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FR TOMLINSON COMMEMORATIVE LECTURE

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RESEARCH MANAGEMENT OF WATER ECONOMICS IN AGRICULTURE – AN OPEN AGENDA

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Preamble

It is indeed a privilege and an honour to deliver the FR Tomlinson Commemorative lecture this year. Although the invitation was quite unexpected, it is of course highly appreciated. When Prof Johann Kirsten phoned me with the request, I was initially not sure what topic I should address. The topic, which I have now formulated, is one which has fascinated me and certainly kept me busy for the most part of my career. I want to share with you some thoughts and perspectives, but will steer away from a laborious review or an abstract analysis. In doing so, I trust that this is appropriate within the spirit of the occasion, which is now a well established tradition in the Agricultural Economics Association of South Africa (AEASA). Let me start with a quotation which is at the core of the theme I want to unfold in this lecture.

> *"Our most important resource is not land, nor capital and even less the climate. Our most important resource is not the gold under the earth's crust, or the oil that might be there. Our most important resource is our human material. We must develop our human material and make full use of it."* (Groenewald JA, 1973a)

1. INTRODUCTION

The above statement was made at the end of a review of the quality of management in South African agriculture. At least three things are significant for me in this regard: First, the date 1973 is the year in which Prof Tomlinson went on pension, having made wide-ranging and distinguished contributions as an academic and public servant. Second, Prof Jan Groenewald wrote those words, who earlier became Head of Department at the University of Pretoria and who I consider as my mentor in the discipline of Agricultural Economics.

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Third, a comparison is made between renewable and non-renewable natural resources on the one hand and human resources on the other.

The question is on what basis should the relative importance of natural resources (including water) and human resources (or people) be distinguished? An indication was given a few years earlier when Mr DF Kokot (1967), former Secretary of Water Affairs, argued that management and not water is the limiting factor in the development of South Africa. Ten years before that, Ms Joan Whitmore (1957) claimed that of all the natural resources, the welfare of a nation depends most vitally on water. These references clearly illustrate what Prof Glenn Johnson from Michigan State University and guest speaker at the 1987 AEASA conference meant, when he said the following: *"If someone maintains to have made an original discovery, he/she is either a genius, or he/she has not done his/her homework or he/she is wrong!"*

This now requires that I elaborate on the concepts in the topic, beginning with some definitions. After all, precise definition makes the difference between science and ideology (Groenewald, 1973b).

2. RESEARCH AND AGRICULTURE – THE ESSENTIAL INTERACTIONS

Broadly defined, research is a systematic investigation to obtain knowledge (Groenewald, 1973b). It is a creative process, generating ideas and reading about what has been done before. We involved in research must be reminded by the wisdom of Oscar Wilde (1891) that "an idea that is not dangerous is unworthy of being called an idea at all". Research is therefore comparable to a journey of exploration, which is totally overwhelming, sometimes tiring, requires perseverance, taking risks and eventually making breakthroughs.

An important issue in research is how knowledge is created or when is it possible to say that we know something? This concerns the methodological debate around **falsification** vs **verification** (Wilber & Harrison, 1978). In the first case the emphasis is on hypothesis testing and the statistical design of a survey or the treatments and replicates of an experiment. In the second case the emphasis is on construction of a simplified representation of reality and testing for correctness and validity (Backeberg, 2000). There are those who maintain that falsification, or the orthodox research method, as practiced by e.g. neo-classical economists, is the only pure way to obtain knowledge. Verification through the modelling approach and a holistic, systematic and evolutionary explanation of social change by e.g. institutional economists is often questioned. However, in the context of applied research, both schools of thought have merit, depending on the problem that must be solved. In practice it is more a question of finding the effective balance between, e.g. research station trials, farmer participation in on-farm experiments and modeling research.

Problem solving research means that prescriptions are made which contain both value-free and value knowledge related to the specific situation of a decision-maker. In particular, if this type of research is done by agricultural economists as part of a multi-disciplinary team, it requires disciplinary excellence in Economics etc., as well as respect for the contributions by other applied sciences (Johnson, 1987). It is worthwhile to note that Prof Tomlinson (1973) was of the opinion that farm-level, practically oriented research by agricultural economists, is futile if it is done in isolation from other disciplines.

Keeping this in mind, agriculture can be defined as an activity of people, which is primarily undertaken for the purposeful production of food and fibre by means of crop cultivation and animal husbandry within constraints of available resources (Spedding, 1988). Any part of this definition can be the focus of applied research, including that of agricultural economists, but for the purpose of this discussion I will refer to three resources:

People in agriculture comprise a diverse group of subsistence, emergent and commercial farmers. In South Africa diversity can furthermore be described in terms of amongst others, gender, age, race, ethnicity, culture, training and experience, size of operation and degree of dependence on farming as a source of income. Not only are the needs and requirements of these farmers very different, but the decision environment is also constantly changing. As mentioned before, water is only one of many resources and production inputs for which management information is necessary. Nonetheless, the essential interaction is between the **activity of research** and the **activity of people** in agriculture. Through research data (facts and figures) must become information (data with context) and then knowledge (information with meaning). Knowledge is the capacity for informed action and is always linked to people. In the information age, knowledge is a resource which is the basis for wealth creation and economic growth (Kfir, 2004, personal communication). This **usefulness for decision and action** is an important criterion against which all applied research output must be measured.

Given the complex relationships between biophysical, technological, social, economic and political processes which influence the activity of people in agriculture, it is important to identify some key characteristics. Based on the seminal work by Boulding (1956) in his article entitled "General Systems

Theory – The Skeleton of Science", a possible approach is "*…to arrange the empirical fields in a hierarchy of complexity of organisation of their basic 'individual' or unit of behaviour, and to try to develop a level of abstraction appropriate to each… One advantage of exhibiting a hierarchy of systems in this way is that it gives us some idea of the present gaps in both theoretical and empirical knowledge".* With application to the **water resource system**, a number of systems and sub-systems can be identified (Backeberg & Oosthuizen, 1995). These include the following:

- the national water system;
- a number of catchment or drainage sub-systems;
- within each river catchment a number of grassland, woodland, dryland, irrigation or mixed farming sub-systems;
- within each relative homogeneous area a number of representative farming sub-systems; and
- within each farming sub-system a number of enterprise and resource sub-systems, which in turn consist of a number of components.

In the case of water management in agriculture, the farming household and firm are the two key "basic units" of decision and action. As such, these water users on a primary agricultural level and their related advisory support services form the target group for research (Backeberg, 2000).

3. RESEARCH AND WATER ECONOMICS – THINKING DIFFERENTLY ABOUT WATER

In Economics we study one aspect of human behaviour namely how available resources are utilised to satisfy needs (Schumann *et al,* 1964). Water economics is therefore quite simply what people do with water[2]. Estimates by Prof Alan Bennie *et al* (1998) have again highlighted that approximately 62% of rainfall is used annually for maintenance and production by natural grasslands, woodlands and forests; 12% is used as evapotranspiration for crop production on drylands; whereas water use for irrigation is equivalent to 2,0% of rainfall. In spite of the predominantly semi-arid production conditions, the substantial contributions of agriculture to the South African economy are generally recognised. These are highlighted by the delivery of food at affordable prices; contributions to gross domestic product of 20 to 30% due to linkages with other sectors; and earning of foreign exchange (Fényes & Meyer, 2003). However, the current realities are still high levels of unemployment, poverty

[2] *This phrase is derived from a discussion on contingent valuation with Dr Roger Bate who said "economics is what people do and not what they say they are going to do".*

and undernourishment, particularly in rural areas (Department of Agriculture, 2001). The official national unemployment rate in 2003 is 31,2%; 48,5% of the population fall below the poverty line[3] (United Nations Development Programme (UNDP), 2003); and stunting rates amongst children aged 1 to 9 years vary from 14 to 30%, with an average of 22% (Labadarios & Nel, 2000).

With this background, the strategic focus of research in the Key Strategic Area of Water Utilisation in Agriculture of the Water Research Commission (2002) is on:

- increasing the efficiency of water use for food, fibre, wood and timber production (i.e. improving the knowledge of biological, technical and economic processes of **production**);
- increasing the household food security and profitability of farming and thereby the livelihoods of people dependent on agriculture (i.e. improving the knowledge of management processes by **people** who are using water); and
- ensuring sustainable water resource use in rainfed and irrigated areas (i.e. improving the knowledge of natural processes and human-induced impacts of **resource** use).

These strategies are implemented by means of research thrusts, which give direction and driving force for research activities. One of four research thrusts is on "Water utilisation for poverty reduction and wealth creation in agriculture". In two research programmes, research projects are undertaken within the following interrelated sub-sectors of agriculture namely:

- irrigated agriculture;
- dryland agriculture;
- woodlands and forestry;
- grasslands and livestock watering; and
- aquaculture.

By combining solicited and non-solicited research proposals, a shift in emphasis has been made to address real-life problems.

If we accept that management, knowledge and water are the relative scarce resources, what can agricultural economists who specialise in natural resource economics research do? Specific contributions can be made by identifying gaps in knowledge within the holistic conceptual framework referred to

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[3] *R354 per month per adult equivalent in 2002.*

above. Let me give some examples of rainfall water use and surface or groundwater use by predominantly black subsistence and predominantly white commercial farmers.

3.1 Rainwater harvesting

A proven water management practice which has prospects for much wider application is rainwater harvesting and conservation (RWH&C). Following pioneering research work by Dr Malcolm Hensley *et al* (1997; 2000), further development of infield RWH&C techniques was done in the central Free State province. It has been shown that yields of crops such as maize and sunflower can be increased by at least 50% compared to conventional tillage (Botha *et al,* 2003). A start has been made with evaluating the social acceptance and economic viability of infield RWH&C (Kundhlande *et al,* 2004), but much more research work can be done by agricultural economists and rural sociologists.

In this process local and scientific knowledge must be combined, giving priority attention to low-potential areas (which are ecologically variable, more remote, politically less visible with high rainfall variation, yet concentrated poverty) and preferring a food-security-first strategy (which will encourage the ability of poor people to acquire food by production, purchase, exchange or gift) (Maxwell, 2001). In provinces such as North West, Limpopo, KwaZulu Natal and Eastern Cape where the majority of people live in rural areas, the poverty rate is highest and agricultural production is mainly dependent on rainfall, dignity, self-respect and confidence of people will be promoted by progressing from mere survival to at least household food security. The case studies done under leadership of Prof Gary Minkley (2003) on "Framing agrarian transformations and food security" in the Eastern Cape, indicate the way forward. In addition to food or cash crop production in homestead gardens, RWH&C can be expanded to arable fields, natural grazing for livestock and agroforestry, or any combination thereof.

3.2 Revitalisation of irrigation schemes

At the beginning of the process of irrigation policy reform, the scope for upgrading of underutilised land and water resources on existing smallholder irrigation schemes was estimated (DWAF, 1995). Over the last ten years or more, many of these schemes in the former homelands have collapsed or became defunct (Bembridge, 2000). Revitalisation is now accepted government policy and the requirements have been spelt out by the Department of Agriculture (2002). Implementation of this policy is apparently progressing at different rates in different provinces. The report by Prof Sylvain Perret (2003) documenting the processes followed on the Thabina irrigation scheme in Limpopo province, clearly demonstrates the challenges of a participative approach. Other completed or near-completed research on sustainable settlement of smallholders in Limpopo (Machete & Mollel, 2004); KwaZulu Natal (Mwanyama, 2004); and Eastern Cape province (Tlou *et al*, 2004), also confirm that each situation is practically unique.

Provisional results of a research project on "Principles, guidelines and approaches for participatory revitalisation" (Denison, 2004) again shows the dangers of repeating mistakes of the past with one-sided attention to investment in water supply infrastructure and irrigation equipment. Important as these resources or inputs are, they should not be attended to at the neglect of people within social relations; land tenure arrangements and water use entitlements; economic location and access to markets, financial capital and various support services; as well as the technical, financial and economic viability of farming operations, given the objectives and available resources of households. As I have postulated elsewhere (Backeberg, 2003), investment in management and entrepreneurial capacity within the existing institutional and organisational framework should receive priority attention.

Although all resources are utilised much more intensively, the potential contribution of irrigated agriculture to rural livelihoods is probably less than rainfed agriculture, due to the relative small percentage of water use. A comparative benefit-cost analysis or social, fiscal and economic impact analysis would be an interesting topic for research.

3.3 Intensification of irrigation

Currently the major share of irrigation water use and the biggest contribution to agricultural production is by commercial farming. It is expected that increasing competition will be experienced for water allocated to irrigation, due to expanding domestic and industrial demand. At the same time, full cost recovery user charges are being phased in and volumetric billing will be introduced (Backeberg & Odendaal, 1998). Since promulgation of the new National Water Act in 1998, water and land rights are also separable. How this translates into water management in practice is explained in the National Water Resources Strategy (DWAF, 2002). Taking the "existing lawful use" as a point of departure, there are at least three management options available to increase the efficiency of water use, for which decision-support is required.

First, measuring water use and applying water according to crop requirements: Research is being completed on indirect measurement (Du Plessis, 2004) and direct metering (Van der Stoep *et al,* 2004) of water which is accurate, reliable and cost-effective. However, it appears that there is resistance to farm- and scheme-wide installation of meters due to prohibitive costs. Conclusive evidence is necessary that water metering is economically justifiable.

Second, switching to crops with lower water use and/or higher yields as well as irrigation methods with lower percentage water losses but more uniform application: Models have been developed, tested and implemented to estimate crop water requirements (Van Heerden *et al,* 2001) and test results are available on the efficiency of irrigation equipment (Simpson & Reinders, 1999; Koegelenberg *et al,* 2002). Information is necessary on the same basis for optimal irrigation strategies (full irrigation versus deficit irrigation) and optimal investment strategies in more efficient but expensive equipment (see also discussion below).

Third, temporary or permanent transfers through trade in water use entitlements: Empirical studies have been done on actual market transfers of water use rights in irrigation areas of the Crocodile river (Bate *et al,* 1999) and the Orange river (Armitage & Nieuwoudt, 1999). According to these findings and supported by international evidence, more information is essential on key variables such as physical security of water entitlements, possible third party effects and ways to reduce transaction costs.

3.4 Competitive water use

Due to the deregulated market environment and devolvement of water management to a local level, the need for tools to give timely management and/or policy advice has increased. Irrigation farming is undertaken by individuals with different objectives and under varying resource constraints. Farming operations are also time dependent and based on incomplete knowledge of changes in the weather, technology and prices. Under these circumstances, modelling is a tool to provide decision-support, for example on the financial viability of farming when water user charges are increased. Although models which adequately take account of features such as time and risk have obvious merit, they also involve the greatest modelling difficulties. Research is nearing completion to construct a skeleton model of a representative farm (Oosthuizen & Grove, 2004). This means that the model can be applied on any irrigation scheme or homogeneous farming area, provided that the data specified is available. Using GAMS, it appears that dynamic and stochastic programming of key decision variables is computationally feasible.

Taking this modelling further, reallocation of water within farms from lower valued, annual crops to higher valued, perennial crops means that farming operations must be restructured. Presently it is not known what the economic boundaries are within which water reallocations can be managed sustainably on a farm level and what the potential impacts are on a regional economic level. It has already been shown that it makes significant difference to consider economy-wide benefits and multi-sector linkages in the case of irrigated crops and plantations in the Crocodile river catchment, Mpumalange province (Hassan, 2003). Knowledge of these issues is of particular importance in provinces such as the Western and Northern Cape, where agriculture is a dominant economic sector. Instability influences not only employment and income on farms, but also processing and input supplying industries through forward and backward linkages. A project is under way to analyse the related production and marketing risks and to develop models which link economic activities on a farming and regional level (Van Schalkwyk & Louw, 2004).

On a related issue, salinisation of soils has an increasing negative impact due to irrigation in the Western Cape, Northern Cape, Free State and Limpopo provinces. Available knowledge on salinity management in agriculture fails to capture the dynamic nature of inter-seasonal changes in irrigation water quality as well as the cumulative economic effect of irrigation with varying water quality levels. Research is being done to address this gap in knowledge through multi-disciplinary interaction and aims to determine the relationships between hydrology, soil water movement and the economic viability of farming. The impact of various management practices and policy measures will be modeled to evaluate the sustainability of farming as well as at a scheme and regional level (Viljoen *et al,* 2004).

4. RESEARCH AND MANAGEMENT – LEADING THE INNOVATION PROCESS

It is not my intention to give a discourse on the art of research management. Essentially management is about getting things done with people. The successful manager does not only adapt to circumstances but also creates circumstances (Sadie, 1987). In this sense the focus is on the leadership element in management, which encourages amongst others the initiative and creativity of people (Landsberg, 2000). This spirit of curiosity, innovation and invention is the driving force of progress (Boulding, 1963). Again it is worthwhile to remember that "radical new ideas are the only way to create new wealth" (Hamel, 2002).

One way to describe the innovation process is a circular sequence of ideas, experiments and ventures (Hamel, 2002). Another way is by the three elements of creativity, invention and exploitation (McBain, 2004). According to this view, the first stage of creativity involves scientific research by testing ideas and doing experiments. During the second stage new discoveries are turned into inventions that have practical application. In the final stage exploitation takes place by utilising the commercial potential in a business concept that will generate profits.

In this cycle of innovation it is therefore important to evaluate the output of each research project. If this is not done, it will be unlikely to accomplish outcomes, which are of practical use, and the trend will be to just move from one research project to the next. Clearly the stage must be reached where enough applied research has been done. Only by explicitly testing end-user or farmer acceptance, through for example technology exchange projects, can the practical usefulness be assessed. If that has been achieved, service providers such as advisory bureaus at cooperatives, extension staff in government departments or private consultants can consider further implementation. A balance must therefore intentionally be found between applied research projects and technology transfer projects in the project portfolio on water utilisation in agriculture. This is being done in terms of the functions of the Water Research Commission, *inter alia* (1) to cause research to be undertaken in collaboration with universities, science councils, government departments or other organisations; and (2) to disseminate knowledge regarding the results of such research and the application thereof, and to promote development work for the purpose of such application (Republic of South Africa, 1971). Gradually it is possible to demonstrate progress, as in the case of the implementation of models for flood damage management in irrigation areas, developed by Prof Giel Viljoen and his team. Various technology transfer projects are currently being undertaken, including training courses and refinement of the farm level management simulation model (Meiring *et al,* 2004) which was developed by Prof Klopper Oosthuizen and fellow researchers.

During a recent seminar in Midrand, Prof Gary Hamel highlighted these aspects of innovation which I find relevant:

First, innovation is a numbers game – thousand ideas, hundred experiments, ten projects and one winner.

Second, allow time – "the information economy's most important source of productivity is creativity, and it is not possible to create interesting things in a constant hurry or in a regulated manner from nine to five" (quoting Pekka Himanen in The Hacker Ethic).

Third, involvement – all people must experience participation.

Progressing from ideas to research projects to useful applications is only possible through continuous discussions with farmer representatives as customers and researchers as service providers. Real (and not perceived) problems must be determined while competent and capable experts (or at least those with potential) must be located, that are able to deliver results on time and within budget. These discussions provide insights and better understanding of the practical realities. Therefore they assist in forming a judgment over the merit of a research proposal. It also assists in forming a common understanding or highlighting critical differences and building trust in the relationship with researchers (Backeberg, 2000).

Regarding time there is an inherent tension: All research projects must obviously be completed in a reasonable time, but time is important to mature in the selected field of specialisation in natural resource economics. Particularly for the benefit of young scientists I share the sentiments of Dr Norm Dudley from the University of New England, that at least ten years of consistent involvement in research is necessary, before one can be considered something of an "expert" on a topic. The wise choice is therefore to give full attention to substantial research projects and not be diverted by a large number of small tasks.

Involvement by both senior and junior researchers is achievable through regular engagement on the contents of the strategic research plan within the holistic conceptual framework I described earlier. The benefit of this approach is that the question must continuously be asked "How can decision-support of farmers be improved through research?" The obligation for scientists from all disciplines is therefore to show what particular contribution they can make which will "make a difference". Thereby the research strategy ensures that the problems farmers experience will be addressed while it also gives the necessary scope for researchers in any discipline to apply their expertise (Backeberg, 2000).

Lastly I want to refer to a challenge that all of us must attend to: Continuous effort must be made to attract agricultural economists to research on water economics through post-graduate training, and improving gender and race representivity. Opportunities exist to form project related partnerships between universities, science councils, government departments and research funding organisations. University lecturers are in the best position to identify suitable candidates; employers can set aside time for career development; and training can be incorporated in the research proposal. Obviously there are risks involved and it requires commitment by everybody beyond the time and funds available, but these are risks we simply have to take!

5. CONCLUSION

The agenda for research on water economics in agriculture is open for three main reasons:

First, there are obviously additional contributions to be made by agricultural economists active in this field of specialisation. The points I have raised are also open for debate, and as Oscar Wilde (1891) said, “when people agree with me, I always feel I must be wrong”. In any case, the creative process requires that alternative ideas be put forward.

Second, quite clearly many more examples can be added regarding the activity of people in relation to water, which are being researched. I have not discussed matters such as non-point source pollution, water valuation, natural resource accounting, climate change and other environmental or policy issues. However, all of these can be accommodated within the holistic conceptual framework, which I have proposed.

Third, a range of unfinished tasks still need attention. On all topics I mentioned, applied research has either not started or still has to be completed or can be broadened. More opportunities will then arise for technology exchange and practical application of research findings.

Referring finally to the relative importance of people and water, sustainable management of water as part of natural capital is dependent on human and social capital. **Human capital** is the total capability residing in individuals, based on their knowledge and skills. The productivity of people is increased through interaction, while leadership and organisational skills are important in making other resources more valuable. Furthermore, **social capital** yields a flow of mutually beneficial collective action, contributing to the cohesiveness of people in their societies. It includes social assets such as norms, values and attitude, that predispose people to cooperate, based on relations of trust and mutual acceptance of common rules (Pretty & Buck, 2002).

There is abundant scholarly thought which leads me to conclude that interaction between people in a multi-cultural society, such as South Africa, is rich in diversity. However, we are unified by unanimous agreement on human rights and belief in the inclusion as members of God's family (cf. Van der Walt, 2003; Leistner, 2003; Villa-Vicencio & Ngesi, 2003; Falola, 2003; Abdullahi A An-Na'im, 2002). Only on this basis can the consequences of the apparent tensions if not conflicts between farmers or people of African and European origin, which are evident in the Summary Report of the Tomlinson Commission (1955), honestly and sincerely be confronted. The **forward-looking** conclusions of the report by the UNDP (2003) released earlier this year, highlight the key prospects for sustainable development:

- re-orientation towards an inclusive, broad-based economy;
- unlocking society's creativity; and
- improving mechanisms for involvement of resource users in management activities.

In addition to "land care" and "water care" it is necessary to introduce "people care" in order to achieve success with people centred development (Backeberg, 2003). In this regard research on water economics in agriculture can certainly make a tremendous contribution.

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Before I close I want to thank my colleagues at the Department of Agriculture, Water Research Commission, Universities, Science Councils and Private Companies for the many discussions we have on water issues in agriculture. These have and still are contributing to a better understanding of what research has to be done in service of all farmers, both black and white.

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