors and farmers have collaborated in developing DSTs to pursue improved farm management practice, benefits have been realized (Nelson *et al*, 2002). McGill (2001) found that farmers who developed DST applications were able to gain greater insights into the problem they were facing. Moreover, there is some evidence of this view in Australia from experiences with DSTs such as MIDAS (Kingwell and Pannell, 1987), SIRATAC (Hearn *et al*, 1981) and Wheatman (Woodruff, 1992), which have facilitated such social interaction (Nelson *et al*, 2002). Decision support tools are important as information providers to make production decisions.

6. Criteria for success in DSTs for farmers

Seeking to aid the future development of a user-friendly and easily understood DST, numerous criteria have been proposed. These criteria mean that the DSTs could be used by a wider number of farmers to help optimize the structure of agricultural production and choose the best solutions for sustainable development planning within farm and agricultural business management. This section discusses the criteria that experts have suggested should control the design of DSTs for farmers. Nguyen *et al* (2006) discovered that these include:

- Widespread problems need to be addressed;
- They need to be location specific ;
- There needs to be strong support from initial users;
- Relevance, simplicity, effectiveness and low cost are key attributes and
- Users need to be closely involved in the development of these tools.

There are many criteria that need to be met for broad adoption of DSTs to occur. Farmers' production decisions are complex and multifaceted (Janneh, 2001). For a DST to aid the decision-making process, it needs to focus on the widespread problems and opportunities to meet the complex needs of a large number of farmers (Nguyen *et al*, 2006). These opportunities or problems must be sufficiently complex to require a DST (Nguyen *et al*, 2006). This might particularly be useful in countries like South Africa, where extension officers are inaccessible to provide farmers with answers.

Cox (1996) argues that DSTs need to address issues that are causing considerable concern to farmers. He points out that these should be issues that farmers are not already making good decisions about, and something that farmers themselves think they are struggling with or need help with (Cox, 1996). This is most likely to be achieved through a true participatory approach that generates ownership of the process and confidence in the tools ability to stimulate real farm outcomes (Carberry & Bange, 1998). This is to make sure that the tool really meets farmers' needs, is understandable, and easy to use (Cain *et al*, 2003). For this to happen, Urs *et al*, (1999) argues that these tools must be designed to be accessible, transparent and credible to people who may be unfamiliar with computer technology. Clearly, developing tools with limited applicability will limit their widespread use (Cain *et a*l, 2003).

For any DST to be useful to its intended users, it needs to be simple and quick to use. For this to happen, farmers need to be included in model development process, from design to implementation stage (Nguyen *et al*, 2006). This will ensure that the objective that the farmer has when making his/her decisions is actually reflected by the decision support tool and that the tool is understandable and easy to use (Nguyen *et al*, 2006). The author argues that unless DSTs are made very simple and quick to use, majority of the farmers are unlikely to use them (Nguyen *et al*, 2006). In reality they are more simple and single tools in use by service providers and experienced managers than larger ones (Armstrong *et al*, 2003). However, the shortcomings of these tools is that they are less comprehensive in the representation of processes, less flexible and have a reduced ability to include complex interactions (Freebairn *et al*, 2002).

Though no particular DST may be successful under all circumstances Cox (1996) and Newman *et al* (2000) have suggested several characteristics of a successful DST for farmers. Some or all of these attributes characterize successful DSTs. The characteristics of a successful DST should include:

- When the tool reaches a certain percentage of the targeted market in terms of both distribution and accessibility;
- When it can be shown that farmers have changed or improved farming practices through the use of the tool;
- If the tool continues to exist and has some use among researchers, extension officers and farmers when its becomes obsolete and
- If farmers are able to use the information generated from the Decision support to make tactical and strategic decisions.

7. Summary of the literature review

Decision making is the essence of appropriate farm management. Effective decision making depends heavily on accurate, relevant and timely information. The review of literature revealed that small-scale farmers in South Africa lack appropriate information to make better decisions regarding production, and that ICT related DSTs can contribute substantially and significantly to information related problems that small-scale farmers have. A DST is usually an interactive computer-based system that offers both information and decision making procedures designed to improve the quality of the decision making process. In the past decade, hundreds of these tools have been developed to aid decision making for farmers in the developed world compared to the developing world. A body of research is emerging on the role of DST's in agriculture worldwide. Research has discovered that the use of these tools in agriculture is declining and not living up to its apparent early promises.

Some of the reasons behind the low rate of adoption of these tools in agriculture in the developed world include complex design; poor end user involvement; mismatched objectives between developers and users; limited computer ownership; irrelevance and farmers fear of using computers. Although less research has been conducted on the adoption of these tools in the developing world, the same barriers or reasons would presumably exist or would be intensified. Therefore, it is clear that there is a need for a user-friendly DST that is able to really meet farmers' needs.

When planning or designing user-friendly DST that can easily be understood and used by a large audience, numerous criteria have been suggested to control the design. Some of these criteria include the suggestion that the tool should be able to address the widespread of problems that farmers are faced with; these tools need to be location specific, relevant, simplified, effective and most importantly, users need to be closely involved in the development of the tool.

CHAPTER THREE
DESCRIPTION AND TRAITS OF STUDY SAMPLE

In developed countries, where most DSTs are used (exist), these tools are more common among extension officers than farmers (Nelson *et al*, 2002). This is because extension officers have a bigger role to play in as far as dissemination of information to farmers is concerned. Their role requires them to learn, filter, organize and disseminate a large amount of information to farmers with the aim strengthening their capacities in order to improve production (Nelson *et al*, 2002). This role also applies to many extension officers, including researchers (agricultural scientists) in the developing world. This chapter provides a brief description of both groups (extension officers and researchers (agricultural scientists) in South African context, with specific reference to the group of extension officers from Cascades and the group of researchers from Dundee, where the study was conducted.

3.1 Extension officers

Extension officers are frontline staff for the Department of Agriculture throughout the country in as far as dissemination of information is concerned (Tire, 2006). They interact directly with farmers on behalf of the department and are in contact with farming communities on a daily basis (String Communication, 2007). In the Umgungundlovu District (Cascades), where this study was conducted, there are about 58 extension officers working for the Department of Agriculture. Each responsible for rendering direct technical support service to the farmers spread out in most of the province’s rural areas, known as Field Service Units (FSUs). They are placed at various FSUs to ensure rendering of efficient and ongoing technical support to the rural farming communities. South African extension officers have over the years built solid working relationship with the farming communities in the country, and having served these areas over time, they also have an added advantage of being familiar with the socio-economic and agro-climatic conditions of their allocated service areas (Tire, 2006).

3.1.1 The role of extension officers

Extension officers are intermediaries between research scientists and farmers (ARC, undated). Their role is to teach, assist and inspire farming communities by sharing new knowledge and information to help farmers in decision making and also acquire the technical and managerial skills required to cope effectively with the farming needs (ARC, undated & String Communication, 2006). Many extension officers see their role as one of improving the quality of farmers' decision making in order to help farmers achieve their goals more satisfactorily (Bollinger *et al*, 1992).

Extension officers help to improve the quality of farmers' lives by helping them achieve higher yields, which in turn provide better returns. Agricultural extension officers are also responsible for communicating with farmers on agricultural information such as natural resources, animals, crops, how to utilize farmlands, how to construct proper irrigation schemes, economic use and storage of water, combat animal disease, and save on the cost of farming equipment and procedures (ARC, undated). Their prime responsibility is to ensure that farmers understand this information and use it on their farms in order to obtain the best production (ARC, undated). Extension officers use various methods in an effort to disseminate information to farmers. These include lectures, on-farm demonstrations, distribution of leaflets and the use of electronic media (Tire, 2006).

As promising as their roles seem, problems have been raised, which decrease the effectiveness of agricultural extension officers in South Africa. Problems such as extension officers not being able to disseminate information due to staff shortages, extension personnel lack of training in extension methods and communication skills, lack of adequate transport facilities to reach farmers effectively, lack of essential teaching aids, demonstration materials and communication equipment (Thamaga-Chitja, 2008; Worth, 2009). Other problems have been linked to lack of infrastructure, lack of support from staff at regional and head offices, unnecessary delays and failure from the government to some of their service delivery efforts (Tire, 2006). Clearly, these extension officers need support and resources in order to be able to make an impact in the livelihoods of the rural farming communities. The use of DSTs and crop management manuals can play a major role in making information more accessible to rural farmers.

3.1.2 Traits of an extension officer

To be an extension officer, there are a few different traits that an individual must or should have. These include: having good communication and interpersonal skills; possess persuasive abilities; be tactful; have a keen interest and knowledge of farming and the environment and enjoy working outdoors.

3.2 Researchers (Agricultural Scientists)

An agricultural scientists or agriculturist studies plants, animal and cultivation techniques and endeavours to increase productivity of farms and agricultural firms. They look for ways to improve quality, but in a less labour-intensive way. Many different kinds of scientists work in agriculture: microbiologists, chemists, veterinarians, stock researchers, engineers, plant pathologists, nutritionists and many other specialities. What they all have in common is that they are working out how to grow crops, raise livestock, produce renewable raw materials for industry and help preserve our environment. In Dundee, were the study was also conducted, there are exactly 60 agricultural scientists employed under the Department of Agriculture. They range from plant pathologists, food scientists, and veterinarians to stock researchers. Their duties and general responsibilities are outlined below.

3.2.1 General responsibilities/duties of agricultural scientists

Agricultural scientists have a very important role to play in society. They are responsible for working with the environment on a daily basis and ensuring that it is much more pleasant for everyone. Agricultural scientists work in a variety of environments, depending on their exact job title. They work with plants, animals and other natural items. Tasks undertaken by an agricultural scientist include collecting and analysing soil samples, plants and ground water, designing and conducting research, and providing technical information to assist farmers, graziers and commercial firms to plan and monitor agricultural activities. Agricultural scientists may also be required to supervise, train or coordinate the work of technicians, field workers or research staff. The majority of agricultural scientists work as members of a team alongside other scientists and farmers, although there are some who work alone.

Agricultural scientists concerned with crop science investigate field crop problems and develop new and improved growing methods to obtain higher yields or better quality. They may specialize in a specific crop, group of crops, production, weed and pest control or irrigation. They process and communicate new ideas and information to farmers so they can use it. They must present them in a light which is most easily understood by the audience receiving the information. Agricultural scientists are also responsible for advising farmers on farming methods. Training, counselling and research are important tasks of an agriculturist. This was true for the group of agricultural scientists that participated in the study.

3.2.2 Traits of an agricultural scientist

There are a few different traits which every agricultural scientist should possess. To be an agricultural scientist, one needs to have an interest in agriculture, demonstrate strong communication skills, be able to tackle problems head on and work effectively in a team. It also helps if he/she is accurate, observant, and has good organisational skills. Preciseness, efficiency, adaptability, strong, athletic and love or interest for the outdoors and the environment are among other additional traits an agricultural scientist should possess. Some of the traits, such as strong communication skills and working effectively in a team were conveyed by the group during the time of the study

CHAPTER FOUR
STUDY METHODOLOGY

This study evaluated the effectiveness of a new DST for organic and small-scale farmers with extension officers and researchers in KwaZulu-Natal. As an extension to the DST a crop disease management component linked to the DST was developed. The study also focused on evaluating the effectiveness of the crop disease management component in guiding farmers on minimizing crop diseases. This chapter describes the research design and methodology applied to collect and analyse data.

4.1 Sample selection

This study set out to evaluate the effectiveness of a new DST and its crop disease management component, with a group of extension officers and researchers (agricultural scientists) in KwaZulu-Natal. Extension officers and researchers were purposively selected for this study because both groups play a major role as far as organising and disseminating information to organic and small-scale farmers is concerned. There are a number of extension officers and researchers working within the KwaZulu-Natal province. However, due to the groups (extension officers and researchers) availability and accessibility on the scheduled time and their willingness to participate in the study, only a group of extension officers from Cascades and a group of researchers from Dundee participated in the study. Permission was obtained from the Regional manager through a formal letter to conduct the research for both groups. The group were notified by telephone and requested to participate in the study before hand.

4.2 Data collection methods

The researcher conducted two participatory workshops. One participatory workshop took place with a group of extension officers from Cascades on the 5th of November 2009 at the Department of Agriculture at Cascades. The other participatory workshop took place with the group of researchers in Dundee on the 4th of December 2009. During the participatory workshop sessions, the DST (Appendix B, C and D) and its crop disease management component (Appendix E) were demonstrated and the groups' perceptions were explored using focus group discussions as the data collection technique. A focus group questionnaire guide was used as a base for the focus group discussions (Appendix A).

4.2.1 Focus groups

Detailed data was collected from focus group discussions with the groups (extension officers and researchers). Brierty (1999) stated that focus group discussions are one way of extracting a small sample and obtaining feedback. Meyer (1997) explains that a focus group discussion is a method used in collecting in-depth qualitative information about groups' perceptions, attitudes and experiences on a defined topic. Focus group discussions formed an important part of the study as they provided opportunities to investigate critical issues as perceived by the groups (Lewis, 1995). In this study, focus group discussions were used to gain in-depth information on the groups perceptions of the DST and its crop disease management component. Moreover, focus group discussions were also used to gain in-depth information on issues that affect small-scale farmers and how the DST and its crop disease management component can provide solutions. The information obtained from the discussions was compared against the key measures for effectiveness of DSTs and crop disease management guides presented in Chapter five (Figure 5.1 and Figure 5.2, respectively) to determine effectiveness of the new DST and its crop disease management component.

Workshops started with greetings and a formal introduction from the researcher about the purpose of the research. They were followed by a demonstration of the DST and its crop disease management component. Topics in the focus group questionnaire guide were posed to create discussions and groups responded (Appendix A). The groups generally expressed issues that affect small-scale farmers and how the new DST and its crop disease management component can provide solutions. When there was disagreement, further discussion followed until consensus was reached. A consensus was reached through the researcher encouraging further discussion among the groups and facilitating the discussions. If there was no consensus after further discussion, more than one answer was recorded. Each workshop was a day long.

Data analysis and treatment

Qualitative data from the focus group discussions was analysed through summaries and tables. The study used analytical frameworks developed from key measures for effectiveness of DSTs and crop disease management guides drawn from literature to analyse the results of the study. The three key measures for effectiveness of DSTs used to analyse the results on the effectiveness of the new DST included: relevance, ability to improve access to information, and transparency to users. The two key measures for effectiveness of crop disease management guides used to analyse the results on the effectiveness of the crop disease management component included: relevance and transparency to users. Table 4.1 presents the data collection and analysis plan that was followed to obtain answers and to analyse each sub-problem of the study. The next chapter presents a discussion of the findings of the study

Table 4.1 Data collection and analysis plan for each sub-problem, 2011

Sub -problem	Data collection tool	Data collected	Analysis
1. Is the DST effective to extension officers and researchers?	-Focus group discussions	-Groups perceptions of the DST -Strengths and Weaknesses of the DST	- Criteria established from literature, Summary tables
2. Is the crop disease management component effective in guiding and improving management of crop diseases for organic and small-farmers guide?	-Focus group discussions	- Groups perceptions of the crop disease management component - Strengths and Weaknesses of the crop disease management component	- Criteria established from literature, Summary tables
3. How can the DST and its crop disease management component be improved?	-Focus group discussions	-Suggestions for further development or improvement of the DST and its disease management component	-Summary tables

CHAPTER FIVE

CRITERIA FOR EFFECTIVE DECISION SUPPORT TOOLS AND CROP DISEASE MANAGEMENT GUIDES

Evaluation is an important and necessary step to measure the effectiveness and successfulness of a DST (McCown *et al*, 2002). However, this step has been overlooked by developers of DSTs during the development process (Rafn, 2002). This study aimed to evaluate the effectiveness of a new DST for organic and small-scale farmers. In this study, a DST evaluation framework was developed to measure the effectiveness of the new DST (Figure 5.1). The construction of the framework was supported by a detailed review of literature on previous DST evaluations. From previous literature, the study identified common measurement factors used to evaluate DSTs and classified these into three key measures for effectiveness: relevance, ability to improve access to information, and transparency to users. These three key measures are suggested to be the main measurements for effectiveness of the new DST.

As an improvement to the DST, a crop disease management component linked to the DST was developed. The study also set to evaluate the effectiveness of the crop disease management component in guiding farmers on minimizing crop diseases. In this study, an evaluation framework for the crop disease management guides was developed to measure the effectiveness of the crop disease management component (Figure 5.2). The construction of the framework was supported by a detailed review of literature on previous crop disease management guide evaluations. From previous literature, the study identified common measurement factors used to evaluate crop disease management guides and classified these into two key measures for effectiveness: relevance and transparency to users. These two key measures are suggested to be the main measurements effectiveness of the crop disease management component.

5.1 Evaluating the effectiveness of the DST

From literature on previous evaluations of DSTs, the study identified common measurement factors used to evaluate DSTs and classified them into three key measures for effectiveness: relevance, ability to improve access to information and transparency to users. A summary of each key measure for effectiveness is presented, individually, in terms of what the DST effectiveness measure is, why it is important and valid, and its application.

Relevance

When considering the effectiveness of an agricultural DST, one theme is becoming more prevalent in the literature. That is, ensuring that the DST is relevant to potential users (O'Brein, 2004; Cox, 2006; Nguyen *et al*, 2006.). This means that the DST needs address at least one important issue(s) that is of interest or need to users and at least one problem(s) that is causing considerable concern(s) (Nguyen *et al*, 2006). In other words, the DST needs to provide data and procedures that will address issues of uncertainties and risks in production (O'Brein, 2004). This could be an issue(s) or problem(s) that users are not already making good decisions about, and think they are struggling with or need help with (Cox 1996).

Ability to improve access to information

In addition to ensuring that the DST is relevant to potential users, another measure for effectiveness that is prevalent in the literature is the tools ability to improve access to information (O'Brein, 2004; Sekwyewa, 2005; Nguyen *et al*, 2006). This means that the DST needs to allow a faster delivery of information, make information available to users that may otherwise not be accessible, present a wider and faster dissemination of information to people hitherto unreached or underserved areas, and provide rare opportunities and challenges for government to provide services to the rural populations (O'Brein, 2004; Sekwyewa, 2005; Nguyen *et al*, 2006). In cases where a DST has had the ability to improve access to information for its users, benefits have been realized (Nelson *et al*, 2002).

Transparency

Transparency is another approach to evaluating DST effectiveness. Transparency in DSTs can be measured in terms of flexibility and user friendliness. This means that the DST needs to be simple, understandable, easy and quick to use (Cain *et al*, 2003; Nguyen *et al*, 2006). If DSTs are to perform a support function, they should be user friendly and provide a high degree of flexibility (Haklay & Tobon, 2003). This means that users with an average level of computer literacy should be able to handle the DST without prior training (Geertman, 2002). Transparency should be part of the design of DSTs aimed at promoting a successful decision making process (Geertman, 2002). A DST with a low level of transparency may experience a low level of utility from the perspective of users. The ability of a DST to provide transparent documentation of all the information and data being considered to complete decisions provides an accessible avenue for stakeholders and citizens to follow and, therefore, become increasingly engaged within the decision-making process (Drew, 2003; Geertman, 2002; Haklay & Tobon, 2003).

Relevance:

- Address at least one important issue(s) that is of interest or need to users and at least one problem(s) that is causing considerable concern(s) that users are not already making good decisions about, and something that they think they are struggling with; and
- Address uncertainties and risks in production.

Ability to improve access to information:

- Should allow a faster delivery of information;
- Makes information available to farmers and their advisors that may otherwise not be accessible;
- Presents a wider and faster dissemination of information to people hitherto unreached or underserved areas; and
- Provides rare opportunities and challenges for government to provide services to the rural populations.

Measures for Effectiveness

Transparency:

- Flexibility and user friendliness (simple, understandable, easy and quick to use).

Figure 5.1 Framework for evaluating the effectiveness of the DST, 2011

5.2 Evaluating the effectiveness of the crop disease management component

From literature on previous evaluations of crop disease management guides, the study identified common measurement factors used to measure effectiveness in crop disease management guides and classified them into two key measures for effectiveness: relevance and transparency to potential users. A summary of each key measure for effectiveness is presented, individually, in terms of what the crop disease effectiveness measure is, why it is important and valid, and its application.

Relevance

Ensuring that the crop disease management guide is relevant to it users first key measurement for effectiveness (Otsyina & Rosengberg, 1997). Similar to the first key measure for the effectiveness of DSTs, this means that the crop disease management component needs to address a real problem(s) and need(s) for users (Carter, 1999). In other words, the DST needs to provide data or procedures that will help address issues of uncertainties and risks in production (Morris & Stillwell, 2003). Like DSTs, these could be issue(s) or problem(s) that users are not already making good decisions about, and something that they think they are struggling with or need help with (Cox *et al*, 1996).

Transparency

Transparency is the other approach to evaluating DST effectiveness. Like DSTs, transparency in crop disease management guides can be measured in terms of flexibility and user-friendliness. This means that the crop disease management guide needs to be simple, understandable, easy and quick to use. A study (Stephano *et al*, 2005) discovered that farmers considered crop management guides to be transparent if they contain simple and easy formatting. This includes the use of colourful pictures; sufficient and simple text; large print size; easy to read; use of simple English and translation into a local language. Stephano *et al* (2005) discovered that the inclusion of colourful pictures makes guides look good, easy to understand, interesting and encourages readership, as compared to black and white pictures, which provides less information. Beyond the use of colourful pictures, the same study also highlights the importance of having sufficient text accompanying the pictures (Stephano *et al*, 2005). Based on the findings of the study, this makes it easy for users to fully understand what is being conveyed in the pictures. Stephano *et al* (2005) asserts that where no accompanying text is used to convey what is on the picture, the guide is considered to lack clarity. A crop management guide that includes a common language and a local language is likely to gain more popularity than one that includes only a single language. In a study conducted in KwaZulu-Natal (Stephano *et al*, 2005), it was discovered that most farmers did not use the guides offered to them since they did not include a local language (isiZulu), therefore, these material were useless to them.

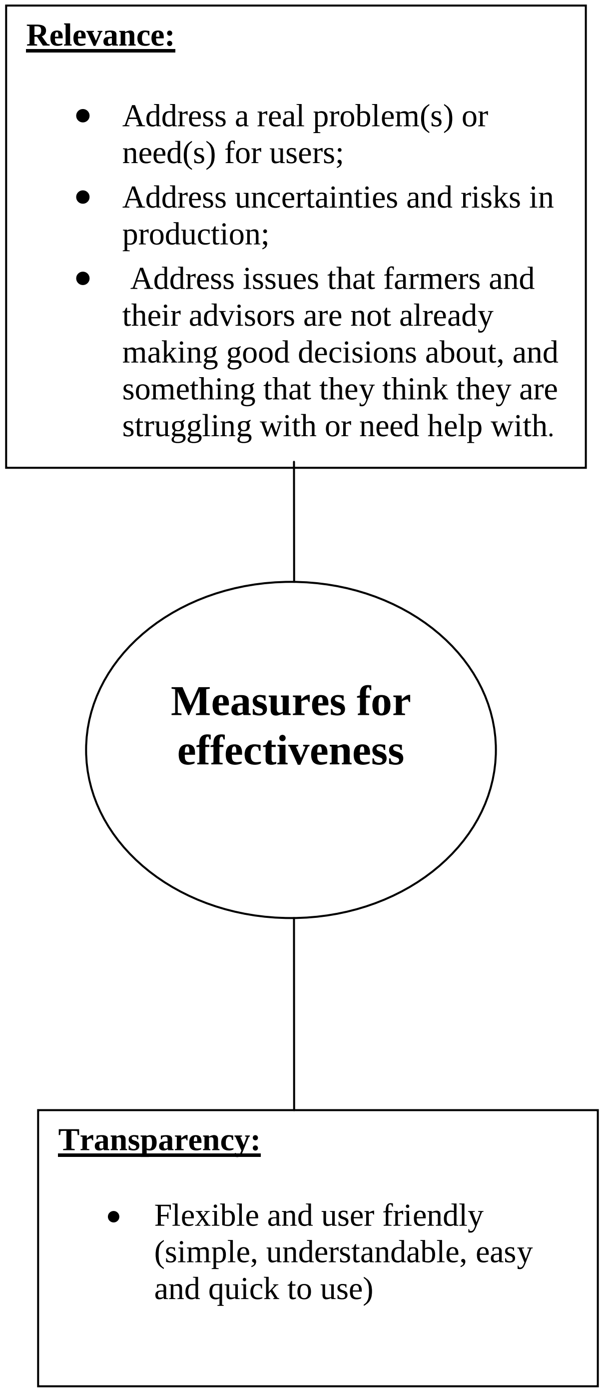


Figure 5.2 Framework for evaluating the effectiveness of the crop disease management component, 2011

CHAPTER SIX
RESULTS AND DISCUSSION

The main purpose of this study was to evaluate the effectiveness of a newly developed production DST for organic and small-scale farmers with a group of extension officers and researchers in KwaZulu-Natal. This DST designed to enhance production decisions for organic and -small-scale farmers also includes a crop disease management component aimed at improving planning and management of crop disease for organic and small-scale farmers. This chapter presents and discusses the findings of the study. The study addressed three sub-problems in order to answer the main research problem. The study explored the following sub-problems:

Sub-problem 1: Is the DST effective to both extension officers and researchers?
Sub-problem 2: Is the developed crop disease management component of the DST effective in guiding and improving management of crop disease for organic and small-scale farmers?
Sub-problem 3: How can the DST and its crop disease management component be improved?

6.1 Is the DST effective to both extension officers and researchers?

Analysis of the key measures influencing the effectiveness of the DST was conducted in chapter five. A framework for measuring the effectiveness of the DST (Figure 5.1) was developed to analyze the results in order to answer the sub-problem on the effectiveness of the DST. The framework identifies three key measures for evaluating effectiveness of DSTs and uses these to explore and establish whether in the light the groups (extension officers and researchers), the DST meets these measures for effectiveness.

Relevance

When considering the effectiveness of an agricultural DST, one theme becoming more prevalent in the literature is ensuring that the DST is relevant to its potential users (O'Brein, 2004; Cox, 2006; Nguyen *et al*, 2006). This means that the DST needs to address at least one important problem that is causing considerable concern to users (Nguyen *et al*, 2006). In the case of this newly developed DST, groups were in general agreement that the DST addresses numerous problems for small-scale farmers. The discussions with groups revealed that among the many problems that small-scale farmers in South Africa are faced with, farmers lack tools and information when faced with production decisions and therefore require support. Table 6.1 shows that groups believed that the DST can be a solution for small-scale farmers since it has the ability to provide appropriate production information to help farmers make better decisions. These results support the findings of O'Brein *et al* (2003) which states that DSTs are only relevant if they are able to provide up-to-date data, procedures and analytical capacity leading to better-informed decisions.

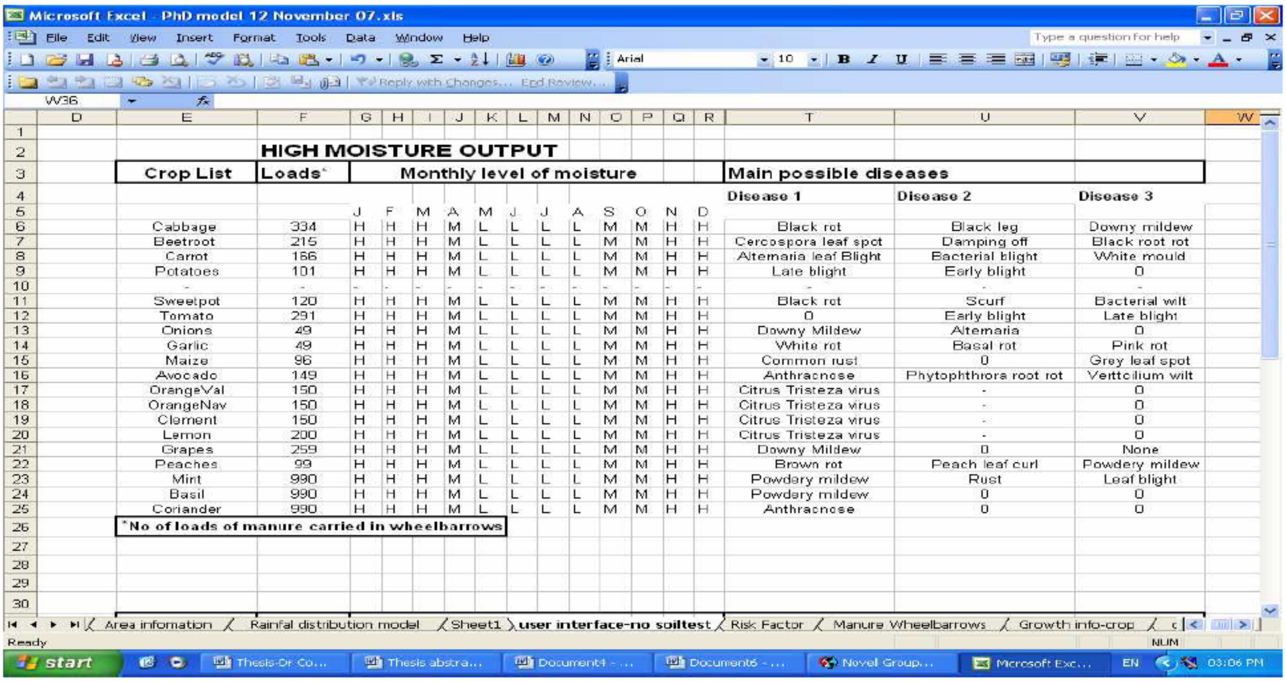
Furthermore, groups reported that small-scale farmers want to be more productive and prosper in farming, but lack appropriate information and successful farming experience to make sound decisions that could help improve production. The groups added that extension officers, in their work as farm advisors, are often not adequately trained to serve all the small-scale farmer needs. Table 6.1 indicates that overwhelmingly, groups believed that the DSTs' ability to provide information that is often not available for small-scale farmers (i.e. information on monthly disease risk in production planning, new choices and ideas about crops) could help them make better decisions in farming. These results correspond with the findings of Sekyewa (2005) which mentions that a DST is considered relevant through its ability to make information available to users that may otherwise not be accessible.

Discussion with the groups revealed that small-scale farmers have an interest and desire for organic agriculture, yet lack sufficient and appropriate information on what type of products to grow and management of pest and disease. Moreover, groups reported that many extension officers in South Africa are not trained in organic farming and find it difficult to support organic farming, particularly in critical areas such as pest and disease and therefore need support. Results in Table 6.1 indicate that groups felt that this new DST can contribute solutions for small farmers since it provides information that could help address uncertainties and risks associated with organic farming. Such information includes new choices and ideas about crops that are compatible with the environment and monthly disease risk information. These results support the findings of O'Brein (2004) and Nguyen *et al* (2006) which emphasize that in order for a DST to be relevant to users, it needs to address uncertainties and risks in production.

Groups expressed that this information provided by the DST will help farmers know how and when to watch out and avoid crop disease and could assist small-farmers in making decisions regarding adoption or intensification of agriculture, particularly organic agriculture. These findings confirm the results from studies by (Nguyen *et al*, 2006; Sekyewa, 2005; O'Brein, 2004), which state that for a DST to be considered effective, it must address issues that are causing considerable concern to farmers. An example of the disease output of the DST is presented in Figures 6.1 and 6.2. The output at this stage is a two-page document.

Table 6.1 Evaluation of the DST on its relevance to small-scale farmers, 2011

Measure for effectiveness of DSTs	Groups responses about the DST
Relevance	• Provides appropriate information that could help farmers make better decisions in farming (i.e. monthly disease risk information in production planning, information on new choices and ideas about crops). • Makes information available to farmers and their advisors that may otherwise not be accessible (i.e. monthly disease risk information in production planning; information on new choices and ideas about crops) • Addresses uncertainties and risks associated with organic farming by providing information on new choices and ideas about crops that farmers and extension officers; monthly disease risk information in production planning)

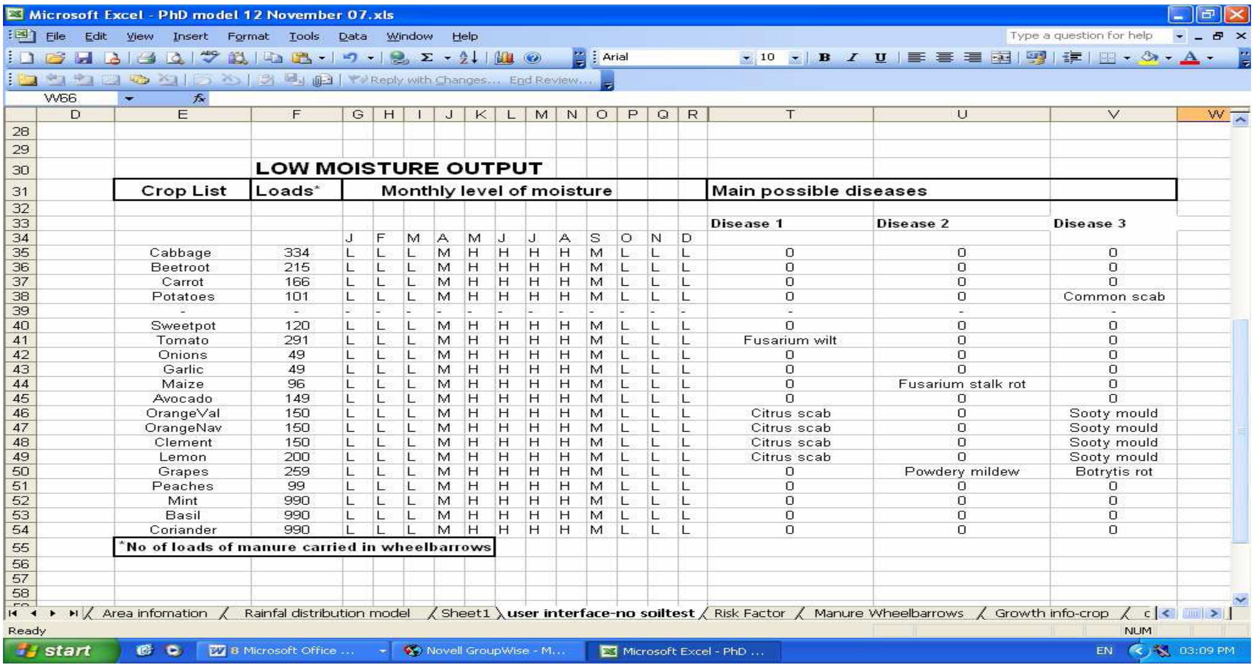


HIGH MOISTURE OUTPUT

Crop List	Loads*	J	F	M	A	M	J	J	A	S	O	N	D	Disease 1	Disease 2	Disease 3
Cabbage	334	H	H	H	M	L	L	L	L	M	M	H	H	Black rot	Black leg	Downy mildew
Beetroot	215	H	H	H	M	L	L	L	L	M	M	H	H	Cercospora leaf spot	Damping off	Black root rot
Carrot	166	H	H	H	M	L	L	L	L	M	M	H	H	Alternaria leaf Blight	Bacterial blight	White mould
Potatoes	101	H	H	H	M	L	L	L	L	M	M	H	H	Late blight	Early blight	0
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sweetpot	120	H	H	H	M	L	L	L	L	M	M	H	H	Black rot	Scurf	Bacterial wilt
Tomato	291	H	H	H	M	L	L	L	L	M	M	H	H	0	Early blight	Late blight
Onions	49	H	H	H	M	L	L	L	L	M	M	H	H	Downy Mildew	Alternaria	0
Garlic	49	H	H	H	M	L	L	L	L	M	M	H	H	White rot	Basal rot	Pink rot
Maize	96	H	H	H	M	L	L	L	L	M	M	H	H	Common rust	0	Grey leaf spot
Avocado	149	H	H	H	M	L	L	L	L	M	M	H	H	Anthracnose	Phytophthora root rot	Verticilium wilt
OrangeVal	150	H	H	H	M	L	L	L	L	M	M	H	H	Citrus Tristeza virus	-	0
OrangeNav	150	H	H	H	M	L	L	L	L	M	M	H	H	Citrus Tristeza virus	-	0
Clement	150	H	H	H	M	L	L	L	L	M	M	H	H	Citrus Tristeza virus	-	0
Lemon	200	H	H	H	M	L	L	L	L	M	M	H	H	Citrus Tristeza virus	-	0
Grapes	259	H	H	H	M	L	L	L	L	M	M	H	H	Downy Mildew	0	None
Peaches	99	H	H	H	M	L	L	L	L	M	M	H	H	Brown rot	Peach leaf curl	Powdery mildew
Mint	990	H	H	H	M	L	L	L	L	M	M	H	H	Powdery mildew	Rust	Leaf blight
Basil	990	H	H	H	M	L	L	L	L	M	M	H	H	Powdery mildew	0	0
Coriander	990	H	H	H	M	L	L	L	L	M	M	H	H	Anthracnose	0	0

*No of loads of manure carried in wheelbarrows

Figure 6.1: An example of the first page of the DST showing output for high moisture-induced crop diseases (Thamaga-Chitja, 2008: pg 76)



LOW MOISTURE OUTPUT

Crop List	Loads*	J	F	M	A	M	J	J	A	S	O	N	D	Disease 1	Disease 2	Disease 3
Cabbage	334	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0
Beetroot	215	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0
Carrot	166	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0
Potatoes	101	L	L	L	M	H	H	H	H	M	L	L	L	0	0	Common scab
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sweetpot	120	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0
Tomato	291	L	L	L	M	H	H	H	H	M	L	L	L	Fusarium wilt	0	0
Onions	49	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0
Garlic	49	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0
Maize	96	L	L	L	M	H	H	H	H	M	L	L	L	0	Fusarium stalk rot	0
Avocado	149	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0
OrangeVal	150	L	L	L	M	H	H	H	H	M	L	L	L	Citrus scab	0	Sooty mould
OrangeNav	150	L	L	L	M	H	H	H	H	M	L	L	L	Citrus scab	0	Sooty mould
Clement	150	L	L	L	M	H	H	H	H	M	L	L	L	Citrus scab	0	Sooty mould
Lemon	200	L	L	L	M	H	H	H	H	M	L	L	L	Citrus scab	0	Sooty mould
Grapes	259	L	L	L	M	H	H	H	H	M	L	L	L	0	Powdery mildew	Botrytis rot
Peaches	99	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0
Mint	990	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0
Basil	990	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0
Coriander	990	L	L	L	M	H	H	H	H	M	L	L	L	0	0	0

*No of loads of manure carried in wheelbarrows

Figure 6.2: An example of the second page of the DST showing output for low moisture-induced crop disease (Thamaga-Chitja, 2008: pg 77)

In addition to ensuring that the DST is relevant to potential users, another measure for effectiveness that is prevalent in the literature is the tools ability to improve access to information (O’Brein, 2004; Sekwyewa, 2005; Nguyen *et al*, 2006). This means that the DST needs to allow a faster delivery of information, make information available to users that may otherwise not be accessible, present a wider and faster dissemination of information to people hitherto unreached or underserved areas, and provide rare opportunities and challenges for government to provide services to the rural populations (O’Brein, 2004; Sekwyewa, 2005; Nguyen *et al*, 2006). Results from the discussions with the groups about the DSTs ability to improve access to information are presented next.

Ability to improve access to information

The discussion held with groups about the DSTs’ ability to improve access to information revealed that majority of small-scale farmers in South Africa are found in rural and remote areas and lack appropriate tools to support them in decision making and therefore need better tools. Groups added that being spread over a vast area of land makes it difficult for extension service to provide assistance to the scattered communities, which means that small-scale farmers often have insufficient access to resources and information to help improve production. Results, as indicated in Table 6.2, show that groups strongly believed that this DST can improve access to information for small-scale farmers. Table 6.2 shows that groups were generally in agreement that the DST presents a wider and faster dissemination of information to people hitherto unreached or underserved, and a deeper geographic penetration, especially to rural areas. Moreover, groups shared a common few that the DST delivers information in a consistent and timely manner, allowing the users (farmers and extension officers) to make decision timeously. These findings confirm the results from the study by Sekyewa (2005), O’Brein (2004) and Nguyen *et al* (2006), which discovered that DSTs are effective if they allow a faster and effective delivery of information.

Interaction with groups also revealed that government extension services in South Africa are very limited and often out of reach for poorly resourced farmers. Table 6.2, shows that groups felt this DST can be a solution for South Africa’s government since it provides rare opportunities and challenges for them to provide services to the rural population. Additionally, groups also reported that extension officers are often not adequately trained to serve all the small-scale farmer needs. Results in Table 6.2, shows that groups felt that this DST can contribute solutions for extension services since it could help boost the value of information they provide to farmers. Moreover, enhance the knowledge and empower small-scale farmers so that reliance on external support can be minimized. This is echoed in the studies conducted by Sekyewa (2005), O'Brein (2004) and Nguyen *et al* (2006), which discovered that DSTs are effective to their users if they improve access to information, hence fostering capacity building of individuals in the area.

Table 6.2 Evaluation of the DST on its ability to improve access to information for small-scale farmers, 2011

Measure for effectiveness of DSTs	**Groups responses about the DST**
Ability to improve access to information	• Presents a wider and faster dissemination of information to people hitherto unreached or underserved, and deeper geographic penetration, especially to rural areas. • Provides rare opportunities and challenges for government to provide services to the rural population • Minimizes farmers reliance on external support • Delivers information in a consistent and timely manner, allowing the users (farmers and extension officers) to make decisions timeously

Transparency is another approach to evaluating DST effectiveness. Transparency in DSTs can be measured in terms of flexibility and user friendliness. This means that the DST needs to be simple, understandable, easy and quick to use (Cain *et al*, 2003; Nguyen *et al*, 2006). Results obtained from the discussions with the groups about the transparency of the DST to its potential users are presented below.

Transparency

Discussion on the DSTs' ability to be transparent to users revealed that the majority of small-scale famers in South Africa are either non-educated or have low levels of education and therefore fear or cannot use computer technology. Moreover, groups also revealed that illiteracy level among small-scale farmers is very high and majority of farmers cannot read or write in English. Furthermore, groups revealed that farmers are always busy and do not have time for tinkering long and sophisticated software. Table 6.3 shows the groups believed the DST could be useful for these farmers since it is simple and quick to use. These results confirm the findings of Nguyen *et al* (2006) which states that farmers find DST to be effective if they are simple and quick to use, allowing farmers to make decisions timeously.

Furthermore, Table 6.3 shows that although farmers might be illiterate and fear using computers, groups felt that this DST is user-friendly and has been made as flexible as possible for small-scale farmers since it includes a local language (see Appendix B, C and D) and uses a Microsoft Office Excel (version 2003) instead of a complex programme that would require the user to be well versed in computer usage. Nguyen *et al* (2006) argues that unless DSTs are made very simple and quick to use, majority of farmers are unlikely to use them. Figure 6.3, shows the starting point of the DST, which represents a simple and easy to use user-interface.

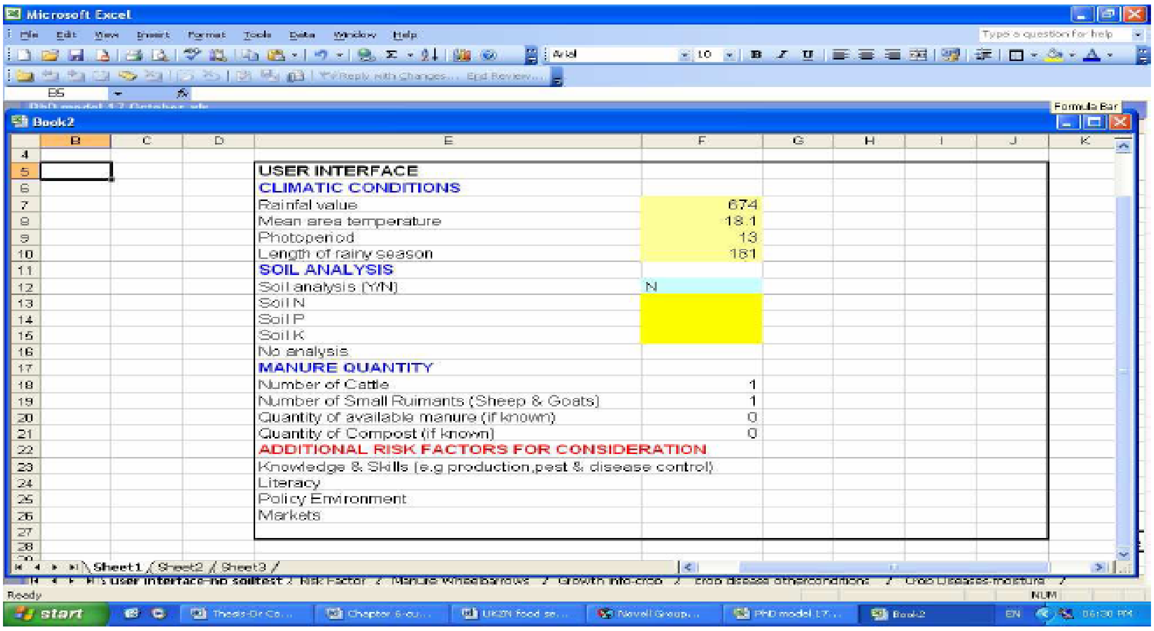


Figure 6.3: An example of the user interface of the DST

The interface operates in Microsoft Office Excel (version 2003). This is a dominant and relatively simple computer programme, which requires medium computer usage, and provision they have the required information. Once the required information is entered into the Excel spreadsheet, two printouts of the output are received instantly at the push of the 'enter' button (Figures 6.1 and 6.2). Given consistent amount of training, all farmers can use it.

Results, as indicated in Table 6.3 show that although groups felt that the DST is user-friendly and flexible for small-scale farmers, half the respondents felt farmers would still need the knowledge of an extension officer to help them acquire some of the prerequisite information to enter the user interface and receive the output (four initial requirement for receiving the output) and to show them how to use the DST (Figure 6.3). However, the other half felt that the DST is simple enough that farmers would not need to depend totally on extension officers when not present or available and may access the DST once available to public.

Table 6.3 Evaluation of the DST on its transparency to small-scale farmers, 2011

Measure for effectiveness of DSTs	**Groups responses about the DST**
Transparency	• DST is made simple as possible for the end-user since it uses a Microsoft Office Excel (version 2003) instead of a complex programme that would require the user to be well versed in computer usage • Farmers will be able to use the DST, especially because it is translated into isiZulu, making it more accessible to them. • Farmers would not need to depend totally on extension officers when not present or available and may access the DST once available to public. • Farmers would still need the knowledge of an extension officer to help them acquire some of the prerequisite information to enter the user interface and receive the output (four initial requirements for receiving the output). • Farmers would need an extension officer to show them how to use the DST. • Quick to use

6.1.1 Summary of Strengths and Weaknesses of the DST

Overwhelmingly, groups believed that the ability to provide and improve access to information for small-scale farmers is the greatest strength of the DST (Table 6.4). The prediction of long-term impacts was the second perceived strength of the DST. Other perceived strengths of the DST included: ability to address uncertainties and risks associated with organic farming; ability to present a wider and faster dissemination of information to people hitherto unreached or underserved areas; ability to provide rare opportunities and challenges for government to provide services to the rural population; ability minimize farmers reliance on external support; ability to deliver information in a consistent and timely manner; and ability to be simple enough to be used by farmers (Table 6.4).

The fact that the DST does not include information on pests is perceived by the groups to be the greatest weakness of the DST. The second perceived weakness of the DST is the fact that it has a limited amount of crop diseases. Other perceived weaknesses include the fact the DST does not show the amount of irrigation required for each crop, does not incorporate other problems that small-scale farmers are faced with, and the inability to show the required loads of manure if a farmer has more than a single hectare (Table 6.4).

Table 6.4 Summary of Strengths and Weaknesses of the DST, 2011

Strengths	Weaknesses
• Provides and improves access to information that could help farmers make better decisions in farming • The prediction of long-term impacts • Addresses uncertainties and risks associated with organic farming • Presents a wider and faster dissemination of information to people hitherto unreached or underserved, and deeper geographic penetration, especially to rural areas. • Provides rare opportunities and challenges for government to provide services to the rural population • Minimizes farmers reliance on external support • Delivers information in a consistent and timely manner, allowing the users to make decisions timeously • Simple and quick to use	• Does not include information on pests • Has a limited number of crop diseases • Does not show the required loads of manure if a farmer has more than a single hectare • Does not show the amount of irrigation required for each crop • Does not incorporate other problems that small-scale farmers are faced with into the tool (i.e. the price of each crop).

6.2 The crop disease management component of the DST

As stated earlier, part of farmer involvement in the development of the DST and its evaluation in 2008, indicated strongly the need for a crop disease management component of the DST. As a response to this identified need to improve the DST, a small booklet consisting of different kinds of crop diseases for each crop that was identified in the study (Thamaga-Chitja, 2008) and a natural disease control method to help control each disease was developed. The disease management component of the DST is divided into a high moisture-induced crop diseases and a low- moisture induced crop diseases. There are 20 different kinds of crops and 39 different kinds of crop diseases in the high moisture-induced section of the disease management component and only 13 different kinds of crop diseases in the low-moisture induced section of the disease management component of the DST. The rationale for choosing the diseases was based on economic importance and extent of devastation.

The disease management component of the DST consists of 80 pages in full length. Before the development of the crop disease management component, it was agreed that it needed to be as simple as possible for the end-users, particularly farmers. Consequently, the disease management component of the DST uses coloured pictures to show images of each crop disease symptoms to assist users to easily identify the diseases, instead of plain black and white pictures that may make it difficult for users to identify the type of the disease or crop. It clearly and briefly states the symptoms of each disease with the disease picture above the symptoms. Due to the fact that most organic and small-scale farmers in South Africa use little agro-chemical (Thamaga-Chitja, 2008), cultural disease management methods were chosen and are applicable. The disease management component of the DST is written in English and also includes a local language translation (isiZulu) as requested by farmers in the 2008 PhD study. After the DST was evaluated, the evaluation of the crop disease management component of the DST followed. A full preview of the crop disease management component of the DST is provided in Appendix E of this study.

6.2.1 Is developed crop disease management component effective in guiding and management of crop diseases for organic and small-scale farmers?

Analysis of the key measures influencing the effectiveness of the crop disease management guides was conducted in chapter five. A framework for measuring the effectiveness of the crop disease management component (Figure 5.2) was developed to analyze the results in order to answer the sub-problem on the effectiveness of the crop disease management component. The framework identifies two measures for effectiveness in crop management guides for farmers and uses these to determine whether based on the groups responses, this crop disease management component meets these key measures. This section presents the findings from the discussions with the groups. The results are discussed in relation to each measure for effectiveness.

Relevance

Ensuring that the crop disease management guide is relevant to it users first key measurement for effectiveness (Otsyina & Rosengberg, 1997). Similar to the first key measure for the effectiveness of DSTs, this means that the crop disease management component needs to address a real problem(s) and need(s) for users (Carter, 1999). In other words, the DST needs to provide data or procedures that will help address issues of uncertainties and risks in production (Morris & Stillwell, 2003). These should be issues that users are not already making good decisions about, and something that they think they are struggling with or need help with (Cox *et al*, 1996).

Discussion held with groups revealed that, among many constraints that small-scale farmers in South Africa are faced with, crop disease poses the greatest challenge. Groups reported that small-scale farmers want to improve production and prosper in organic farmers, but lack of appropriate information and knowledge to help them make best decisions on disease management and control. Results as indicated in Table 6.5 show that groups felt that this new disease management component of the DST could contribute solutions for small-scale farmers since it provides monthly disease risk information that could help them make better decisions in organic farming and disease management, which are major concern to them. These findings are in line with the study by (Carter, 1999), which states that a relevant crop management guides for farmers is one that is able to address issues that are causing considerable concern to farmers.

Groups added that lack of appropriate information and knowledge on disease management has lead to yield losses, particularly for poor farmers who cannot afford agrochemicals. Moreover, it has also hampered success of certified farmers and farmers planning on converting or adopting organic agriculture. Results as indicated in Table 6.5 show that groups felt that this disease management component of the DST could be a solution to farmers' problem of crop disease since it provides information on natural disease control, which can assist farmers in making decisions that could help minimize and manage crop disease, particularly those farmers' who cannot afford agrochemicals. Moreover, groups added that this information could assist farmers in decision making regarding adoption or intensification of organic agriculture.

Table 6.5 Evaluation of the crop disease management component on its relevance to small-scale farmers, 2011

Measure for effectiveness of DSTs	Groups responses about the crop disease management component of the DST
Relevance	• Provides monthly disease risk information that could help them make better decisions in organic farming and disease management, which are major concern to them • Makes information available to farmers and their advisors that may otherwise not be accessible • Provides information on natural disease control, which can assist farmers in making decisions that could help minimize and manage crop disease, particularly those farmers' who cannot afford agrochemicals • Provides appropriate information that could help farmers make better decisions regarding adoption or intensification of organic agriculture

Transparency is the other approach to evaluating DST effectiveness. Like DSTs, transparency in crop disease management guides can be measured in terms of flexibility and user-friendliness. This means that the crop disease management guide needs to be user friendly and flexible (simple, understandable, easy and quick to use) (Stephano *et al*, 2005). Results from the discussion with the groups on the transparency of the crop disease management component to small-scale farmers are presented next.

Transparency

Results in Table 6.6, shows that groups felt that this disease management component has been made as simple as possible for small-scale farmers since it uses coloured pictures showing images of the diseases, to assist farmers and extension staff in easily identifying the diseases instead of plain black and white pictures (see Appendix C). This is echoed by a study conducted by Stephano *et al* (2005), which discovered that the inclusion of colourful pictures makes crop management guides look good, easy to understand, interesting and encourages readership, as compared to black and white pictures, which provides less information.

Furthermore, Table 6.6 indicate that groups felt the disease management component of the DST is simple since provides sufficient text about the different key crop diseases and their control methods, therefore, enabling farmers to manage the problem before and during plantation. These findings correspond with a study conducted by Stephano *et al* (2005), which highlights the importance of having sufficient text accompanying the pictures in the guides. The use of sufficient text makes it easy for users to fully understand what is being conveyed in the pictures (Stephano *et al*, 2005).

Table 6.6 Evaluation of the disease management component on its transparency to small-scale farmers, 2011

Measure for effectiveness of DSTs	**Groups responses about the crop management component of the DST**
Transparency	• Uses a simple design: Includes a local knowledge (isiZulu), making the disease management component more accessible to local people; Uses coloured pictures showing images of the diseases, to assist farmers in recognizing these diseases; Uses sufficient text

6.2.2 Strengths and Weaknesses of the crop disease management component

Groups believed that the greatest strengths of the crop disease management component include: its ability to provide monthly disease risk information that could help farmers make better decisions in organic farming and disease management; ability to make information available to farmers and their advisors that may otherwise not be accessible; ability to provide information on natural disease control, which can assist farmers in making decisions that could help minimize and manage crop disease;

the use of simple design, local language and sufficient text (Table 6.7). The weaknesses of the crop disease management component as perceived by the groups include the fact that the disease management component does not contain information on pests and chemical methods of disease control for those who can afford organic pest control agrochemicals (Table 6.7).

Table 6.7 Summary of Strengths and Weaknesses of the crop disease management component, 2011

Strengths	Weaknesses
• Provides monthly disease risk information that could help farmers make better decisions in organic farming and disease management, which are major concern to them • Makes information available to farmers and their advisors that may otherwise not be accessible • Provides information on natural disease control, which can assist farmers in making decisions that could help minimize and manage crop disease, particularly those farmers' who cannot afford agrochemicals • Uses a simple design (colourful pictures) • Uses a local language • Contains sufficient text	• Does not include information on pests • Does not include inorganic methods of disease control for those who can afford organic pest control agrochemicals

6.3. How can the DST and its crop management component be improved?

Table 6.8 shows the points raised by the groups regarding improvement of the DST and its crop disease management component. The evaluation of the effectiveness of both the DST and its crop management component led to a number of recommendations relating to the improvement of these tools. These includes the inclusion of an extra column in the DST that will calculate and show the required loads of manure if a farmer has more than a single hectare. In this way, users of the tool will save time since they will not have to do the calculations themselves, thus, increase the accuracy of the tools output, particularly for illiterate users.

Although groups were happy that the DST provides monthly disease risk information in production planning, to help users know when to watch out/avoid key crop diseases, they expressed concern about the fact that the DST did not include any information on pests, which is one of the major problems facing most small-scale farmers today. As is common in model and DST development, including a disease management component can be considered in the next stage of improving the DST. Bontkes *et al* (2001), Matthews and Stephens (2002) and Walker (2000) assert that if a DST is to gain popularity among small farmers, it must not only address a single problem but must be able to address the complexity and diversity of small-scale agriculture. This is in line with a study by Nguyen *et al* (2006), which states that any effective DST needs to address issues that are causing considerable concern to farmers. Therefore, it is given that the improvement of the DST should include both pests and diseases for it to gain better usage.

Table 6.8 Groups recommendations for further development of the DST and its crop disease management component, 2011

DST	**Crop disease management component**
• Include an extra column in the DST that will calculate and show the required loads of manure if a farmer has more than a single hectare • Include information on pests OR a disease management component • Include more diseases • Include an irrigation column indicating the amount of irrigation required for each crop • Incorporate other problems that small-scale farmers are faced with into the tool (these include decisions relating market).	• Include information on pests • Include inorganic methods of disease control for those farmers who can afford organic pest control agrochemicals.

The results of the study also show that the DST provides a limited amount of crop diseases. Both disease and pest management are important for food security. It was suggested that further improvement of the DST should include more diseases. Without interfering with the output of the DST, it was suggested that the tool include an irrigation column indicating the amount of irrigation required for each crop. Moreover, since the DST focuses only on production decisions of farmers, recommendation related to further improvement of the tool also involved incorporating of market information relating to prices of the crop. The responses from evaluating the effectiveness of the crop disease management component of the DST revealed that the component did not include any information on pests and chemical methods of disease control. It was suggested that the crop disease management component be improved by including information on pests and and inorganic methods of disease control for those who could afford organic pest control agrochemicals.

This chapter has presented and discussed groups' perceptions of the new DST and its crop disease management component, particularly highlighting issues that affect small-scale farmers and extension officers and how the DST and its component can provide solutions. The next chapter presents the conclusion and recommendations of the study.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

Decision support tools (DSTs) are increasingly being used to aid decision makers in agricultural systems worldwide. Most of these tools have been developed for large-scale farmers in the developed world and a few are aimed at small-scale farmers in the developing world. Yet these tools have the potential to contribute significantly in improving the quality of small-scale farmers' decisions. For farmers in the developed world there are hundreds of DSTs available to them. A body of research is emerging on adoption of these tools in agriculture. Barriers have been identified on the adoption of these tools in the developed world. These include complexity in the design and the need for farmer computer ownership. However, little has been done on the adoption or use of these tools in the developing world. This study was set out to evaluate or explore the effectiveness of a new DST and its new component of crop disease management for small-scale farmers with a group of extension officers and agricultural scientists in KwaZulu-Natal. This investigation used a qualitative data collection and analysis method. Qualitative data was collected through focus group discussions with the two groups that included extension officers (n=12) and staff employed at a research station (n=15). This was done to obtain in depth information on the groups' perceptions of the DST and its crop disease management component.

7.1 Conclusions

The DST, including its disease management component were both deemed effective by groups. Results from the study revealed that extension officers and researchers felt that the DST and its crop disease management component are effective since they meet key measures for effectiveness identified in the frameworks. The groups agreed that the DST and its crop disease management component are relevant to small-scale farmers. They also agreed that the DST has the ability to improve access to information to small-scale farmers. Lastly, they also agreed that the DST and its crop disease management component are transparent (meaning that they are simple and easy to use) to small-scale farmers. Some of the areas for improvement identified by the groups included a need for information on pests and more diseases for DST and its crop disease management component. All two groups anonymously agreed on the positive effectiveness of the tool in enhancing production decisions and guiding organic and small-scale farmers.

7.2 Recommendations for further study

This study evaluated the effectiveness of a basic crop disease management component linked to the DST with a group of extension officers from Cascades and researchers from Dundee and did not evaluate the effectiveness of the disease management with its main users, farmers. Therefore, a further study should be conducted where the disease management component of the DST can be used in the field in various agro ecological zones of KwaZulu-Natal to test if indeed relevant diseases are in the DST component and if the methods of control work for farmers. Furthermore, another study is needed which will aim at developing a pest management component of the DST as this was clearly requested by groups in this study.

7.3 Institutional Recommendations

Results of this study showed that half the respondents felt that the DST was easy enough to be used by farmers without help from extension officers, while the other half believed that farmers will still need assistance from extension officers to show them how to use the DST. This raises the need for government or other relevant institutions to provide appropriate training for farmers that might encounter difficulties in using the DST. The study revealed that extension officers often fail to use existing tools and information designed to assist farmers due to complexity of design and poor presentation of information. It is recommended that government provides appropriate training for extension officers on the use of these tools and information to ensure that they are performing their duties efficiently and effectively. The result of this study showed that extension officers and small-scale farmers can benefit from using DST. It is recommended that government supports the development of agricultural DSTs and fosters existing technology transfer to its appropriate users.

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APPENDICES

APPENDIX A: GUIDE FOR FOCUS GROUP DISCUSSIONS

Name of group:

Location:

<u>DECISION SUPPORT TOOL (DST)</u>

1. What are your perceptions of the decision support tool (DST)?

1.1 Does the DST address at least one important issue(s) that is of interest or a problem(s) that is causing considerable concern(s) to small-scale farmers? Y/N

If yes, what kind of issue(s) or problem(s) does DST address and how does it address the problem(s) or issue(s)?

1.2 Does the DST improve access to information for small-scale farmers? Y/N

If yes, how does DST improve information access? Consider the following in your response:

- Does it allow faster delivery of information?
- Does it make information available to farmers and their advisors that may otherwise not be accessible?
- Does it present a wider and faster dissemination of information to people hitherto unreached or underserved areas?
- Does it provide rare opportunities and challenges for government to provide services to the rural populations?

1.3 Is the DST flexible and user friendly (i.e. simple, understandable, easy and quick to use)? Y/N

If yes, in what way(s) is the DST flexible and user-friendly?

1.4 What are the strengths and weaknesses of the DST?

1.5 How can the DST be improved?

<u>CROP DISEASE MANAGEMENT COMPONENT OF THE DST</u>

1. What are your perceptions of the crop disease management component?

1.1 Does the crop disease management component address at least one important issue(s) that is of interest or a problem(s) that is causing considerable concern to users? Y/N

If yes, what kind of issue(s) or problem (s) does disease management component address and how does it address the problem(s) or issue(s)?

1.2 Is the crop disease management component flexible and user-friendly (i.e. simple, understandable and easy and quick use)?

If yes, in what way(s) is it flexible and user-friendly?

1.3 What are the strengths and Weaknesses of the crop disease management component?

1.4 How can the disease management component be improved?

APPENDIX B: ZULU TRANSLATED VERSION OF THE USER-INTERFACE

USER INTERFACE	
CLIMATIC CONDITIONS/ ISIMO SEZULU	
Rainfal value/ Inani lemvula	1000
Mean area temperature/ Izinga lokushisa lendawo	30
Photoperiod/ iFothophiriyodi	13
Length of rainy season/ Ubude besikhathi semvula	100
SOIL ANALYSIS/ UKUHLOLWA KOMHLABATHI	
Soil analysis (Y/N)/ Ukuhlolwa komhlabathi (yebo/cha)	N
Soil N	
Soil P	
Soil K	
No analysis/ Akuhlolwanga	
MANURE QUANTITY/ ISAMBA SAMANYOLO	
Number of Cattle/ Inani lezinkomo	1
Number of Small Ruimants (Sheep & Goats)/ Inani leziklabu nezimbuzi	1
Quantity of available manure (if known)/ Isamba isikhona samanyolo (bekwaziwa)	0
Quantity of Compost (if known)/ Isamba somquba (bekwaziwa)	0
ADDITIONAL RISK FACTORS FOR CONSIDERATION/ OKUNYE OKUYIZIPAWU ZOBUNGOZI OKUNGAQASHELWA	
Knowledge & Skills (e.g production,pest & disease control)/ Izinga lolwazi nekhono	
Literacy/ Izinga lwemfundo	
Policy Environment/ Imigomo yokwevikela ezemvelo	
Market/ Imakethe	

APPENDIX C: ZULU TRANSLATED VERSION OF THE HIGH-MOISTURE INDUCED DISEASE OUTPUT

HIGH MOISTUREOUTPUT

Izitshalo	Crop List	Inani/Loads*	Monthly level of moisture/ Amazinga okuswakama												Main possible diseases/ Izifo ezingaba khona		
															Disease 1/ Isifo sokuqala	Disease 2/ Isifo sesibili	Disease 3/ Isifo sesithathu
			J	F	M	A	M	J	J	A	S	O	N	D			
Iklabishi	Cabbage	334	H	H	H	M	L	L	L	L	M	M	H	H	Black rot	Black leg	Downy mildew
ubhithiruthi	Beetroot	215	H	H	H	M	L	L	L	L	M	M	H	H	Cercospora leaf spot	Damping off	Black root rot
Ukherothi	Carrot	166	H	H	H	M	L	L	L	L	M	M	H	H	Alternaria leaf Blight	Bacterial blight	White mould
Amazambane	Potatoes	101	H	H	H	M	L	L	L	L	M	M	H	H	Late blight	Early blight	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ubhatata	Sweetpot	120	H	H	H	M	L	L	L	L	M	M	H	H	Black rot	Scurf	Bacterial wilt
Utamatisi	Tomato	291	H	H	H	M	L	L	L	L	M	M	H	H		Early blight	Late blight
U-anyanisi	Onions	49	H	H	H	M	L	L	L	L	M	M	H	H	Downy Mildew	Alternaria	
Ughaligi	Garlic	49	H	H	H	M	L	L	L	L	M	M	H	H	White rot	Basal rot	Pink rot
Umbila	Maize	96	H	H	H	M	L	L	L	L	M	M	H	H	Common rust		Grey leaf spot
ukwatapheya	Avocado	149	-	-	-	-	-	-	-	-	-	-	-	-	Anthracnose	Phytophthrora root rot	Verticilium wilt
Okusamaolintshi	OrangeVal	150	-	-	-	-	-	-	-	-	-	-	-	-	Citrus Tristeza virus	-	-
Okusamaolintshi	OrangeNav	150	-	-	-	-	-	-	-	-	-	-	-	-	Citrus Tristeza virus	-	-
Okusamaolintshi	Clement	150	H	H	H	M	L	L	L	L	M	M	H	H	Citrus Tristeza virus	-	
Okusamaolinshi	Lemon	200	-	-	-	-	-	-	-	-	-	-	-	-	Citrus Tristeza virus	-	-
Amagilebhisi	Grapes	259	-	-	-	-	-	-	-	-	-	-	-	-	Downy mildew		-
Amapentshisi	Peaches	99	-	-	-	-	-	-	-	-	-	-	-	-	Brown rot	Peach leaf curl	Powdery mildew
Amakhambi adliwayo	Mint	990	H	H	H	M	L	L	L	L	M	M	H	H	Powdery mildew	Rust	Leaf blight
Amakhambi adliwayo	Basil	990	H	H	H	M	L	L	L	L	M	M	H	H	Powdery mildew		
Amakhambi adliwayo	Coriander	990	H	H	H	M	L	L	L	L	M	M	H	H	Anthracnose		

*No of loads of manure carried in wheelbarrows/ Inani lamanyolo eliphethwe ngebhala

APPENDIX D: ZULU TRANSLATED VERSION OF THE LOW-MOISTURE INDUCED DISEASE OUTPUT

LOW MOISTURE OUTPUT

Izitshalo	Crop List	Inani/Loads*	Monthly level of moisture/ Amazinga okuswakama												Main possible diseases/ Izifo ezingaba khona		
															Disease 1/ Isifo sokuqala	Disease 2/ Isifo sesibili	Disease 3/ Isifo sesithathu
			J	F	M	A	M	J	J	A	S	O	N	D			
Iklabishi	Cabbage	334	L	L	L	M	H	H	H	H	M	M	L	L	0	0	
Ubhithiruthi	Beetroot	215	L	L	L	M	H	H	H	H	M	M	L	L	-	-	-
Ukherothi	Carrot	166	L	L	L	M	H	H	H	H	M	M	L	L	0	0	
Amazambane	Potatoes	101	L	L	L	M	H	H	H	H	M	M	L	L	0	0	Common scab
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ubhatata	Sweetpot	120	L	L	L	M	H	H	H	H	M	M	L	L	0	0	
Utamatisi	Tomato	291	L	L	L	M	H	H	H	H	M	M	L	L	Fusarium wilt	0	
U-anyanisi	Onions	49	L	L	L	M	H	H	H	H	M	M	L	L	0	0	
Ughaligi	Garlic	49	L	L	L	M	H	H	H	H	M	M	L	L	0	0	
Umbila	Maize	96	L	L	L	M	H	H	H	H	M	M	L	L	0	Fusarium stalk rot	
Ukwatapeya	Avocado	-	L	L	L	M	H	H	H	H	M	M	L	L	-	-	-
Okusamaolintshi	OrangeVal	-	L	L	L	M	H	H	H	H	M	M	L	L	-	-	Sooty mould
Okusamaolintshi	OrangeNav	-	L	L	L	M	H	H	H	H	M	M	L	L	-	-	Sooty mould
Okusamaolintshi	Clement	150	L	L	L	M	H	H	H	H	M	M	L	L	Citrus scab	0	Sooty mould
Okusamaolintshi	Lemon	-	L	L	L	M	H	H	H	H	M	M	L	L	-	-	Sooty mould
Amagilebhisi	Grapes	-	L	L	L	M	H	H	H	H	M	M	L	L	-	-	-
Amapentshisi	Peaches	-	L	L	L	M	H	H	H	H	M	M	L	L	-	-	-
Amakhambi adliwayo	Mint	990	L	L	L	M	H	H	H	H	M	M	L	L	0	0	
Amakhambi adliwayo	Basil	990	L	L	L	M	H	H	H	H	M	M	L	L	0	0	
Amakhambi adliwayo	Coriander	990	L	L	L	M	H	H	H	H	M	M	L	L	0	0	

***No of loads of manure carried in wheelbarrows/ Inani lamanyolo eliphethwe ngebhala**