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Effectiveness of Technology Transfer in Mitigating Food Insecurity amongst Resource Poor Maize Farmers

A case study of two Agricultural Research Council's projects in Limpopo, South Africa

A Research Project submitted to Van Hall Larenstein University of Applied Sciences In Partial Fulfillment of the Requirements for the Master Degree, Management of Development

Specialization in Training Rural Extension and Transformation

By

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DEDICATION

I dedicate this work to my dearly departed father Moses Jabulani Ngcobo, whose wise words have guided me from childhood to this point. I treasure the valuable lessons you imparted and the encouraging pride you had towards me. Thank you, Mapholoba!

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LIST OF ABBREVIATIONS

AIAS	Australian Institute of Agricultural Science
ARC	Agricultural Research Council
AEI	Agricultural Engineering Institute of ARC
ARD	Agricultural Research for Development
CBSP	Community Based Seed Production
DAFF	Department of Agriculture, Forestry and Fisheries
DST	Department of Science and Technology
EMC	Executive Management Committee
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field Schools
FGD	Focused Group Discussion
FPR	Farmer Participatory Research
FSR	Farming Systems Research
GCI	Grain Crops Institute of ARC
GDP	Gross Domestic Product
GPAP	Grain Production Advancement Project
KI	Key informant
KT	Knowledge Transfer
LDA	Limpopo Department of Agriculture
LIMPAST	Limpopo Province Agricultural Strategic Team
MIG	Maize Information Guide
NGOs	Non Governmental Organizations
NTK	Noord Tranvaal Kooperasie
OD	Organizational Development
OPV's	Open Pollinated Varieties
PAR	Participatory Action Research
PhD	Doctor of Philosophy
PRA	Participatory Rural Appraisal
PTD	Participatory Technology Development
R&D	Research and Development
RPF	Resource Poor farmers
SA	South Africa
SADC	South Africa Development Cooperation
SETA	Sector Educational and Training Authority
SETI	Science, Engineering and Technology Institutes
SoE	State Owed Enterprise
SSI	Semi structured Interviews
TT	Technology Transfer
TTOs	Technology Transfer Offices
ZAR	South African Rand

ABSTRACT

Like in many countries in the Sub Saharan Africa, poverty is one of the major challenges South Africa faces. Agricultural research is looked upon for innovative solutions to alleviate poverty, especially food insecurity. Measures to ensure that technologies developed through research are more appropriate for complex farming conditions of resource poor farmers (RPFs) have been taken by the Agricultural Research Council (ARC). The expected contribution to the socio-economic improvement of the poor is facilitated through Technology transfer (TT), however felt impact is yet to be made as per the SETI review.

The study reported on here, aimed to evaluate ARC's TT programme to determine its effectiveness towards improving the food security status of resource poor maize farmers and to identify communication strategies used in TT and how the strategies influence success in meeting the organizational mandate. It was a qualitative study based on a literature review and a case study on two projects of ARC's Grain Crops Institute (GCI) which promotes improved seed maize varieties. The projects under the case study were the Community Based Seed Production and LIMPAST. Data collection was through semi-structured interviews (SSIs) focus group discussions (FGD) and key informant interviews with project stakeholders including farmers, government extension officers researchers and management. The study targeted 67 respondents altogether spread across the categories mentioned above.

The study established that efforts towards technology transfer in ARC were constrained by internal and external factors. Internally, the organization had put in place policy instruments as well as structural mechanisms to achieve TT. These included the development of a Strategic Framework and establishment of a TT Division. However, the framework is yet to be mainstreamed to facilitate common understanding on what TT entails and use of the office to support TT activities at institute level is sub-optimal. The organization also suffered from human resource limitation with only a handful of researchers doing TT with RPFs. Similarly, funding constrained the potential impact TT could have. Externally, weak linkages between ARC and LDA's extension officers hampered efforts since much on the project depends on optimal relations and synergy between the two key players in research and development. It was emphasized that LDA officials carry the day-to-day responsibility of technical support to the farmers with ARC's guidance. Additionally, the ill-affordability of production inputs limited utilization of the knowledge and skills farmers gained from the TT efforts accorded by the projects. The projects only marginally affected food security and this was attributed to the production constraints mentioned above. The farmers were nevertheless very enthusiastic about gaining valuable skills and knowledge on crop management, and particularly on seed maize husbandry and this was attributed to the communication strategies used.

Technology Transfer should be better mainstreamed in the organization to ensure common understanding about what the organization seeks to achieve. This could be realized through a process (or campaign) to streamline the strategic framework and TT functions across the organization. This would have far reaching potential benefit to the society. This type of institutionalization is important in order to curb food insecurity and other social challenges. Furthermore, there is a need to build capacity of researchers for facilitation of effective TT. A system wide intervention with clear mechanism to allow for transfer is required and should consist of removal of production constraints as a key stumbling block. Efforts should also be made to create more synergistic linkages between ARC and LDA.

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Poverty is one of the major challenges South Africa (SA) faces especially in the rural areas where 65% of inhabitants are categorized as poor (Machethe, 2004). The country's rural poverty is different in three ways from that of other developing countries: income generated and food consumed from agriculture is a minor component of household resources, food is available but people do not have the financial resources to access it and high rural-urban migration limits the amount of labour available for farming (HSRC, 2004a). SA is self sufficient in food production, but approximately 14 million people are considered vulnerable to food insecurity and 43 percent of households suffer from food poverty (HSRC, 2004). It is a country with one of the most skewed distribution of income in the world, classified as an upper middle-income with a huge gap between the extremely rich and abjectly poor.

According to Machethe (2004), small holder agriculture has a role to play in alleviating poverty and increasing food security of the country's rural poor. He argues that this role can be enhanced by making appropriate investments in the main programmes of agricultural development: human capital, agricultural research, biophysical capital formation, and rural institutions (Machethe, 2004).

Research plays a significant role in helping to alleviate poverty. Information and support from research can empower the poor in various ways. It can increase their access to decision making processes, enhancing their capacity for collective action and reducing their vulnerability to economic shocks through asset accumulation (Hazell & Haddad, 2001). The report of the Inter-academy Council (2004) further asserts that, correct *and diligent application of a range of technology options can lift crop and animal production in Africa and make more effective, efficient use of land, labour and capital.*

The situation of resource poor farmers (RPFs) in South Africa is yet to realize the benefits of research and development (R&D). Chambers & Jiggins (1987), observed that the challenge of agricultural research is not how to increase food production overall, but how to help RPFs produce more. Measures to ensure that technologies developed through research are more appropriate for complex farming conditions of RPFs have a place, enabling poor farmers to gain access to knowledge and inputs necessary to escape poverty.

The Agricultural Research Council (ARC) has a twenty year history of innovative research in SA and beyond. It is the country's principal agricultural R&D institution mandated through the Agricultural Research Act (Act no. 86 of 1990) to conduct research, develop technologies and disseminates research results through technology transfer (TT) to the agriculture sector. It does this in order to:

- promote agriculture and related industry,
- contribute to a better quality of life, and
- facilitate/ensure better resource utilization.

The vision of the ARC is 'Excellence in Research and Development' and it guides the organization in transferring and disseminating the products of research to facilitate technology development in agriculture, foster competitiveness of clients, ensuring that the sector (including RPFs) becomes sustainable in their development efforts.

1.2 Problem Identification

On a five yearly basis, the Department of Science and Technology (DST) conducts reviews of all Science, Engineering and Technology Institutes (SETI) including the ARC to identify impacts and inform future research agenda. The latest review, conducted in 2006, highlighted the need for the ARC to improve its efforts in serving the RPFs. It proposed the reorientation of the institutional R&D agenda to better service the developmental needs of the poor farming communities (ARC Strategic Plan, 2011/2015).

The SA Agriculture and Agro-processing Foresight (1998) recognized TT as important for the country, due to an identified weakness in the system, particularly the failure to positively impact the less developed agricultural sectors. Eponou (1993), raises some thought provoking questions to this effect; observing that *'the ability of researchers and/or technology transfer agents to communicate and cooperate has a strong influence on whether agricultural science succeeds or fails as a catalyst of national development and as a tool for eliminating poverty'.*

The ARC is keen to contribute to the socio-economic upliftment of the poor and use TT as the avenue to achieve this; however the situation of RPFs growing maize has not improved. Within TT, communication strategies in their wide ranging forms are used as a mechanism to reach farmers, through information dissemination and training packaged as technology. The manner in which the organization seeks to attain its mandate through technology transfer strategies warrants investigation. Currently, a lack of insights on the ability of TT to improve the situation of RPFs is perceived as a problem.

1.3 Research objective

The study therefore aimed to:

- Evaluate ARC TT programme to determine effectiveness towards improving the food security status of resource poor maize farmers.
- Identify communication strategies used in TT and how these influence success in meeting mandate.

1.4 Research questions

Main Research Question 1: What are key determinants of effective TT at ARC?	Main Research Question 2: What factors determine selection of communication strategies used for TT?
Sub-questions 1.1 What are the perceptions of researchers and extension officers on effective TT? 1.2 What are the preconditions necessary to enhance TT? 1.3 What are farmer's technical challenges to effective TT in maize production?	Sub-questions 2.1 What are the communication strategies used in ARC's TT? 2.2 What is the competence level of researchers for selection and management of these strategies in TT? 2.3 To what extent do communication strategies used influence TT?

1.5 Study context

1.5.1 Location

South Africa occupies the very southern part of the African continent.The total surface area is 122.3 million hectare as shown in figure 1.1. The population of SA is over 44.8 million with a growth rate of 10.4%. The country has nine provinces with Limpopo Province covering 11.8% of the total land area as depicted in figure 1.2. The study proposed was conducted in Limpopo province which lies at the uppermost tip of the country bordering three of SA's neighbours, Botswana, Zimbabwe and Mozambique. It is named after the great Limpopo River that flows along its northern border. The province is mainly rural and divided into five district municipalities, namely: Capricorn, Mopani, Sekhukhune, Vhembe and Waterberg. The study sites were located in the Sekhukhune and Capricorn districts.

Figure 1.1: Map of South Africa

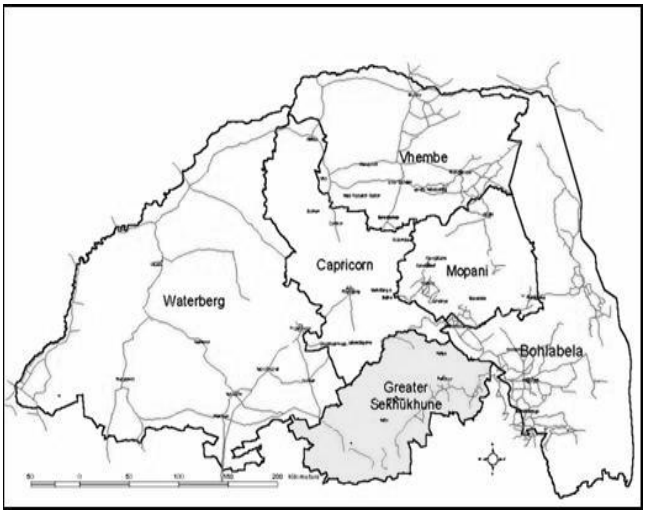

Figure 1.2: Map of Limpopo province

1.5.2 Agriculture in South Africa and Limpopo

The current SA government follows prudent economic policies, and the country is recovering from the impact of the global crisis. In competition with mining and manufacturing, agriculture enjoys third place in the SA economy. There is however a steady growth in agriculture, with the total contribution into the economy reaching South Africa Rand (SAR) 36 billion in 2007 pointing to an increase from R27 billion in 2001 (DAFF, 2010). Primary agriculture contributes only approximately 2.5% to the gross domestic product (GDP) of the country and about 8% to formal employment. The stated significance that agriculture enjoys stems from the strong linkages it has into the economy, such that total agro-industrial sector comprises about 12% of GDP. The country is agriculturally self sufficient in almost all major agricultural products and is a net food exporter, making it 1 of 6 countries in the world capable of exporting food on a regular basis (DAFF, 2010).

Due to its colorful and sad past, SA is a land of contrast marked with dualism running across all sectors including agriculture. It has a dual agricultural economy, constituting of a well-developed commercial sector on one hand and subsistence-oriented agriculture on the other. The predominantly white-controlled commercial sector and its access to applied research and improved farm management dominates the country's agricultural production. Dualistic agriculture

is also found in the Limpopo province, wherein the smallholder farms cover approximately 30% of the provincial land surface area. Farming under these smallholder systems is characterized by low level of production technology and small size of farm holding of approximately 0.5 – 1.5 hectares per farmer; with production primarily for subsistence and little surplus sales. According to Statistics South Africa (2002), there were approximately 303,000 small holder farmers in the province. White farmers on the other hand, practice large scale farming system using the most advanced production technology and occupied approximately 70% of the total land area. These commercial farmers are well organized and situated on prime land. StatsSA (2002) further estimated there to be approximately 5,000 commercial farming units in Limpopo Province.

The Limpopo province is mostly semi-arid and prone to drought and floods. Even with these climatic occurrences, it is considered SA's food basket (with much credit to the commercial farms). The province is the second-largest producer of potatoes in the country, accounting for 19% of South Africa's total production. Maize, millet and groundnuts are mainly grown for home consumption and stock feed, whilst sisal, sunflower and cotton are grown for industrial purposes.

1.5.3 Rural Poverty and impact on food security

With the high agricultural potential stipulated under 1.5.2 above, it is a wonder that Limpopo is one of the two provinces most affected by poverty. It has the highest proportion of the poor in the country with seventy seven per cent (77%) of its population living below the poverty income line (SSA Challenge Programme, 2009). This can be further explained in the 'dualism', where resources are available to all but inaccessible to some. In SA, the cause of hunger and malnutrition is not due to a shortage of food but rather inadequate *access* to food to certain categories of individuals and households in the population. The Challenge Programme Report, further states that food insecurity is a constant problem with approximately a million people relying on food aid in the areas close to the Limpopo River basin. It is amongst this group where the concept of RPFs takes root, describing those lacking resources required to succeed in farming. A study conducted under FARNPAN'a FIVIMS project, (2006) found that a wide proportion of the Sekhukhune district is not suitable for crop production. Added to this, household food security is threatened by constraints (for consumption or sale) such as; lack of money, access to seed, fertilizer, and water.

1.5.4 Maize production

Maize (*Zea mays L*.) is South Africa's staple crop, contributing approximately seventy five per cent (75%) of the total grain crops. The major stock of maize produced is by large commercial farms, with only 11.36% produced by subsisting and emerging farmers. The aim for these subsisting and emerging farmers is to provide for their basic household food requirements. Excess production is sold as green mealies or grain to supplement the household income. Maize production is dependent on an even distribution of rain throughout the growing season. It is produced mainly in North West, the Free State and Mpumalanga. In Limpopo province, (using the area and volume of production), maize remains the most important dry-land crop. The area under cultivation in 1990/1 was 43 256 hectares, but this declined to 25 000 hectares in 1995/6. Total output in 2000 was estimated to be 182 500 tons, which represents about 2.8% of total production in the country (Thomas, 1996). The ability of the poor to produce their own maize is therefore important for food security.

1.6 Organizational context

Through various programmes and strategies, the organization has tried to respond to wider societal needs such as food insecurity with the latest of these programmes being TT.

The advent of the democratic dispensation in 1994 in SA brought about many changes, one of which was the amalgamation of agricultural research centres into an ARC in 1992 as per the Agricultural Research Act (Act number 86 of 1990). Prior to this period agricultural research was carried out by the government's Department of Agriculture. Government researchers were tasked with only the responsibility of research, developing technologies and passing these on to other directorates namely, extension and land-use planning for transfer to end-users. The post-democratic election (held in 1994) ARC was expected to broaden its focus to reflect the policy changes. These changes called for provision of services and assistance to all farmers; with special attention to the subsisting and emerging RPFs and facilitation of their access to appropriate information and technology. The inclusion of this new clientele was a challenge to researchers sufficiently skilled to address technical problems in commercial large scale farms. The previous resource rich client, (often white), wealthy and educated commercial farmers presented text book problems to these researchers who would then ably provide solutions.

By stark contrast the new clientele, marginally participated in mainstream agriculture due to innumerable constraints including lack of access to production resources including capital credit facilities, water and equipment. Purnell appreciates this new mandate, clarifying that the recognition to have the ARC cater for the RPFs was made in 1995.

1.6.1 Organizational structure & culture

Macro factors have significant influence over what organizations do and the extent of success in these efforts. Structure and culture draws boundary on the permissible and the non-permissible in an organization and this is no different for TT. The hierarchy culture is dominant in my organization, characterized through high levels of formalization and use of procedures to govern practice. The hierarchy culture further manifests through emphasis on expected outputs for each staff member and performance is measured. Good use of company resources is closely monitored and policy instruments, (e.g. PFMA[1] Act No 29 of 1999), governs measures taken in the case of infringement. Five structural configurations are provided by Mintzberg (1993) and ARC is of a 'machine bureaucracy. Organizations structured according to the 'machine bureaucracy observe stringent rules and have a rigid hierarchy of authority. Mintzberg (1993) recognizes the large size nature of organizations as determining the adoption of this structural configuration, but warns that "*Large machine bureaucracies are well suited to serve the efficiency goal, but do not adapt quickly to new situations"*. A structure that helps an organization adapt to the changing environment and respond accordingly to the needs of its clients can be regarded as an effective one. Flexibility in allowing people to innovate could help the organization excel in agricultural research and development as per the vision. Research is a very dynamic field; researchers innovate to be of repute and to stay abreast, however there seems to be less innovating on methodologies and processes for better engagement with farmers. The organizational chart in figure 2 below indicates divisions and coordination.

[1] South Africa's Public Finance Management Act (Act No 29 of 1999) was promulgated to regulate financial management in government to ensure that all revenue, expenditure, assets and liabilities are managed efficiently and effectively; to provide for the responsibilities of persons entrusted with financial management in government institutions; and to provide for matters connected therewith.

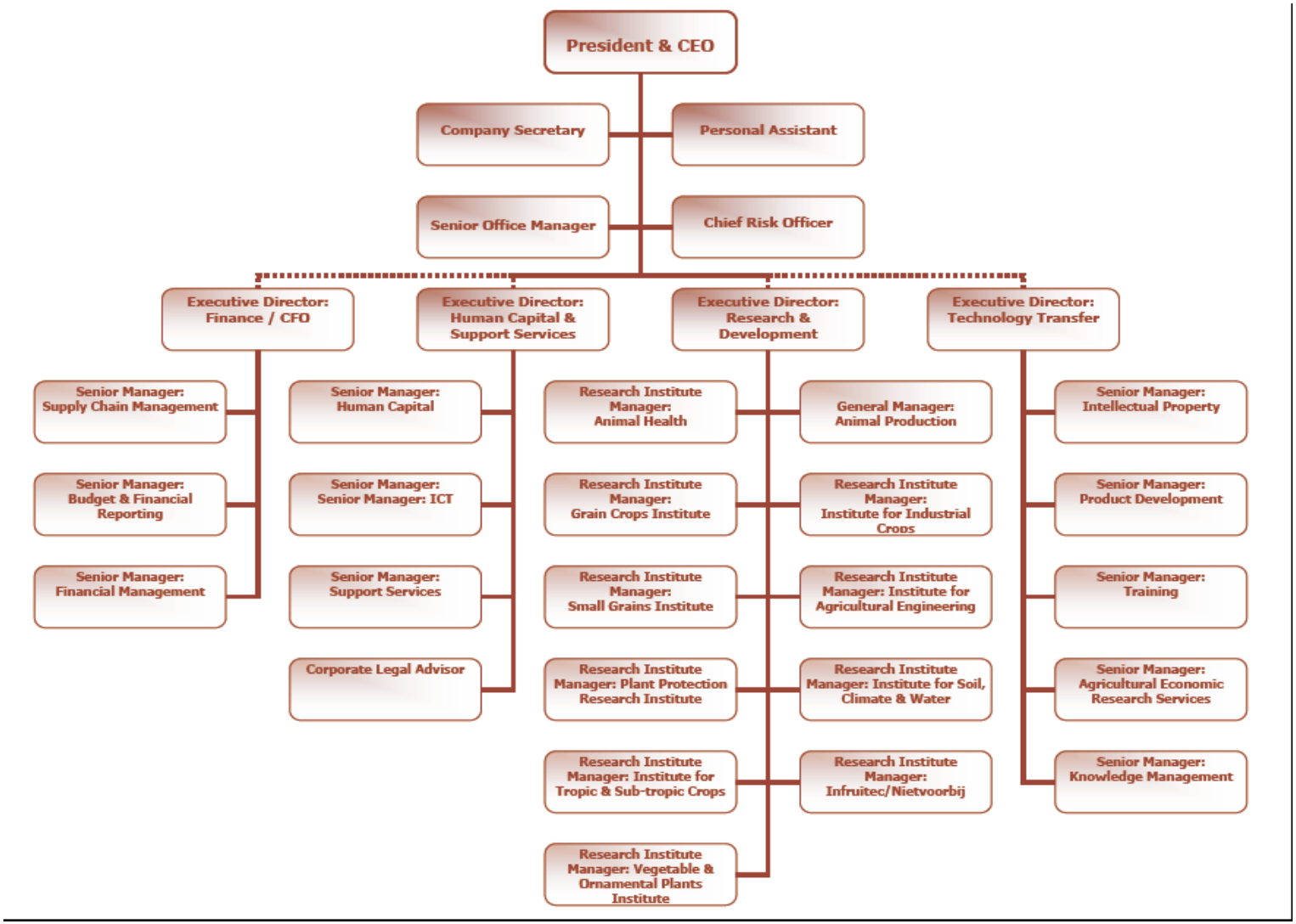

Figure 1.3: Organogram of the Agricultural Research Council, source ARC website; www.arc.agric.za

1.6.2 Current Technology Transfer Efforts at ARC

The TT Division, established in 2008 is one of the four core divisions in the organization. The division seeks value creation from public investment in science, ensuring that ARC contributes to a prosperous agricultural sector. The division is centrally located and based at the head office in Pretoria in order to provide strategic assistance across the organization. It aims to facilitate and respond to:

- the transfer of new and improved technologies,
- the provision of support to resource-poor farmers towards productivity,
- the need to address the competitiveness of South African agriculture, and
- the need to address organizational sustainability and excellence.

The division's strategic outcome addresses two issues that are pertinent to the agricultural sector, namely promoting access and competitiveness, leading to improved quality of life for the South African people. The Division has six units which work together to facilitate partnerships and coordinate and integrate technology transfer processes to deliver tangible products and services into the market (quoted from www.arc.agric.za, accessed 23/08/10). The units are; Agricultural Economics & Biometric Services, Commercialization & Business Generation, Intellectual Property Management, Training and Information Dissemination, and Knowledge Management. The illustration below indicates how the units and their functions are integrated and operationalized through three key elements.

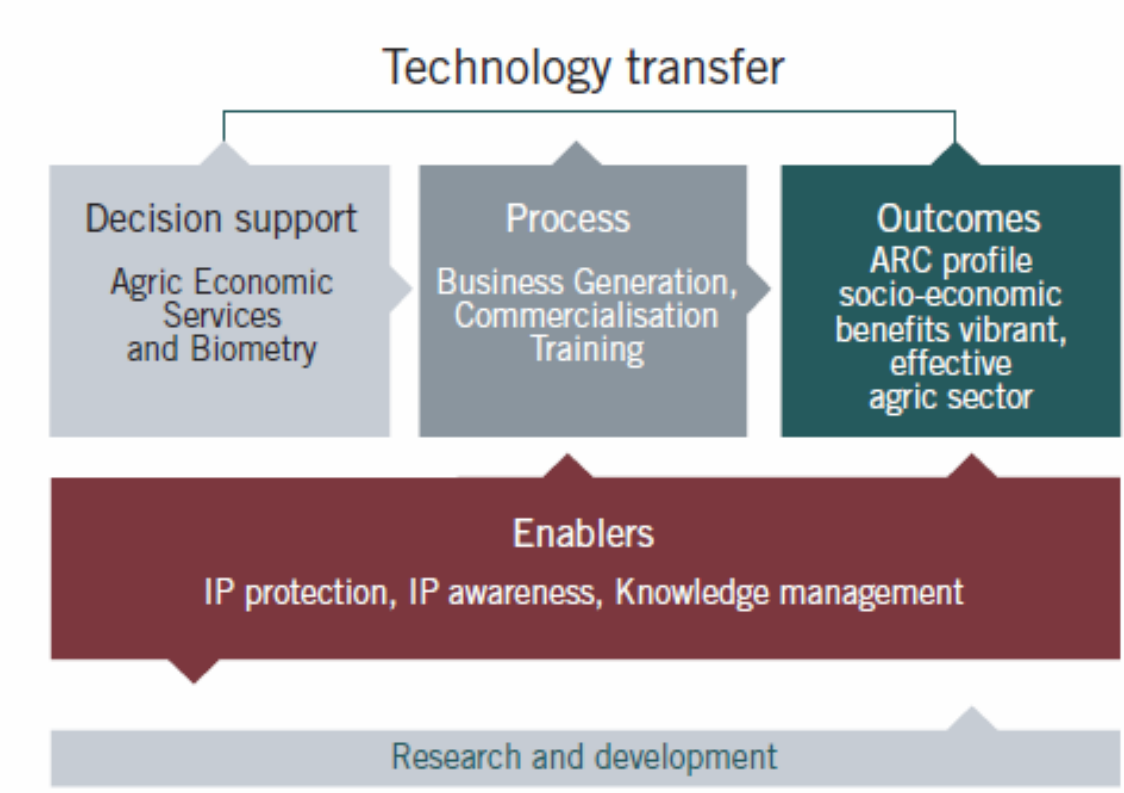

Figure 1.4: Framework for Technology transfer at ARC

The figure 1.4 indicates the three key elements of the framework; enablers, processes and decision support and anticipated outcomes. Enablers outline what needs to be in place for optimal performance and includes intellectual property protection and knowledge management.

Processes on the other hand are concerned with how technology transfer is effected and include commercialization, business generation, training, and information dissemination. Lastly, decision support deals with management of information to support investment decisions, do market intelligence and perform impact assessments. TT activities are operationalized at institute level along production clusters. These are grain crops, horticultural crops and ornamental crops, livestock and natural resource management. Maize research is undertaken at the Grain Crops Institute (GCI) and the study focused on the efforts of this institute to transfer technologies.

1.6.3 ARC Grain Crops Institute's technology transfer programme

The ARC-Grain Crops Institute (ARC-GCI) is situated in Potchefstroom in the North West Province of the country. Its programme of operation includes strategic and needs-driven research on; cultivar evaluation, crop rotation, plant breeding, improvement of crop quality, weed control, tillage, plant nutrition, water utilization, plant pathology, entomology and nematology. The institute's mandate is limited to staple crops and high protein food and feeds; which includes maize, sunflower, dry beans, sorghum, groundnut, soybeans, canola and crops of lesser importance such as cowpeas, millets and Bambara.

1.7Justification of the research

As 'progressive[2] as SA is, compared to developed countries it lags behind in many respects including in technology transfer. Wolson (2007) states that institutional TT offices are a new development in the country and that not all research organizations even have these. SA also has an insignificant number of patents registered and the TT practice is based on models long replaced in the developed world as this study will show. The linear model, previously referred to as Transfer-of-Technology (ToT) model that accompanied the Green Revolution era in the 60's 70's and 80's is now replaced by processes such as collective innovation system, informs the conduct of TT in the country. These issues will be explored in more detail in the next chapter.

According to Wolson (2007), there is lack in comprehensive benchmarking of the performance of South African Technology Transfer Offices (TTOs). This study is therefore to be of relevance to the broader than the agricultural sector and encompass R&D generally. It is anticipated that the outcomes of this research will provide insights into factors constraining the TT profession, challenges of serving a complex farming sector in a developing country and measures that should be taken to address these. This research is applicable to; policy makers, researchers, extension agents, development workers, academic community and managers of these in agriculture and related fields. Applicability extends beyond the agriculture discipline as social scientists generally and communication specialists can make use of it.

[2] South Africa displays economic characteristics found in developed states, counted amongst major exporters of agricultural commodities and raw materials for the manufacturing and mining sector. It also has the highest gross domestic products (GDP) in the African continent at $287.2 billion (2009 estimates). It is one of six countries in the world capable of exporting food on a regular basis. Officially the country is regarded as a middle-income emerging market on par with Brazil and India, sometimes referred to developing. The World Fact book, found at https://www.cia.gov/library/publications/the-world-factbook/geos/sf.html

CHAPTER TWO: PERSPECTIVES ON TECHNOLOGY TRANSFER - LITERATURE REVIEW

This chapter explores scholarly views on the concept under study that is, technology transfer. Within this scope, it will provide definitions of the key concepts, views on effectiveness of TT and communication strategies used within TT. Literature presented in this chapter will help give insight into these aspects. It will review technology transfer in terms of challenges experienced, models and approaches used and best practice. It will further contextualize the domain through its application concepts of knowledge transfer and communication strategies.

2.1 Technology Transfer – an overview

The arguments for science to contribute towards Africa's agricultural development and economic growth are made in literature (Mignouna *et al*, n.d). The manner in which scientific and technological solutions are communicated to 'would-be' users hold a key to the realization of this aim. TT is the intervention process used to communicate these results to the public including the rural poor. TT is not a new concept; it dates as far back as prior the explicit knowledge era. The domain of TT is broad and covers all activities around technological development and utilization. It provide a key link in the R&D chain; identifying user needs, advising scientists on what will or will not work and applied as one of the aspects of a technological cycle. The Australian Institute of Agricultural Science (AIAS, 1989) proposes four ingredients for TT to function well; a clearly defined objective, an appropriate system of land tenure, adequate infrastructure and appropriate system of communication. This illustrates the complexity of the TT domain due to the many concurrent processes at play. These processes include; the message to be communicated; the source of the message, how it is to be communicated, the packaging of the message, the intended recipient, and the expected outcome of the message once received. Each of these processes is laden with complexity, typical of human induced practices where views are multiple and individual, organizational and system wide convergences have to be reached. The multiplicity of views held in an agricultural R&D system with; researchers, extension agents, management, input suppliers, farmers and other role players is cause for many high level debates on the field. This particular research is concerned with the source of the message, how it is communicated and whether the expected outcome is achieved.

2.2 Contextual definitions of terms

Technology - is a product of research or a tool used to transfer knowledge for use and application.

Communication - the process of exchanging meaning between individuals through words and language, pictures, drawings, letters of the alphabet, body language, and etc

Extension officers - a term used SA to personnel with a professional training background in crop production, livestock husbandry, entomology, fisheries resources development, cooperatives and marketing. The term extension worker is used in many countries.

Innovation -although sometimes used to mean new technology (as in diffusion of innovations), it is used to denote a process of technical and institutional change to impact productivity, sustainability and poverty reduction

Collective innovation system – emerges out of collective social interaction between and amongst individuals, organizations and institutions in technology development

Communication for innovation – a series of embedded communicative interventions meant to develop and/induce innovations to help resolve problematic situations

2.3 Operationalizing the concept of Technology Transfer

The term TT differs from one field or sector to the next. Bozeman (2000), citing Roessner, defines agricultural TT as the movement of know-how, technical knowledge or technology from one organizational setting to the other in order to enhance knowledge and skills. AIAS presents an even more challenging definition where they argue that 'technology is the application of science to produce desired outcomes and TT as the process of duplicating these outcomes for consumption by the public. The ARC Act (86 of 1990) defines TT as the transfer of knowledge, techniques and processes from research and development; understood to mean facilitating the application of research results. The ARC's TT Strategic Framework further defines TT as the process of transfer of knowledge, technology, skills and know-how from a source to the user. The concept of TT has many elements, used to emphasize the different aspects associated with the concept and expected outcomes based on the setting. From the three definitions, it can be argued that TT needs to be understood within a context of practice.

2.3.1 Contrasting Technology Transfer models

Whilst many models of TT can be found in literature such as Wahab, *et al* (2009), Eponou (1993), Leeuwis (2004); two dominant ones could be identified based on definitions provided and the nature of practice. The two dominant models are presented below, as well as associated models with special elaboration on their characteristics.

Dissemination model

The first model presented here is the traditional linear model defined above, whereby 'scientific constructs' or technological packages are passed through training or information dissemination to potential users. This model is called the dissemination model, as it suggests the importance of the technology to be diffused or disseminated to the potential users by the experts (Ahmed, 2004). This TT model is informed by the concept of 'normal professionalism'. Normal professionalism stems from a *belief in the superiority of scientific method and of modern knowledge as these are taught, learned and disseminated* (Chambers & Jiggins, 1989). University training of SA's agricultural scientists, the pressures (to innovate and thus excel) and incentives offered (e.g. reward system for scientific publications) have tended to induce work within the dissemination mode. These authors also concurs, listing four forces promoting the wide and common use of the dissemination model. These are; education and training, government and commercial funding influences, research methodology and professional and personal reward system. This notion of TT is rather persuasive and paternalistic, implying a rather top-down process of delivering specific technical recommendations to farmers about the practices they should adopt. Communication in this model is of a one-way or unilateral characteristic, with no involvement of the user, except for utilization of the knowledge passed for the eventual adoption or discarding of the technology. A different variation of this model is presented by Leeuwis (2004) and he calls it the instrumental or persuasive transfer approach, whereby convincing as many people as possible to adopt a given innovation is the main goal (Leeuwis, 2004). It is linear in fashion, observing a clear sequence illustrated figure 2.1:

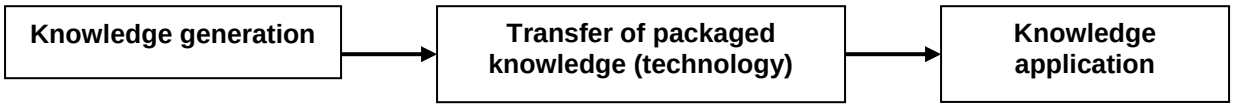

Figure 2.1: Transfer of technology in a linear continuum

This model sugegsts a scenario whereby knowledge generation is the responsibility of the researcher, transfer the duty of the extension officer and use is for the technology recipient. Due to the linear fashion, Röling (2009) refers to it as simply, the linear model, whilst the terms Transfer-of-Technology (ToT) and 'Technology Supply Push' has been used as well (Röling, 2009). The model makes no emphasis for interaction or feedback loops amongst the three actors. Farmers are excluded from the technology generation process, as scientists bring solutions developed elsewhere and thought to be of value and having potential to resolve problems. It is commonly used in public sector agricultural research organization, where emphasis is laid on the role of the state in fostering technological change and knowledge as originating from scientific researchers and flowing to the end user, the farmer (Röling, 2009). The linear model has not been successful in transferring all types of technologies, particularly those needed by resource-poor farmers (Eponou, 1993) but has positively contributed in the successes realized by resource rich farmers notably in America and Europe (Chambers & Jiggins (1989)

Communication model

In many countries, the paternalistic model described above is gradually being replaced by participatory approaches to research. In these constructivist approaches, the knowledge and opinions of farmers is considered to be just as important as that of researchers or government officials. The communication model encompass a number of similar sub-models, all laying emphasis on two things; a) the importance of interpersonal communication between the technology developers (researchers) and technology users and b) the importance of dealing with organizational barriers or facilitators of TT. Wahab, *et al* (2009) presents the ranging forms of the communication model, from those with low levels of participation to those with high levels. An illustration of the participation levels are depicted using a ladder metaphor, figure 2.2 refers.

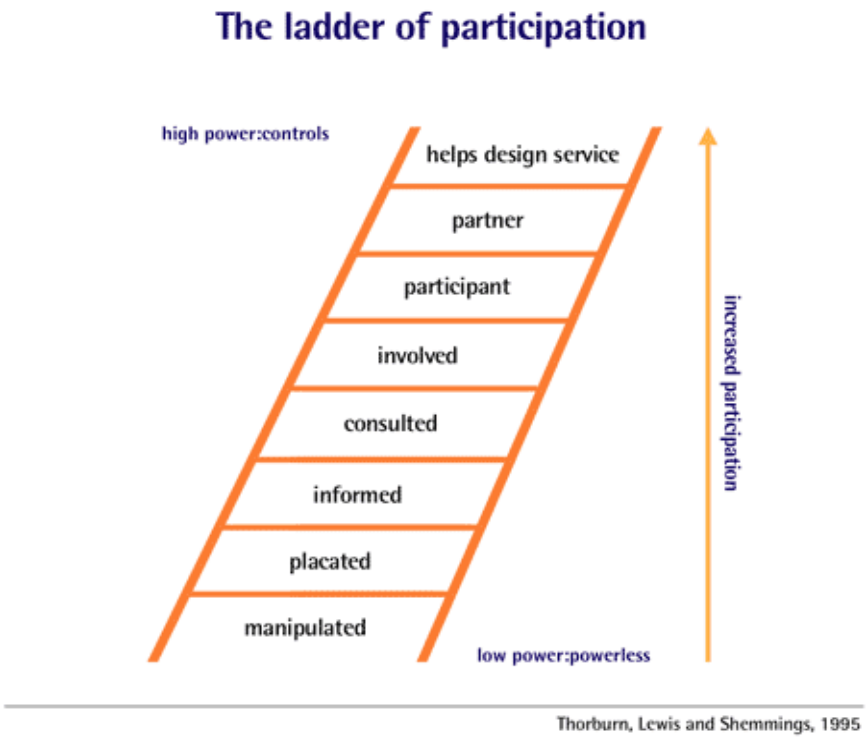

Figure 2.2: Ladder of participation

The least participative, the knowledge utilization sub-model focuses on ensuring that knowledge is organized in a manner that ensures its effective use in the technology user's setting technology application level. At its worst; the knowledge utilization sub-model presents some limitation in communication. Whilst valuing interaction between researcher and farmer, technological information is primarily the responsibility of the researcher. Leeuwis (2004) calls this sub-optimal participation, *passive information giving,* owing to how farmers are asked to respond to information requests of experts who then make decisions about research interventions required. The farmer's involvement is limited to taking responsibility of the trials on their farm and eventually adoption. On the ladder (figure 2.2), participation within this frame of thinking is restricted to the four lowest levels.

At best, the communication model is concerned with the full exchange and sharing of responsibility between the researchers and farmers. In this context the model views *TT as an ongoing two-way interactive process with continuous and simultaneous dialogue among the individuals concerned* (Wahab, *et al* (2009). This author equates this optimal participation model with the network communication paradigm where feedback is all pervasive and participants in the TT process become 'transceivers' instead of sources and receivers and help design intervention services as depicted in figure 2.3. Participants in the TT process within this model use feedback to reach convergence about key aspects of the technology. Ahmed (2004) stated that *small-holder farmers' participation as active decision makers in the development and transfer, will help ensure they get the technology they want and can adopt.* TT referred to here is rooted upon information-sharing and joint decision-making as core processes, from problem identification to joint experimentation on technical solutions identified and adoption. Another model that applies the same principles is the popular Participatory Technology Development (PTD) model. According to Eponou (1993), the strength of PTD lies in the highlighted role of the farmer whereby through adaptive research, he/she exert a real influence on the institutions involved in both technology generation and transfer. A newer version of PTD called Farmer Participatory Research is depicted in the figure 2.3.

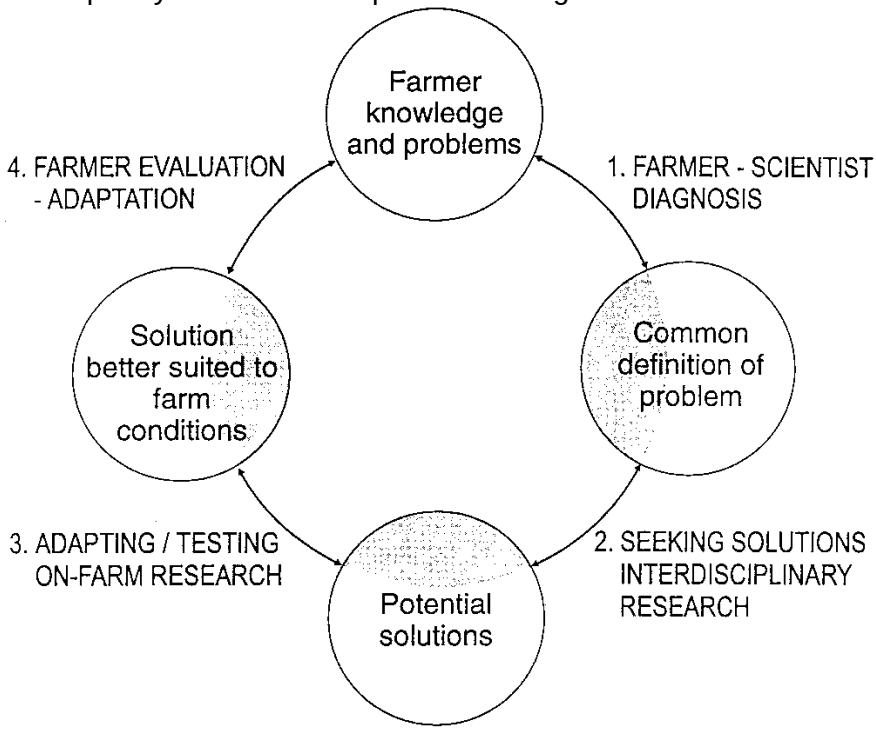

Figure 2.3: Farmer Participatory Approach process, source Lado (1998)

In this context, 'technology transfer' is the creation of knowledge systems or what Leeuwis (2004) terms interactive/ innovation systems. According to Hall (2007), knowledge systems are scenarios in which farmers are seen as co-experts rather than adopters of technology. Leeuwis (2004), talks of network building, social learning and negotiation as key processes of interactive and innovative systems of working. He further clarifies that, in this context, the role of communication is not to sell ready-made solutions but rather to help generate and design innovations appropriate in close interaction with societal stakeholders. Another popular approaches pursuing the objectives of participation is the Farming Systems Research (FSR) approach rooted in promoting active farmer involvement. Röling (1990) applauds FSR for ensuring '*the goodness-of-fit between technology and its users, as it emphasize the importance of collecting information from and about farmers before designing technology and while testing it'*.

2.3.2 Distinction between knowledge transfer (KT) and technology transfer

To say the least, the distinction between TT and KT is somewhat flawed since one cannot exist without the other. Borrowing from AIAS, technology is packaged knowledge, implying that the two are sequential phases in a continuum of the R&D chain. This point becomes clear when Wahab (2009) suggests a level in the TT process called the Knowledge and Technology Creation level. He describes a process whereby technology developers conduct and develop research into knowledge and avail results through research publication, a form of technology. However, Gilbert and Cordeyhayes (1996), provides a distinction and classifies KT as ''scientific knowledge used by scientists to further science'' and TT as ''scientific knowledge used by scientists and others in new applications''. For the sake of argument, this research is to deal with these concepts separately due to the fact that KT requires much debate. The value placed on knowledge held by individuals varies greatly, depending on the value system. Explicit knowledge tends to enjoy higher value compared to implicit/tacit knowledge and is therefore the one often referred to in the context of 'transferring' knowledge. Leeuwis, (2004), asserts this view more succinctly stating that *'scientists tend to look at their scientific knowledge as universal, generally applicable and superior to that of farmers'*. The issue of using knowledge to solve the world problems is often placed at the hands of scientists, those with explicit knowledge. There exist flaw in this perception since R&D is conducted with the view to help farmers. Farmers frequently try innumerable ideas/options in response to production challenges and have better understanding of local farming systems. Their knowledge should therefore count in the design and delivery of solutions aimed to help them. Zipp in Wallace (1998) agrees with this view, stating that farmers are central to the debate and developments on technology, information, skills and attitudes should better intergrate this and reminds us that; research, education and extension are means not ends. As stakeholders discuss issues common understanding is reached towards 'created knowledge' achieved through dialogue. Knowledge creation is an interactive process of utilizing the best of each institution and integrated towards new solutions, new processes and new knowledge. This implies a shift from the notion of 'KT' to dialogue, recognizing the value of knowledge as a mechanism through which experiences are exchanged. This calls for high level of competence, not only of the technical, but also of the social processes involving multiple network stakeholders. Leeuwis (2004) concludes this argument by suggesting that the KT process takes time, that it requires good planning and use of well-thought out communication strategies by project stakeholders.

2.4 Measuring Effectiveness of Technology transfer

Determining whether TT meets its stipulated aims has been looked at in various ways (Arnon 1989, Bozeman 2000, Ahmed 2004). The most useful and relevant for the study is one developed by Bozeman (2000), termed the Contingency Effectiveness Model and some

adjustments were made by the researcher on the model for appropriateness. The model proposes five broad dimensions to determine effectiveness of TT:

- characteristics of the transfer agent – capacity of the institution to optimally conduct TT through staff capacity, institutional policies/strategies (facilitative and prohibitive), norms and regulations and infrastructural considerations, government/private, culture
- characteristics of the transfer media – the vehicle or means used to transfer the technology; formal/informal, face-to-face, publication and etc
- characteristics of the transfer object – technology itself and its content and form; scientific knowledge, devices used, process, general know-how and specific characteristics of each
- characteristics of the transfer recipient – agency targeted as recipient of transfer, whether it is; a firm/business entity, informal group, individual, an institution and associated characteristics e.g. resource endowment
- the demand environment – factors in the market creating a demand for the technology/serving as competition/deterrent, determining the need for the technology; financial, substitutability and etc

The five dimensions capture well the issues of concern to the ARC and for that reason this research will apply the dimensions to explore TT in the organization. The characteristic of the transfer recipient is an important consideration in the study, due to the limited resources in the farming system. According to the Food and Agriculture Organization of the UN (FAO), a *technology transfer programme would be considered effective when there is minimal or no gap between the potential and realized impacts of the technology amongst its users* (SD Dimensions, FAO, 1996). This view is also supported by Kaindaneh (n.d.), stating that a more productive farmer with improved crop varieties, grown under improved agricultural practices is a measure of effective TT.

2.5 Types of Communication Strategies used in TT

TT (and generally communication for innovation) is practiced in many forms and this is not only limited to methods and techniques used. This is packaged as communication strategies (sometimes the term communication services is included here) and entails intervention purpose, approach to be used, methods within that, resource mobilization and other such related matters. Communication strategies take cognizance of the wider intervention purpose, the rationale behind bringing a development programme in the first place. It is a complex process, going beyond having a message in hand and needing to deliver it to the user (Leeuwis, 2004). In agricultural research, communication should be more than dissemination of information containing technical solutions, contrary to this assertion; emphasis is often placed on the message (the technology). Hambly and Kassam (2002) supports this assertion, noting that '*dissemination of scientific information is now also closely related to the growing realization among researchers that public support depends upon their ability to engage in inclusive and interactive dialogues with farmers*'. Operationalizing this dialogue between research and farmers involves the use of communication strategies and shifts in power dynamics that are not necessarily natural or easy in human interaction. Wahab (2009) states that '*the scope of transfer is determined by how much information is contained within a technology'*, meaning the complexity embodied in the technology. A technology that requires a lot of information for one to use it is less likely to be adopted. This is because adults tend to seek learning experiences that relates directly to their life and seek knowledge that can be assimilated easily (Jarvis, 2003). Arnon predicted in 1989 increased relevance of TT in future due to enhanced complexity and need of explanation of new technologies. Chambers & Jiggins (1989) acknowledges the role communication plays in ensuring successful technology adaptation and/or adoption by RPFs.

2.5.1 Application of Communication Strategies in Technology Transfer

A good grasp therefore of what one is trying to achieve, the intervention logic, the manner in which they will go about achieving that (including methods) is important, all articulated as communication strategies. Van Mele (n.d) suggests engaging farmers in the development of learning tools and communication strategies. Leeuwis (2004) provides an overview of six different communication strategies/services used in communication for innovation including technology transfer. In short the strategies are; advisory communication/services, supporting horizontal knowledge exchange, generating (policy and/or technological) innovations, conflict management, supporting organization development and capacity building and persuasive transfer of (policy and/or technological innovations). These strategies help explain what technology transfer agents do and for what purpose and are elaborated on the section that follows.

2.5.2 Types of Communication Strategies Used for Technology Transfer

Advisory communication

This strategy is sometimes referred to as advisory services and consists of farmers seeking solutions to deal with a particular management problem. The problems may be immediate and operational; e.g. fighting disease infestation) or long-term (future crop estimates for market intelligence, or viability of farming). The interaction between the farmer and agents is often not limited to the provision of relevant knowledge (advice) sought; it may consist of guidance on ways of solving the problem in the future. By definition, this strategy is demand-driven; with farmers requests used a source of service provision. There may be cases where the agent concern does not have knowledge sought, and connects the farmer with experts in that area, internally and externally. This is akin to acting as a broker; coordinating and utilizing specific skills to discern the needs of farmers and who could best meet them accordingly.

Supporting horizontal knowledge exchange

This strategy is operational within farmer-to-farmer transfer of experiences and exchange of knowledge and information. The arrangements within this strategy are often informal and TT agents facilitate the horizontal exchange, bringing people together and catalyzing learning.

Generating (policy and/or technological) innovations

Public TT agents are sometimes called upon to organize processes for designing innovations to resolve production problems. These processes often involve various stakeholders. According to Leeuwis (2004), the strategy is premised upon design of appropriate and coherent innovations to address specific challenges. Activities undertaken may include experimentation and other means of exploring the 'innovation' to generate new knowledge, insights and mutual understanding. The strategy therefore requires a high level of facilitation skills as the agent's role is forging effective linkages amongst the stakeholders concerned.

Conflict management

This strategy is informed by the inevitability of conflicts in human practice. It is focused on productively facilitating dialogue amongst stakeholders (including farmers) to resolve conflicts leaving space for innovation development. The TT agent plays a mediating/facilitative role or by encouraging and involving experts if deemed appropriate. Leeuwis (2004) calls this 'creation of a platform' bringing stakeholders to a discussion point to overlook the conflict and learn and negotiate towards a productive outcome.

Supporting organization development and capacity building

Farmers associations, community organizations or groups often have an influence on services provided to farmers. Against this backdrop, TT agents often find themselves spearheading activities to assist these parties become well organized and improve their lobbying abilities. These functions fall under organization development (OD) and capacity building and lobbying (Leeuwis, 2004). Researcher often refrains from these activities, leaving it at the hands of extension agents.

Persuasive transfer of (policy and/or technological innovations).

Leeuwis (2004) rightly identifies this strategy as the most widespread form of communicative intervention. It is rooted on persuading farmers or other groups to adopt specific technological packages. The main intervention goal is to realize specific policy objectives to induce behaviour change (e.g. adoption of cash crops and/or new varieties), through strategic manipulation.

The distinguishing factor between the strategies presented here, is the intervention logic not the methods and/or processes used. This is to avoid undue justification for practices employed. The important thing here is to recognize areas where TT offices and their agents need to make adjustments. Quite often theory is far removed from practice; in development work this is even more common. Knowledge about approaches and strategies does not always translate to 'perfect' practice. This may be due to factors earlier mentioned; education, incentives, funder/donor influence and research methodology. The dominant strategy in the ARC is persuasive transfer, even though in the projects studied elements of horizontal knowledge exchange and advisory communication are evident. The strategies are illustrated in table 2.1 below.

Table 2.1: Different communication strategies /services and their characteristics

STRATEGY	INTERVENTION GOAL	ROLE OF TT IMPLEMENTER	ROLE OF CLIENTS	KEY PROCESSES	BASIS FOR LEGITIMIZATION
Focus on 'individual' change or farm management communication					
A) Advisory communication	- Problem solving - Enhancing problem solving ability	- Consultant - Counselor/coach	- Active problem owner	Problem solving, counseling, coaching	- Active demand
B) Supporting horizontal knowledge exchange	- Knowledge exchange - Diffusion of innovations	- Source of experience	- Active learners - Source of experience	Learning, networking, problem solving	- Active demand - Public interest - Limited resources
Focus on collective change/coordinated action					
C) Generating (policy and/or technological) innovations	- Building coherent innovations	- Facilitator - Resource person - Supporting vertical knowledge exchange	-Active participants	Problem solving, social learning, network building, negotiation	- Societal problem solving - Ensuring progress - Qualities of interactive mode of working
D) Conflict management	- Managing pre-existing conflict	- Mediator - Facilitator	- Stakeholder participant	Negotiation, social learning	- Wish to remove obstacles to progress
E) Supporting organization development and capacity building	- Strengthening the position of a group/organization	- Organizer - Trainer - Facilitator	- Active participants	Social learning Negotiation	- 'Political' sympathy
Focus can be individual or collective change					
F) Persuasive transfer of (policy and /or technological) innovations	- Realization of given policy objectives - Pre-defined behaviour change	- Social engineer	'un-expecting' receiver (at least initially)	Adoption Acceptance	- (democratic) policy decision - Preceding interactive process

Source: Leeuwis, 2004

CHAPTER THREE: APPLYING THEORY - RESEARCH METHODOLOGY

3.1 Analytical Framework

The study was of a qualitative nature; giving perceptions on determinants of effective technology transfer, identifying gaps in practice and areas requiring improvement. Where gaps are identified, ideas on how this could be improved through better communication strategies and improved practice were also explored. It explored how improving technology transfer broadly and specifically communication strategies could enhance food security situation of target farming communities. There were three areas of focus for the study and these were informed by the research objectives articulated in chapter 1:

- Interventions employed by the ARC towards improving food security of resource poor maize producers
- Extent to which results expected are achieved
- Communication strategies used in pursuance of its TT mandate

The identification of the themes was informed by the study objectives. The objectives centred around two dimensions; key determinants of effective TT and factors determining selection of communication strategies used for TT. Through the first dimension, the study explored perspectives on effective TT, preconditions to improvement of TT and factors limiting positive impact of ARC technologies for maize production. The first two themes are applicable here. The second dimension on the hand, allowed for the exploration of; communication strategies used in TT, researcher competency in selection and management of TT communication strategy and influence these communication strategies have on TT. Graphically, the framework can be presented as shown in figure 3.1:

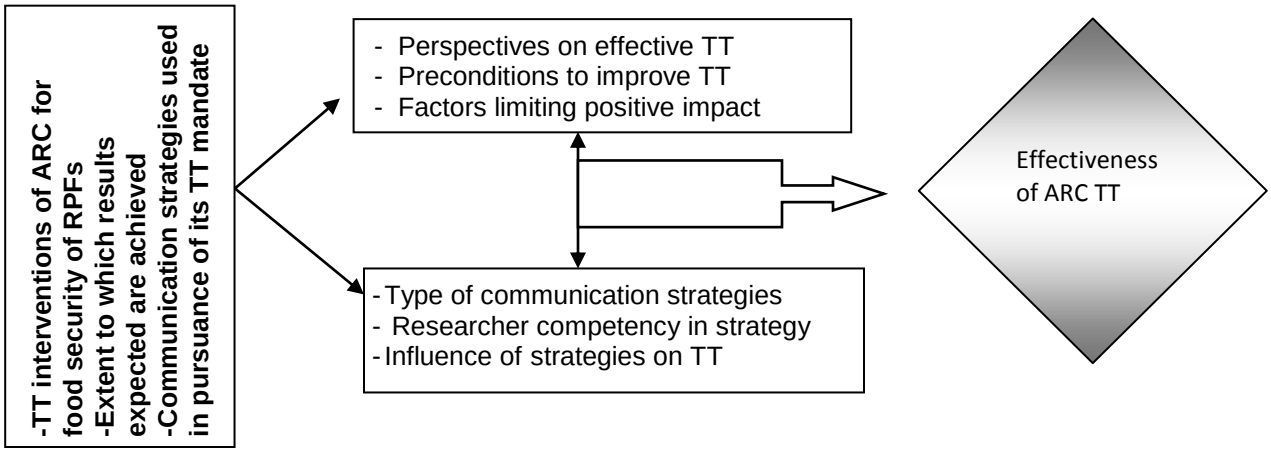

Figure 3.1: Conceptual framework for the exploration of TT effectiveness

The field of study, technology transfer is broad and for that reason conscious delineation is made. As appearing in chapter two, the study focus was limited to one R&D organization in South Africa, within that organization, one institute and within it two projects of that institute.

3.2 Study population

The study explored perspectives on TT and how TT helps the organization meet the needs of concerned maize farmers from researchers (implementing TT activities), management

(responsible for setting TT objectives and programmes), farmers (recipients of TT services) and partner government extension staff (co-implementers of TT activities). The following respondents were interviewed:

- one member of Executive management committee
- four researchers (comprising of two managers and two technicians)
- five extension officers – EOs (with one of them being a manager and treated as a key informant)
- two senior managers responsible for management of related TT programmes (treated as key informants - KI)
- six groups of farmers (totaling 56 people were interacted with during the study)

3.3 Research strategy

The study used the case study strategy. It was chosen as it allows for deep exploration of the issues and embraces the use of qualitative methods. Case studies have a restricted space and time, looking in this case at the ARC and efforts to positively respond to production constraints in maize. This strategy facilitated the comparison of the two cases (the two projects) through an exhaustive analysis of key distinguishing features between the groups. It gave focus on contextual information about the cases presented in order to understand causal processes. Figure 3.2 depicts an illustration of how the study progressed.

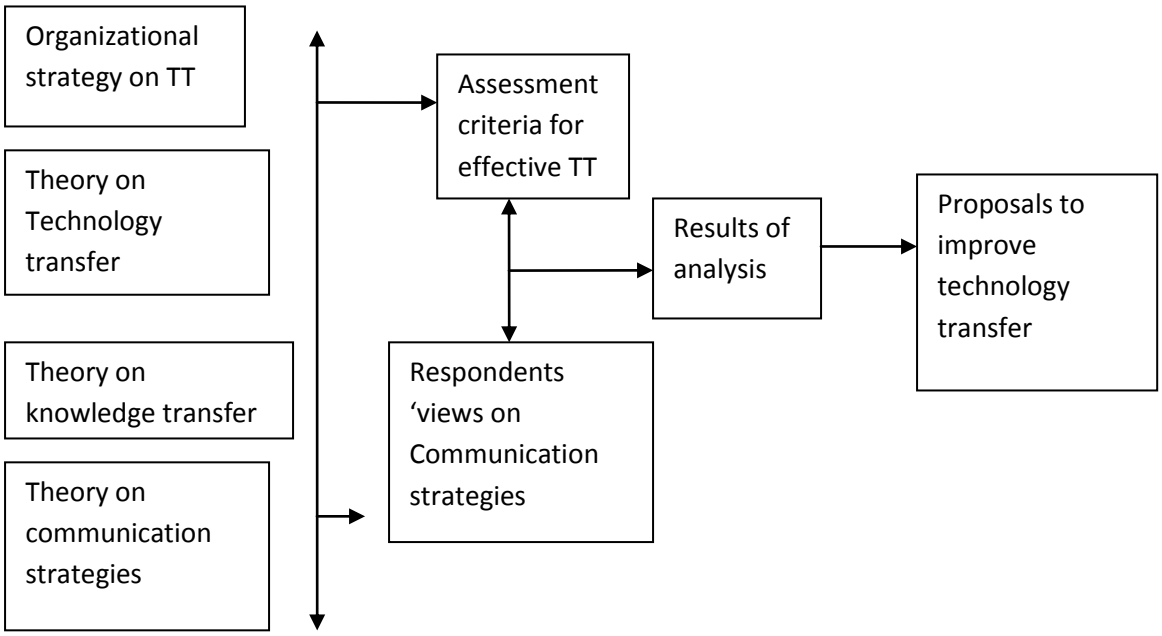

Figure 3.2: Research framework for evaluation of effectiveness of technology transfer, adapted from Verschuren & Doorenwaard, (1999)

3.4 Methodological considerations

As described above, the study was of a qualitative nature and used Participatory Action Research (PAR) as the main paradigm. By definition, PAR *is a flexible cyclical process which allows action (change, improvement) and research (understanding, knowledge) to be achieved at the same time (Dick, 2002).* The understanding periodically gained allows more informed change for the next step which then informs change in the manner in which the inquiry is conducted. The field research was initiated through the pretesting stage, whereby response of two researchers to the questions developed in the checklist helped the researcher to modify for

better clarity. This iteration also manifested in the literature review, where understanding gained on the themes and concepts helped refine the analysis. Furthermore as the field research progressed, new information facilitated the refining of the interview process for better practice.

In PAR, people affected by the intervention are involved in the action research and are not viewed merely as information givers, but rather as inquirers. This was important to foster interactive engagement with the respondents. For example, a farmer may have started the interview projecting a helpless image due to poverty, the discussion ended with them being instigated to identify the next course of action to take so as to realize their development vision. In this way, the study adhered to two main principles of PAR, bringing about change/action whilst gaining new understanding through research. The two principles can be explained as follows: action component seeks to ensure research is more than an act of just finding out consciously engender positive change; the research component emphasize the need for the research process to be participatory, with equal and collaborative involvement of the 'community of research interest' (Dick, 2004). The issue of ensuring that research has benefit to those 'researched' through clear action for improvement of people's situation was an important consideration for the choice of this paradigm. The study therefore had to actively seek respondents' views of what would constitute improvement or change and proposals for realizing it. The most compelling reason for choosing PAR is value-laden. The researcher holds the conviction of respect for people; their knowledge, views, beliefs and opinions.

3.5 Study Methods

The collection of the data for this study was through secondary and primary sources. Primary data was collected through a number of qualitative methods. These included; visioning exercise, semi-structured interviews (SSIs) and focus group discussions (FGD) with farmers, government EOs and researchers. A select group of experts on either technology transfer or communication strategies were interviewed as key informants using SSIs as well. Perceptions on the problem as well proposed solutions were explored through discussions with respondents. Interviews were also held with one member of the Executive Management Committee and senior managers in the organization to determine scope for enhancing technology transfer. The study comprised altogether 67 respondents.

Secondary data

A desk search based on literature from journal articles, text books, Doctor of Philosophy (PhD) thesis, ARC and government documents helped gather information upon which the discussions and conclusions of the research were to be based. This secondary data helped identify what has been done in the topic under study. An investigation of the key concepts of effective technology transfer, knowledge transfer and by implication the use of communication strategies to realize the aim of TT (or KT) was undertaken and this process was iterative in nature. The scholarly views obtained through the desk search were shared not only in the literature review section but throughout the report including informing research findings.

Semi-structured interviews

Semi-structures interviews (SSIs), a one-to-one interviewing technique to elicit individual opinion about an issue was used. This technique helped to guide the interview with select group of ten farmers in Zebetiela as individual opinions were considered best in giving a picture of improvements in household food security through maize technologies brought by the ARC's project intervention. The tool was also used to gather insights of researchers and EOs.

Key informant interviews
Key informants are those respondents that are specialists in a particular topic. Four experts were interviewed; two from other institutes of the ARC managing TT, Executive, and one manager from the Limpopo Department of Agriculture (LDA). The information gathered helped to explore views on institutional determinants for effective TT, obstacles towards it and mechanisms for improving these.

Focus group discussions
FGD is an informal interviewing technique used to gather views of a group on an issue of common concern. FGD were conducted with five groups involved in two projects of the ARC, Community Based Seed Production (CBSP) and Limpopo Province Agricultural Strategic Team (LIMPAST) on how they experience TT. The groups have a membership component of approximately five to 40 members and participation at the meetings where discussions were held by the group and facilitated by the researcher ranged from 3 to 18.

Visioning
Visioning helps instigate future thinking among rural poor. In this case with farmers it shifted thinking from current problems as farmers mapped change desired through articulation. This tool was very useful in getting farmers to vision future development in their farming enterprises and how these visions may be realized.

3.6 Ethical considerations

To ensure adherence to research ethics, all respondents were asked to participate voluntarily, the purpose of the research was fully explained and confidentiality was maintained. During the interaction with respondents, the researcher ensured collaborative interaction among the discussants. The research also avoided fabrication of data and plagiarism.

3.7 Data analysis

Aspects of systems analysis was used to analyze the data collected. This was achieved through the stakeholder analysis, as part of understanding the organization as a system; identifying conflicting and common perspectives of the problem and solutions. Visioning was another system model used (as discussed above) to map the current situation and the envisaged (or ideal) situation. Out of this comparison arose a better understanding of aspects that need to change. After studying the system and clearly depicting the key elements and how these perform towards the attainment of the goal of effective Technology Transfer, required adjustments were identified.

3.9 Research Limitations

A tendency to expect much from outsiders rears its head even when clear introductions were made concerning the purpose of the research. The undue expectation for eventual financial assistance from farmers was expressed with EOs entertaining it. It was only in situations where ARC technician was available that these expectations were quelled.

The period starting end of July saw the beginning of the public service strike in the coutry and this affected the research somewhat. One of the EOs could not help with organizing farmers as he was required to report to his district 40 kilometers away office four times a day.

CHAPTER FOUR: RESULTS

Findings of this research are a result of a reflection on the ARC's intervention to address the challenges faced by communal small scale farmers in the study areas using technology transfer. The intervention was informed by conviction that, there is potential to reduce poverty and food insecurity amongst the concerned groups if they are accorded the right support. The findings will therefore provide insights of the respondents' views on the extent to which this aim was met as obtained through SSIs, the FGD and key informant interviews. The findings will be reported as per each cluster of the respondents. Data obtained from organizational and project documents will also be presented in this chapter. The results are presented in three ways as per the conceptual framework presented in chapter two; according to the two research objectives, under the themes and lastly according to the three respondents cluster. A contextual overview of the studied projectswill be provided first.

4.1 Technology Transfer in Maize production – an overview of the projects studied

Two project of the ARC provided context of the study and these are the LIMPAST project and the CBSP Project. The thrust of these projects was maize cultivar technology promotion. Seed is a key input in crop production and for this reason the institute has an innovative seed breeding programme. Understandably, all cultural practices are designed to exploit the full genetic potential of the seed sown. Furthermore, no agricultural practice (tillage, cultivation, weeding, irrigation, fertilizer application, pest control, etc.) can improve a crop beyond the limit set by the seed genetic potential. This is more of an issue for RPFs, severely constrained by agro-ecological as well as resource limitations (Mashingaidze, 2010 in www.arc.agric.za). ARC recognizes that food security is not possible without the use of locally adaptable cultivars of staple foods such as maize (ARC Business Plan, 2009/2010). In Limpopo, trials were conducted at a number of villages across the province and the study reported on here reviewed the broad TT interventions in six villages comprising of three villages for each project. The cultivar trials were mainly conducted to fulfill the needs of the small holder producer, referred to in SA as a small scale farmer. The aim of the trials can be split into two categories. Firstly, to make a comparison between newer open pollinated varieties (OPV's) and hybrid maize. Secondly to demonstrate or illustrate differences between the two groups of cultivars; Ga-Thaba, Ga-Mmamba and Driekop were the three sites selected for the CBSP project, whilst Bellingsgate, Tafelkop and Zebetiela were for the LIMPAST project. Below is an overview of the two projects.

4.1.1 Limpopo Province Agricultural Strategic Team (LIMPAST)

The project, whose technical name is the Grain Production Advancement Project (GPAP), was developed after a need to improve grain production in Limpopo and other parts of Mpumalanga was identified in 2000. According to project documents; grain production, especially maize was in decline although it remains the staple food diet. The harsh environmental conditions in these provinces made it almost impossible to produce sufficient grain yield per unit land. The document further identifies drought and low rainfall as the most common natural dilemmas limiting grain production in these provinces. The project targeted selected smallholder or communal farmers in an attempt to stimulate production of maize. The project became known as LIMPAST after the establishment of the inter-institutional approach involving stakeholders such as ARC, LDA, Agri-North, and Noord Tranvaal Kooperaisie (NTK) and the Maize Trust (SEIA Report, 2007). This project has been completed and the study is therefore an ex-ante evaluation of TT in the project.

4.1.2 Community-Based Seed Production

The CBSP project aimed to curb household food insecurity due to lack of resources to buy hybrid seed and inadequate seed marketing system. The project therefore promoted community-based seed production of farmer-preferred open pollinated varieties. These OPVs are markedly cheaper than hybrid seed at R17.50 ZAR (€1.75) compared to about ZAR30 – 85 (€3 - €8.50 depending on the place of purchase) per kilogram. The farmers targeted, due to resource limitations struggle to buy hybrid seed and resort to planting landraces or old OPVs and recycled seed of unknown origin. According to the project documents, the project has empowered small holder farmers to produce certified seed of OPVs, due to these varieties to meet their anticipated level of input. Specific objectives of the CBSP project in pursuance of this approach were to enable:

i) farmers to assess new and improved varieties under their own management practices and make informed decisions about varieties suited to their conditions and preference
ii) farmers to learn good agronomic practices (spacing, fertilization, weed control, stock borer control, etc)
iii) researchers to evaluate and verify the performance of newly released and promising experimental varieties on farm, under both researcher and farmer-managed conditions
iv) researcher to get feedback from farmers on the performance and acceptance of their varieties under farmers' conditions
v) EOs to make informed variety recommendations to farmers in their target environments to enable informed decisions
vi) EOs to hold Information (Field) Days and use the trials to demonstrate new or suitable varieties and good agronomic practices
vii) quick release and adoption of new improved varieties
viii) Seed producers to direct marketing of varieties towards the areas where they perform well.

4.2 Approach used in the two projects

The study noted positive developments in the manner in which TT is conducted in the organization through the two projects. Both projects observed principles underpinned in the communication model particularly that of ensuring that researchers understand and relevantly address farmers' problems and collaborate with EOs on best methods of disseminating the results of their research. It was indicated that this was operationalized through the Farmer Participatory Research (FPR) approach, a newer version of the PTD approach discussed in chapter two. The key informants explained that this approach allowed researchers to involve farmers in the adaptation of technologies under field conditions to maximize benefits to farmers as production decisions are based on resource availability.

4.3 Profiles of the project groups

The project groups are profiled in an overview below. The insights were gained as part of the introductions between the researchers and the groups. This introduction revealed area of coverage, land size, membership, general perceptions about the groups and their challenges. The information and the level of detail varied across the groups, owed to the nature of the discussion, with each group emphasizing certain aspects over the other. Observations made by the researcher and informal discussions with the research assistant and the research technician respectively also helped in gathering the perception reported on in the table to follow.

Table 4.1 Profile of the project groups

PROJECT	GROUP NAME	KEY CHARACTERISTICS
Limpopo Province Agricultural Strategic Team (LIMPAST)	**Tafelkop**	Out of the three groups that benefited from the LIMPAST project, this is the only site where ARC is still active. The organization is involved in a trial promoted by the Maize Trust to curb soil acidity though lime application. The lime promotion is accompanied by hybrid maize seed and other production inputs. The Tafelokp was also the only group with a significant number of young people attending the FGD, with only seven being elderly out of 18 people. It was learnt the group was farming on of 50 ha plot divided amongst 22 farmers and it was formed in 2002. The name of the group is Regodile Baleme.
	Zebetiela (Madisha-ditoro)	Ten members of this group were interviewed individually through the SSI technique. The views shared were therefore with respect to individual plots. However, issues raised were common to other groups as per the FGD and the proposed solutions did not differ. The theme that resonated in the responses given by individuals in this group highlighted heavy reliance on outsiders for production, e.g. to access seed, mechanization and fertilizers. Plot sizes varied from 0.5 to 2 ha
	Mashishana (Bellingsgate)	The group comprised of 17 members (12 women and five men) and was established in 1996. This group is called Mpepu-same baleme. The group was amongst the first to benefit from the LIMPAST project. According to the Research Technician who accompanied the researcher, this was the least feasible site in the project. It was explained that the area is characteristic of less favourable agro-ecological conditions, hilly, rocky, suffers from shallow soils and as such more suited to livestock production. The group was observed to have been the most affected by ARC's departure in the area. It was explained that difficulties of securing seed was worrisome, prompting purchasing of any cheap seed. The discussion revealed that the 'cheap' seed produced low yields when compared to the OPV preferred (ZM521).
Community-Based Seed Production Project	**Spitskop (Driekop**	The group is made up of 11 members and their association is called Jack Mafarane Maize Project. The group is led by a retired school teacher, responsible for planning project operations including organizing marketing. The group was observed to be more developed compared to the other five. Through government funding, a project structure was built and functions as a facility for; storing harvested maize, shelling, storing treated maize (ready for sale) and packaging of grain for milling. One of the rooms was initially planned for the Seed Treatment process thus offsetting the costs incurred through engaging Madzivhandila College. The group identified a need for skills in business development, entrepreneurship, financial management and requested help for training in these regards.
	Ga-Thaba	This group is made up of ten member and referred to themselves as the Mapeu Seed Growers. The group was established in 2006, utilizing a plot of 3ha divided in 11 sub-sections with each member's allocation plus a plot communally managed by the whole group. The group was observed to be highly reliant on EOs and ARC for operations. A visit to the field revealed unharvested matured maize due to in-clarity on appropriate timing for harvesting.
	Ga-Mmamba (Mafefe	The Mashushu Seed Growers is the largest of all the groups, comprising of 38 members, although only three were available for the FGD due to the Public Service Strike. The extension officer could not organize the members 'whilst not at work'. This group is also the only one farming under irrigation, drawing water from the Olifants River. The group's main concerns were maintenance of the irrigation infrastructure which was often non-functional and lack of organized market. The extension officer was awaiting the LDA engineering section to fix the infrastructure. For marketing, the College often delayed in collecting seed for treatment. It was established that local maize growers became the group's only market as a result. Farmers explained that selling untreated maize is at a loss, with 4kg seed sold at R40 whilst 5kg treated seed is sold at R85 seed.

4.4 KEY DETERMINANTS OF EFFECTIVE TECHNOLOGY TRANSFER

4.4.1 Perspectives on Effective Technology Transfer

Bozeman's Contingency Effectiveness Model was used as criteria for measuring effectiveness of the TT intervention. The five characteristics presented in chapter two refers; the relevance of the technology (*transfer object*), the clarity of the technical messages (*transfer medium*), ARC's knowledge and capacity (*transfer agent*); the extent to which technologies promoted met the need (*demand environment*) and the degree to which the intended farmers could adopt the technologies (*transfer recipients*).

All the farmers interviewed individually and in groups perceived the technology (*transfer object)* of improved maize varieties (OPVs) to have increased food security. Farmers could not identify aspects that were not done well in the project. The less successful aspect in the projects was thought to have been incapacity to fully utilize the service for marked improvements in their farms due to constraints in their farming system (*transfer recipient*). These are to be discussed in later sections. Whilst the intervention was through the initiatives of the local EOs, (*the demand environment*), the technologies were very relevant and helped alleviate some of the production constraints. According to the farmers interviewed, ARC's knowledge for good farming practices for the improved maize seed varieties (*transfer agent*), facilitated increase in yields. These increases meant more food for their families. Lastly, the method used of field schools and the information presented made learning easy (transfer media). These dimensions are captured in the figure 4.1

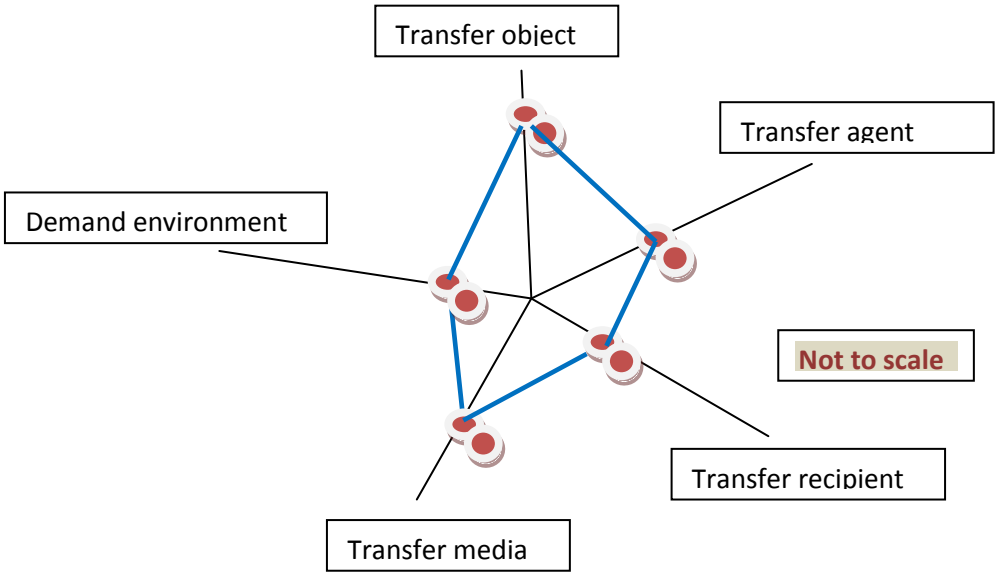

Figure4.1: Contingency Effectiveness Analyses

All the groups valued the added benefit of exchanging maize for maize flour (maize meal) at the local Progress Milling depot, as it meant one less food item to budget for. The study established that green maize is used to feed the family soon after harvest whilst dried grain is sold. It is

exchanged in lieu of payment of R95[3]/80kg maize flour bag whilst the rest of the community buys at R180.00/80kg bag. To farmers, the discount enabled purchase of other food stuffs, such as cooking, oil, sugar and meat and etc. Farmers further explained that the rest of the maize is sold as seed and the thrust of their activities as it is for the purpose of income generation. Data suggests that the money generated from selling seed is used for macro family expenses, such as such as school fees, clothing and dues for social clubs. According to the three groups in the CBSP project, market arrangements are insecure. It was explained that they relied on government officials to transports the grain to Madzivhandila Agricultural College for processing into seed through a special treatment regime, at a cost of 1kg seed for every kilogram treated. Another issue with market was the delay in treatment and packaging by the college. Amidst the marketing constraints, farmers observed a marked difference between themselves and their non-farming counterparts in the community, achieved through better means of securing food through the project. A statement from one of the farmers alongside captures sentiments shared.

Box 1: Personal Communication, Selena Kekana, Zebetiela
'We can safely say our families no longer go hungry'.

The views expressed by EOs concurred with those of farmers. All five respondents (including the KI) stated that TT intervention, of drought resistant (OP) varieties with higher yielding characteristics performed better than local landraces and this boosted household food resources. The respondents compared TT with publications as alternative medium used in research to transfer knowledge and information and perceived that TT with RPFs addresses challenges expressed by farmers and thus offer appropriate technical solutions.

The views shared by the researcher cluster were also similar to those given by farmers and EOs. All respondents were of the opinions that TT enables farmers to produce more food by providing supportive technical solutions, thereby increasing household food security and improving self reliance. An exception was a response of one key informant, that indicated that ARC technologies and information is not fully accessed by RPFs, as ARC doesn't have a clear profile of these farmers and their needs, that ARC often rely on government and as such technology development is not always needs-based.

4.4.2 Meaning Ascribed to Effectiveness in Technology Transfer

The study further explored perceptions of researchers and EOs on what is meant by effectiveness in TT through SSIs. The views of the key informants are also included in the discussion. The perspectives varied although common elements could be derived in the views of both researchers (6) and EOs (5), the table 4.2 refers. Similar as well as conflicting views are captured accordingly. The executive was of the opinion that improved ARC IP portfolio, accredited courses and commercialization were important measures of the Division's performance in terms of meeting its mandate. According to the respondents, effective technology transfer involves the following aspects:

[3] The exchange rate is roughly R10 ZA Rands to 1 Euro

Table 4.2: Researchers and EOs' perception of effective technology transfer

	Shared perceptions	**Conflicting perceptions**
Definition of technology transfer	i) Transferrable technologies, with farmers following guidelines in their farming ii) collaborative engagements between researcher, extension and farmers (optimal stakeholder participation) iii) active farmer involvement vi) positive & visible change in the farmer's situation vii) measurable impact, with traceable contribution of ARC's tech for econ development	i) Farmers taking ownership of the technology promoted and promote it amongst peers ii) Development of user-friendly technological information iii) Good communication between transferor and receiver of tech iv) commercialization of research programs, tech generate income i) recognition of TT as a contact spot, ARC plays broker role between producers and users.
Advantages of technology transfer	i) application of technology & information well beyond project scope ii) improved production practices iii) sustained increase in yields & cost-effective farming iv) improved food security v) adoption of more innovative ways of engaging with the farmer	i) clear difference from before and after intervention & technology adoption ii) needs-based interventions iii) exercising patience with farmers working with them at their pace iv) facilitates capacity building of local extension staff v) institutionalization of the technology, i.e. it becomes widely used in the area

4.4.3 Preconditions to Improvement of Technology Transfer

Farmers were very positive about the TT service provided by the ARC and struggled to find things the organization could do better. Five groups out of six appreciated the advice and the training (knowledge and skills acquired), but were constrained by not having a tractor to facilitate utilization of these skills. These respondents were of the opinion that if the organization could help in securing a tractor, the success rate would have been higher. It was established that late planting is a common occurrence due to difficulties in accessing a tractor in good time. ARC was also requested to advice farmers on pest control and safe use of pesticides and herbicide application and management. The Ga-Thaba group was of the opinion that regular monitoring of trials for timely response, in case things go wrong could be improved. Tafelkop held the view that ARC should facilitate better access to inputs (seeds, fertilizers, herbicides/pesticides) and markets before projects ends. Zebetiela supported this view especially the need for ARC to provide assistance broadly, as government extension does, that structuring assistance through projects is not helpful as interaction ends at completion.

Zebetiela further proposed that LDA and ARC should help forge linkages with Progress Milling for the establishment of a local depot as Rakgatha is 1.5 hrs away. Driekop needed input on avenues to follow in order to export their seed product to achieve the commercialization goal.

Box 2: Personal communication, Selena Kekana, Zebetiela
'If ARC could engage with us for a longer period, it disturbs us when they disappear just when we are gaining confidence'

Professional views on the preconditions necessary to improve TT are outlined in table 4.3 and 4.4. Whilst five broad challenges emerged from the interviews with all ARC researchers, three key issues could be identified; inadequate capacity to do TT, limited funding and institutional factors. The other two factors (d) and (e) were mentioned by only one respondent respectively. Additionally, the key informants stressed the importance of institutionalization of TT in the organization with clear roles identification across all the institutes. The slow pace of change management was identified as an issue of note by the executive. The executive further observed that the TT Division is new and some resistance has been experienced at institute level, with staff preferring to conduct business in familiar territory serving resource rich farmers practicing conventional agriculture. Positive development noted were; the existence of a TT strategy for the organization, a commonly agreed upon definition of TT and increased awareness of intellectual property protection and advances in commercializing technologies generated.

The early exit of ARC was raised by four out of seven respondents under this cluster, lending it significance. Respondents proposed establishing a knowledge and information system to effectively manage and pursue TT initiatives once ARC leaves. The box alongside captures well the sentiments expressed.

Box 5: Personal communication, E Nemadodzi

TT is a system wide response covering publications, training and information provision. For it to work there needs to be longer involvement than what ARC can currently afford, we withdraw just as people begin to understand and take up our technologies

More details follow views appear in table 4.3 below.

Table 4.3: Factors constraining effective TT - researchers

Challenges and obstacles to enhancing TT within ARC	***Support required to enhance TT***	***Opportunities to exploit***	***Steps taken***
a)limited human capacity to do TT - *high staff turnover & unfilled posts* - *lack of guidance to do good TT* - *lack of pro TT incentives* - *lack of capacity & know-how (methodologies, processes & techniques)* - *reluctance by majority of researchers* - *disjuncture between policy and practice*	- *Training of project leaders equipping them to better guide TT*	- *Direct lines of communication with the TT Division @ Head Office* - *Structural changes conducive to institutionalizing true TT*	- *GCI nominated to attend TT Division's upcoming courses to enhance training and facilitation skills*
b)institutional factors - *weak linkages between ARC and extension and lack of support by EOs* - *poor TT policy mainstreaming* - *stringent financial procedures* - *limited buy-in into TT by institute's management* - *Participatory research (true TT) not institutionalized* - *TT much more visible at head office* - *R&D policy of 100% cost recovery is disconnected to reality, RPF can't pay for services*	- *Establish better linkages between farmers, ARC and EOs /services* - *Total buy-in by management (for needed support for TT)* - *Establish dedicated units or programme to promote participatory TT at institutes* - *Recognition of TT as an appropriate vehicle to improve people's livelihoods in the organization*	*-Collaboration forged through joint committees* *-TT strategy in place* *-Parliamentary portfolio committee focus ARC to RPFs* *- National network established & (chaired by ARC) to advance participatory research*	- *Committees established (nationally and provincially)* - *Some managers have joined the network for active work at institute level*
c) Limited funding to support TT *- conflicting focus with funding agencies* *- short funding cycle unable to facilitate adoption*	*Ring-fence funds towards TT, financial allocation*	*-New focus on training and gaining SETA money for training DAFF and DST availing funds for TT activities*	- *Researchers in regular contact with heads of DAFF to capitalize on funding opportunities for projects*
d) Insufficient user-friendly visual materials, not many agencies fund this	*Improved understanding of the nature of field work amongst management*	*-Workshops to showcase TT projects and success stories across the grains institutes*	- *Training being used as a mechanism to ensure TT is consistent*
e) incapacity to reach a wider coverage of rural areas leading to over-expended staff servicing too many projects	*Active development of appropriate mechanisms to transfer technologies to RPFs*	*-Opportunities not known*	

Table 4.4: ***Factors constraining effective TT – EOs***

Challenges & Obstacles to enhancing TT at ARC	***Support required to enhance TT***	***Opportunities to exploit***	***Steps taken***
a)Limited human capacity - *Insufficient ARC staff doing TT* - *less experts available prompting use of technicians and assistants* - *time spent with farmers is often insufficient* - *high staff turnover & loss of research capacity*	- *Making funds available to recruit more staff* - *Allocate more ARC specialists at provincial or district levels* - *Better conditions and salary structure could ensure quality researchers remain with ARC*	*Training on participatory approaches* *Co-supervision of extension staff doing post-graduate studies by ARC and LDA*	*Adoption and use of the participatory approach by the two projects*
b) Management of the TT process - *ARC located far from projects* - *Ill-affordability to adopt technologies, e.g. high costs of production required* - *Delayed activities due to farmers constraints*	- *Establish a satellite office where ARC has projects* - *Establish dedicated units or programme to promote participatory TT at institutes* - *Adapt farmer's equipment to be compatible with new practices*	*Trained EOs on technologies promoted*	
c) Institutional factors - *Weak relationships with farmers, LDA, NGOs and private sector* - *Conflict between ARC and LDA on rights to project information* - *Structural arrangements and policies that are counter to TT* - *Rigid planning within ARC whilst conditions in the field require flexibility*	- *Management buy-in into TT functioning* - *Strong collaboration between ARC and provincial departments of agriculture* - *Regular communication between LDA and ARC researchers; regular meetings help to solve problems that arise*	*Discussion to synchronize online advisory service of ARC and of Department of Agriculture*	*Further trials on other crops, e.g. groundnuts* *Sharing of developments on both ARC and Department e.g. Extension suite online*
d) Limited financial resources to facilitate TT - *Heavy reliance on external funding for TT activities* - *Conflicting interests and funder influence* - *Short funding cycle & project timeframes*	- *Department of Science & technology funds* - *Active development of appropriate mechanisms to transfer technologies to RPFs*	*Government programmes, to help farmers with mechanization and to purchase a maize treatment equipment*	*Developed proposal to government*

4.4.4 Technical challenges to effective technology transfer in maize production

The study also explored farmers' views on constraints impeding their production efforts through the project and proposed solutions to deal with these constraints. Figure 4.2 immediately below indicates the FGD responses whilst figure 4.3 displays the views of Zebetiela farmers obtained through the SSI. Frequency stands for the number of times response was given.

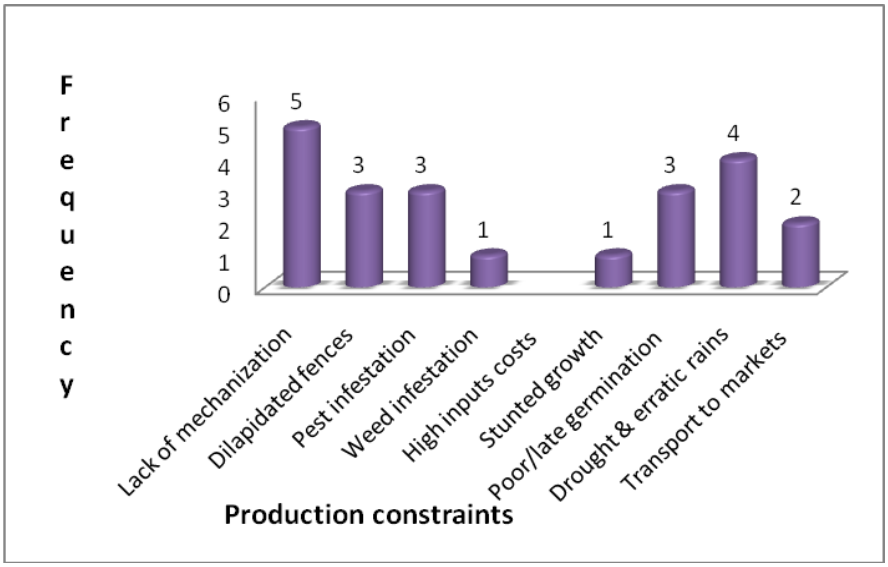

Figure 4.2: Technical production constraints - FGD

As can be seen from the figures 4.2 and figure 4.3, mechanization (lack of tractor) was of a significant concern as followed by drought and erratic rains in both cases; FGDs and SSIs at Zebetiela. Crop losses results from late planting as farmers wait their turn to access tractors; hired mechanization used is on a first-come basis. Further difficulties of the CBSP were found to concern the ripper planter, a technology brought by the ARC whereby the heavy weight resulted in tractor owners (where farmers hire from) refusing to use it.

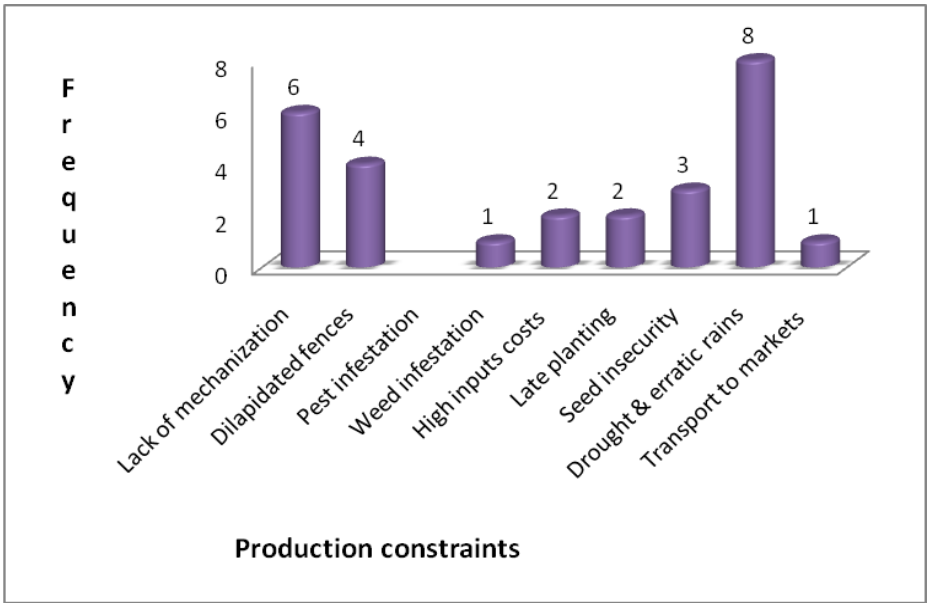

Figure 4.3: Technical and production related constraints – SSIs in Zebetiela

All ARC interviewees identified lack of and high costs of production inputs amongst farmers as constraining and therefore influencing implementation of TT activities. Two out of seven interviewees indicated that poor infrastructural development hinders access to markets and inadequate access to improved inputs such as high yielding seed varieties was a key constraint. The divergent nature of the messages farmers receive from ARC and government extension confused farmers was identified as a further constraint by respondent EOs.

4.4.5 Matching technology development with farmers' needs

It was established from all seven researcher respondents that ARC initiates interventions based on government information. All respondents listed diagnostic survey as an important needs assessment tool and included workshops using Participatory Rural Appraisal (PRA)[4] techniques prior the intervention and during the project to ensure relevance. The two key informants and one interviewee at management level explained that the normal process of engaging entails;

- diagnostic survey, including cropping systems analysis to address appropriate needs,
- development of an action plan in consultation with farmers, and
- establishment and conduct of on-farm trials at farmer's field
- establishment and conduct of demonstration plots at a central location.

It was learnt that the farmer's fields are used as a platform for technology transfer. Over and above the diagnostic surveys, the respondent EOs also identified themselves as playing a key role in the identification and matching exercise, as they are locally based.

4.4.6 Stakeholders involved in TT

The study explored farmers' views on the roles of the different stakeholders in supporting their seed multiplication activities in the order of importance. The table below provides more insight. Further deliberation is provided below the table.

Table 4.5: Stakeholder identification matrix

Organization	Services provided
LDA	Coordination and facilitation of production activities, gives technical advice during the crop season especially correct fertilizer application and crop maintenance, transporting of seed to/from Madzivhandila
ARC	Technical support, especially on drought tolerant maize, provides basic seed for seed multiplication, seed variety selection
Madzivhandila	Treatment and packaging of seed
CIMMYT	Training on seed multiplication process, through establishment of demonstration plots of new cultivars to help observe agronomic practices
SANSOR	Supply and certification of seed
Beyer	Training on seed treatment prior planting, technical advice on soil sampling and fertilizer procurement process
SASOL – NITRO	Helps provide fertilizers
Municipality (Lepelle-Nkumbi)	Agricultural business development funds

[4] Participatory Rural Appraisal is an intensive and quick appraisal method of data collection and utilizes a range of techniques. It is based on Action Research, and involves local people and outsiders from different sectors and disciplines.

According to the farmers, the services rendered by the stakeholders above were perceived to be very relevant for the challenges met. It was indicated that the ease of application of the technologies enabled adoption; particularly techniques observed during demonstration could be applied immediately. All the farmers interviewed stated that inputs are provided in the trial plots and this contributed to the success. Tafelkop felt LDA's service could be improved; this was due to the delay in getting assistance requested.

4.4.7 Vision of food secure farm enterprises

The visions articulated by the farmers helped to identify mechanisms to repeal the factors identified as limiting the impact of technologies promoted. The Bellingsgate group envisioned living sustainably from farming, sufficiently meeting all their food needs. It was understood through the interview that this group was barely meeting their household's food needs currently. Ga-Mmamba, Ga-Thaba and Tafelkop on the other hand, aspired to produce all-year with green fields full of crops and vegetables sold commercially. According to Tafelkop, access to relevant knowledge specifically on how to achieve the productivity gains envisaged from the different organizations including ARC could enable realization of this vision. Driekop dreamt of exporting seed and in order to reach that dream, a seed treatment plant of their own should be secured, as relying on Madzivhandila is proving to be fraught with difficulties, as earlier discussed. The study also learnt from Driekop the need to have their maize seed bar-coded, so as to penetrate mainstream retail outlets. The groups are currently not acknowledged as producers of the seed on the packaging, only LDA's details were noted, a situation the Driekop group felt needed to change. Appropriately fenced and well irrigated fields (using borehole water, in absence of rivers) were viewed as a potential draw card to other villagers, showing that farming can be prosperous.

4.5 FACTORS DETERMINING SELECTION OF COMMUNICATION STRATEGIES USED FOR TECHNOLOGY TRANSFER

4.5.1 COMMUNICATION STRATEGIES USED IN TECHNOLOGY TRANSFER

Understanding of the concept of communication strategies

The views expressed varied widely across the six researcher respondents. Aspects mentioned were; the familiarity with one's field of expertise and context, i.e. the farming systems and the level of farming intensity of the farmers determines the choice of strategy. It became apparent that researchers learn through trial and error. The inclination towards persuasive transfer with commercial farmers was thought to be appropriate. Resistance to engage in TT, especially with RPFs was indicated as a limitation. This resistance was attributed the misconceptions about what the TT concept means amongst researchers. One of the two key informant observed that in projects with optimal participation, the concept of communication strategies is highly understood, as training and design is done jointly throughout the project period.

The EOs interviewed were of the view that all ARC project personnel had a good grasp of rationale behind their interventions and the linked purpose, even though technicians and assistants are somewhat limited on the how. ARC's knowledge of the technologies promoted in the project was perceived by all respondents as satisfactory, and this was important to them as EOs. It was explained that this is due to communicating knowledge being the real essence of extension work. All respondents mentioned farmers' literacy level as a factor used to select a communication strategy. The key informant under this cluster identified practicality or demonstrability of the technology as a key factor, due to farmers preference to learn by seeing

and doing. The horizontal exchange strategy used in the two projects was perceived to serve the interest of researchers as well, since verification of on-station research is key to their work.

4.5.2 Strategies used to address needs identified and intervention goal

Below is a list of suggestions for the goal of TT according to the respondents from the two professional clusters. Many similarities could be observed in the responses given as table 4.8 below indicates.

Table 4.6 Professional perspectives on strategies and intervention goal

Strategies used to address needs identified	
Researchers' views	***Extension officer's views***
- Helping farmers to identify new markets, and to link them with commodity groups - Liaising and linking with other ARC institutes - Conducting on-farm trials to test new technologies alongside current practices - Use of FPR and PTD, farmers are the ones eager to see their situation improves - Farmer participatory evaluation for variety selection to help identify the most appropriate ones, to establish training platforms and to demonstrate appropriateness of improved technologies. - On-farm trials which are initially researcher-managed and later farmer-managed	- Drought resistant cultivars through demonstration trials. - Interactive and participatory training workshops - Collaborating with multiple stakeholders - Training of farmers on seed multiplication to enable producing own seed
Intervention goal for the ARC's communication programme	
- To increase production and farmer's production systems towards food security through the transfer of knowledge, information and technology. - To improve current farming practices with a clear consideration of the type of client being targeted - Improved production towards food security by first determining what is being done on agro-ecological conditions - To build the capacity of farmers enabling them to improve maize production - To promote sustainability in the practices established in the process of improving farmers' situation - To improve the livelihoods of farmers through enhancing food security and helping them achieve commercialization aims	- To enable farmers to increase current yields and as such improve their livelihoods - To bring about improved sustainable agriculture production - To ensure that developed technologies can have impact on the society - To improve the adoption of technologies thereby contributing towards people's livelihoods

4.5.2 Training and information dissemination

The views of the farmers are tabled first, followed by researchers' views and lastly, the EOs. The box below demonstrates the link in communication for interventions:

Box 1: Personal communication, Driekop

"Prior to ARC coming, we used to plant any seed available, LDA advised us on importance of growing improved seed and brought ARC," they helped us to obtain good quality seed"

According to five groups out of six, the local extension worker helps farmers to get information required from relevant stakeholders. The Tafelkop group was an exception, having approached the ARC themselves. It was learnt that these farmers had obtained ARC details through attending a Farmer's day in another village. The group were pleased that through the intervention, they gained access to improved seed. Table 4.7 below provides an overview of the farmer's perception of training and information dissemination.

It became apparent in the study that training and information that has been disseminated enhanced farmers' knowledge of good crop management. The packaging of these messages will need to improve to cater for sub-optimal English skills of farmers, for example developing visual materials in local language could facilitate learning better. Reliance on EOs to read the guidelines and pass the information through could be costly to the ARC, due to the room of error this presents. The researcher's experience casts doubt over this materializing. In the 14 years of training, self-reading has proved to be the least used by trainees, particularly adults. This point can also be supported by the non-mention of this information by farmers, only the ARC structured trainings during field and information days were mentioned by the farmers. However, this cannot be construed to imply that farmers do not receive information from EOs.

Additionally, heavy reliance on EOs for the monitoring of TT activities and information dissemination was identified as an issue. It was explained that this was due to sub-optimal support by some of the officials; seed production has not expanded as envisaged. It was further indicated that where possible information is packaged in a user-friendly manner, graphically and with big writing, lack of funds limits this. The Maize Information Guide (MIG) was identified as a very useful source for EOs, for use as a guide for advising farmers on production matters.

Table 4.7: Farmer's analysis of training and information dissemination

Clarity of message	Form/packaging	Form preferred	Reason
- Very clear - Understandable - Delivered in local language	Verbal: - Demonstrations - Exchange visits - Farmers Days - FFS (farmer Field Schools)	Bellingsgate Ga-Thaba Tafelkop Zebetiela	Observability of concepts presented (demo) Illiteracy Practicality of the training
- Clear during training - Difficult to refer to after - If visual, clear	Print media: - at training workshops - Farmers Days - Information days - Agricultural shows	Ga-Mmamba Driekop	Easy to forget what was said Can read and write Manuals are useful for later referral

Findings of the farmer interviews suggest training provided by ARC addresses good crop management and production from planting through to harvesting practices. Farmers clarified that

training has also equipped them with soil sampling techniques and insights on fertilizer application. According to one group, ARC sometimes sends representatives to workshops on various topics related to seed production. The findings further suggested that Field Schools were central in the learning that took place amongst the farmers. The farmers attributed this to the practical nature of the interaction during the FFS and the fact that presentations are given by people 'like them'. The same was indicated for exchange visits, where novel ideas from host areas were showcased. Farmers perceived the points below as the most positive aspects of the training were:

- *it is mostly verbal,*
- *lessons are easy to remembe*r
- *can now identify positive crop characteristics*
- *gained skills in row spacing*
- *learnt how to operate a ripper planter*
- *learnt pesticides handling techniques*

Box 2: Personal communication, Driekop
Training took us from darkness to light; it helped create interest towards farming amongst the community, after seeing how we were applying skills learnt and it helped us to produce disease free seed

The study further explored information provision in the two projects from the perspectives of researchers and extension workers. Findings reveal that information printed in pamphlets and guidelines is often in English with the expectation that EOs translate into farmers' language. Further details appear on the table 4.8 below.

Table 4.8: Professional's assessment of information dissemination

Types of information given to farmers	***Means to identify information needs***	***Sources of information***
- *Introduce new & improved maize varieties* - *new production and cultivation techniques* - *new pest control methods* - *row planting and correct spacing* - *chemical weed control* - *conservation agriculture* - *crop fertilization* - *all aspects of production from soil preparation to harvesting*	- *Participatory trials,* - *Farmers/information days, Short courses,* - *Presentations at conferences or provincial seminars,* - *Needs analysis,* - *Field observation,* - *Interaction with farmers and other stakeholders,* - *Discovery learning and Farmer Field Schools*	*EOs – but limited due to large area coverage* *ARC, only within projects* *Grain SA & other commodity groups* *Social network; neighbors/study groups, community based organizations and co-operatives, organized agriculture, private consultants.* *SASOL-Nitro (agronomy section), Universities to a limited extent* *ARC's MIG, most used by literate farmers & EOs* *Production manuals of the Department of Agriculture* *NGOs (Non Governmental Organizations), private companies*

The information given by researchers concurred with farmers' views. The following explanation was offered; information days consisted of presentations by experts, whilst field schools and feedback and planning sessions comprised of farmers sharing with others how they managed the trial, including challenges and mitigating measures taken. The study also revealed that training of extension officer is also offered, using Train-the-Trainer approach equipping them with skills to pass knowledge onto farmers. Table 4.9 below provides a synopsis of factors influencing comprehension of the training content and challenges researchers face when delivering training. There is no correlation in the information given across or downwards.

Table 4.9: Synopsis of training issues

Factors affecting training		***Challenges***	***Successes with training***
Hindering	***Facilitating***		
Presenting on the wrong level, giving complex content	*Good translator in a situation where the trainer does not speak the language*	*Presenting scientific information at farmers' level, in the local language*	*Good established participatory trials*
Lack of good visual presentation material or information guides	*Soft skills (social, e.g. facilitation* *Use of practical and participatory approach, demonstrate concepts*	*Great distance between farmers needing assistance and the organization* *Funding for presentation material*	*Farmers implementing new methods*
Dominance from VIPs who get invited to Farmers days who divert focus of the training	*Experience in training*	*Insufficient number of researchers with skills to do TT*	*Production increases where technologies were transferred* *Increased area of production e.g. in LIMPAST project*
Inappropriate time slot, e.g. farmers can't follow during afternoon session	*Involving farmers from beginning secures understanding & buy-in*	*lack of appropriate skills required communicating with resource poor farmers*	*Call backs from farmers who attended information and farmers day*

4.5.3 RESEARCHER COMPETENCY IN COMMUNICATION STRATEGIES FOR TT

Knowledge and skills at entry level

As regards, capacity (knowledge, attitudes and skills) to do technology transfer prior to joining ARC (venturing into TT work), the findings listed disciplinary knowledge as an important basis to start from. Data from all the respondents suggests that most researchers learn through trial and error after university training. It was further observed that prior field experience and/or rural background contributes to one's ability to do TT. Presentation and good communication skills were mentioned as important. A good command of the languages spoken in the target areas was considered an added bonus. This was highlighted as information is prepared in English and this is inappropriate for illiterate farmers, rendering the information inaccessible. Researchers try to interpret this information but some of the terms used are too technical and prone to misinterpretation. EOs shared the views of the researchers. A number of respondents (3out of 5) proposed prior field experience and disciplinary knowledge, e.g. on maize production as important to do TT. It was revealed in the study that people venturing into TT work with social/soft skills manage very well; due to emphasis these skills have on appropriateness of solutions provided as farmers' problems are broader than technologies. It was also learnt that the ability to discern technical (research) information and making it digestible to farmers was a positive attribute.

Knowledge and skills for optimal job performance

For what researchers need whilst on the job to be competent in TT, EOs mentioned; updated knowledge of subject matter and a wider knowledge including vision of agriculture (nationally) was proposed. It was explained that such knowledge helps one manage challenges better. This was said to entail being goal oriented, being visionary and displayyempathy towards the situation of farmers to give appropriate support. Exposure to participatory methods and techniques, through attending training in FPR and PTD was listed by one key informant in the researchers cluster as a pre-requisite. He argued that this should expose researcher to basic principles of constructivist paradigm, where learning is an active, contextualized process of constructing knowledge rather than acquiring it. Broadly; participatory research skills (effective communication skills including active listening, problems solving techniques, facilitation, critical thinking, community mobilization and adult learning principles were regarded by four out of five respondents as essential to do TT. The TT Division's course on 'Development Oriented Research' (commonly known as Agricultural Research for Development - ARD training[5]) was seen as having contributed towards the development of skills mentioned under this theme

4.5.4 INFLUENCE OF COMMUNICATION STRATEGIES

Factors influencing choice of communication strategies

As can be seen in the information to follow, many factors were listed as having bearing on the choice of communication strategies. These factors mentioned by the EOs and researchers were demarcated along two areas of influence; farmer characteristics and researcher's capacity to discern appropriate strategy to use. The study identified the following farmers' characteristics; literacy level, size of farm enterprise (large scale or small scale), farmer's age and the type of cropping system concerned to strongly influence choice of strategy to use. From the perspective of researchers; technical considerations, knowledge of the subject, resources availability, language skills and manner of communication all played a role. The respondents further indicated level of extension support/lack thereof, observability (visibility) of the technology being promoted and impact envisaged/purpose of the intervention. One key informant held the view that the participatory approach should be the communication strategy used, as it is the most accepted by farmers. This strategy can be likened to the supporting horizontal knowledge exchange and the generating (policy and/or technological) innovations strategy.

[5] In addition to specialist disciplinary skills, the ARD practitioner also needs **crosscutting or "meta-disciplinary" skills** that enable such specialist knowledge to be applied. Similarly, everyone who works with other people needs **social or "soft" skills** that are linked to a certain professional ethos:

- Process facilitation – encouraging communication between different stakeholders or social groups, team management, promoting decision making, conflict management, etc;
- Systems analysis - capacity to visualise complex entities as systems at various organisational levels, analyse interactions between the components of these systems and their environments, etc;
- Planning – the ability to define objectives, analyse future scenarios, develop multi-stakeholder action plans and individual business plans, monitoring and evaluation frameworks, etc;
- Motivation – the desire to improve one's own performance, to continue learning, re-evaluate beliefs, cross inter-personal barriers, etc;
- Emotional intelligence - empathy, sensitivity, self-awareness and self-regulation, etc;
- Being a "team player" – the willingness to value the contribution of others, and work with them to produce an overall result that could not have been achieved through individual efforts.

CHAPTER FIVE ANALYSIS AND DISCUSSION

Introduction

This chapter draws an analysis from the findings presented on the previous chapter. Specifically, it will give meaning to the empirical findings of the field research with some consideration of theoretical insights explored through the literature review in chapter two. The study's objectives were; to evaluate ARC's TT in order to determine level of effectiveness and to identify communication strategies used. The analysis will therefore highlight similarities, differences and patterns and items of particular significance along the two objectives. The problem the study attempted to resolve was lack of insights on the ability of TT to improve the situation of RPFs.

5.1 KEY DETERMINANTS OF EFFECTIVE TECHNOLOGY TRANSFER

5.1.1 Perspectives on effective Technology Transfer

The data indicated that farmers were generally enthusiastic with the technical interventions provided by the ARC. Du Toit & Nemadodzi (2008) also found this enthusiasm over the project. Farmers were of the opinion that the projects achieved expected aim; that it helped enhance food security through improved, drought-tolerant, disease resistant and high yielding OPVs and other related technologies. In line with the positive sentiments, farmers could not identify things requiring improvement. However, the challenges faced prior the intervention were still encountered and will be discussed in greater detail in 5.1.3. Furthermore, in close inspection the technologies were found to have only marginally contributed towards food security, farmers only had food during the crop season and soon after harvest. It was also established that whilst they percieved their situation better than non-farming neighbours, their efforts could harldy be equated with the commercial or even emergent farmers. This point confirms Leeuwis' assertion that technology (alone) may not be sufficient to deal with complex problems of small holder farmers (Leeuwis, 2004). Many examples provided by Röling (2009) casts doubt over technology as sufficient to solving the food insecurity challenge in particular. In the cases discussed in Röling's paper, technology needed to have been integrated with social/organizational development. Leeuwis (2004), concurs purporting that complete change results where there exist an appropriate mix and balance between technology and novel social organizational arrangements. Whilst this point was not emphasized as the project aim, the social benefits of the field schools (and resultant learning through these) received high rating by all the respondent clusters; farmers, researchers and EOs. The exchange visits, another social learning promoting method was appreciated by farmers. This is a clear pro argument for re-thinking the technology focus towards the notion of agricultural innovations, a well balanced integration of technical and institutional development (Röling, 2009).

Contrary to farmer's enthusiasm, researchers and EOs identified a number of things as needing improvement for the intervention (and by extension TT) to be regarded effective. This contradiction stems from the welcoming nature of resource poor communities to development interventions. The aspects requiring improvement identified by the professionals cluster were; limited human capacity to do TT, institutional factors and limited pro TT funding depicted in tables 4.3 and 4.4 respectively. These will be discussed in more detail under the analysis performance against characteristics of effectiveness in 5.3. The definition of effective technology transfer proffered by professional respondents identified four main streams. These were; active involvement of farmers in the process, appropriateness of the technologies promoted to farmer's situations, concrete and sustainable change in farmer's enterprise and adoption of technologies with farmers utilizing new knowledge beyond project scope.

5.1.2 Preconditions to improvement of Technology Transfer

An important finding of the study was the identification of institutional factors as constraining the effectiveness of technology transfer. The structure, culture and the general make-up of the organization was found by all seven ARC respondents and four LDA respondents to have negatively influenced TT. The stringent procedures and processes, was noted in this regard. The respondents identified this as a likely obstacle towards enhancing TT. A related finding expands on this point, whereby participatory aims informed the project but implementation tended to characterize a skewed power balance with researchers identifying the needs, designing the response and engaging the farmers at later stages. Mbabu, (2008), (citing, Pretty *et al* 1995; Chambers 2005; Leeuwis 2004) identifies such a gap between the rhetoric and practice attributable to application within rigid and standardized hierarchies and organizational cultures that constrict decision making, limits the possible options of development and ultimately diminish the effectiveness of the efforts.

Another institutional factors identified in the study was a disconnect between advances in institutionalizing TT and prohibitive attitudes, behaviors and practices. Existence of a TT Strategic Framework was identified by all ARC interviewees as positive development. However, the study revealed that the TT strategy has not been mainstreamed across the whole organization, and that due attention should be accorded. The findings pointed to efforts towards strategy mainstreaming being limited to management level with expectation that information will filter downwards. Additionally, the visibility of the strategy as accorded through it being available on the organization's intranet was seen to be important in furthering its aims. As a case in point, it was observed that the five researchers interviewed were not familiar with the contents of this strategy and measures to encourage use of this avenue are therefore necessary. Similarly, the presence of a dedicated division tasked with TT was seen to be a crucial milestone in the organization. However, researchers were found to have utilized this office conditionally; only when opportunities and services were communicated and through past interactions with Divisional staff. Two incidents were cited here: responding to training courses to strengthen researcher's soft skills and funding opportunities being facilitated by the division; and seeking analytical services of the Agricultural Economic Services & Biometry Unit.

The weak linkages between the key project stakeholders, namely ARC and LDA gravely influenced likely impact of the project. Again, this pinpoints the failure of the dissemination (linear/ToT/supply-push) model as described in chapter two to forge strong linkages among role players in R&D. The scenario described in figure 2.1 in chapter 2 identifies the EOs as mere recipients of messages from experts, a pill not easily swallowed by EOs already burdened with government statutes to follow. Additionally, the relationship dynamics manifest in the conflict over right of information/data generated and confusion on the boundary of responsibility. Contrary to the expectation, the refusal to support ARC was observed even in the most participatory of engagements. The issues surrounding this apparent lack of support needs to be addressed jointly by ARC and government, in this case LDA.

5.1.3 In pursuit of effective technology transfer in maize production

The study overwhelmingly found ill-affordability of production inputs (seed, fertilizers, chemicals and lack of mechanization) and dilapidated infrastructure (fences and irrigation canals) to have limited the impact of technologies promoted through TT. All the respondents of the SSIs, the FGD and key informants were in agreement on this view. Based on the results of the study, development oriented efforts such as ARC's TT with RPFs cannot expect change without addressing such challenges. A total systems support should be developed to ensure real

change results not just technology oriented change. Institutional and social factors such as low literacy levels and illiteracy, lag-time of processing grain to seed by the college and high cost of seed treatment were found to have impacted on potential success as well. It is risky, to say the least to accord the responsibility of marketing to outside agencies, business development skills should accompany such interventions to ensure farmers do the marketing themselves. The college provides much needed service, however significant complications have resulted from engaging this stakeholder. Firstly, it is located between two and three hundred kilometers away from the target areas, making delivery and collection of seed a major undertaking. Secondly, as the only certified agent for seed treatment in the province, it understandably receives high volumes with the six target areas not being the only source of supply. The suggestion made by Driekop, for treatment equipment and accreditation in order to effectively utilize the structure established in their project is a more sustainable option. The feasibility of this option warrants further investigation, particularly for potential to be utilized by all seed producers in the CBSP project.

5.2 FACTORS DETERMINING SELECTION OF COMMUNICATION STRATEGIES

5.2.1 Communication strategies used in Technology Transfer

The findings indicated wide ranging views on the concept of communication strategies amongst the researchers. The responses suggest a *liaisez faire* scenario, whereby researchers learn through trial and error with emphasis on methods with no consideration of the intervention purpose and expected outcome, especially the social outcomes. The findings of the study point to a link between communication strategies and engagement in TT with RPFs. It was established that researchers who have not considered the broad goal (purpose) of heeding persuasive policy of contributing towards societal development resists working with RPFs. The FAO report (1996) noted this issue as well, stating that resistance to policy and institutional reforms was evident, even where reality calls for change. The findings of this study are grave in that regard, if the estimates proffered of only 1/3 of researchers doing TT with RPFs truly represent the status in the organization, the organization is far from realizing its mandate. Chambers & Jiggins (1987) suggests familiarity with resource rich farming context, as the cause of reseracher's reluctance to work with RPFs.

The study found the inclination towards the participatory way of working significantly affected understanding of communication strategies and what they entail. The active involvement of researchers in the collective innovation process from the beginning resulted in a better understanding of the project rationale; the methods likely to induce change (including codes, games, and symbols), and broader communication approaches to inform implementation. This is in line with Mefalopulos & Kamlongera (2004) in their assertion that good understanding of communication strategies is a pre-determinant of success in development projects. Jointly developed strategies help eliminate dominance by one group at the expense of others, through reached common understanding. These authors argue that communication strategy development should take a broader view, with wider focus than designing appropriate and effective messages. Leeuwis (2004) advices that, *the grounds on which communication strategies are built must be deemed socially acceptable, desirable and/or legitimate.* This statement makes a clear case for the adoption of strategies rooted on participation.

The data exhibits a mix of communication strategies in the two projects, with visible elements of five out of six strategies mentioned in table 2.1. Strategies A, B and F had more prominence, with strategy F being the most prevalent in the organization. The horizontal exchange (strategy

B) was revealed in the findings to be instrumental in the two projects with focus on collective change hence the use of the field schools method. The exception was strategy four; conflict management, whereby the project staff were not found to have played an active role. From this finding, it can be deduced that the aspect of forming human relations (the component of 'connecting') was not pursued. This seems to suggest a limited level of involvement by the organization in the 'community' system. Interactive engagements such as those identified by Röling (2009) in the collective innovation systems pathway, describe a situation whereby 'outsiders' become part of the community. In this pathway, conflicts are viewed as important learning platform, through which stakeholders engage in a process of harnessing their positive energy and negotiating towards more productive outcomes (Leeuwis, 2004).

5.2.2 Competency in selection and management of TT communication strategies

The study revealed adequate agronomic knowledge amongst the researchers tasked to educate farmers about the technologies promoted in the projects. It also became obvious that this knowledge needs to be augmented with soft skills, deemed essential in doing TT. Another essential component of competency is attitudes. A competency is more than just knowledge and skills. Soft skills entails development of attitude traits favourable in working with complex farming systems and this is a clear recognition of the value-informed communication strategies (and generally interventions) is proposed. Individuals that have developed soft skills in the organization did so out of pressure either from donor influence or compliance with management instructions. It was clarified that the soft skills mentioned were acquired through attending a three-month course offered by a Division that preceded TT. These individuals were marginal across the organization and were trained in 2004/5/7. At GCI only three researchers received this ARD training.

The OECD report (n.d) identifies three integrated key competencies as necessary for capability to optimally support technology transfer. The first competency cluster is capable use of a wide range of tools for interacting effectively with the physical and socio-cultural environment. Information technology is offered as an example of the physical tools, whilst the use of language, serves as a socio-cultural; and effective utilization of these skills for adaptation for their own purposes. The second cluster of competency responds to the increasing interdependency amongst institutions, ability to effectively engage with others, is an admirable competency, eqiuping one to interact in heterogeneous groups. The last category of competency enables individuals to take responsibility for managing their own lives, their work, situate these in the broader social context and act autonomously. The graphic below (figure 4.4) refers.

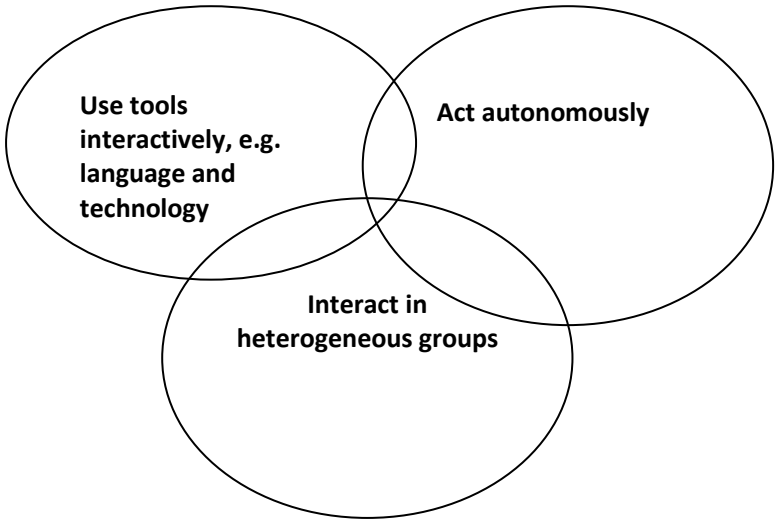

Figure 4.4: Key competencies for technology transfer agents; adapted from OECD, report (n.d)

5.2.3 Influence of communication strategies on Technology Transfer

As a public entity, ARC responds to national challenges. This was found to have been applicable in this case as stated in the projects background, whereby the aim was to respond to government policy of addressing food security. The intervention therefore was informed by the persuasive transfer strategy, although the project proponents utilized participatory means. Leeuwis (2004) identifies intervention purpose as having greater influence over the choice of communication strategies and this was confirmed in this case. The table 2.1 provided in chapter two illustrate this point well, the what and how is often preceded by rationale. Whilst some effort was made to seek farmer's opinions of the issues (through diagnostic surveys for needs assessment), the research agenda had been developed elsewhere and farmers were merely recipients. Farmer's characteristics and researcher's capacity to make appropriate selection were identified by both researchers and EOs as somewhat influencing choice of strategy.

5.3 DIMENSIONS OF TECHNOLOGY TRANSFER EFFECTIVENESS

The analysis will therefore consider the extent to which the measure of TT effectiveness was explored through the study using the dimensions identified in chapter two; characteristics of the transfer agent, characteristics of the transfer media, characteristics of the transfer object, characteristics of the transfer recipient and the demand environment.

5.3.1 Characteristics of the transfer agent

The study found that the ARC is considered moderately effective in the conduct of its technology transfer mandate as discussed in 5.1. However, views presented in the study identified; institutional constraints, human capital and intervention logic (goal) as important determinants of success in TT. Two of these factors are deliberated on below; the intervention logic was discussed under the analysis of communication strategies.

Institutional factors

The central location of the TT office was perceived by researchers to constrain the potential TT could have in the organization, as it removes feeling of responsibility for TT at institutes. The findings show that leaving the discretion to facilitate the institutional development, e.g. through establishing parallel offices (or function) at institute level with managers undermines efforts made centrally. Much of what is being achieved is through informal linkages forged with institutes. The Division conducts roadshows to communicate developments in the three key elements (processes, enablers and decision support) and to synchronize these with institutes' programmes. From the results, it can be said that 'old' understanding and individually held perceptions of what TT is informs staff practice.

Human capital

The issue of staff shortage was raised by all the respondents and the effect this had on each cluster of the respondents. It became evident during the interviews that increased work loads of staff, exert pressure to engage in more field work. EOs were of the view that added field trials monitoring becomes their responsibility if less ARC staff are on the ground, whilst farmers suffer from delayed trials activities if a researcher leaves. The researchers interviewed expressed concern with lengthy absence from home, lasting up to five weeks at a time. Resource limitation, in the form of parliamentary financial allocation to promptly replace in the event of staff turnover plays a role here. One key informant observed the number of vacant posts at every institute. The inability of the ARC to retain high quality research capacity was also highlighted by a key informant from the LDA. It was learnt through informal discussions with one programme manager that GCI lost four senior researchers to universities and private entities this year.

5.3.2 Characteristics of the transfer media

Two main aspects are noted under this section; information dissemination and training and the extent to which this facilitated learning amongst the target group. It was established that learning techniques used were of an informal nature and this facilitated assimilation of knowledge transferred and skills development amongst farmers. Amongst these techniques; demonstration, experimentation and exchange visits ranked highly, based on the number of times mentioned. There was agreement across all the respondents that these techniques enabled farmers to retain information imparted and this contributed to enhanced ability to manage field trials from preparation to crop maturity. This knowledge and skills were in turn transferred further to others during the field days and participatory evaluation at the end of the season. Through experimentation, farmers made observations on crop progress (noting positive and negative development), which served as a stimuli for reflection and drawing conclusions on required future action (Leeuwis, 2004). Dick (2004) calls this action learning, a process of using reflection to inform practice. This author suggests that action learning may be the strategy to adopt in order to improve transfer of technology and information (Dick, 2004). He contrasts this with skills learned in workshops which do not transfer easily beyond the 'classroom' due to many responsibilities adults have. Farmers in the study mentioned age as a deterrent factor in memory retention (and thus learning), that by discussing problems and experiences in a group, they are more likely to remember. This is an important determinant of the extent to which TT was conducted effectively, acting as a system of communication to enhance farmer's knowledge. The ideal was however not realized in these projects, a situation whereby knowledge generation was equally shared was not evident, 'knowledge transfer' was mostly one way with the 'experts' imparting learning. The ideal can be summed up in this way, communication in participatory research happens without distinct groups of senders and receivers, activities take place within a *knowledge system* consisting of many actors who play different roles at different times, as discussed in chapter two.

5.3.3 Characteristics of the transfer object

There are two products of research; knowledge and technology and the extent to which these are relevant to farmers' and other users' need is only half the task. The other half is delivering the goods in suitable form. The effectiveness of the TT process relies heavily on the type of technological innovations promoted and the manner of promotion. The type of technologies the organization sought to transfer in these projects varied. It was embodied in; tools, improved maize varieties, and improved farming practices (row planting and spacing, reduced tillage systems and chemical weed control). The evaluation of improved maize varieties technology was found to have been mostly verbally communicated and all farmer respondents valued this fact. Two groups of farmers out of six thought the combination of verbal and written media helps utilize a range of skills in a complementary manner. The content, in terms of knowledge of the discipline (agronomy) and good command of the relevant crop was identified by all respondents as being of commendable level. Skills to transfer this knowledge were another matter; the need for researchers to be trained in social skills was identified by all the professionals interviewed (as earlier discussed). This finding highlights the fact that TT is not only about bringing technological solutions; the ability to transfer knowledge is a key ingredient. Skills that fall under the soft skills field are outlined in footnote number 5. These skills necessitate a shift from being experts to facilitators of learning, enabling people to discover and learn things themselves (Leeuwis, 2004).

The participatory approach facilitated the design modification of technologies resulting from the dialogue between farmers, EOs and researchers on what is needed for better performance of the trials and what can be achieved. Manzuri (2004) also observed that the use of participatory approaches in the Asian Development Bank improved information flow. Capacity enhancement in problem solving abilities and managing trialss could be clearly established amongst the project participants, as the findings show. However, the study identified some aspects requiring improvement as regards application of the approach for it to be optimal. The decision to adopt participatory modes of intervention is a job only half done; the true measure is the application of underpinned principles. As one key informant aptly put it, involving stakeholders in a collective innovation process is much more complex than mere engagement. According to Leeuwis (2004), the process described here travels along an interactive trajectory, highlighting learning, network building and conflict management and the organization has fair amount of development in this regard. The ladder of participation sheds some light on progressing to a more genuine level of participation, the higher up the ladder the better. Leeuwis (2004) provides the ideal through the definition of participation found in the World Bank website;

> '*Participation is a process through which stakeholders' influence and share control over the development initiatives and the decisions and resources which affect them.*'

5.3.4 Characteristics of the transfer recipient

The low resource endowment of the project participants, gravely affected TT and its contribution towards food security, an issue that became more apparent with the LIMPAST groups where ARC is no longer functional. Farmers' exposure to the new technology and their positive assertion of it failed to induce adoption. From the three groups; the study established that lower yields were now being experienced due to reverting back to locally available seed and difficulty in securing improved seed. This raises the issue of sustainability, earlier mentioned as one of the goal of the ARC in doing TT. According to UNEP (United Nations Environment Programme, 2003), the end result for technology transfer interventions should be the development in ability of the recipient to use, replicate, improve and, possibly, re-sell the technology. Out of the six groups, this statement can almost be used to describe Driekop, the rest having only reached the level of use.

5.3.5 The demand environment

The establishment of need for the technology and as such the intervention was mainly done through government at macro and micro level and through diagnostic surveys. Both these methods of analyzing the demand are not client-informed; they were rather externally driven although of noble purpose. Positively, the diagnostic surveys are interactive, seeking to establish dialogue between the three main stakeholders, thus enabling ownership of the process.

Taken altogether the five characteristics display a skewed measure of success. The prism figure (4.1) depicts some characteristics as being effective whilst others as grossly. A pentagon of five balanced prism is an ideal one to strive for.

CHAPTER SIX CONCLUSIONS AND RECOMMENDATIONS

Introduction

The study concerned determining the conduct of TT by the ARC as a key mechanism towards food security of resource poor maize farmers. Against this background, the extent to which ARC attains this specific goal and influence of communication strategies to the attainment of this goal were explored in the study. Two research questions emerged from the researcher's perspective; 'What are key determinants of effective TT' and 'What factors determine selection of communication strategies used for TT'. This chapter therefore identifies issues noted in the study around this.

6.1 Conclusion

The rationale for improvement in the system to ensure the ARC technologies have wider reach in the SA society is well established. The organization has made significant strides towards addressing the society's needs through technology transfer. The changes effected in the organization in the past three years have been positive. The development of strategies and policies meant to drive TT was a first and necessary step, so was the establishment of TT office centrally but attainment of the goal is yet to be realized. The implementers of TT (researchers) neither have the good command of the strategy aimed to guide their practice nor utilize TT office for support in dealing with challenges experienced in the practice. Currently, mainstreaming of the company's TT strategy and the concept is yet to move beyond management level. Similarly, a process to streamline functions and activities conducted in the name of technology transfer for better coordination is required. A pattern of segmentation is prevalent in the organization whereby institutes operate as separate entities from the central office. The organizational restructuring, referred to as the Organizational Design (OD) that birthed the TT office meant to address such issues.

High staff turnover and unfilled posts limits impact that ARC could have in helping the country combat food security through TT. The available staff were found to be competent (especially in technical knowledge), bringing much needed solutions to production problems encountered by farmers. However, these technical skills would need to be augmented with social skills, which are in essence the skills necessary to do TT competently. Efforts also need to be made to cultivate inteerst to do TT amongst researchers to facilitate better impact thus raising the organization's profile.

A mix of communication strategies was apparent in the organization, although persuasive transfer and advisory communication were more dominant. The projects under study, leaned towards the horizontal knowledge exchange through the use of a Farmer Participatory Research (FPR). Training and information dissemination, were the main methods of transferring technology and knowledge for TT. It is commendable that the project's emphasis is on involving farmers through on-farm participatory trials, as this is novel in the organization however, much requires improvement. Whilst the approach was found to have created an environment conducive to learning and improved farmers' engagement in technology application and testing, farmers were not part of identification of the issues initially and as such joint setting of research agenda was found to have been absent. Similarly the nature of knowledge exchange was found to have been more of information giving about the trials. Adoption of the collective innovation systems approach could ensure genuine partnership amongst all stakeholders including farmers.

The ARC's intervention in the projects studied duly delivered towards project goals. The improved maize varieties (particularly OPVs) technology was appropriate and addressed the main challenge of drought. However, the efforts initiated could not be sustained beyond the project scope in the LIMPAST. Well intentioned initiatives often undermine achievements due to failure to draw up sustainability plans and proper exit strategies. Real improvements in food security could not be established due to production constraints in the farming systems, such as ill-affordability of inputs costs and lack of mechanization. The ultimate goal of productivity gains, ensuring more sustainable and viable farming, was identified only as a dream. The adoption of technologies promoted by farmers could be a clear measure of utilization of new knowledge gained through TT in their own accord, and this was not evident.

A disconnect between research and extension systems was revealed in the study. This situation should be addressed as failure to do this could negatively affect the whole agricultural R&D system, as one cannot exist without the other. Better coordination and project management especially between ARC and LDA, for streamlining interventions could help resolve the situation.

Public entities are at the mercy of government for their main functions and experience serious funding constraints. This is even more of an issue for technology transfer, where alternative private donors do not often share social upliftment goals, opting to promote high yielding hybrids. Proactive efforts to search for and appropriation of funding opportunities that are pro TT could help offset the constraints mentioned in this study.

6.2 Recommendations

Mainstreaming of TT strategic framework and streamlining of TT functions

Technology Transfer should be institutionalized in the organization to ensure common understanding amongst staff. This institutionalization should consist of securing buy-in by management and researchers alike through road shows and workshops, for improved focus and intensity. It is anticipated that this could enhance the profile of TT for much needed know-how the country requires to curb food insecurity and other related social challenges. This campaign will need to be driven by the TT Division but endorsement from the Executive Management Committee (EMC) to receive due recognition. Similarly, a process to streamline functions and activities conducted in the name of TT is required for better coordination across the organization and this activity could be facilitated and managed by the TT Division.

Strengthening capacity of researchers for facilitation of effective TT

The organization stands to benefit from effecting a programme to augment technical skills of researchers with soft skills for enhanced TT capacity. These types of skills could enable attainment of competencies facilitate multi-stakeholder processes for innovation development, holistically view farming systems, empathize with farmers and communicate effectively. The Training Unit of the Division in collaboration with the Human Capital and Support Services could facilitate this training with financial resources from either the Agriculture Sector Education & Training Authority (AgriSETA) and/or Department of Science and Technology (DST).

Better linkages between extension and research

The success in any agricultural intervention can only be realized through facilitative linkages between key institutions, particularly research and extension as was the case in this study. There needs to be more emphasis on building collaborative relationships amongst these two institutions for TT to succeed. The envisaged collaboration is necessary for the purpose of working synergistically to support decision making and problem solving by the farmer clients

being served. The positive initiatives of strengthening relations at micro level such as joint committees for project management should be used to inform building of these complementary relations at macro level facilitated by TT's Training Unit in partnership with the Extension Directorate of LDA.

Funding towards technology transfer interventions

Active efforts to scout funding opportunities beyond the country may help secure much needed resources for TT. Each institute would need to utilize the services of the Public Relations Officers (PROs) to identify potential sources of financial resources.

Organization wide conscioutization on communication strategies

The organization will need to facilitate development of understanding about communication strategies as an important aspect of TT. The Training Unit will need to develop guidelines for researchers to inform future practice. These guidelines could be a valuable resource, outlining the various types, the context of use, methods involved, advantages and disadvantages of each.

A holistic response to challenges of resource poor farmers

To ensure that the organization's efforts impact concerned communities significantly, a stakeholder platform should be established around the challenges faced. This could help increase chances of success. A system wide intervention with clear mechanism to allow for transfer, removal of production constraints as a stumbling block can be achieved through such a collective innovation system. The ARC's TT Division and LDA,s Extension Directorate will need to facilitate this activity.

REFERENCES

Ahmed A., (2004), ***Challenges of Agricultural Technology Transfer and Productivity Increase in the Sudan***, International Journal of Technology, Policy and Management, Vol 4, No 2

AIAS (1989), ***Agricultural Technology Transfer: The Relevance of the Australian Experience***, Proceedings of the Australian Institute of Agricultural Science National Conference, Darwin, May 1989

Arnon I., (1989), ***Agricultural Research and Technology Transfer***, Elsevier Science Publishers Ltd, England, UK

Boon E.K, (n.d), ***Food Security in Africa: Challenges and Prospects In Regional Sustainable Development Review: Africa***, published in the *Encyclopedia of Life Support Systems* (EOLSS), http://www.eolss.net/ebooks/Sample%20Chapters/C16/E1-48-02.pdf, accessed 27/08/10

Bozeman B., (2000). Technology Transfer and Public Policy: A Review of Research and Theory. *Research Policy*, 29: 627-655.

Chambers R., & Jiggins J., (1987), ***Agricultural Research for Resource Poor Farmers: Part 1; Transfer of Technology & Farming Systems Research***, Journal of Agricultural Administration & Extension 27 (1987) 35-52

Dick B., (2004), ***Action research literature: Themes and trends,*** Sage Publications, available at http://arj.sagepub.com/content/2/4/425, date accessed 27/08/10

Dick B., (2002), ***Action research: action and research***, available at URL, http://www.scu.edu.au/schools/gcm/ar/arp/aandr.html, accessed 27/08/10

Du Toit A.P.N. & Nemadodzi E.A., (2008), ***Evaluation of the Appropriateness of Certain Grain Production Technologies for Small-scale Farmers***, South African Journal of Agricultural Extension, Vol 37, 2008:132-142

Eponou T. (1993), ***Partners in agricultural technology: Linking research and technology transfer to serve farmers,*** International Service for National Agricultural Research (ISNAR) Research Report No. 1, The Hague: Netherlands

FANRPAN (2006), Food Security Information Bulletin no1, ***Fighting Hunger: Linking Information to Action***, Food Insecurity and Vulnerability Information Management System (FIVIMS). Food and Natural Resources (FANRPAN)

Franken K., (2005), ***Communication for Innovation in the German Dressage Sector***, Report of Thesis Equine Management, Larenstein Hogeschool, University of Professional Education

Gilbert & Corderhayes (1996) in Olmos-peñuela J., Castro-Martínez E., & Manjarrés-Henríquez L.A (2010), ***Knowledge Transfer in Humanities and Social Sciences Research Groups***: ***The Influence of Organizational Factors,*** Paper presented at the DRUID-DIME Academy Winter 2010 PhD Conference, Comwell Rebild Bakker, Aalborg, Denmark, January 21 - 23, 2010 http://www2.druid.dk/conferences/viewpaper.php?id=500679&cf=44

Hagman J., (1999), ***Learning Together for Change: facilitating innovation in natural resources management through learning process approaches in rural livelihoods in Zimbabwe,*** Margraf Verlag, Germany

Hall A., (2007), ***The origins and implications of using innovation systems perspectives in the design and implementation of agricultural research projects: Some personal observations*** United Nations University – UNU MERIT, Working Paper Series No 2007 - 013 http://www.merit.unu.edu/publications/wppdf/2007/wp2007 -013.pdf

Hambly-Odame H. & Kassam A. (2002), ***Tuned into Farmers: agricultural research and rural radio*** linkages, Briefing Paper No 48 The Hague, International Service for National Research (ISNAR)

Hazell P., & Haddad L., (2001) ***Agricultural Research and Poverty Reduction,*** Food, Agriculture, and the Environment Discussion Paper 34, International Food Policy Research Institute (IFPRI) on International Agricultural Research Technical Advisory Group (TAC), Consultative Group

http://www.fanrpan.org/documents/d00498/FIVIMS_Info_Brief1_Food_insecurity_Sekhukhune.pdf [accessed 5 July 2010]

Human Sciences Research Council, (2004a), ***Food Security in South Africa: Key Policy Issues for the Medium Term***, Integrated Rural and Regional Development, (as cited in Machethe, 2004)

Human Sciences Research Council, ***Poverty in South Africa***: Fact Sheet No1, 26 July 2004

Inter-Academy Council Report, (2004), ***Realizing the promise and potential of African agriculture***, available at http://www.interacademycouncil.net/Object.File/Master/8/394/Africa%20-%20A1%20Front%20matter.pdf, accessed 27/08/10

Jarvis P., Holford J. & Griffin C., (2003), ***The theory and practice of learning***, Routledge, London and New York

Kaindaneh P.M., (n.d.) ***Technology Transfer from the Adaptive Crop Research and Extension Project in Sierra Leone***, available at *http://www.idrc.ca/en/ev-30813-201-1-DO_TOPIC.html, accessed 02/09/10*

Lado C., (1998), ***The transfer of agricultural technology and the development of small-scale farming in rural Africa: Case studies from Ghana, Sudan, Uganda, Zambia and South Africa***, *GeoJournal* **45:** 165–176, 1998, © 1998 *Kluwer Academic Publishers. Printed in the Netherlands*

Leeuwis C., (2004), **Communication for Rural Innovation: Rethinking Agricultural Extension**, 3rd edition, Blackwell Science Ltd, Oxford, UK

Machethe C.L., (2004), ***Agriculture and Poverty in South Africa: Can Agriculture Reduce Poverty?*** Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, Paper presented at the Overcoming Underdevelopment Conference held in Pretoria, 28-29 October 2004.

Manzuri G., *(2004),* ***Effectiveness of Participatory Approaches: Do the New Approaches Offer an Effective Solution to the Conventional Problems in Rural Development Projects?*** Operations Evaluation Department, Asian Development Bank

Mbabu P.I., (2008), ***A Critical Reflection: The Rhetoric and Practice of Participatory Approaches in Rural Extension: The Case Study of Ministry of Agriculture Mwingi District Kenya***, Research project submitted to Larenstein University of Applied Sciences

Mefalopulos P. & Kamlongera C., (2004), ***Participatory Communication Strategy Design:*** A handbook the SADC Centre of Communication for Development in collaboration with the Communication for Development Group Extension, Education and Communication Service Sustainable Development Department, 2nd Edition, available at *ftp://ftp.fao.org/docrep/fao/008/y5794e/y5794e00.pdf accessed on 3 /09/2010*

Mignouna H.D., Abang M.M., Omanya G., Nang'ayo F., Bokanga M., Boadi R., Muchiri, N & Terry E., ***Delivery of Agricultural Technology to Resource-poor Farmers in Africa***, African Agricultural Technology Foundation (AATF), Nairobi, Kenya

Mintzberg H., (1993), ***Structure in Fives: Designing Effective Organizations***, Prentice Hall Incorporated, New Jersey, USA

Organization for Economic Co-operation and Development (OECD), (n.d), ***The Definition and Selection of Key Competencies*** available at http://www.oecd.org/dataoecd/47/61/35070367.pdf, accessed 09/09/10

Poulton W., Lennon S., & Steenkamp L., (n.d) ***What Are The Options of Technology Transfer For South Africa?***, Eskom, Po Box 1091, Johannesburg, 2000, Department of Trade and Industry, Private Bag X84, Pretoria, 0001, available at http://www.econ4env.co.za/archives/climate/poulton.pdf, accessed on 27/08/10

Röling N., (2009), ***Pathways for Impact: Scientist's Different Perspectives on Agricultural Innovation***, International Journal of Agricultural Sustainability 7(1) 2009, p1-12, EarthScan

Rollinson D. and Broadfield A., (2008), ***Organisational Behaviour and Analyses: An integrated approach***, Fourth edition, Prentice Hall, New York, USA

Thomas R., (1996), Crop Production in the Limpopo Province, Department of Plant Production, Limpopo Department of agriculture, available at http://www.lda.gov.za/downloads/downloads_reports/ accessed 13/08/2010

UNEP (2003), ***The Seven "C"s for the Successful Transfer and Uptake of Environmentally Sound Technologies***, International Environmental Technology Centre, United Nations Environment Programme, Osaka, Japan

Van Crowder L., (1996), Integrating ***Agricultural Research, Education and Extension in Developing Countries***, Food and Agriculture Organization (FAO) Research, Extension and Training Division, SD Dimensions in www.fao.org

Van Mele P., (n.d), ***The Role of Agricultural Research Centres in Strengthening Rural Extension***

Vaus, D.D., (2001), ***Research Design in Social Research***, Sage Publications, London

Verschuren P. & Doorewaard (2005), ***Designing a Research Project***, Publisher LEMMA, Utrecht

Wahab S.A., Rose R.C., Uli J., & Abdullah H., (2009), A ***Review on the Technology Transfer Models, Knowledge-Based and Organizational Learning Models on Technology Transfe***r, European Journal of Social Sciences, Vol 10, Number 4

Wolson R., (2007), ***Technology Transfer in South African Public Research Institutions***, council for Scientific & Industrial Research (CSIR)

Zipp W., (1998), ***Extension: empowerment through communication***, (in Wallace I., 1998), Rural Knowledge Systems for the 21st Century, AERDD, University of Reading, UK.

UNPUBLISHED MATERIAL

Agricultural Research Act No 86 of 1990, (available on www.arc.agric.za , accessed on 20/06/10)

Agriculture Policy, (1998), a Discussion Document, Ministry for Agriculture and Land Affairs www.nda.agric.za,

ARC Annual Report, 2008/2009, (available on www.arc.agric.za), unpublished

ARC Business Plan 2009/2010, (available on www.arc.agric.za)

ARC Strategic Plan, 2007/8-2011/12, (available on www.arc.agric.za)

ARC, (2009), A Strategic Framework for Technology Transfer at the ARC

Department of Agriculture Forestry & Fisheries, Crop Estimates Committee, 2010,

Du Toit, (JUNE 2009) Grain Production Advancement Project Final Report

Mashingaidze K., Mkhari J.J., Masideni D., Fourie A.P., & Maqongwa S.M. (2010), Smallholder Farmer Participatory Maize (Zea mays L.) Cultivar Evaluation and Deployment in South Africa: The Limpopo Model (Poster)

Mashingaidze K., (2010), Maize Breeding and Farmer Participatory Variety Evaluation, www.arc.agric.za

Public Finance Management Act No 1 of 1999, Republic of South Africa.

Statistics South Africa, 2002, Census of Agriculture Provincial Statistics – Limpopo, Financial and production statistics, Report No. 11-02-10 (2002), available at www.statssa.gov.za

Socio-Economic Impact Assessment for the Grain Production Advancement Project, 2007, study commissioned by the Agricultural Research Council,

South Africa Agriculture & Forestry Foresight Report, 1998, www.**dst.gov.za**

ANNEXES

ANNEX A: PROBLEM CAUSAL DIAGRAM

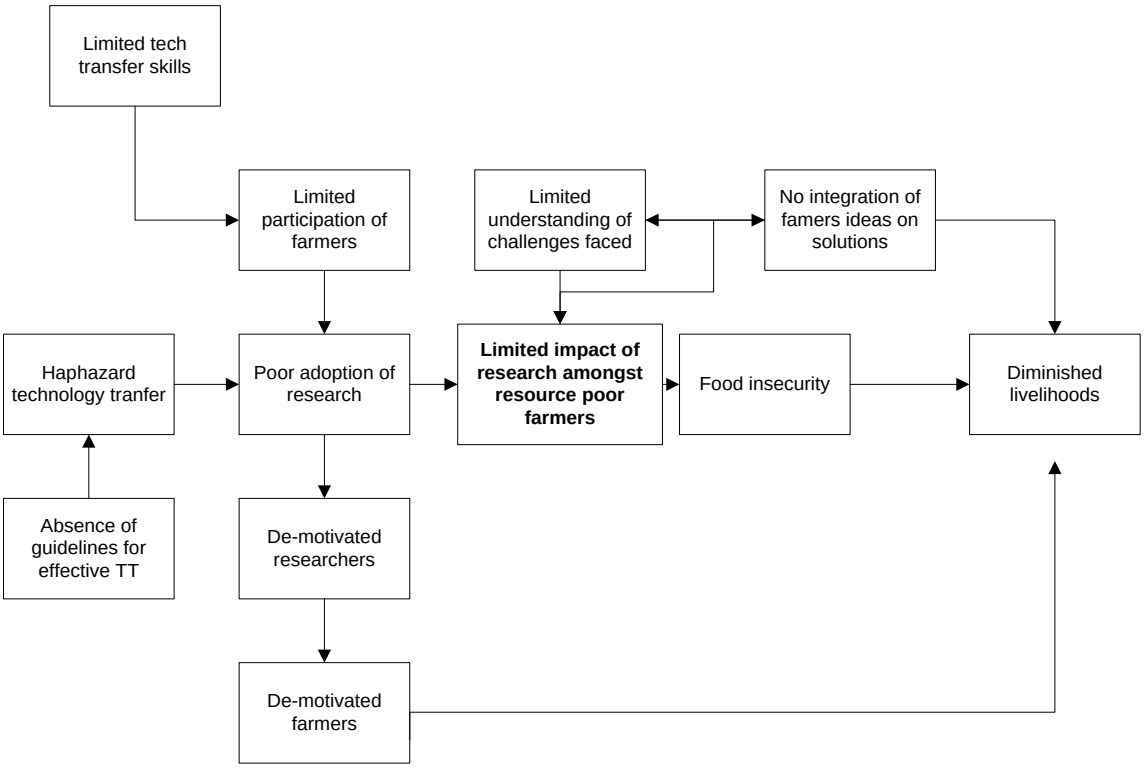

Figure 1: Problem causal diagram

ANNEX B: WORK PLAN

	DURATION FROM 28TH JUNE TO 22ND SEPTEMBER 2010 in weeks						
	28/06 – 09/07	12-16/07	19-30/07	2-6/08	9-13/08	16/08-10/09	13-17/09
ACTIVITY	week 1-2	week 3	week 4-5	week 6	Week 7	8-11	Week 12
Proposal development							
Presentation of proposal at ARC Head office							
Pre-testing research tools with 2 researchers working on maize located in Pretoria							
Data collection							
Data analysis							
Presentation of preliminary results to GCI and ARC-CO							
Report writing and submission							
Colloquium and Oral Exam							

ANNEX C: INTERVIEW QUESTIONS 1 - (researchers, extension officers & managers)

Main Research Question 1

a) SRQ1.1- What are perceptions of stakeholders on an effective (technology transfer) TT service?

- What does the concept of effective TT mean to you?
- What are the characteristics for effective TT?
- What role is played by TT in the broader challenge of curbing food insecurity through maize production?
- What are the challenges faced by the ARC in delivering an effective TT service?

b) SRQ1.2 - What are the preconditions necessary to enhance TT?

- What could be likely obstacles in the ARC to enhancing TT for a better service?
- What (support mechanisms) would need to be in place to improve TT?
- What opportunities currently exist to enhance TT (also perspectives for the future as well)?
- What steps are being taken to capitalize on these opportunities?

c) SRQ1.3 - What technical factors impact on effectiveness of in maize production?

- What are farmers' needs and production constraints and how do these influence TT?
- What processes are used to match farmer's needs with technology development?
- What strategies are used by GCI to assist farmers meet the above-mentioned production constraints?

Main Research Question 2

d) SRQ2.1 - What are the communication strategies used to transfer technologies in the ARC?

- What goal (logic) informs the communication programme of the ARC with TT scope?
- What are the various types of information sent out to (communicated with) RPFs?
- What mechanisms are used to identify information needs?
- What is the level of understanding of the concept of communication strategies in TT amongst researchers?
- What factors determine choice of communication strategy over the other?

e) SRQ2.2 - What is the competence level of researchers for selection and management of communication strategies in TT?

- What prior experience and training exist amongst researchers to do TT?
- What skills and knowledge are required to competently do TT?

f) SRQ2.3 - To what extent does communication strategies used influence TT?

- What factors hinders or enhances understanding of training given by ARC researchers?
- What challenges do researchers face in effectively communicating maize production technologies

g) Other general questions

- Do farmers know the services available from the ARC through TT?
- How has training and information dissemination been happening within the TT ambit?
- What are the constraints/successes in training and information dissemination?
- What are other sources of information and training available to farmers?

Interview Guidelines: Farmer questions

Name: ……. Age: ……. Gender: ……

Farm/ Area: …….. Farm/Plot size: ……

Project name: …….. Association: …….. ……

Interview date: ……

- What technical or production related constraints do you face in successfully producing maize?
- What help or assistance do you need to help you deal with these production constraints?
- Which companies, organizations, networks help you deal with these production constraints?
- How relevant/useful is the service you receive from each of these different sources of help?
- Do you know anything about the ARC? If yes, what do you know about them? (If no, researcher mentions the specific project and the ARC personnel involved to jog farmer's memory)
- What do you think are the services available from the ARC to help deal with production related constraints, such as the ones you mentioned above?
- How does the ARC find out what you need before assisting you?
- How clear is the message given by ARC staff to you? If not, how can it be improved?
- In what form do information and support from ARC come to you? Which form do you prefer?
- How does the ARC give you training? Are there any problems associated with the training provided? If so, what are these?
- What do you like best about the training and information given by the ARC? Why?
- What do you think about the role of ARC's advisory service in the broader challenge of curbing food insecurity through maize production?
- How effective is the service being provided by the ARC? Why?
- How can the ARC improve its service?
- What is your vision for your farm and what better services would make realizing this vision possible?

ANNEX D: PICTORIAL PRESENTATION OF FIELD DATA COLLECTION

Interview at Driekop

Mature, unharvested maize at Ga-Thaba

Focus Group Discussion at Bellingsgate

Respondents of the SSIs at Zebetiela

Participants in the FGD at Tafelkop

Ga-Thaba farmers after FGD

ANNEX E: MAIZE PRODUCTION PER PROVINCE[1]

Production year	Production[2]				
	Cape	Natal	Free State	Transvaal	Total
	1 000 t				
1970/71	278	325	3 447	4 180	8 230
1971/72	434	311	3 220	5 138	9 103
1972/73	95	224	1 286	2 355	3 960
1973/74	551	378	3 936	5 745	10 610
1974/75	494	299	3 299	4 708	8 800
1975/76	397	254	2 545	3 928	7 124
1976/77	458	391	3 553	5 083	9 485
1977/78	481	490	3 474	5 456	9 901
1978/79	369	464	3 021	4 315	8 169
1979/80	371	533	3 414	6 356	10 674
1980/81	814	667	5 015	7 927	14 423
1981/82	303	443	2 766	4 749	8 261
1982/83	128	272	1 342	2 262	4 004
1983/84	51	576	1 295	2 387	4 309
1984/85	541	360	3 105	3 903	7 909
1985/86	436	447	3 027	4 016	7 926

Production year	Production[2]									
	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	Limpopo	Mpuma-langa	Gauteng	North West	Total
	1 000 t									
1986/87	4	86	112	2 262	328	162	1 813	424	1 878	7 069
1987/88	4	70	110	2 262	300	95	1 480	359	2 050	6 730
1988/89	4	70	162	3 640	362	137	2 194	534	4 449	11 552
1989/90	4	62	104	2 779	319	74	1 832	394	2 773	8 341
1990/91[3]	3	62	110	2 121	340	107	2 074	435	2 573	7 825
1991/92	2	34	125	850	237	49	1 092	163	404	2 956
1992/93	5	65	157	3 316	295	69	2 254	450	2 466	9 077
1993/94	6	76	178	4 336	359	168	2 672	716	3 635	12 067
1994/95	20	90	160	1 257	266	68	1 135	281	1 167	4 406
1995/96	25	117	180	3 292	328	64	1 948	465	3 275	9 694
1996/97	25	45	192	3 410	339	69	1 732	389	3 385	9 582
1997/99	5	34	176	2 540	269	48	1 486	370	2 275	7 204
1998/99	8	31	201	2 760	247	47	1 870	366	1 923	7 461
1999/00	9	47	258	4 194	289	124	2 360	455	3 256	11 001
2000/01	9	46	320	2 695	256	88	1 520	334	2 215	7 487
2001/02	14	45	511	3 217	402	106	2 068	484	2 885	9 732
2002/03	21	51	534	3 337	385	162	1 882	418	2 601	9 391
2003/04	15	82	511	3 100	390	115	2 219	482	2 568	9 482
2004/05	20	88	557	4 113	400	120	2 807	483	2 862	11 450
2005/06	27	70	443	2 080	310	58	1 615	325	1 690	6 618
2006/07	20	83	541	2 855	359	131	1 490	254	1 392	7 125
2007/08	40	85	662	4 928	489	224	2 875	568	2 829	12 700
2008/09	50	92	634	4 527	521	247	2 870	534	2 575	12 050

[1] Excluding hybrid seed

[2] Commercial production in the RSA

[3] Source: Crop Estimates Committee from 1990/91