CHAPTER 1

INTRODUCTION

THE THESIS

The thesis begins with an examination and review of the current extension literature. A number of conclusions are drawn and the areas needing further investigation have been identified as:

- Extension will need to be informed by theories made explicit by the practitioner;
- Extension will need to allow critical dialogue among practitioners, agency management, primary producers and academics; and in doing so,
- Extension will need to embrace the notion of a higher order of learning when planning strategies to improve the well-being of the majority (if not all) of its clients.

The areas requiring further investigation provide the direction for problem area definition and reveal the emerging issues. These issues are given context by the theories which guide the research and lead to a series of propositional questions.

To address these questions, methodology and method are discussed which produce a number of outcomes, which are then analysed and interpreted.

Finally, the interpretations allow for a discussion of generalisations about current practice, best practice, and the implications for extension. A summary follows which includes an outline of further work required.

THE RESEARCH PROJECT

Following concerns expressed by canegrowers in the Burdekin River Irrigation Area (BRIA) of Northern Queensland, regarding rising groundwater and salinity, the Department of Primary Industries instigated action to investigate and develop Best-On-Farm Water Management Practices (see Appendix One for locality maps and a more detailed description of the study area). The process of instigation was a co-operative one in which all key
stakeholders had input. A Project submission resulted and funding was secured from the National Landcare Program (NLP). The funding provided the salary for an Extension Officer/Researcher for twelve months. The short duration of this project and the commencement date (January 1995) influenced the methodology and techniques selected for the investigation. The major problem was that proposed farmer group meetings clashed with the sugar-cane harvesting period which made organising groups and ensuing subsequent attendance at these extremely difficult. However, participation was good and useful outcomes resulted.

The Purposes of the Project were to:

1. Improve landholder awareness of water use to maximise cane production while minimising the likelihood of salinity and changes in the groundwater balance.

2. Facilitate the development of soil and water management practices on a range of soils in the BRIA.

The Outcomes are:

1. Improved landholder awareness of the relationships between salinity, on-farm water use and groundwater, and practices to best manage them.

2. Identification of a range of “best practices” which reflect the vast array of individual farm/farmer situations.

3. Identification of a suite of social theories about current and best on-farm water management practices; development of an extension model based on the value of indigenous knowledge; equality between government and farmers; examination of underlying assumptions in relation to water management by both Government and farmers.

4. Identification of issues for future research and extension.
THE EXTENSION COMPONENT

Extension is having difficulty coming to terms with both the heterogenous and situation-specific nature of rural activity. To date extension practice, as we know it, has done well in its role as the “fixer of problems;” the transference of non-contextual technologies (that is technologies which are developed without regard for the individual farm and farmer); and the promoter of increased production and productivity. However, the traditional approach requires a labour-intensive service which “hand feeds” its clients in a reactive manner. For the majority of recipients, this approach satisfies their need for information for a short time, only to re-occur when the next “problem” is recognised. It also makes those farmers who use it dependent on Extension Officers (EOs). As a result, extension tends to have contact only with those who actively seek out information, who question their own practices, and who query the impacts their practices on the broader community.

Extension has been reluctant to embrace the notion of a higher order of learning when planning strategies to improve the well-being of the majority (if not all) of clients. There is a small percentage of clients (Roling, 1987), who have intuitively moved to this higher order of learning. These people are generally those who have a voracious appetite for information; who utilise a wide variety of information sources; who are willing to listen, discuss and try new ideas; and whom extension services seek out as their first contact for the diffusion of technologies (the innovators, according to Rogers, 1983). The balance of rural people are left to fend for themselves. It then becomes difficult to rationalise a disproportionate use of public monies, in the case of public funded Government extension agencies. It may be argued that the benefits to the wider community are gained once the new idea/technology diffuses from the innovators to the balance of the rural community. The existence of continuing salinity, erosion, overgrazing, soil structure decline, compaction, groundwater rises, chemical resistance, nutrient loss and fisheries depletion to name a few, sends clear messages that the current ways of conducting extension is not working.

The Queensland Department of Primary Industries (DPI) launched its Extension Strategy in 1993. One of the significant changes identified in the strategy was to move from single
discipline extension, for example, Pasture Agronomist, to that of role based extension, for example, Information Extension Officer, Program Extension Officer, Development Extension Officer and Extension Specialist. Coupled with this was the move towards group activities and away from the traditional one to one role. (Direct farmer contact is, and will continue to be, practiced widely, due to its importance in building relationships, trust and credibility, as well as for its efficiency when testing a new idea or when large distances separate neighbouring farmers which makes group work difficult). At the same time, the Queensland Government budget allocation to the DPI has remained static. In real terms, with Consumer Price Index adjustment, this has meant a decrease in funding. The implication of this has been a reduction in staff. For those remaining, it has also meant a decrease in operating funds which are used to support vehicle and travel costs. The situation at present is that in order to meet current demand for DPI services, a lesser number of staff have to do more work. For EOs, this must mean that the work they do with their clients must be more meaningful, more efficient and capable of instilling a sense of ownership and empowerment so that the clients will continue to learn and develop in the absence of the EO.

The BRIA, is a diverse location in terms of soil type, crops grown and social cultures. In terms of land area, the dominant crop grown is sugarcane. This provides an interesting consideration when planning an extension programme. Sugarcane is milled locally with the resultant raw sugar being traded on the world market. The price is set in US cents/pound. Growers are paid on the concentration of sugar expressed as a percentage of gross plant yield. This expression has been given the term Commercial Cane Sugar (CCS). This means that competition between growers does not result in premiums paid for the “best” producer. To explain this a little better, contrast the cane grower with the horticultural crop grower. The horticultural crop grower receives premiums in terms of price for produce when he/she achieves a market edge by say getting the crop to market when there is a short supply and high demand. This edge is not likely to be shared with other growers for fear of losing it and the resultant premium. This then limits the extension strategy to generalisations and not specific, meaningful best practice discussions amongst groups of growers. There is only a limited competitive environment among canegrowers.
Specific best practice discussions are important in a sustainable resource management context when individuals’ practices are seen by the community as possibly affecting the current environmental quality and the common good. Best practice provides a focus for groups of growers to form and discuss issues relevant to their own situations. It also credits growers’ knowledge as an equally important component of any grower/EO discourse.

The present extension service is claimed by cane growers to be very good. (This claim is supported by cane growers interviewed by the research team). The reason being that whenever the grower needs something, the relevant EO is only a phone call away and will make an effort to be on farm as soon as possible. This type of extension is very reactive and although the individual’s immediate needs are addressed, the farmer will again need to call on the EO when the next problem arises. By doing this, the EOs set a standard of service which the farmer then expects in future interactions. The metaphor is someone noticing people drowning in a river and continually rescuing them, without walking upstream to find out why they are falling in. Some would argue, using another metaphor, that when you are surrounded by crocodiles you don’t think of draining the swamp. The argument may be put that there is a way of dealing with the former metaphor even in the context of the latter.

When we examine the interaction between EO and the client following a request to supply information, the EO is able to assume a sense of power over his/her client, being the holder of knowledge which the client requires. In feeding the client with his/her “fix” of information, the EO knows the client will need to return in the future to obtain another information fix. So the EO is able to perpetuate the power exerted over the client. For example, a grower has noticed an area of sugarcane which is stunted compared to the rest of the paddock. He calls the Bureau of Sugar Experimental Stations (BSES) EO who then visits the grower and finds the cane in question is growing on a sodic soil. The EO suggests the application of Gypsum, maybe explains what is happening and why Gypsum will work and then leaves. The grower is then happy until another problem surfaces. A power relation is established through continued dependency.

To add to this discussion, it is important to note that the key sugar cane extension service is the (BSES) which is funded partly from: a grower levy; a Mill owner levy; DPI; and external
funding sources like the Sugar Research and Development Corporation. It is the grower contribution to the BSES which has a large influence on both the growers’ expectation of the extension service provided, and BSES EOs expectation of their own role.

What is being proposed as an improvement is a paradigmatic shift from a knowledge/expert opinion approach to a theory informed process approach to extension. A theory informed approach draws on relevant social theories to guide both the thinking and action of the Extension Officer which provide a deeper understanding of the extension act. An essential component of this approach is critical reflection which encourages the Extension Officer to look back at the guiding theories in relation to a particular event and by doing so make an informed judgement about the value of the guiding theories.

The theories which influenced this work are:
- Critical Theory;
- Constructivist Theory;
- Critical Systems Heuristics;
- Appreciative Systems; and
- Adult Learning.

These are discussed in more detail in Chapter Three.

From these theories, two areas are developed:
1. Farmer as learner;
2. Extension Officer as facilitator of learning who in turn is reflective and therefore engaged in praxis (that is, theory informing practice informing theory).
CHAPTER 2

REVIEW OF LITERATURE

INTRODUCTION

This review will present a case that extension theory and practice today cannot afford to rely on yesterday’s theory and practice alone. Whereas past models have proved successful for their defined, and later assumed, purpose, perpetuation of these is proving ineffective.

Extension needs to learn from its history and take forward those aspects which are still relevant, and incorporate these with more appropriate models which better reflect the current climate of extension. This climate is characterised by:

- concerns about the apparent persistence of practices which research and development produced technologies to improve;
- agriculture constantly changing, resulting in increasingly complex systems;
- agricultural practices being questioned by urban communities; and
- rainfall variability, market fluctuations and poor profitability which put pressure on all stakeholders to do more with less.

Extension is having difficulty coming to terms with the heterogeneous and context-specific nature of rural activity. To date, extension practice has done well in its role as the fixer of problems; the transferrer of non-contextual technologies; and the improver of production and productivity. However, this approach requires a labour-intensive service which hand feeds its clients in a reactionary manner. For the majority of recipients, this approach satisfies their urge for information for a short time, only to reoccur when the next “problem” is recognised. As a result, extension tends to have contact only with those who actively seek out information and who question their own practices in order to better understand why they do what they do and what the impacts these practices may have on the broader community.

The conclusion will be that extension practice:

- will need to be informed by theories made explicit by the practitioner;
will need to allow critical dialogue among practitioners, agency management, primary producers and academics; and in doing so,
will need to embrace the notion of a higher order of learning when planning strategies to improve the well-being of the majority (if not all) of clients.

SECTION ONE: AN OVERVIEW OF EXTENSION

1.1 THE NATURE OF EXTENSION?

The definition of extension is not clear and is proving a difficult task as there is no single model to suit all situations or viewpoints. (Roling, 1987, Hyde and Tamara-Prinsley, 1993, and Russell, Ison, Gamble and Wilson, 1989). Eveland, (1986, p.308) states, “what extension really is, is virtually impossible to untangle from all the things people think it should be.”

Roling, 1987 provides a broader outline of the many faces of extension. Depending on the purpose of the intervention, extension can:
• support the free choice of individuals;
• develop the agricultural industry;
• maintain employment opportunities and hence the welfare of farm families;
• be used in a pre-determined, deliberate way to achieve the intervener’s goals; or
• only be effective by encouraging voluntary change, through satisfying client goals.

However, Roling, 1987 whilst agreeing that extension is difficult to define, believes that “Extension is a professional communication intervention deployed by an initiation to induce change in voluntary behaviours with a presumed public or collective utility.” However, he states that it is conditional on:
• extension objectives being the same as client objectives;
• extension objectives overlapping with client objectives;
• extension objectives being linked to client objectives; or
• client objectives being made to fit extension objectives.
Oakley, (1988) describes extension as having two parts: Agricultural Extension, which is concerned with increasing agricultural production, and Rural Extension, which looks at building up local capabilities and organisations and other important rural activities including health and home economics. This is an important distinction which has significant implications in terms of underlying theories and the practice of extension. The former, according to Oakley, (1988), is seeking to bring about changes in knowledge levels, practices and attitudes by focussing on increasing agricultural production, technology transfer and communication. This approach is symptom orientated. The latter is seeking to ameliorate the imbalances with respect to resource allocation and to improve the negotiation skills of the rural poor. This approach is cause orientated.

A choice of approach, therefore, will begin with a choice of purpose followed by a choice of theory which will inform the process. In more general terms, extension is multi-contextual and therefore, multi-methodological.

Thus, there will be no absolute definition of extension used in this review but there will be an analysis of both parts of extension as articulated by Oakley, (1988) and in doing so, a discovery of the many contexts of extension. Often the distinction between the two parts will appear unclear. This may be a reflection of the “fuzziness” of agriculture itself (as well as the nature of learning) and/or of the perceptions of extension held by its practitioners. To define extension today in one particular context, may overlook aspects which ought to be included in another.

1.2 BACKGROUND AND HISTORY

Extension, as part of an information transferring process, has been around for more than 100 years (Baxter and Pickering, 1988). The history of extension coincides with the development of Australian agriculture. There were four eras (McKenzie, 1990 and Bawden, 1990):

1. Pioneering (pre 1940) - where trial and error were common practice; technology was not readily available; and there was little public sector involvement. Hiddlebrand, (1988), through a series of statements about learning and the early and late adopters, believes that the early
adopter demonstrates a trial and error behaviour when adopting new technologies. Therefore, it could be argued that the Transfer of Technology (TOT) model has carried with it elements of this phase to the next era but not much further.

2. **Production** (1940’s to 1950’s) - where scientific method was used to determine the limiting factors to agricultural production; technological advances were developed by scientists and once transferred, were highly successful with progressive farmers.

3. **Productivity** (1960’s to 1980’s) - where the emphasis was on the ‘whole farm’ and farmers were recognised as decision makers; there was a focus on problem solving; and discussion groups and decision support systems were the order of the day. There was confusion between extension as ‘teaching’ and extension as ‘facilitating’. It was during this time that construct theory and autonomous adult learning emerged. Salmon, (1981) proposed a model of extension where its function was to transfer “a pool of knowledge” to which each participant contributed. This model however, has proven inadequate in the cases of (i) those farmers (the majority) who would not be categorised as progressives; (Drinan, 1992 and Campbell and Junor, 1992); and (ii) those problematic situations which are not resolvable through technology-propelled development like the maintenance of long term, stable production systems (Russell, 1994 and Vanclay, 1992).

4. **Persistence/sustainability** (1980’s to 1990’s) - where the focus was on long term survival of whole industries and on the maintenance of the resource base; there is conflict between farmer perception of his good and community perception of the public good; and there is a need for skills to handle all four. An example of this is soil and water conservation, prevention of pollution and the maintenance of long-term stable production systems. (Russell, 1994 and Vanclay, 1992). The latter is currently one of the major research and extension thrusts of the Department of Primary Industries (DPI), Queensland.

From the Pioneering time of pre 1940 to the present, many approaches to extension have been developed in response to changing circumstances. Contado, (1990) presents eight alternatives:

(i) the agricultural extension approach;
(ii) the commodity specialised approach;
(iii) the training and visit approach (T&V);
(iv) the participatory approach;
(v) the project approach;
(vi) the farming systems approach;
(vii) the cost-sharing approach; and
(viii) the educational institution approach.

All except the participatory approach focus on information (as content) and the imposition (as process) of this on to willing, though passive, farmers (Khatoonabadi and Bawden, 1993). The Extension Officer (EO) then, is the expert and thus the holder and supplier of knowledge. A sense of power is felt by the EO over the client (Ivin, 1993). This frame of mind (both in EO and farmer) may therefore prevent change occurring in the individual because to do so would result in an undermining of the individual’s expertise and influence (Beck, 1994).

The Industrial Revolution brought with it many new technologies and accompanying this was the establishment of various research institutes which housed many scientists whose endeavours were directed towards production improvement. The scientists were characterised by:

- being rational and lineal thinkers;
- accomplishing goals and objectives which were concrete, specific and measurable;
- having inputs directly related to outputs;
- believing causes and effects could be controlled; and
- being specialists having narrow areas of competence (Patton, 1987).

The extension theories of the day therefore, were related to the model: (after Rogers, 1983).

RESEARCH → KNOWLEDGE → TRANSFER → ADOPTION → DIFFUSION

This model depicts the researcher as the source, and the farmer, as the passive receiver, of knowledge. This process attracts the small segment of farmers known as “progressive” or “innovator” who are active information seekers and are in the right position to apply the knowledge.
1.3  EXTENSION TODAY - CURRENT MODELS

Ison, (1992) presents general criticisms of the way extension is currently conducted and lists eight factors which constrain beneficial change and innovation. Some of these are:

- lack of an “appropriate” theoretical framework;
- lack of clarity about client identification;
- insufficient value attributed to local knowledge;
- EOs reluctance to take on facilitating roles for fear of loss of self esteem; and
- too much emphasis on the “product” rather than the “process”.

1.3.1  Transfer Of Technology

Transfer of technology in its literal sense means, “to convey the application of science” (The Concise Oxford Dictionary, 1979). The model developed for this purpose - the Transfer of Technology (TOT) model - was based on a belief that research done by scientists is transformed by them into “knowledge”. This “knowledge” was then translated into useful farm practices by the EO. To do this effectively, the EO linked up with the most progressive, knowledgeable and financially secured farmers (called innovators) who would “adopt” the new practice (Russell et al, 1989 and Roling, 1987). The increase in productivity resulting from the adoption, was immediately visible and appealed to other farmers whose desires were to increase returns, reduce hard work and/or increase social standing (Chamala, 1987).

The Transfer of Technology (TOT) school, (Baxter and Pickering, 1988, Larsen, 1988 and Hidlebrand, 1988), argues that once scientifically generated knowledge has been passed onto the innovators the process of diffusion will enable this knowledge to reach the wider community (Rogers, 1983). Diffusion Theory has a basic tenet that once the new technology has been transferred to the innovator it will “diffuse” to the rest of the homogeneous population (Rogers, 1983, Oakley, 1988, Roling, 1987 and Russell et al, 1989). This assertion has been extremely successful for the few innovators and early adopters (Hidlebrand, 1988, Roling and Engel, 1990 and Drinan, 1992). But evidence indicates that the balance of the
community are not realising the benefits (Russell, 1994), and therefore diffusion is not occurring.

![Diagram](image)

*Figure 1 The Effect of TOT on the Farming Population (Roling and Engel, 1990)*

Larsen, (1988) supports TOT, and argues that it works best with highly educated farmers. Due to the rapid and considerable impact, technology can have on total agricultural production, it makes good economic sense for extension to at least partially focus its efforts on this group (Russell et al, 1989).

Roling and Engel (1990) believe that the conceptual frameworks used in technology transfer have not been very highly developed or explicit. Instead TOT has been based on metaphors, which introduce, to each individual, a set of implicit assumptions, which are not necessarily intended. Roling, (1987) goes on to argue that TOT is inadequate for resolving the issues of:

- how to bring the rainfed areas into production which support the majority of the worlds rural population?
- how to avoid the mass loss of livelihoods of those resource poor farmers before alternatives are found for them? and
• how to make the paradigm shift from production to purchasing power in order to create markets?

Hidlebrand, (1988) says that newly acquired knowledge of agricultural technologies is diffused through "interpersonal communications networks." He provides no evidence of the time needed or process for this flow to work to the point where behaviours are changed. He states that if research is done in a wide variety of farm environments (and not limited to the "top" farmers), there is little likelihood that the innovator-early adopter-late adopter-non-adopter concept of the Diffusion model will apply. The reason given is that by researching in many different environments, one is researching in all the major "diffusion domains."

Vanclay, (1992; 1994) also criticises the Diffusion model because:
(a) it ignores many of the important social issues, for example, unequal distribution of impacts and benefits of technology and of extension service itself;
(b) it only applies to production innovations and not the adoption of conservation technology;
(c) by focussing on adoption, rural sociology has ignored the social and ecological consequences of technological change without considering that most of the new technologies may in fact be detrimental to the interests of society and/or farmers;
(d) barriers to adoption only exist from the old extension perspective (that is, that innovations ought to be adopted, that technology will be beneficial to farmers and if new technology is not adopted, then there must be barriers); and
(e) the theory and methodology have been based on the introduction of innovations and on seeking compliance of all farmers lest they be labelled a deviant.

Russell, (1994), Lincoln, (1993) and Chamala, (1987) add another criticism of the Diffusion model namely that it assumes the new technology can be identified by the individual in terms of his own farming system, including the financial component.

The Training and Visit System (Baxter and Pickering 1988, Roling, 19887) is a technology transfer system aimed purely at increasing agricultural production. It was developed for Third World application and funded through development aid. The model argues that EOs should be strictly supervised and have a set program for regular visitations of "contact" farmers.
These farmers may also act as supervisors and are seen as the source of diffusion of knowledge. It works only in a context of a high value monocrop. This model is not used in the Australian context and so will not be discussed further.

Bawden and Macadam, (1991), Lincoln, (1993) and Hiddlebrand, (1988) argue that the existing model of extension based on Diffusion, is neither good practice nor good theory. The former two go so far as to suggest that the term extension should be dropped because of the connotations it has for practitioners.

1.3.2 Farming Systems Research and Extension

The Farming Systems Research and Extension (FSR/E) approach is presented as one of the farmer managed research strategies. It offers the farmer-managed research principle, as opposed to either the researcher coming in, conducting the research and leaving, or the researcher conducting the research elsewhere and extrapolating to other situations. However its downfall is that it is still based on the transfer assumption and has failed to include the socio-economic or cultural context, impacts and appropriateness of the innovation (Davidson, 1987 and Russell, 1994).

The FSR/E approach is a form of hard systems thinking which is goal directed (Checkland, 1981 cited in Frank and Van Beek, 1994, p. 149). Its goal orientation has been criticised by Frank and Van Beek (1994) because planned methods of implementation to reach these goals are ineffective due to the temporal changes in the system as you work toward those goals.

The application of soft- systems concepts by agricultural extension is said to have overcome the constraints traditionally associated with scientific methodology (Frank et al, 1994). These constraints typically reflect a focus on single, definable, measurable parts of the whole rather than the system itself as a whole (Rirling and Engel, 1990).
1.3.3 Landcare

Landcare is an approach based on “bottom-up” or “grass roots” action determining the decisions and funding for on-farm activities aimed at developing “profitable, non-degrading land management systems” in a community group environment (Campbell and Junor, 1992). It was conceived in 1988 when the National Farmers Federation and the Australian Conservation Foundation released their joint proposal for a National Land Management Program and was reacting, in part, to criticisms that the traditional TOT approach to extension was top down and unilinear, marginalised farmers local knowledge, and was unsatisfactory when dealing with environmental management (Vanclay, 1994 and Chamala, 1987).

The basic assumptions of Landcare are (Campbell and Junor, 1992):

- groups will accelerate attitude change toward more appropriate land management systems;
- attitude change leads to behaviour change;
- land users who take responsibility for identifying and tackling their problems will improve commitment to the solutions;
- groups with a common goal will achieve more than individuals;
- extension resources will be more effectively used in a group setting;
- groups will attract more “outside” assistance than individuals;
- a catchment approach will better tackle those problems (like salinity) which don’t heed property boundaries;
- group participants will benefit from the synergy created.

Its major impact on extension is that it actively involves a wider portion of the rural community than approaches based on TOT are able to achieve. The success of Landcare will be dependent on changes in extension belief within government agencies, which seek to empower rural people, as opposed to directing them (Campbell, 1991, Campbell et al, 1992 and Green and Kreuter, 1991). They believe that this change will not occur by simply changing the titles of jobs. There must be a real commitment to change demonstrated by government.
The belief is that Landcare could improve the benefit/cost ratio of government extension services.

The shortfalls of Landcare are (Campbell and Junor, 1992):
- whilst the concept is good, it hasn’t worked well in practice. For example, EOs in the Hunter Valley region of NSW, and farmers in general, see Landcare as an extra duty, politically motivated, stifled by bureaucracy, and lacking a clear mandate (Cloonan, Dayman and El-Chamy, 1990 and Campbell and Junor, 1992).
- easy access to government money could create a handout mentality and an over-reliance on government funding
- government staff fear a loss of power as groups become more self reliant
- the needs of groups may be incongruent with government programs
- EOs feel a need to prevent groups “going off the rails” thus preventing them attaining real self direction and self reliance
- it requires a change in extension philosophy to be successful.

1.3.4 Farmer as Adult Learner

Extension has developed from the Landcare model previously discussed, to incorporate the theories of Adult Learning. Much of the extension literature from the late 1980’s to the present addresses the issue of the need for an extension approach based on these principles (Tully, 1966, Reason and Herron, 1986, Mezirow, 1991, Courtenay, 1994 and Burns, 1995).

Adults, argue Brookfield, (1993), Reason and Herron, (1986), and Knowles, (1988) are self-directing and must be given the opportunity to determine their own fates. Unlike child learners, adults are individuals and have a wealth of experience to draw on to inform decision making and learn best in experiential situations. This individualism, warns Brookfield, (1993) can cause adults to become independent, a function Brookfield, (1992) believes prevents the individual from analysing their own assumptions using the same value windows through which they derive their assumptions. This can be overcome by individuals exploring assumptions in small groups.
Courtenay, 1994 holds the view that within any group of farmers, there will be different learning qualities, different learning needs and therefore different learning motivations. These motivations will only be harnessed when the individual recognises a gap between where they are now and where they want to be (Knowles, 1988). There is a role in this situation for a facilitator whose role it is to (Knowles, 1988):

- demonstrate the value of learning in improving performance and therefore quality of life;
- providing real or simulated experiences which enable the learner to discover the gaps in real-life contexts; and
- respecting the learners sense of self-identity by acknowledging the value and importance of their own experiences.

Following this line of thought, the evidence suggests that extension should focus on the facilitation of learning rather than technology diffusion, which would overcome the shortfalls in diffusion theory already outlined.

Mezirow, (1991) takes the learning focus a step further by arguing for the need for learners to understand how others in the group make meaning out of what they are experiencing. He says a vital part of the meaning-making process is the “validity testing by reasoning ” which uses the weight of evidence and supporting arguments rather than the coercive processes commonly used such as authority, tradition, and/or brute force. However, this activity requires a group learning environment which (Burns, 1995):

- is challenging;
- strives for team decision making;
- is supportive;
- encourages innovation;
- has regular evaluation and feedback built in to the process;
- allows different views to be held and debated freely; and
- identifies learning needs.
1.3.5 Rural Community Development (RCD)

Khatoonabadi and Bawden (1993) believe that extension needs to move from the technology transfer paradigm towards community development activities to improve people’s social and economic situations. The underlying philosophy, they argue, is to help people become subjects, not objects and acting with their situations, not reacting to them.

Summers (1986) defines rural community development as, “planned intervention to stimulate social change for the explicit purpose of the betterment of the people.” The focus should be on the quality of life, or well being of people living in sparsely settled areas. Any development of these communities then, will require goals which are based on a vision of what might be or ought to be. However, the vision may not necessarily, be shared by all concerned.

Summers (1986) assumes that rural community development is limited to those communities who are suffering “misery and need.”

Williams, Rowe, Warr and Walsh, (1992) provide a complementary view of community development and add that the emphasis needs to be on the development of critical thinking, problem-solving ability, learning how to learn and communicating and taking action in ways which are significant to the clients as they pursue their self-development. Once purpose is clarified, the underlying success of this process will be the exploration of different “appropriate” assumptions.

“How to act?” needs to be considered so that the theories outlined can be translated into practice. The key point then is “planned intervention.” (This sits well with the theory of Action Research discussed in Chapter 4). So the question, “How best to intervene?” uncovers a mass of debate in Summers (1986). A number of conflicting positions are stated:

(i) The Reform vs Revolution debate centres on the question of whether the desired improvements in the human condition can be achieved by revisions of the existing system or only by revolutionary action.
(ii) The Populist vs Elitist debate focuses on who should control the decisions regarding goals and methods of intervention. Should control be in the hands of the people whose lives would be more directly affected or should it reside with scientists, technicians, and other planners with specialised knowledge, or with persons who own scarce resources and therefore have a powerful vested interest in systems changes?

(ii) The Structural vs Individualistic debate concerns the appropriate target for intervention. Should efforts be focussed on improving institutional or individual capacities?

(iv) The Outcome vs Process debate emphasises the time perspective of development. Should intervention be diverted toward producing immediate improvements in material well being, or toward developing new social, economic, and political process presumed necessary to sustain well being in the long run?”

Summers, (1986) offers some ideas in achieving local action through the use of “weak tie networks.” (see also Waters-Bayer and Farrington, 1990). He sites Granovetter’s definition as, “less intense social relationships which often occur in large, loosely knit organisations and associations.” This in contrast to “strong tie networks” which are “repetitive social relationships with high emotional intensity and intimacy.” Granovetter argues it is the ‘weak ties’ which build bridges over the chasm between people of differing backgrounds, education and interests.

While the authors explore how to act, it is done at a conceptual level, leaving the pragmatic issue unsolved. This deficiency is exemplified when Summers, (1986) leaves the reader with the following critical questions:

- how does one go about bringing these groups together?
- how does one recognise and then map the weak tie network? and
- how does one work within these networks to achieve community action?

1.3.6 Membership Reference Group

In the mid sixties, Tully (1966) provided evidence of the need to look beyond the development and transfer of technologies to theories about the socialisation structures in which farmers live and work. She explains the use of some of these theoretical concepts through a case study of
dairy farmer's adoption of improved pastures. Originally, a group formed to look at their problems, one of which was weeds in pastures. Tully mentions the social structure of the community and identifies:

- A “membership reference group,” (that is, one to which an individual refers or relates his behaviour, and one to which he wants to belong). Changes in farming practice would not occur if the proposed new practice was in conflict with the group norms. (This is a similar concept to the “strong tie networks” in Summers, (1986) discussed earlier. Also in Salmon, 1981).
- The Socialisation Process, (that is, the interaction process through which individuals gain their values, beliefs and attitudes). When the socialisation process occurs in the group, one would expect many of the values, beliefs and attitudes to be shared by the group.
- Group Control, i.e. members of the group who divide too far from group norms have social pressure applied to them by the rest of the group. If they refuse to conform to group norms, they will lose their influence in the group. So the concept of consensus is important here.

The interesting point Tully makes is that if the group which come together are not “membership reference groups” in their own right, then when those individuals who were trying out a new technology (in this example, improved pastures) they would possibly be referred to as “deviants” when they returned to their own “membership reference group.”

Two questions become apparent: 1. Should people manipulate a group in such a way? and
2. Do all farmers belong to these permanent membership reference groups? If not, there may need to be a different approach. The model espoused here is still about the transfer of technology, although the author goes another step in realising that there is a demand for the use of cognitive processes in practical extension.

Ison (1992) builds on Summers’ concept for developing rural communities by offering two ways to trigger change in human social systems. Underlying both, is the requirement for experiences outside the network of conversations which make up the individual group members social system:
- through encountering others who don’t confirm the current status quo and
• through interactions which trigger in us reflections on the nature of our coexistence with others. In other words, How do I exist in relation to others? Does what I do (as a result of my values, beliefs,) affect others? How? Why?.

SECTION TWO: ANCILLARY THEORIES

There is much literature which describes and argues theories related to extension but not tied directly to existing extension models. These theories are a useful aid in understanding the extension models outlined previously as well as aiding to assign meaning to the current models and interpret the developing models.

2.1 GROUP THEORY

The DPI Extension Strategy Statement (QDP, 1992), outlines the direction for extension in the 1990's. This direction requires a focus on industry bodies, producer groups, producers, and geographically defined communities as clients. Therefore the majority of extension activity will be in group situations. The literature has revealed many aspects of group theory, each of which may have validity when planning extension activities.

2.1.1 Homogeneity

In the past, Extension Officers (EO) have assumed their audiences were homogeneous and that it was possible and desirable to segment them into homogeneous groups (McKenzie, 1990) and with this in mind, then tailor approaches. Theoretically this may overcome the problem of delivering an extension service to a diverse range of farmers but it assumes that the needs of these groups will remain homogeneous over time, an assumption refuted by Checkland and Casar, (1986).

The principles underlying the Transfer of Technology (TOT) model apply when the targeted groups possess common characteristics. (Russell, 1994). However, most groups of people are anything but homogeneous (Tully, 1966, Larsen, 1988; Baxter and Pickering, 1988; Chamala 1987; Oakley, 1988). Schelling, (1993) articulates this well when he points out that education (be it formal or otherwise) creates inequality: of individuality; of success; of talent; of genius;
and that it is this inequality which is the measure of the progress of the world. So to think of farmers as homogeneous groups is fundamentally flawed. So this means that while TOT principles will not apply to groups, they may apply to individuals.

The benefit of heterogeneity is supported in Guba, (1990) and Beck, (1994). They argue that the existence of alternative paradigms provides an excellent opportunity for exploring unexplored assumptions. Paradigms are defined by Lonergan, (1994) as, "...underlying patterns, basic constructs, fundamental ways of looking at the world." The presentation of these alternatives encourages participants to state their own view, uphold them and in doing so, understand them better. This occurs by forcing participants in the debate to clarify their assumptions in order to both present and defend them. The process pushes participants outside their comfort zone and can be very unsettling if not sensitively and supportively managed. When properly managed, it results in a better understanding by all those involved in the discourse. (Boje, 1994 and Lonergan, 1994).

2.1.2 Language and Dialogue

Russell and Ison (1990) believe that it is "biologically impossible to instruct or determine an outcome with 'information'." They state that in a conversation, participants can only hope to achieve some sort of response but the act which provides that response will not predetermine that response.

Russell and Ison (1990) continue by arguing that what is needed so that people may communicate with each other is a commonality in the "processes of perceiving and conceptualising." Although there may be a commonality in the process used from one situation to another, the outcome will not be common. The sharing during these conversations is of individual perceptions of their world and not the actual world as it is experienced. There is a difference here albeit subtle in that no two people can perceive of the same experience in the same way.

The problem with how people from different groups relate to each other seems to be due to the absence of a language which will enable participants to converse systemically. (that is
considering human activities as systems with four characteristics - hierarchy, emergent properties, control and communication, Checkland, 1981). This lack of language (used in its literal sense), will restrict the ability of participants to enter into critical discourse/dialogue, which is vital in allowing participants to understand why each do what they do (Senge, 1990). Critical Discourse is defined in Woog and Bihl-Dimitrov, (1994) as, “an exchange in which the participants involved clarify, or in the language of post-modernism, deconstruct their own position: to identify the values and beliefs, the historical hermeneutic basis for the reality which they accept, while they actively work to understand the positions of others.... Values are explored, history is revealed and anticipation or vision of the future is reconstructed.” Dialogue will be an important component of the group learning environment. It is defined in the Australian Pocket Oxford Dictionary, (1994) as, P.287: “...2a discussion between the representatives of two nations, groups, etc. with different opinions. b valuable or constructive criticism or communication.” Isaacs (1993) defines dialogue as P.25: “...a discipline of collective thinking and inquiry, a process for transforming the quality of conservation and, in particular, the thinking that lies beneath it.” It comes from the Greek roots, dia and logos which is “meaning flowing through.”

Discourse and dialogue using these definitions will be considered synonymous for the purpose of this review.

The importance here is meaning - and the process of communication people go through in order for one person to firstly describe the meaning and how it was assigned and secondly for the other person to critically “listen” to the other and enter into a dialogue which enables the speaker to clarify his/her view and the listener to understand that view in the listener’s own terms.

The basic essential skill of the human in dealing with solving complex problems, Schein, (1993) will argue, is that of dialogue. If group action is to be effective, he says, dialogue must be the root. Therefore, dialogue will have an important role in the developing extension models.
As dialogue occurs in a group, participants will become aware of their choices about when to speak and what to say. Schein, (1993) believes that this is the basic concept of dialogue. He goes on to say that, further on in this process of making choices about when and what to say, people may begin to question the validity of their own perceptions and in doing so, discover that they may be incorrect.

This concept can be related to the concept of deframing and reframing discussed earlier by Westenholtz, (1993).

However, the potential for conflict and personal exposure would cause many to avoid becoming involved in such discussions (Orlando, 1993). To overcome this problem, an EO would need to ensure the group environment was safe and that the participants felt comfortable enough to address the issues which may cause conflict.

Senge, (1990) believes that thinking is fragmented because the language is fragmented. And due to the belief that language shapes perception, to overcome this fragmentation, a language of “interrelationships,” a language of trust, sharing, cooperation, teaching and learning” must be used. The reliance on the linear Western sentence structure of subject-verb-object should be avoided. A learning environment, (Isaacs, 1993), can be created through dialogue, and holds the potential for a synergy of intelligence.

A language of interrelationships, as described by Senge, (1990), could do much to promote an active learning environment and therefore, a process of effective extension.

Eveland (1986) uses the concept of “Metaphor Formation” to explain how groups and/or individuals understand new things. Metaphor formation is about “understanding how the new thing is both like and unlike the things already familiar.” Some of the problems with TOT have occurred because certain words used to describe the technology conjured up the wrong image in the minds of the farmers. This implies two things:

(1) that EOs must understand the context in which farmers operate in relation to a certain technology or practice and therefore
(2) that the language used to converse with farmers must be understandable by them.
2.1.3 Environment And Behaviour

Covey, (1991) supports the claim that the environment (as well as upbringing and genetics) does have some influence on individual behaviour. This is demonstrated in his reactive model, (see Figure 2), where it can be assumed that the stimulus has come from the surrounding environment.

![Figure 2 The Reactive Model (Covey, 1991)]

However, Covey, (1991), like Westenholtz (1993), believes that individuals have the freedom to choose their responses and presents this in Figure 3.

![Figure 3 The Proactive Model (Covey, 1991)]

Covey prefers the proactive model over the reactive model based on the assumption that individuals have the freedom to choose their options and this represents their greatest power. He states that behaviour is a function of decisions (taken based on choice rather than values), not conditions.

The consequence of this on learning-focussed extension is that providing the options are presented clearly, using common nomenclature (to aid in a real comparison), individuals will
choose an action based on self-awareness, imagination, conscience, and independent will (Covey, 1991).

The messages for extension are: be proactive, begin with the end in mind, put first things first, think win/win, seek first to understand then to be understood and finally synergise (Covey, 1991).

2.1.4 Decision Making and Environment

The question of how to improve decision-making ability is developed in Burnside and Chamala, (1992) who cite Campbell, (1992) as saying that the focus of extension should be improving farmer decision-making. This statement results from an observation that experiential learning alone will not improve poor decision-making. What can be improved, argue Burnside and Chamala, is the environment in which decisions are made. Mention is made of a “multi-attribute model” developed by Lefroy et al, (1992) which when used with the knowledge of the procedures to clarify the decision environment, “may assist the assessment of sustainability.”

Burnside, (1993) presents an argument that judgement behaviour in an uncertain environment can be quantified using an innovative application of Social Judgement Theory. Peoples judgement behaviour is investigated in a number of situations in which specific, available information must be used to assess an unknown criterion. The analysis of judgement uses multiple regression to relate the information sources (cues) to a person’s judgement of a criterion, over a sufficiently large number of cases. The regression statistics, then, represent a persons “judgement policy.” Burnside believes that this approach can be used as part of an extension methodology aimed at facilitating improved day-to-day decision-making.

However, the reasons for the shortfall in this style of quantifying decision making are that subjective beliefs are difficult to elicit; the approach is complex; and decision-makers are unlikely to accept prescriptions from analysis based on assumptions that don’t match their own view of the world (Burnside et al, 1993).
This again reaffirms the need for extension to focus on creating learning environments which enable the group to understand the environment of individual farmers. This understanding then provides the contextual understanding needed for applying technologies.

2.1.5 Frames Of Reference

Westenholtz, (1993) provides a discussion of environmental responses by suggesting that individuals choose the environmental responses which confirm their way of constructing pictures of the world, or what she calls “frames of reference,” (“principles of value relevance” in Guba, 1990) rather than the commonly held belief that the opposite is the case, in other words, that peoples environments affect their frame of reference. (Dow-Scott, 1994)

Westenholtz uses the frame of reference concept to explain why individuals continually repeat the same behaviour, even though their external world has changed. However, this doesn’t mean learning can’t and doesn’t happen. On the contrary, Westenholtz believes that individuals can learn from responses to changes in their environment, but will not be able to go beyond the limits placed on them by the environmental responses they have chosen unless they firstly, make the distinction between single loop and double loop learning (Fulmer, 1994) and secondly, move from level one cognition (single loop learning) to the metacognitive level (second loop learning).

Single loop or level one cognition is learning for doing and is concerned with learning about actions or matters at hand (Strohm-Kitchener, 1983 and Woog, Kelleher and Andrews, 1994). Double loop learning or metacognition is related to thinking about doing. It involves questioning values and assumptions which underlies actions.

However, the ability of individuals to make this transition is made difficult, Westenholtz argues, because their existing frames of reference limit the way responses are interpreted as meaningful.
Guba, (1990) believes that it is the process of exploring the ideas that motivate people and the associated activities which result (frames of reference), that will provide information about what the environment should consist of.

Williams et al, (1990) refers to a process of deframing and reframing. Rosenau,(1992) refers to this process as “deconstructing”, while Mezirow, (1978) uses the term “meaning transformation”. Generally speaking, the terms refer to the realisation by the individual that previous frames of reference no longer create meaning and hence become ineffectual. By deframing the previous frame of reference, the individual experiences how right or wrong the previous understanding of the environmental responses was.

It cannot be assumed that a change in the frame of reference will cause a change in belief, attitudes and behaviour. Once the person changes, he/she may lapse into the old frame of reference because of peer pressure and/or fear of the unknown.

2.2 GENERAL THEORY

2.2.1 Context and Culture

There is a need for EOs to understand the context in which an individual farmer is perceiving a particular technology or more generally knowledge, in order to clarify communication with the farmer (Scrimgeour, 1993). The opposite must occur as well.

This context is like a set of criteria which must be satisfied when a farmer is considering adoption of certain practices. Some of these criteria are needs, economic conditions and attitude toward certain practices (Post, 1988). It is within this context that meaning is assigned and a deeper understanding of individuals actions and cognition arises and is vitally important (Webber, Ison, McClintock, Russell, Major, Dignam and Davey, 1993 and Eveland, 1986).

If producers perceive a problem (say soil erosion) differently to the EOs, then the solution (via some innovation or change in practice) posed by the EO will not be accepted by the producer (Chamala 1987). The important point here is that EOs must strive to understand producer perceptions in order to firstly define the problem, secondly to define the improvement and
thirdly to develop strategies to work towards the improvement. In other words, EOs need to bring about situations in which the producer and professional discover what the other is about (Gibson, 1994). There will also need to be an understanding of the EOs perceptions by the farmer if this improvement is to occur. (Russell, 1994)

The culture of the community also provides context. This is where all external messages are filtered and interpreted. Culture is defined as, (The Concise Oxford Dictionary, 1979 and Wilson, 1971, cited in Guba, 1990), a particular form, stage or type of intellectual development or civilisation which is a form of socially shared and transmitted knowledge of what is and what ought to be, symbolised in act and artefact. But it is up to the individual to assign meaning internally and no amount of external inducements will ensure long term change. The implication is that EOs should concentrate more on how people think about a change rather than what actually changes (Eveland, 1986).

This can be more clearly understood when considered in terms of the Appreciative Systems concept outlined in Vickers, (1980) and elaborated in Checkland and Casar, (1986). This theory is expressed in more detail in Chapter 3, page 47.

Mezirow, (1978) argues that it is culture which helps or restricts the movement of a community toward maturity by governing the rate of change and by providing or denying the opportunity for people to understand, theirs and others, assumptions which influence the way people see themselves and their relationships and the way they organise their lives.

Guba (1990) presents a theoretical view of this. He believes that if you provide for knowledge acquisition in a critical sense, the process of doing so will reveal how the conditions of existence came about and how they impact on people both positively and negatively. This realisation, he argues, may motivate people to act, provide a self-reflection opportunity in the quest for greater autonomy and, responsibility and freedom from social and political constraint.

Culture needs also to be considered from the Government service delivery side as well. Boyle, (1989) points out a need to change/modify extension theory/practice so that
practitioners see the need to change and that they see this change as pivotal to a healthy, productive organisation. Organisational and individual cultures (or traditions) will need to change and look beyond agriculture to social and human issues that concern a larger proportion of our clients and stakeholders. (Boyle, 1989) The call is for greater flexibility in organisations and the taking of risks so that action can occur based on our best knowledge, without having to wait for science to provide the full picture.

Williams et al, (1990), Ison, (1992) and Chamala, (1992) state that beliefs underlie the formation of attitudes and values which are also influenced by personal needs, family situations and farming systems and therefore, it would be necessary to focus on beliefs if any desirable culture change is to occur.

Generally, Williams et al, (1990) offers some ideas about affecting cultural change. Cultural change will depend upon:

(i) the existence of clear criteria for success;
(ii) the community’s political constitution; and
(iii) the extent to which the community is externally focussed.

These principles may have a universal applicability but people cannot assume that because a particular system works well in one setting it will work in other settings although there could be elements of the system which, when incorporated in a system in a different environment, could be transferred (Ingram, 1988).

A further examination of culture, reveals it is really the product (albeit dynamic and probably unstable) of our, (and others before us), history. Culture is built upon people’s beliefs, attitudes and consequential behaviour (Williams, Dobson and Walters, 1990). It tends to be used as an excuse for certain types of behaviour when people cannot think of any other way to behave (Guba, 1990). However, providing these alternative ways of behaving can create conflict, or when managed properly, opportunities for learning.

A word of warning, though, from Eveland (1986) is that if farmers change their behaviour because of a monetary incentive alone, then when this incentive is revoked, farmer behaviour
will resume its pre-incentive pattern. In addition to this, old behaviour patterns can also recur because of peer pressure. It would seem that this pressure could also create new behaviour patterns.

Chamala, (1992) addresses the problem which arises when the norms of the social group are contrary to those of the broader community. The extreme case is when individuals change their behaviour in response to that of the broader community and are then outcast by the social group. Chamala, (1992) does so by saying that opinion leaders in a community uphold existing norms or create new norms in a community. The answer here for the EO, so it seems, lies in identifying these opinion leaders and working with them hoping their influence will permeate the rest of the social group. However, this is no more than the Diffusion theory in action which has been discredited when applied beyond the purpose of transferring technologies to innovators.

2.2.2 Indigenous Knowledge

Too often, EOs have gone to the farmer with a notion that the farmer knows less than the EO (Russell 1994). The paradox of this situation is that the farmer has the same view of the EO - that the farmer knows more about the situation than the EO. It comes as no surprise that technology transfer has been the only thing which has been done well, albeit with a small percentage of farmers (Roling, 1987).

Guba, (1990) and Elden and Chisholm, (1993) support the need to utilise indigenous knowledge and believe that such a process is of value. However, there is a need to examine the fit between the message and the medium in the inquiry processes, meaning that EOs need to look at what it is they are trying to achieve (technology transfer, information dissemination, or learning), and marry the delivery method to suit.

Ison, (1992) believes that the failure by R&D to acknowledge indigenous knowledge restricted creativity and thus innovation and in doing so restricted any beneficial change.
Miller, (1985) believes that even with data available, it serves only to rationalise choices already made by individuals and that decisions are really made based on the individual’s values, that is, who wants what, when. This would suggest that when a person makes up his or her mind, no amount of relevant data will influence it. However, provided the data is presented using a language and delivery medium which are understandable, and the data is relevant to the individual’s context, there should be opportunities to change an opinion (Tully, 1966).
SECTION THREE: CONCLUSION

In this review, a background of extension through an historical reflection has been provided. Extension as it is now, followed by a look at the future were also outlined. However, there is no clear demarcation between the three, because today’s thinking and action will be tomorrow’s past. In addition, we seem to be in a constant state of transition - an oscillating transition between the past and the present. With this in mind, there will be cases where thinking and action, described as history, continues today and will probably do so in the future.

Summary Points From the Literature Review

- The purpose of extension is confused and therefore a decision on what theory and method to use will be determined by the particular application. In other words, extension is multi-contextual and therefore should be multi-methodological. (The issue of multiple contexts is demonstrated through paradoxes on page 115)
- TOT continues to be applicable to the small percentage of progressive farmers;
- Diffusion theory is flawed due to the incorrect assumptions it makes about the nature of the farming community, especially in regards to homogeneity, and in doing so creates unequal distribution of services, applies only to production technology and ignores the individual farmer’s situation.
- Landcare is a good concept based on assumptions that:
  ⇒ groups can accelerate attitude change which leads to behaviour change;
  ⇒ groups can achieve more than individuals;
  ⇒ and a bottom up approach will be more appealing to farmers and therefore, Landcare will be more successful.

However, individual political desires, access to funding and the existing extension philosophy have hindered its progress.
- There is a growing emphasis on Adult Learning theory in extension theory;
- The new extension paradigm of Rural Community Development (RCD), has the potential to move extension away from a total focus on technology to one of stimulating social
change for the betterment of the people. However, intervention or the “how to act” component has uncovered much disagreement. Questions like:

⇒ can desired improvements be achieved given the existing systems?
⇒ should control of methods be in the hands of those directly affected or with scientists, technologists or planners?
⇒ should the intervention target be at the institutional or individual level?
⇒ should intervention strive for immediate material benefit or sustainable social, economic and political processes?

These questions continue to be unresolved, thus restricting any further useful development of the RCD model but at the same time, provide opportunities for further research.

- EOs working with groups of farmers will have to consider:
  ⇒ heterogeneity;
  ⇒ the use of techniques to challenge underlying assumption while creating situations where participants are at ease with this process;
  ⇒ the individuals context and culture so that communication and hence learning is improved;
  ⇒ the distortions which context and culture have on each of the participants perception of specific issues;
  ⇒ that community norms will also distort peoples behaviour;
  ⇒ that double loop learning may overcome the limitations placed on people by their surroundings;
  ⇒ that individuals possess a freedom to choose their own actions; and
  ⇒ the value of indigenous knowledge.

**General Comments**

Burnside and Chamala, (1993) and Southwood, (1992), mention that there has been an increase in the scale and complexity of management due to the need to analyse and understand the “systems operating in agriculture,” and that extension has also increased in complexity in response to this. The striving for sustainable agriculture has added to this complexity.

Therefore, innovations alone do not hold the key to improving management but rather, as
Campbell, (1991) suggest, the process of continually searching for and using shared knowledge.

From the arguments outlined, the message is clear:

- science needs to continue to research and develop technologies which will improve efficiencies, lower production costs and enable products to compete on world markets. Extension will play a vital role here in transferring these technologies.
- Extension also needs to move on: from the emphasis on science-technology transfer as the sole focus, to that of the management of human endeavour and to divorce itself from the concept of “diffusion”
- the focus of extension should be on the learning process which will include both the intentional creation of the environment in which the learning is to occur and the changes to this environment which will occur as the process develops
- the EO developing an extension strategy, will need to understand the heterogeneity of the farming community and be aware that, like the EO, farmers will easily accept those notions which reinforce their own beliefs
- to enable meaningful, critical conversations to occur, differing points of view must be presented in a way which will encourage involvement by all participants. The term “wrong” will exist only to demonstrate the enormity and complexity of the task and therefore, that no individual could know it all. There need not be agreement on the reasons given for certain actions but the assumption should be that people have good reasons for their actions, even if they are wrong (Guba, 1990).

The issue of equity must also be included here (Ivin, 1993, Southwood, 1992 and Russell, 1994), as with the allocation of public funds to extension, the whole community should be the beneficiary. By working with only that small segment called the innovators, or concentrating on a specific production system, this is clearly not the case. (Serimgeour, 1993 and Patton, 1993).

Willmott, (1994) and Miller-Hosley, Lau, Levy and Tan, (1994) may have an insight into encouraging farmers to be involved in extension groups. They argue that people are educated in such a way that they are penalised for “not knowing.” So situations in which this “not
knowing” may become evident, are avoided. However, Willmott, (1994) says that this “not knowing” should be viewed as a virtue because it provides that individual (and those who have contact with this person) with a recognition of the uncertainty of the established forms of order and authority. This then creates “an openness” which is necessary for the development of new forms of learning and action.

**Extension in the Future**

EOs need to fully understand the situation and value systems of their clients (McKenzie 1990, Keith and Hobson, 1993 and Jimmerson, 1989). They need to change their thinking from “lineal” to “recursive” in order that they may better deal with complexity (Bawden and Macadam, 1991).

The relationship between government and community needs to change so that the interests of one are not subverted by those of the other (Macadam and Wilson 1993).

As communities move into the information age, extension needs to pay more attention to the beliefs and values which guide EOs as they work to provide communities with information to solve problems (Jimmerson, 1989 and Patton, 1987). They also need to be more flexible, work creatively, work in cross-disciplinary teams, take a “systems approach.” (Patton, 1993 and Zack, 1992). Patton, (1987) takes this a step further by outlining what needs to occur to make these ideas work: job descriptions must be flexible, adaptable and responsive; and work plans must reflect a variety of tasks with varying contributions in response to the nature of the current problem.

Southwood, (1992) supports the need for a changing approach to extension when he states that an over-riding feature (of the rural depression) will be the continuing fragmentation of the farming community caused by economic circumstance. A consequence of this will be the need for different types of programs for different groups. Roling, (1987) has argued that transferring of technologies is adding to this problem.
Currey, (1992) believes that extension will need to focus on the development of leaders. He outlines nine attributes these leaders will need to have:

(i) vision;
(ii) strategy to achieve the vision;
(iii) ability to select and manage a team;
(iv) integrity and trust;
(v) first among equals;
(vi) knowledge of the mind of farmers;
(vii) insight to create and service essential support systems;
(viii) courage to challenge the status quo;
(ix) ability to link management and leadership.

Sustained community action and change will not occur unless there is strong leadership. This must be the obligation of extension (Jones and Preston, 1993). Leaders will need to come from both sides - rural industry and government. Currey, (1992) says the leader must have these attributes: innovates; is original; develops; focuses on people; inspires trust; has a long-range perspective; asks what and why; has an eye on the horizon; originates; challenges the status quo; is his/her own person; and does the right thing.

Funding by Research and Development corporations for extension is about 5% of their overall budgets (Hyde and Tamara-Prinsley, 1993). The question raised is should R&D corporations fund only transfer of technology they develop, or should they also fund learning processes, organisational skills and training the trainer?

Extension, if it is to survive, needs to be able to analyse it self to determine what difference it is that it really makes. (Patton, 1993). It also needs to stop competing with other service industries like health, youth services and teachers. The challenge also remains to become collaborative and complementary with these services.
Messages for Extension Officers

Eveland, (1986) has the following comments:

- the more you study technological innovation processes that underlie TOT, the more complex and contingent they seem
- no one model, however sophisticated, can adequately represent more than a small part of the whole range of processes of interest to us
- technological change is a process without beginning or end. You can liken this to a soap opera - characters come and go; roles constantly change and are reinterpreted; and what was bad one day may later on be good again.
- the context of change is vitally important
- the culture and connections with the outside world provide the context within which all external messages get filtered and interpreted (also Vickers in Checkland et al, 1986)
- a technology transfer system that can facilitate change processes rather than sell specific technologies is one that will have long term success
- technology affects culture dramatically
- helping others to think and talk creatively about change, requires that we (EOs) think as creatively ourselves and find the appropriate organising vision for our knowledge.
- if what you seek to transfer does not facilitate the achievement of goals, you are not likely to succeed
- don’t use terms whose connotations are directly opposite from what we wish to convey ultimately, TOT is a function of what individuals think - because what they do depends on those thoughts, feelings and interests.

An understanding of the importance of critical dialogue, through a higher order of learning, is a vital component of the new approaches to extension. Without it, EOs and rural community people are left to make value judgements based on observational, and to a lesser extent, shallow question - answer discussions. There needs to be an understanding that from an individual’s view of another’s activity, rightly or wrongly, that ‘other’ does things because he/she believes they are the right things to do; that people don’t normally go out to do the wrong thing. So as an EO or neighbour, the activities of another are deemed “wrong”, “bad”, or “unsustainable” means that there is a lack of empathy for the other. This problem will not
be corrected by simply transferring more technologies. It will only be corrected when the process of this “finding out” is a learning process (Guba, 1990); when small groups of people (and that includes the EO) come together in an environment which encourages equal participation and critical discourse. (Green and Kreuter, 1991 and Jacques, 1992).

Boyle (1989) warns, that as EOs strive to adapt extension practices to accommodate the expressed needs of clients, the EOs must not give in to the “quick fix,” but at the same time, be conscious of the occasions when they can’t wait for science to provide them with 100% proof. To overcome this paradox, partnerships are needed; so too is shared learning and shared responsibility for actions and reactions to these. (Summers, 1986).

It follows then that extension philosophy needs to change to that which concerns itself with involving more people in the process.

The challenge lies in facilitating ways of dealing with the issues in a collaborative, communicative way (Bawden and Macadam, 1991, Emadi and Woog, 1993 and Ching, 1993). Woog and Bihl-Dimitrov, (1994) argue that this challenge would be met through the use of critical discourse where values are explored, history is revealed and some concept of a future is built.

TOT will remain important but new models such as Landcare, will complement it (Campbell and Junor, 1992) and the distinction between research, development and extension will become blurred (Macadam and Wilson, 1993).
CHAPTER 3

THE PROBLEM AREA AND EMERGING ISSUES

This chapter begins by outlining the theories which guide the research. Each of the theories has a particular relevance to extension, which is also discussed. From the theories, a list of working philosophies is provided which combine the major themes identified through the literature review and the theories guiding the research. Finally, a number of propositional statements are presented which inform the research methodology.

3.1 THEORIES GUIDING THE RESEARCH

This research follows Action Research principles and the theories which guide it are:

- Critical Theory;
- Constructivist Theory;
- Critical Systems Heuristics;
- Appreciative Systems; and
- Adult Learning.

The principles of Action Research, described by Zuber-Skerritt, (1990) are based on a belief that people can learn and create knowledge:

- on the basis of their actual experience;
- through observing and reflecting on that experience;
- by forming abstract concepts and generalisations; and
- by testing the implications of these concepts in a new situation.

The latter is the next actual experience and so the cycle continues. The basic assumption is that people can learn and create knowledge.

The philosophy of Action Research is acknowledgment and respect for individuals because it is in the individual’s daily reality that thought is turned into action. (McNiff, 1988).
McNiff, (1988) states that Action Research assists participants to improve the rationality and justice of:

- their own social practices;
- their understanding of these practices; and
- the situations in which these practices are carried out.

Zuber-Skerritt, (1990) provides a list of key words which describe Action Research: practical, participative and collaborative, emancipatory, interpretive, and critical. It is about people reflecting on and improving their own practice by juxtaposing action and reflection in a forum of people interested in improving their respective practice.

The relevance for extension is in the acknowledgment and respect of the individual’s experience and the process by which participants are able to question their own practices and in doing so, better understand them.

The principles outlined above are informed by the following theories:

**Critical Theory**

The aim of Critical Theory is to “transform the (real) world by raising the consciousness of participants so that they are energised and facilitated toward transformation” (Guba, 1990). Nature is seen through a value window and therefore is not ‘real’. However the approach seeks to eliminate false consciousness and rally participants around a common (true?) point of view (Rosenau, 1992).

Knowledge must be situated historically and cannot be a matter of universal and timeless principles. Critical Theory acknowledges that there are real objects out there in the world but when it comes to describing them, there may well be different meanings assigned to those objects by different people. The inquiry then, focuses on both the understanding and the practical transformation of the social conditions necessary for emancipation and empowerment (Gregory, 1994).
Critical Theory draws on a critical version of hermeneutics which seeks to uncover the causes of distorted communication and understanding. (Hermeneutics means interpretation and reinterpretation). These distortions are formed historically hence the emphasis on history. Rosenau, (1992) describes it as seeking to probe the “silences,” to uncover a deeper meaning, masked and hidden perhaps, but waiting to be discovered.

The relevance of this theory for extension is in the process which focuses on understanding the different meanings individuals assign to the same object or situation. These meanings are distorted because the communication is distorted and so there is an emphasis in uncovering the causes.

**Constructivist Theory**

Constructivist Theory focuses on “the presentation of multiple, holistic, competing and often conflictual realities of multiple stakeholders..... ‘Reality’ exists only in the context of a mental framework (construct) for thinking about it” (Guba, 1990, p. 73). Any changes, then, will be of the individual’s mind not of the ‘real’ world.

Constructivism restores humans to the centre of the inquiry process and in so doing, provides a new perspective on the change process, and is empowering and emancipatory (Guba and Lincoln, 1990). It departs from the traditional belief that human activity can be reduced to the approximation of a single reality and that research can: generalise its findings; maintain precise and controlled measurement; and present reality as it really exists.

It assumes that the social system is value laden, complex and somewhat idealistic. The outcomes are not precisely quantifiable and not necessarily factual (in a hard science sense) but are interpretive. Constructivists accept that a given explanation can never be established as unequivocally true. The challenge then, is to work toward a consensus among the holders of the differing constructions.

The importance of this theory in extension practice will be that in a group, there will be many legitimate and sometimes conflicting, views expressed about the situation under discussion.
There will be no single “right” answer and so the EO must be able to guide the group to acceptable decisions based on the best possible information available to the group.

**Critical Systems Heuristics**

The belief of Critical Systems Heuristics is that no amount of fact or expertise can justify the experts claim to present an objective account of the problem, because by defining the problem in the first place, the experts have acted subjectively and hence, their argument will be no more compelling than that of the layman (Ulrich, 1993).

In the literal sense: Critical because value and experience-based judgemental choices are made; Systems because we are dealing with the reality of complexity and chaos; and Heuristics because we are allowing or assisting to discover. Heuristics, described in a metaphorical sense, is like climbing a cloud-covered mountain and not knowing what the view is like from the summit. However the climber/s know of the need to take upwards steps to get there.

Problems with the practicability of holism in systems theory, have led to the use of “boundary judgements” in overcoming the dilemma of having less complex and manageable systems and risking inadequacies in problem definition or the converse. Ulrich, (1993) argues that practicability is achieved by grounding methodology on a practicable concept of rational argumentation by allowing unequal people (unequal in knowledge, experience and ability to present points of view) to participate equally and argue equally with others regardless of their power, expertise and argumentative skills.

The most fundamental concept, according to Ulrich, (1993), is the “context of application” (that is, the value judgements which underlie the system and the practical consequences it may have for those affected by its implementation). In any discussion where there will be disagreement, it won’t be taken for granted that the side which puts up the best argument, will win the argument. On the contrary; Critical Systems Heuristics is about presenting the question of what is the ‘right’ context of application. The process of determining the context of application begins with some premises and ends when no further questions can be framed.
It will then be a matter for the group to decide whether to take some practical action or whether there is a need for more information.

Critical Systems Heuristics clouds the distinction between questions of ‘fact’ and questions of ‘value.’ This is done by framing discourse around the opposing questions of what is and what ought to be.

The applicability of this theory to extension is the realisation that the expert acts subjectively and therefore should not have a greater claim to being right. Any participant should have an equal say and any decisions taken by the group must reflect the context of those effected by the implementation of that decision.

**Appreciative Systems**

Appreciative Systems Theory was developed by Geoffrey Vickers in 1980. The concept attempts to explain the cyclical process of perceiving reality and the judgements we make in doing so. The model, (see Fig 1) developed by Checkland and Casar, (1986) begins with the Lebenswelt - the continual complex interaction of ideas and events, which together make up an individual’s learning and life experiences (Woog, Kelleher and Andrews, 1990). At the same time, individuals carry around a store of past experiences. This store comprises both recollections of actual events as well as ideas which arose from reflections of those events. The store is continually modified as the individual experiences new events, makes judgements about them and reflects on them.

The theory assumes that people in general have an ability to select and choose relevant information. This information is judged as good or bad, acceptable or not acceptable. It is then used as the basis for decision making on further action.

Time moves on and this action becomes history and will influence the judging of the next lot of information and so on (Forbes, 1983). Checkland and Casar, (1986) refer to this process as an appreciative system. The feature of this system is that of “relationship maintaining” (largely unconscious) rather than “goal seeking.” (largely purposeful)
The more complex the subject matter, the more we rely on judgement in determining what are relevant "facts." These judgements can be either "reality" or "value" and correspond with those observations of "fact" and a comparison then with some accepted norm. Often this norm is not clearly articulated nor is it able to be articulated, but has an effect on an individual's judgement.

The basic structure of an appreciative system is presented in Figure 4.

![Diagram of the Basic Structure of an Appreciative System](image)

*Figure 4 The Basic Structure of an Appreciative System (Checkland and Casar, 1986)*

This is a simplified model of the system. The "flux" is also referred to as *Lebenswelt*. Appreciation is brought about by our ability to select and to choose.

Appreciation perceives (some of) reality, makes judgements about it, contributes to the ideas stream, and leads to actions which become part of the events stream.

Appreciative Systems Theory will assist the EO to understand more about the decision making process by: acknowledging that people have an ability and freedom to choose relevant information. The relevance is judged by comparing the information to a set of standards which the individual has developed over time in response to the flux of events and ideas which the person has experienced.
Adult Learning Theory

The important point here is that there is a marked difference between the way a child and an adult learn. A child, argues Kolb, (1984), learns by responding to symbols in his/her immediate environment. S/he has a limited store of experiences from which to draw on in order to make sense out of existing and/or future experiences. The adult, on the other hand, is able to draw on past experiences and hypothesise on some possible action and will only learn when they want to learn (Gregory, 1994).

Adult Learning is a process in which the learner is in command as s/he continually seeks a better understanding of his/her social and physical environment (Salmon, 1981). Knowledge is a transformation process continuously created and recreated through this process as opposed to being the “end product” (Kolb, 1984).

The underlying assumptions in Kolb, (1984) are: that ideas are not fixed and unchangeable elements of thought but are formed and re-formed through experience; that learning occurs in the interplay between an individual’s expectation of an event and the actual experience of that event; that to be effective, learners must have the ability to:

- involve themselves fully, openly and without bias in new experiences;
- reflect on and observe their experiences from many perspectives;
- create concepts which integrate their observations into logically sound theories; and
- use these theories to make decisions and solve problems; that learning involves the integration of thinking, feeling, perceiving and behaving (also in Senge, 1990).

The mature individual will be one who can hold multiple worldviews at once (Woog and Bawden, 1995).

The relevance of this theory for extension is in understanding that adults learn differently to children and only when they want to. The EO therefore must be able to provide opportunities where participants want to learn and by the application of a process which encourages the participants to examine the differences between their expectations of an event and what actually happens.
Working Philosophies

The Literature Review and theories guiding the research have provided ideals which inform and guide the inquiry but don’t predetermine the outcomes of the inquiry. They are expressed as opposites to assist in contrasting what is proposed and what exists at present. These are:

- Learning as opposed to knowing
- Discovery as opposed to getting it right
- Complexity and chaos as the normal state as opposed to reducing it to clear manageable models of reality
- Respecting local knowledge and constructions of reality as opposed to fitting existing states to a model of reality
- Inquiry boundaries have to be set to capture the context (those above) as opposed to being determined by objectives or expectations beyond the system under study
- Equality and humility in the inquiry as opposed to yielding to the dominance of the expert
- Critical reason as the countervailing point of view to expertise.
- Deliberately identifying the intellectual vision as opposed to acting by instinct and experience alone.

3.2 PROPOSITIONAL QUESTIONS

The literature review, coupled with my own critical reflection of the workplace in terms of extension theory and practice, have provided the background and contextual setting for this research. Based on the theories informing this work, a number of working philosophies have been developed (see P.53). By considering both these facets, the following propositional statements have been made:

- It is difficult (if not impossible) to pre-determine the objectives of an extension program as an “outsider” and still accommodate the inherent complexity and chaos of the contextual and value-laden systems in which farmers operate.
- A methodology, informed by Adult Learning, Critical Systems Heuristics, and Appreciative Systems theories, will close the gap between Government and farmers,
overcome the inequality of service delivery and acknowledge the indigenous local knowledge of the farming community. This will also address the inequality of communication between Government “expert” and the farmer.

- The dynamics of this methodology will improve the discourse among the farming community (including EOs) and provide EOs with an ‘informed’ approach to carry out their work and therefore meet the demands of both their clients and employer.

- Best Practice as a concept can be used to facilitate critical discourse.

- A learning environment is needed to facilitate critical discourse.

- A learning environment can be purposely created by using local knowledge, basic group rules and a time and place suitable for participants.


Extension processes which focus on the technologies are irrelevant, ineffective, inefficient and inefficacious in the post-modern world of agriculture. An extension process focussed on learning, discovery, complexity, local knowledge, context, equality, critical reason and the individual’s construction of reality, will provide a purposeful direction for a currently ‘rudderless’ extension.

**Grounding the Ideas Through Current and Proposed Experience and Theory**

The argument for a new model is based on both personal experience and observation, and on the writings of Basta, (1995), Frank and Van Beek, (1994), Stewart, (1994), Russell, (1994), Woog, Kelleher and Andrews, (1994), Green and Kreuter, (1991), Webber, Ison, Mc Clintock, Russell, Dignam and Davey, (1993) and Keith and Hobson, (1993), who state that we need to get rural communities involved in extension and that we need real participation. To achieve this, we have to establish higher levels of trust, use more holistic thinking and risk new approaches. We need to provide a mechanism to empower individuals to enter into critical conversations with politicians, government agencies and other community members. The reason for the use of critical discourse as opposed to plain conversation is the need for context to be given by participants. With normal conversation, people tend to speak superficially.
about issues unless there is a good relationship between conversers. EOs don’t have the luxury of time to develop these relationships and therefore must be able to provide an environment in which critical conversations can occur without the participants feeling threatened and within a short time.

It is the belief that once people are able to contextualise their own situation, technologies will become relevant. The very process of developing these contexts through critical discourse in a group setting, assists the others to better understand themselves and their peers. A parallel to context is comprehension. We can’t expect to make good judgements and then decisions for action, without fully understanding the situation. This understanding has been lacking in conventional extension because rural people have not been given the opportunity to converse critically with the “experts” in a language which is common to both parties and which ensures a sense of equality and validity in rural people’s side of the argument.

There have been cases where Government have gone to the people to seek their views (called “consultation”) on proposed new legislation, which is encouraging. However, the result of this has been a feeling among those who were consulted that the outcome was already decided and that consultation was in fact “insultation”. This feeling could be overcome if participants were given the opportunity to really participate in critical conversation where their views are valid and where the validity of the “experts’” claims are challenged.

The same can be said for current extension services.

Having made these assertions, the next chapter will discuss an inquiry method which will address them.
CHAPTER 4

METHODOLOGY and METHOD

INTRODUCTION

This chapter will outline how and why the research was conducted. It will then argue the choice of research in the manner outlined in the Method section and what theoretical basis underpins it. This discussion will then lead to how the choices made are justified in relation to techniques used, the alternatives considered and the validity of the outcomes.

METHODOLOGY

How and Why the Research was Conducted

Before outlining the position of the research, Blaikie, (1993), Denzin, (1989), Patton, (1990), Stewart and Shamdasani, (1990) and Polkinghorne, (1983) argue that no single research approach or strategy will provide a perfect solution for the researcher. In fact, all approaches involve assumptions, judgements and compromises (bifurcations) and all have deficiencies. However, when the researcher makes a clear indication of stance in relation to ontology, epistemology, methods and methodology, it is then possible to argue the relative merits of the approach chosen. Dick, (1989) says that many researchers try a method and if it doesn’t succeed, they will try another and so on until they find one that does succeed. In other words, there is a lack of rigour. Denzin, (1989) agrees and believes that this deficiency can be improved through the re-marriage of theory and method or methodology.

Denzin, (1989) and Reason, (1986) agree that the research should be based on three assumptions:

1. Social reality is a social production and that people produce and define their own definitions of situations;

2. Humans are capable of shaping and guiding their own behaviour and that of others; and

3. Humans interact with each other when taking their own standpoint and fit it into the behaviours of others.
The research situation needs to be considered from two perspectives represented by the diagram in Figure 5.

![Diagram](image)

*Figure 5 The Different Research Perspectives*

From the diagram, it is evident that the research was conducted from the broader extension theory and practice perspective within which the study of On Farm Best Water Management Practices was used to (i) identify and discuss issues related to the concept of “Best Practice” and on farm water management and (ii) test an extension model based on a deliberately identified theoretical approach. Hence the containment of the smaller circle within the larger circle.

**The Broader Extension Theory and Practice Perspective**

Prior to the commencement of this post-graduate research program, issues had emerged from undergraduate research work, graduate research work and extension practice in relation to the relevance of current extension processes to the industries they were servicing. These issues were the impetus to engaging in this investigation.

During the initial stages of this investigation, there was a clear need to undertake an intense field work program in order to further analyse these issues. Following negotiation with
employer management, a one year project funded by the National Landcare Program (NLP) was developed and successfully financed.

**Burdekin On Farm Best Water Management Practices**

To satisfy the NLP and employer expectations, the Burdekin River Irrigation Area (BRIA) was the focus of the field component. The BRIA was chosen for its close proximity as well as to respond to concerns expressed by some irrigators in relation to rising ground water and salinity. Employer management has a charter for improving natural resource management and so decided that the concerns expressed would be best addressed by investigating on-farm water management practices with a view to documenting the “best” of these.

The research followed a sequence of events which are represented in Figure 6. A brief explanation of this model will follow. Beginning in the top left-hand corner, there were a number of elements which set the boundaries on the process. The theoretical framework outlined in Chapter Three, formed the basis of the research process, as did the Funding Body requirements in terms of project objectives outlined in Chapter One. The research team was employed by the Department of Primary Industries in other capacities, and so the time allocated to this project had to compete with time allocated to other core activities. These other core activities were expected to be carried out effectively, efficiently and in a timely manner which meant the research process had to be flexible enough to suit all. The final influence was seasonal activities which were carried out by farmers during the course of the research. At the commencement of the project in February, many farmers were planting cane. There was limited free time once this was completed before crushing began in June. This activity continued until early December. The result again was a research process which was flexible but still able to deliver the many outcomes required by the different stakeholders.

Once the enquiry was designed, the data collection began by interviewing farmers individually on their farms because it was easier to organise, it would fit in with the individuals work program and would give the researchers a clear picture of the issues affecting farmers in relation to water management. This phase revealed that on-farm water management could not be considered alone without regard for water management before and after the farm itself. From this revelation, a second phase was initiated. The results then were categorised in terms of the current practices, the “best” practices and implications for extension theory and practice.
Figure 6 The Research Process
Rationale for the Choice of Methods

The method was chosen for a number of reasons.

**Firstly,** the theoretical position outlined in Chapter 3, indicated that the following aspects should be considered in developing the research process:

- people are the centre of the inquiry and outcomes are interpretive (Constructivist Theory)
- adults are able to draw on past experiences and hypothesise on possible action. Learning occurs when there is a deliberate consideration (reflection) of the interaction between the hypothesis and the actual experience of it (Adult Learning Theory)
- people have the ability to select and to choose relevant information and that judgements about both ideas and events are made through experience and that these judgements are used to guide future decisions. The design then must incorporate and appreciate the interdependence of both the judgements of the participants and the events which are the focus of the research (Appreciative Systems Theory)
- people should be given the opportunity to participate equally regardless of power, expertise or arguing skills (Critical Systems Heuristics Theory)
- people should be given the opportunity to uncover the causes of distorted communication and move towards a common point of view i.e. Best Practice (Critical Theory)
- there is a need to present the many competing realities of people (Constructivist Theory)
- there should be acknowledgment and respect for individuals and the focus should be on providing an opportunity for people to reflect on and improve their practice (Action Research Theory)

**Secondly,** the expectations of the funding body (NLP) which are outlined on Page 8.

**Thirdly,** in response to discussions with the Bureau of Sugar Experiment Stations (BSES) extension staff. The discussions were held with BSES for these reasons:

- strengthen links between this project and BSES research and extension work;
- prevent duplication of extension activities in the BRIA;
- discuss the method, timing and focus areas for the investigation.
These discussions presented a bifurcation due to both “shed meetings” scheduled by BSES which would clash with the timing of this project and cane planting activities which were to commence soon after the “shed meetings” and make groups of farmers difficult to organise. A decision was made to conduct the research in two phases. Phase I was to commence immediately and conduct one-on-one interviews, using the semi-structured interviewing technique, of 30% of growers in the BRIA. Phase II was to commence after the completion and assimilation of the Phase I interviews and involve small groups of farmers located in the different sub-districts of the BRIA using the focus group technique. This approach would also give the research team a sound appreciation of the farmers’ issues in relation to water management as a result of the Phase I work, which would then provide a robust basis on which to formulate questions to be posed for the group activity in Phase II.

DATA COLLECTION

Semi-structured Interviews
Semi-structured interviewing is a form of guided interviewing of an individual where only some questions are predetermined and new questions or lines of questioning arise during the interview, in response to answers from the interviewee (Conway, McCracken and Pretty, 1987).

The aim of this technique is to start with a limited number of pre-determined broad questions which will lead to discussion. This method ensures that the interviewed persons address issues which are important to them. They have the freedom to set the direction they want thus enabling the investigation of social processes and relationships as opposed to quantifying something (Gamble, 1989 and Patton, 1990).

Data gathered using this technique allows a “rich picture” of a situation to be developed by utilising the diversity of backgrounds, values and experiences of the interviewees and interviewers (Gamble, 1989).

Patton, (1990) adds that observation is also very important because it complements what is said and thus often provides a higher order of data representation. For example, alone, words
on a page which represent what was said will miss the tongue-in-cheek remark which was punctuated with a laugh and therefore, convey a totally different meaning. The use of tape recording can be used to overcome part of this problem but cannot record the facial expressions and body language which observations will capture.

**Focus Groups**

Focus group interviewing is a qualitative approach which enables the researchers to obtain data, in the form of ideas and diagnostic information, about feelings and opinions of small groups of participants about a given problem, experience or service (Gamble, 1989 and Stewart and Shamdasani, 1990).

The aim is to gain a feel for what the issues are from a particular section of the community and to determine the spread of responses and the assumptions underlying these. To do this, the facilitator must develop an atmosphere which promotes freedom of expression and where each participant feels respected as a person (Gamble, 1989). (refer to Goldman and Schwartz-McDonald, 1987)

**Alternatives Considered**

There are three major methods used to elicit information from a sample of individuals:

1. the face to face interview;
2. the mail questionnaire; and
3. the telephone survey (Nachmias and Nachmias, 1987).

This section will examine these and identify why they were not used in this research as described by Nachmias et al, (1987), Polkinghorne, (1983), Patton, (1990), Moustakas, (1990) and Rhoades (1990).

The face to face interview, (in particular the schedule-structured interview) even though it yields the richest data, was not used because it occurs within a relationship context. The deeper the relationship, the more open the response. Due to the time limitations, the
relationship context could not be developed beyond a one-off interview event. In addition, questions, their wording and their sequence are fixed, determined in advance and are identical for every respondent. Consequently, interviewees must fit their experiences and feelings into the researchers categories, and in doing so can distort what interviewees really mean by completely limiting their response choices.

The other extreme of the face to face interviews is the *non-structured or non-directive interview*. No predetermined set of questions is used, nor are the questions asked in specific order, instead they emerge from the immediate context. Respondents are encouraged to describe whatever events seem significant to them, to provide their own definitions of these situations and to reveal their opinions and attitudes as they see fit. This technique was not used because there were pre-set objectives determined by the funding body which had to be met. The risk of these not being met was considered too high using this technique.

The *Mail Questionnaire* was not used due to the difficulty in obtaining an adequate response rate. A typical response rate for face-to-face interviews is around 95%, whereas that for a mail survey is between 20 and 40%.

There are many other major limitations (Rhoades 1990):

- Mail questionnaires can only be used when the questions are simple and straightforward enough to be comprehended with the aid of the printed instructions and definitions.
- The answers or responses must be accepted as final; there is no opportunity to probe beyond the given answer or to clarify ambiguous answers.
- The researcher cannot be certain that the correct person completes the questionnaire; somebody other than the intended respondent may complete it.
- The respondent can see all the questions before answering any one of them, so the various responses cannot be regarded as entirely independent.
- What people say is not what people do.
- The context of an activity is not revealed.

If these limitations are of little significance to a concrete research objective, the mail questionnaire might be implemented in place of the face-to-face interview.
The *Telephone Survey* was not used because only simple, superficial questions can be posed and it is difficult to obtain detailed information.

**DATA ANALYSIS**

The nature of analysis should be determined by the research questions as well as the purposes for which data are collected (Stewart and Shamdasani, 1990 and Patton, 1990). The discipline and rigour of qualitative analysis depend on presenting solid descriptive data, which is often referred to as "**Thick Description**" (Geertz, 1973, Denzin, 1989 and Patton, 1990). The presentation of these “thick descriptions” must be done in such a way to enable others reading the results to understand and draw their own conclusions. “Thick Descriptions” have the following characteristics:

- they go beyond the mere reporting of an act
- they describe and probe the intentions, meanings, context, situations and circumstances of action
- they are interpretive and
- create conditions for “**thick interpretation**”

In the analysis, there is a need to balance critical thinking and creativity (Patton, 1990). Data should not be forced to fit pre-conceived themes because a lot can be gained by looking at those aspects which disagree with the identified patterns and trends (Patton, 1990). Raw data must be revisited many times to check the meanings made from the data.

**Inductive Analysis**

This type of analysis (Patton, 1990, Blaikie, 1993 and Polkinghorne, 1983), means that patterns, themes and categories of analysis come from the data and that they emerge out of the data rather than being imposed on them prior to data collection and analysis. Inductive Analysis uses both Indigenous concepts (those developed by the participants) and Sensitising concepts (those brought to the data by the researcher).
Any analysis should begin by the researcher immersing him/herself in the data and then looking for patterns, identifying surprising phenomena and being careful in highlighting inconsistencies. The processes may result in new concepts being developed or just a reaffirmation of an existing idea (Bryman and Burgess, 1994).

Bryman and Burgess, (1994) suggest that a distinction be made between analysis made in the field and analysis made after data collection. They argue that the former requires the continual review of field notes, development of new questions and recording ideas about emergent themes. The latter focuses on the development of a coding system which may incorporate headings like, setting/context; interviewee perspectives; interviewees thoughts about people and objects; process; and personal relationships.

Two steps in data analysis require different types of thinking, argue Bryman and Burgess, (1994):

1. Organising raw data to make it manageable which is a fairly mechanical process but does include some interpretation e.g., deciding on theme headings.

2. Drawing out an understanding about what the data is saying which is an intellectual process and requires the researchers to step back and see the data as a whole but with all its intricacies, complexities and relationships.

In this research, a combination of semi-structured interviewing and focus groups was used to collect the data. During the analysis phase, a combination of thick interpretation and inductive analysis was used.

**METHOD**

Any decision on the method selected for data collection should result from careful consideration of:

- the purpose of the inquiry;
- the questions to be investigated; and
• the resources available.

Therefore, the method will be appropriate regardless of the paradigm espoused (Patton, 1990).

From the theories outlined previously, a choice of technique to use to collect and analyse data was made. The technique was to take steps to create an environment which was conducive to presentation of underlying assumptions by the participants at the group meetings. Discussions relating to either the affirmation of, or disagreement with these assumptions provided the data needed and highlighted areas for further investigation. This type of interview is referred to by Dick, (1989) as convergent and has a structured process and an unstructured content. The other types of interview are:

• Structured, which have a structured process and structured content
• Sensing, which use an unstructured process and unstructured content.

The process of convergent interviewing, argues Dick, (1989), begins with interviews, using broad questions, of the most representative and most different people. Critique of these interviews highlight areas to probe in subsequent interviews. Areas to probe are those where there was agreement and disagreement. Where there is agreement, questions are asked to determine when it isn’t true. Where there is disagreement, questions are asked to explain it. Interviews continue until no new data is revealed. If time and cost are strict constraints, then this method may not be suitable, because there is no way of pre-determining how long the data collection will take until no new data is revealed.

In order to provide stimulating questions for discussion at the group meetings, the research team required a good understanding of the issues facing canegrowers in the area. In addition to this, the annual cane planting had begun, and the research team felt that groups of farmers would be difficult to organise.

Due to the limited time available for this project (12 months), a sample of 30 of the 280 BRIA farmers could be interviewed. The farmers to be interviewed, were randomly selected from lists of all growers in each of the areas in the BRIA, namely, Dalbeg, Millaroo, Clare, Mulgrave, Northcote, Jardine, Selkirk, Haughton, Giru and Leichhardt, with farms being served by channel, river or ground water supplies or a combination of any of the three (see locality maps in
Appendix One). The lists of farmers were generated from the Water Resources Client Services data base on an area basis. From these lists, approximately 10% of each grouping were randomly selected for contact. The research team contacted these farmers by telephone explaining the project and asking them if they would be interested in spending about one hour discussing issues affecting on-farm production. A mutually suitable time and date was agreed upon.

The Delta area farmers who number about 500, were not targeted because BSES staff were carrying out research and trial work in this area. However, there were farmers selected from the BRIA who also owned one or more farms in the Delta area.

The interviews were carried out in an open format with growers asked questions relating to 4 broad themes.

1. Size and Nature of your enterprise (including recent developments).

2. Views on the industry generally, and specifically regarding on-farm production.


4. Sources of information used.

The information gathered from this phase was used to present an outline of the current situation to assist the second phase of data collection using groups of growers and research and extension staff. There were three growers groups and three research and extension groups involved. The grower groups were selected from the same lists used for the individual interviews. The method used for each group varied slightly depending on the make-up of the group (farmer or research and extension) and on critique of previous group discussions (more detail on method is discussed on pages 69 to 80).

Generally speaking, data collection was guided through questions designed to allow the participants to express their own views.
PHASE 1 - ONE-ON-ONE DATA COLLECTION

Background

Prior to generating a list of growers from which to randomly select potential interviewees, contact was made with the BSES. (BSES is the primary RD & E body for the cane industry). The reasons for this contact were to update the Bureau on the project and to establish what research and extension activities it was currently running and any others it was planning to conduct over the next 12 months.

From this discussion, it was agreed that growers in the Delta area would not be included in the project. The research team was also informed that there was significant ill-feeling toward the Water Resources section of the DPI in that area due to rumours that Water Resources was going to put meters on the delta growers’ groundwater pumps and charge them for this supply. One of the BSES Extension Officers said that he would not like to be seen in any DPI car in that area.

With this information, the researchers generated a list of growers from the Dalbeg, Millaroo, Clare, Mulgrave, Northcote, Jardine, Selkirk, Haughton, Giru and Leichhardt areas of the Burdekin. A random selection of this list was contacted by telephone for on-farm semi-structured interviews. The research team experienced an average of one refusal every four farmers contacted.

The following questions were asked at these interviews:

1.
   • Size and nature of the enterprise
   • location of blocks (If more than one)
   • recent or intended changes and trends
   • method of operation - yield, water allocation, drill length, irrigation method, pumps used.
2.
- Views on issues facing industry
- Views on issues effecting on-farm production
- ways of improving production

3.
- Current practices - irrigation
- - fertilising
- - crop cycle

4.
- Sources of information used in decision-making
- Adequacy of current services.
- Changes to current services and why.

Recording was done manually by one of the two interviewers.

Following each interview, the interviewer and recorder discussed the overall feeling from the interview. These comments were recorded to give the interviewer an opportunity to pick up comments the recorder may have missed and to make general comments from his perspective.

The data gathered from the questions was analysed by the research team by brainstorming the issues which were the most frequently mentioned.

The next step for the researchers was to re-check these outcomes with the raw data sets in order to determine the major themes. This re-checking allows the researchers to both confirm the validity of their initial thoughts and to uncover those which the researchers have overlooked. From this activity five themes became apparent:

1. Policy and Development of the area
2. Water Supply - Pre-farm Gate
3. On-farm Management Practices and Trials
4. On-farm Services and Advice
5. Environmental Considerations.

To ensure these themes represented the data collected, the raw data was again re-visited. From this activity a sixth theme emerged - Other Issues - which was a grouping of those comments which were incongruous with the other five and could not represent a single theme.

PHASE 2 - GROUP DATA COLLECTION

Background

To gain a deeper understanding of the issues facing farmers in relation to on-farm water management, group discussions were conducted. The assumption here was that interaction in the groups would uncover more than that uncovered in one-on-one discussions. There was also a requirement that the discussions needed to be grounded in a legitimate expression of viewpoints of all participants rather than of those who have the power to influence (Geertz, 1993). The discussion resulting from this was not aimed at consensus but rather a full exposure of the extent of factors which influenced a farmer’s decision to act. So in this environment, disagreement was not considered a failure but rather an opportunity for further investigation and understanding. To aid this, the researchers needed to create an environment in which participants were willing to challenge each other.

The learning theory / critical conversation theory has pointed towards the need to establish some agreed ground rules or guidelines within the group, to encourage participants to actively question and challenge assumptions made by themselves and others. This process provides insights and understandings via the presentation of the “richness of context” within which individuals formulate judgements of their world.

Six groups were involved in this phase of the project. Three were grower groups drawn from areas the researchers felt were fairly homogeneous in relation to soils, age of area and geographic location. These areas were: (i) Clare, Millaroo, Dalbeg, grouped based on the area being the oldest, a long distance from town and most farms having short drill lengths;
(ii) Northcote, Mulgrave, Jardine grouped based on long drill length and problems with obtaining enough water during peak demand; and (iii) Leichhardt which stood alone due to the existing groundwater problems and being located on the opposite bank (right) of the river. The other three groups were drawn from the research and extension fields. They were: (i) Water Quality Research; (ii) BSES Extension; and (iii) DPI Farm Development Group.

<table>
<thead>
<tr>
<th>Farmer Groups</th>
<th>Number Contacted</th>
<th>Accepted</th>
<th>Attended</th>
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<tr>
<td>1</td>
<td>15</td>
<td>6</td>
<td>3</td>
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<td>11</td>
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<table>
<thead>
<tr>
<th>Research and Extension Groups</th>
<th>Number Contacted</th>
<th>Number Accepted</th>
<th>Number Attended</th>
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The farmer groups were selected from lists generated from the Water Resources Client Services database. These lists were grouped in relation to the areas mentioned previously and from these, about fifteen farmers were randomly selected. A letter (see Appendix Two) was sent to each of these farmers introducing the project, outlining the progress to date and the intention to conduct some group meetings. About one week prior to the planned group meetings, telephone contact was made beginning with the first farmer on the list, inviting him/her to a meeting at a nearby community gathering place, to discuss best on-farm water management practices. This process continued until six confirmations were gained. Often, all fifteen on the list were rung before six farmers would agree to attend.

The research and extension groups were selected based on their core functions. Water quality researchers were drawn from the major organisations involved in this area, namely the Australian Institute of Marine Science (AIMS), the Great Barrier Reef Marine Park Authority (GBRMPA), the Australian Centre for Tropical Freshwater Research (ACTFR) the
Department of Primary Industries (DPI) and the Department of Environment and Heritage (DEH). Extension officers were drawn from the major extension agency, the Bureau of Sugar Experimental Stations (BSES). The DPI Farm Development Group consists of a soil scientist, an agricultural economist, an agronomist and a farm layout design engineer.

Each of these groups were contacted firstly telephone and then by letter confirming the date, time, duration and location (see Appendix Three).

THE FARMER GROUPS

Purpose

Using issues raised during individual interviews, the research team intended to:

- gather more detail on issues in relation to the context within which decisions regarding on-farm best water management practices are made,
- highlight differences (if any) between espoused best practice and that which is actually carried out.
- Discuss reasons which prevent/constrain farmers using best practice.
- Test propositions outlined on Page 54.

Outcomes Expected

- deeper understanding of the context within which farmers make decisions about water management and therefore
- demonstrate the complexity of decision-making with what is actually best water management practice.
- Demonstrate that there is no fixed suite of best water management practices - they vary depending on many circumstances.
- Confirmation of proposition.
Rationale

Variations in soil type between areas in the BRIA, make group discussions difficult because the soil types affect most management practices and therefore discussions in such a group will not yield consensus on best practice. To minimise this problem, groups were selected based on both uniformity of soil type and geographic location. Variations in soil type on-farm still occur in this area, but these variations are common to most growers. It was felt that some of the growers may not know each other and this unease often detracts from the value of discussion. To overcome this, a BBQ lunch was included at the start of the meeting, to give the participants a chance to relax in each other’s company.

All growers are currently harvesting and so time away from the farm is an important consideration. A meeting venue within easy reach was used and a time limit of three hours (including lunch) was specified before the workshop day. It was felt that with a definite time, growers could plan around our meeting.

Canegrowers generally deal with the BSES staff, who are production oriented. The type of workshop we planned would probably be unfamiliar to them. To counter this, the workshop format was planned and is described below.

(i) The First Farmer Group (Clare, Millaroo, Dalbeg)

The process used for this workshop is illustrated in Figure 7

An attempt was made to overcome the problem of the person recording, missing out on being part of the discourse. It was done by giving each participant a different coloured pen and asking them to record their own comments on a piece of butcher’s paper laid out on the table we were sitting at. The guidelines were discussed first and then displayed in a prominent position and was a way of encouraging the group to openly challenge each other (including the researchers) in a non-threatening environment. It was assumed that this type of discussion, Critical, would provide a much better understanding of the issues facing growers in this area.
(ii) The Second Farmer Group (Northcote, Mulgrave, Jardine)

In response to the analysis of the first group meeting, a number of changes were made.

- To overcome the poor attendance issue, letters were sent to randomly selected farmers inviting them to attend a workshop at the prescribed time, place and date. A follow up phone call was made to ask for confirmation of attendance. Finally a reminder letter was sent to those farmers who indicated that they would attend.
- To overcome the problem with recording the discussions, a tape recorder and conference microphone were used.
- To ensure more frequent referral to the guidelines, these were typed in 18 point bold font and laid out around the table (see Appendix Four).
- The brainstorming activity was not used. Instead, a number of critical questions were developed by the research team from previous data (see the third farmer group below).

Lunch was not provided in order to maintain the overall time of the workshop while increasing the time spent on discussions.
Figure 7 The Farmer Group Workshop Process
Despite all the preparation and that 5 growers said they would be there, only one turned up. Some informal discussion was carried out with this grower.

The Research Team attempted to explain this poor attendance with the following interpretations:

- Growers in the BRIA don’t see on-farm water management as a major issue.
- Growers are more concerned about DPI Water Resources than on farm practices.
- Growers are currently harvesting and this must take priority over everything else.
- Growers are over serviced and don’t feel comfortable in a group

(iii) The Third Farmer Group (Leichhardt)

The workshop process did not differ much from that planned for the second farmer group meeting. The Research Team posed a number of critical questions which were developed in response to data analysis to date. These questions were:
- When you irrigate, what do you want to happen (ideally)?
- What difficulties have you faced in achieving this ideal?
- How have you overcome these difficulties?
- Given the opportunity, what would you do differently?
- What would that opportunity be?

The attendance was the best of the farmer groups with five out of seven invitees participating.

As with the other groups, guidelines were made available to encourage participants to openly state their views and to begin to uncover some of the underlying assumptions in relation to on-farm water management.

The workshop was planned to run for two hours to enable adequate discussion but without taking too much time out of seasonally busy days.

The workshop concluded with an invitation for a cup of tea or coffee.
THE RESEARCH AND EXTENSION GROUPS

(i) The Water Quality Research Group

Purpose

Present current water quality research
Discuss emerging trends and predictions
Work on acceptable water quality standards for discharge and use.

Outcomes Expected

Trends and their urgency
What is acceptable discharge and why

Rationale

Water management on-farm has impacts beyond the farm gate. With inefficient water management, comes increased runoff and surface drainage and increased accessions to groundwater. These impacts are not only in terms of volume and flow velocity (that is, quantity) but also in the transportation of nutrients either dissolved in water or attached to sediment (that is, quality) (the latter being responsible for most of the phosphorus export). High salinity drainage water discharged into freshwater systems, also has a high impact. (Water with an electrical conductivity greater than three deci-siemens per meter (dS/m) is considered high). Recent release of the Environmental Protection Act, will mean these off-farm (downstream) affects could be deemed “environmentally relevant activities” and as a result, be open for prosecution. It is therefore in the whole community’s interest, that on-farm water management be investigated. This investigation is difficult without understanding what is acceptable discharge from a farm or farms. If the current best on-farm water management practices, fall short of the standards for discharge quality and quantity, 3 things will need to occur. 1. Adjust on-farm best management practices; 2. Adjust the standards; or 3. Combination of both.
Workshop Process

Representatives from each of the major water sampling / monitoring agencies attended an afternoon workshop at the DPI Office. Attendees were drawn from Department of Environment and Heritage; Australian Institute of Marine Science; Great Barrier Reef Marine Park Authority; The Australian Centre for Tropical Freshwater Research (James Cook University) and Department of Primary Industries.

(ii) The BSES Extension Group

This workshop was conducted at the BSES office in Brandon. Two hours were allotted with all five invitees attending. BSES are the recognised extension service for the sugar industry. The significance of this service is underpinned by their funding which comes from a grower levy, a mill levy and contributions from DPI.

The purpose of the workshop was outlined:
1. Discuss past and present water management research
2. Identify what they consider to be Best Practice - (a) without constraints (b) with constraints (name them) (c) what needs to change to overcome the constraints.
3. Discuss the relationship between water use, crop yield and water loss to deep drainage and run off toward what is the optimum yield for minimum water losses.

The group guidelines were not used during this workshop for the same reasons as the previous workshop.

Capturing the data by one of the research team was aided by the use of a tape recorder which was used after the workshop to cross check the hand written notes, fill the gaps left when discussions moved faster than the recorder and to give the researchers an opportunity to listen to the data.
(iii) The DPI Farm Development Group

This workshop was an informal discussion between one of the research team and two out of three invitees. The informal nature of the discussion was due to the participants being well known colleagues of the researcher.

The Farm Development Group is a multidisciplinary team consisting of a farm layout designer, a soil scientist and an agronomist/irrigation specialist. Together, they provide a pre-auction service to potential buyers of new release farms in the BRIA.

The workshop was held in the DPI office in Ayr and was to run for 90 minutes.

This meeting was tape recorded for the same reasons stated in the previous two workshop. The guidelines were not used because of the open relationship between the participants and the researcher.

Guiding questions were:
1. What do you see as the issues in relation to the development in the BRIA - positive and negative?
2. What changes in practice have you noticed?

The workshop ran smoothly as expected and yielded information mostly from a soils and soil management perspective. This was due to the expertise of the participants and also the absence of a key member of the group. (Discussions with this person occurred one to one at a later date).

There was agreement on most issues with BSES especially in terms of recycling - high land values, Chlorotic Streak, on farm storages - and improving soil management especially in terms of the incorporation of organic matter into the sodics.
DATA ANALYSIS

The researchers could be categorised “observer as participant” in which there is one visit/interview and no attempt is made to establish a relationship with the interviewee (Denzin 1989).

Field notes are considered central to the data recording activity. For this reason, much care was exercised in taking notes. In group situations, a tape recorder was used because with many inputs to the discussion occurring, it is difficult, if not impossible, manually recording what is being said. Tape recording can also overcome biases introduced by the manual recorder.

Following each of the individual interviews, the research team discussed the meeting and recorded any extra information in terms of observations, actual content and general thoughts about what was said. The desire and need to use this process seemed to decline as more and more interviews were completed. This can be explained by the content of the new data generated. If the content was mainly a re-statement of previously stated issues, then a post-interview discussion yielded little. However, if the content was different or conflicted with other information, then the post-interview discussion was useful. There were frequent occasions when the continual re-statement of an issue attracted the attention of the research team and this also yielded useful insights which were later built upon in terms of major themes.

The tape recording was used to check the manual recorder’s notes; fill any gaps and to allow the researchers to look at the whole data set and therefore allowed them to view the intricacies, complexities and relationships. Data was looked at from many different angles and organised to assist in finding other ways to understand it.

The research team met to discuss the data at intervals throughout the data collection phase and began analysing it, in relation to emerging themes which became evident by the frequency of certain responses. Also, conflicting statements were identified and these were used as a basis for discussions in subsequent interviews.
Once the data collection phase was complete, new data was either assimilated into the existing analysis or new themes were developed. From these themes, statements were made regarding best and current on farm water management; pre and post farm water management; and the applicability of the theories used in relation to extension practice.

Apart from responses offered in a numerical format, there was no attempt by the researchers to quantify the data. (See Appendix Five for a summary of Production Statistics).
CHAPTER 5

RESULTS, ANALYSIS AND INTERPRETATIONS

PHASE I: THE ONE TO ONE INTERVIEWS

These interviews were conducted at a time convenient to the growers and on their farms, were easier to organise and the desire to be involved was good. Discussions yielded a wealth of information and generally ran over time, indicating growers were happy to share their knowledge and appeared relaxed in doing so.

There were a small number of interviews which the research team found difficulty in drawing out any useful discussion apart from direct responses to the guiding questions. These growers were happy with what they were doing and did not see a need to analyse their practices in relation to water management. An analysis of this by the research team indicated that a majority of these growers were not intending to pass their farm on to other family members and were happy with their current lifestyle and so did not see a need to make any further improvements to their situations.

At the conclusion of this phase, the research team brainstormed the issues which had been revealed. The rationale was that having just completed such an intensive data collection activity, the most important issues would be those that the researchers could easily recall. This activity was completed in about thirty minutes and yielded the issues listed below.

- Most farmers were aware of BSES evaporation pans. Some had them and found they were not using less water, they were soil specific in terms of soil water holding capacity and plant root depth. Of those who didn’t have them, many looked at neighbours who did have them and found they were irrigating within a few days anyway.

- The rapid expansion of the BRIA was seen by farmers to be driven by Government revenue raising. They also felt that the mills were not keeping pace with the extra production, and that it wouldn’t be long before delays in crushing would occur. In
addition, there was concern about the ability of the water supply system to service the extra farms.

- Many farmers had more than one farm. This was considered necessary to make a living, and to have something to pass onto children. A difficulty was expressed though, in managing the second farm if it was removed from the home farm.

- All farmers found the sodics difficult to wet up and that lateral movement was restricted. Immediate results were seen with the use of Gypsum, however a few farmers were concerned with the extra salt being introduced as a result. Most farmers had noticed an improvement, albeit slow, with the incorporation of organic matter. A few farmers were using saline groundwater to overcome the infiltration problem. These farmers felt that it was better to use salt that already in the system rather than introducing it via Gypsum.

- All farmers noticed a correlation between soil variation and yield variation. This was apparent both within a paddock and between paddocks.

- Most farmers expressed difficulty in getting enough water from the supply channels during peak demand. This problem resulted in farmers using water when they could get it and therefore could not irrigate the way they would prefer.

- The use of tailwater recycling was being constrained by fears of Chlorotic Streak, and the cost and availability of land needed on the farm to operate the system.

- The price of water was considered to be too high and that it was preventing the use of cover crop in the fallow as well as subsidising the rainfed areas.

- There was concern expressed about the lack of consultation between the authorities and the farmers on issues directly impacting on them.

- All farmers were concerned with the mill inefficiencies causing a delay in harvest. These delays lengthened the crushing season which meant a loss in production the following year and that they couldn’t plant a manure crop in the fallow.

- Trash Blanketing was considered by most growers to be beneficial on the lighter soils in relation to soil moisture retention and higher CCS. There were problems though with the excessive dry matter yield of cane varieties making incorporation difficult; many harvesters weren’t able to cut the cane green; slope of the paddock had to be greater than for burnt cane and cross fall had to be minimal; there was an added cost to harvest due to the extra yield; and was not suited to the clays because the blanket keeps the soil wet for too long.
- **Grubs** are a problem on the lighter soils especially those in older areas. Suscon was considered ineffectual.

- There was a general preference not to use chemicals but farmers had to in order to be productive.

- **Laser Levelling** technology has been widely embraced in the BRIA. The reason for this is that there are significant savings to be made in water usage on lasered paddocks. However lasering the plough out block has prevented the growing of a manure crop.

- Farmers expressed concern with the decision making bodies in the BRIA over the practice of **different rules for different people**. They also felt that the big growers were being favoured over the smaller ones.

- If growers were given the chance to start from scratch again, most agreed that they would chose an **even shaped block** because the irregularities cost more to develop and were more difficult to manage.

- Too much **tree clearing** was expressed by a majority of farmers with many believing that problems will worsen as more area is developed. Many saw this extensive clearing in a Government controlled area as hypocritical.

- Many farmers enjoyed the climate and the **lifestyle** and their decision making was influenced toward maintaining it.

The researchers then needed to validate these issues and to uncover any issues which had been overlooked. This meant revisiting the raw data and cross-checking it with the issues listed. Firstly though, the raw data as field notes had to be condensed so that the researchers could perform the cross-checking. To ensure the raw data was accurately abridged and that little meaning was lost, minimal interpretation occurred and the list resulting contained actual comments recorded during the interviews (see Appendix Six for this list).

**Extra Issues Identified**

- **Experience** was considered by many to be the most important **source of knowledge**. Neighbours were considered the second most important and the BSES were also good. However there was concern expressed about the **conflict in advice given** especially in relation to soil test results and fertiliser application rates. Many farmers would seek advice
but would ultimately have to make the decision themselves. The presence of conflict in advice given made the decision more difficult.

- Many farmers agreed that higher *sugar prices* resulted in a higher level of inputs and 100% of the arable area was farmed to take advantage of the economic situation.
- There was a general preference for *longer drills* as a labour and steep cost saving practice. Many growers were concerned though for wet years when the longer drills will make harvest difficult.
- All farmers using channel water were not happy with the low level of *channel maintenance*.
- *Channel water quality* was said to be too good in that it would not penetrate and that growers had to pay more to ameliorate the problem with the use of Gypsum.
- For those farmers who were a considerable *distance from town*, many expressed a problem in down time when breakdown occurred. For those with more than one farm, the *distance to the other farm* made management of that farm difficult.

Once the extra issues had been identified, the next task was to attempt to draw out themes. This involved grouping the issues into higher order assemblages. The major themes which emerged from this phase were:

1. POLICY & DEVELOPMENT OF THE AREA
2. WATER SUPPLY - PRE FARM GATE
3. ON FARM MANAGEMENT, PRACTICES & TRIALS
4. ON FARM SERVICES & ADVICE
5. ENVIRONMENTAL CONSIDERATIONS
6. OTHER ISSUES.
These themes are expanded upon in the following pages.

1. POLICY & DEVELOPMENT

Description

With the rapid expansion and development of the Burdekin River Irrigation Area, concerns were expressed regarding the policies governing and the development of this irrigation area.

Issues Raised

The landholders, in general supported the development of the area and in fact saw it as beneficial to the area. However, most of the landholders interviewed expressed concerns with how the development was being carried out. Issues raised were mainly in regard to:

1. Design of the Area
2. Environmental considerations.
3. Price of water.
4. Distribution (including allocation) of water.
5. Distribution of developed farms.
6. Other Policy and Development issues

The design of the area and environmental considerations were common concerns raised by the growers interviewed, with probably the most common problem being lack of consultation with growers, not learning from previous mistakes (farmers want square blocks and the better soils developed first) and the large amount of clearing that is occurring. Aspects of this will be covered in the “Environmental Considerations” section.

The price of water supplied to farms was also a common issue raised. Most growers said that the price is excessive, especially for ground and drainage water, which the landholders saw as beneficial to use for environmental reasons, but had no incentive to due to its price.
The distribution of water was also a common issue raised, with inequity between growers, wheel location and size and the allocation allowance being common. Comments regarding the distribution of the new farms was also a common issue raised, with the most common issue being that the Government was doing a money grab, always selling off to the highest bidder, promoting the blocks to the investor - not the farmer. Most farmers indicated that they felt that it was a good idea to encourage new and young farmers to the area. For a list of the actual grower comments, see Appendix Seven.

2. WATER SUPPLY - PRE FARM GATE

Description Of Water Supply

Supply to the majority of the Burdekin irrigation area is reliant on a combination of pumped, piped and channelled water originating from the Burdekin Falls Dam (Lake Dalrymple). Design, installation, maintenance, administration and distribution is fully controlled by the Department of Primary Industries - Water Resources.

The Delta area is the original area of irrigation within the Burdekin, and this area is served by private bores and from directly pumping from existing watercourses. With the decline in water quality in bores in certain areas within the Delta (due mainly to salt water intrusion), and the need to service a larger areas, the North and South Burdekin Water Boards were set up and have been supplying surface water (from the Burdekin River) to large areas within the Delta by pumping water from the River and supplying it to existing smaller watercourses. Benefit is gained by the landholders by either directly pumping this water or by the recharge experienced into the groundwater aquifers.

Issues Raised

The issues regarding water supply prior to reaching the farm gate raised by the landholders were mainly in regard to:

1. The development of the area (already covered).
2. The infrastructure and its maintenance.
3. Water Quality
5. Safety and other concerns.

The main concern expressed regarding the infrastructure was its inability to supply the peak irrigation needs, and the effect that this has on yields, water use and lifestyle. Maintenance of the system was also of high concern, as growers were stating that channels were becoming overgrown, spreading weeds and leaking in some locations. In general maintenance requested by growers was not carried out within what the grower saw as a reasonable time period.

The quality of the water being distributed was also a common concern expressed by growers. Comments such as “The water quality is to good - it just won’t soak into the soil” were common.

Management of the system was also criticised, but these criticisms appear to be related to delivery during the peak irrigation periods, which could be related to the infrastructure capabilities. However there was many issues regarding inequity of supply between growers and the lack of consultation with growers, especially during high use periods.

Some concerns were expressed with regard to the safety of the channels (drinking and swimming in ), and other issues like the effect that the channels may have on flooding were also raised in this survey. For a list of the actual grower comments, see Appendix Seven.

3. ON FARM MANAGEMENT, PRACTICES & TRIALS

Description

All the farmers interviewed were predominantly cane farmers, using furrow irrigation as their watering method. A small amount of mangoes using undertree sprinklers and small crops using trickle irrigation was also evident during this survey. Some farmers had recently changed from other crops like rice and fodder.
**Issues Raised**

From the survey, the issues that effect the growers management and practices on their property are dependant on:

1. Economic situation and Labour requirements
2. Lifestyle
3. Existing practises
4. New Technologies and External advice

The economic situation of the grower and the crop price was obviously the major issue in determining the amount of development of the farm and the inputs into growing of the crop. It also determined the amount of labour input into the farm and the associated problems with external labour.

Lifestyle was also an important issue to many farmers, with some happy with what they do now, and don’t see a need to change a successful enterprise, as well as those who constantly are seeking new information from a wide source and are willing to experiment with new ideas and practices.

Existing practices were an important to the landholders management of their farm, as they suited each individuals place and expectations. It was evident that practices and expectations did change from area to area.

From this survey, it was obvious that landholders certainly took interest in new technologies coming into the area and used any external advice to assist them with on farm decisions. More details of this will be covered in the “On Farm Services and Advice” section. For a list of the actual grower comments, see Appendix Seven.
4. ON FARM SERVICES & ADVICE

_Description_

In line with the development of the area, on farm services and advice has also been expanding. Services such as soil testing, chemical and fertiliser advice, equipment supply, farm design and research are all common now.

_Issues Raised_

The services and advice available to the landholders could be summed up into three groups:

1. Government Agencies
3. Farmer to farmer.

The Government agencies that farmers access for services and advice are BSES and DPI with some contact made to The Disease and Pest Management Board. Most farmers were very happy with the advice they received from these groups, with special mention of BSES advice as being invaluable being common. There was however a small amount criticism of their service also (especially in variety selection and development). The method of distributing information using small workshops was also often commended.

The non government agencies were also usually commended for their service and advice, however their advice was often treated with caution, and supply of equipment was at times frustrating, and service deteriorating with distance from town.

Farmer to farmer advice in this area appears to be exceptional, with new farmers regularly commenting on the assistance they have received from neighbours in the area. For a list of the actual grower comments, see Appendix Seven.
5. ENVIRONMENTAL CONSIDERATIONS

Description

Whilst growers saw the importance of developing BRIA, especially during the present expansion of the sugar industry, growers also saw the need to address environmental issues as very important for the long term viability of the area.

Issues Raised

Landholders interviewed perceived that environmental issues in the Burdekin were of major importance now, and that these issues were only going to become more important in future. The following areas were issues identified by the farmers:

1. Tree and habitat clearing
2. Groundwater issues
3. Weeds, vermin and disease problems
4. Chemical used in area.
5. Environmental image of the area.

Most farmers saw that excessive tree/habitat clearing as a huge problem to the area, but the landholders said that this was a government caused problem as they had full control over the development of the BRIA. The farmers also said that to make the new blocks pay, they had to develop as much area as possible and hence leaving trees on their blocks was not economical.

Whilst most areas are not having problems with rising water tables, landholders did see that groundwater issues were of concern (mainly comparing this scheme with other irrigation areas). Other groundwater issues raised regarded the quality of the water, and that salt water intrusion was occurring in some areas.

The spread and control of weeds and disease were also of concern to many landholders. Issues like the weeds being spread by the water, on cane bins and the limited area set aside for “clean plant” were commonly raised during interviews.
“Chemicals” was also an issue commonly raised by growers. Usage of the chemical, the form that the chemical comes in, the varying standards of the chemical and disposal of chemical storage containers were all issues raised during the interviews.

The interviews also indicated that a high percentage of farmers were concerned with the “Environmental Image of the Area”, with most saying that they are “conservationists”, as they want to live here and would not purposely do anything to harm their environment. For a list of the actual grower comments, see Appendix Seven.

6. OTHER ISSUES

Description

There were a number of points raised that could not easily be placed into any specific category, hence the miscellaneous issues.

Growers Comments

The following list are actual grower comments presented in the original idiom to give the indication of authenticity both in context and language as well as because there were not many comments in this grouping.

- Vandalism on pumps can be a problem (that is, shot at).
- Tram line cost up river - was a major cost to growers.
- No young people coming to area (up river).
- Too may DPI cars.
- Women don’t seem to be involved in the industry (decisions )
- BRIA - “Excellent opportunity”
- Trees being pushed down and burnt - why not woodchip even if only suitable for gardens
- Build up and movement of sand in the river - possible future flood problems
- Varities: Q124 very pleased with results (slow to strike) Q117 overrated and over advertised

Visible variety of affluence - common in area

Page 93
**REFLECTION and CRITICAL ANALYSIS of FIRST ROUND DATA**

There was a distinction between growers in relation to on-farm practices and attitudes. A small number of growers (about 15%), had good yields, good sugar content (CCS), knew fairly accurately how much water they had used, and how much fertiliser applied. They also seemed to question their own practices in order to understand them better and their affect on productivity. They were prepared to ask questions of a wide range of sources to seek answers to these and were willing to trial new ideas on farm. Interviews with these people were easy and provided a wealth of ideas. As an interviewer, you felt at ease in probing these ideas and offering a point of view for discussion. Knowing that the point of view would not be taken as telling them what to do but as another perspective to be either agreed with or countered with a thoughtful, persuasive rebuttal. These interviews generally ran over time (that is more than the one hour suggested).

There were many farmers (about 75%), who had a reasonable idea of what was going on on their farms but were less interested in questioning their own practices and seeking out information. These people felt they were doing reasonably well and would probably consider new ideas if they saw relevance for them and an increase in dollar returns without having to change considerably what they were doing now. Underlying this was a desire to pass on a profitable farm to siblings. It was this desire which often motivated the owner to purchase another farm.

Finally, there was a small number of growers (about 10%), who were happy with their current situation. There was a feeling that because these growers had no sons, there was no need to improve the farm for transfer purposes. These interviews were hardest of all. The interviewee was reluctant to offer ideas or viewpoints and as a result, the interview didn’t develop beyond a question/answer format.

From these observations and reflections, it could be argued that it is the desire to pass on a viable business to sons which drives growers to seek out information to improve their current
situations. This information comes from a number of sources, one of which is extension service.

The existing extension service was seen by growers as very good. The characteristic of the service which most appealed to growers was its accessibility. Staff were willing, and able, to service grower needs in a very short space of time. The need expressed by growers was of a “fix it” nature. The grower has a problem, contacts the extension service and an officer is dispatched to provide the solution. This style of service although seen as good by growers, doesn’t provide any long term change in the growers’ relationship to his farm. Those growers who operate in this manner see their farm as a source of problems which must be fixed when they arise. Once a problem is solved, life continues as normal until the next one arises and so on. These growers should be the target of an extension program which uses groups whose focus is to facilitate the development of a learning/understanding relationship with the farm and surrounding environment. However, my belief is that extension offices would be reluctant to change the current style of service. Having growers ringing up and requesting solutions to problems, gives the extension officer a sense of power and importance. The EO knows that the grower relies on that answer, without which the grower would not be able to solve it for himself. It also gives the EO a sense of achievement when his answer fixes the problem, and gratitude is expressed by the happy grower. This style of question-answer extension does nothing to investigate the impact current practice is having on one’s environment and then provide a forum to challenge the underlying assumptions which govern the actions of the individual.

The introduction of laser levelling technology has had benefits in terms of irrigation time and quantity but has caused growers to neglect the use of manure crops during fallow. On the surface, there is sound argument in the use of laser levelling over the continuation of using manure crops in the fallow and that is the saving of water and length of irrigation and therefore the saving of money. Many growers expressed that there were significant gains in productivity in years following the use of manure crops in the fallow and that they required less fertiliser. These too offer a sound argument in terms of financial gain although if the manure crop was to be successful, it would require irrigating and was seen by some as a cost which they were not willing to bear. So it would seem that practices which can show a clear financial gain will be used over and above those which provide a benefit which is not easily
quantified in terms of dollars gained by dollars spent. This has implications for conservation practices. The challenge for extension here is to provide the best possible financial benefits of any current practice.

There is more to this than demonstrating financial benefits. The issue of culture and associated behavioural norms and the effects that individuals needing to belong have on farm management decisions needs some discussion. This was demonstrated by farmers who continued practices which the previous generation had done. An example of this is the practice of irrigation where large amounts of water are lost out the end of the drill. ACTFR stream gauging on the main natural drainage system - the Barratta Creek - during the dry season of 1994, revealed 25 000 ML of water moved through this system. This flow is directly attributable to farm surface drainage. When contrasted with the many complaints about the high cost of water, there is definite incongruence. Discussions about this anomaly revealed that this practice reduced the amount of time spent irrigating which then allowed time for recreational activities, especially fishing. The researchers observed fishing vessels on almost all of the farms visited.
REFLECTION and CRITICAL ANALYSIS of PHASE II DATA

1. The Farmer Groups

Generally the number of participants was disappointing, but it did not detract from the outcomes because the outcomes have meaning irrespective of the difference between what was expected and what actually happened.

The process for contacting farmers as outlined in Chapter 4 was followed closely. During the telephone contact activity, there were many occasions when the researcher had difficulty with understanding the farmers accent. No doubt the farmer would have found difficulty in understanding the researcher as well. This may have had an affect on the attendance. The researchers observed on a few occasions during the individual interviews that the family members involved would revert to speaking Italian to explain a particular question or comment made by the researchers. So language problems could have had a bearing albeit minor on the willingness of farmers to be involved.

There were a number of which require more in-depth discussion due to the potential of these to detract from further group activity and therefore to provide opportunities for learning. These issues cover both process and content and are presented below.

Data Recording

The issue of literacy was considered a problem during the first meeting. It is a very sensitive one and required careful handling so as not to humiliate the person involved. During this meeting, growers were encouraged to record their comments on butchers paper as they spoke, so that their comment was recorded in their own words. This technique was used instead of a tape recorder. The refusal of one of the growers to write when it was his turn, was immediately taken as illiteracy. So one of the research team offered to write for him as long as he would correct it if, when read back, was not describing what he wanted to say. The rest of the group then avoided writing on the butchers paper. So this technique was not used in subsequent group activities and was replaced by the tape recorder. It was discovered later the
grower felt the researchers could write what he wanted to say better than he could. This was a reinforcement of the perception that exists about Government and farmer, whereby farmers believe that Government staff are better articulators. An option may have been to continue to encourage him but again it could have been a literacy issue and therefore the researchers would have made the situation worse.

Initially, tape recording was not considered an option because:
1. it could restrict what is said, because people feel uneasy with what may be done with the recording.
2. the time taken to transcribe the interview later on.

The other option was for one of the researchers to record the interviews. However some difficulties with this are:
1. Problems with misinterpretation (Although asking the individual to ensure what is written is an accurate account is often a useful activity in getting a better understanding of what is said by participants.
2. The desire for equal participation which is not possible when one is recording because they have to withdraw from the conversation to write down something. The conversation continues while recording is occurring and so the recorder will invariably miss parts (maybe quite significant) of the discussion.

In the interviews where tape recording was used, participants were comfortable in doing so. Taped recordings of the meetings was an invaluable reflection tool, enabling the researchers to revisit the meetings. The benefits were that interpretations made could be cross checked and during this process new interpretations were revealed.

A conference microphone, which is a flat (3mm), square (15cm x 15cm) metal object and is placed on the table, was used. A long lead connects the tape recorder which is located out of sight. However, the tape recorder used didn’t automatically release the record button when one side of the tape was completed, and was distracting while having to watch the time and the tape recorder in order to gauge when the tape was finished. As a result, some of the
meetings were not recorded. An automatic record button release tape recorder would overcome this problem.

**Brainstorming**

Allowing growers to brainstorm issues they wanted to discuss, gave the research team an opportunity to establish what growers see as important. It also gave the growers a sense of ownership of the meeting because the content was not dictated to them by the research team.

However the researchers were concerned initially about the possibility that by using this technique, the farmers may not mention water management. Since the project was externally funded and had objectives which had to be met in relation to water management, results which were not in keeping with these objectives would not be acceptable. This dilemma was solved when the researchers revisited the theories guiding the research.

From the brainstorm, on-farm water management was not mentioned directly. However, the discussions associated with each of the nine issues raised had direct relevance to components of on-farm water management. This demonstrates the complexity and inter-relatedness of irrigation-based production.

The brainstorming activity was not be used in subsequent workshops because it tended to make critical questioning difficult. The preferred approach would be to analyse data already gathered, and formulate critical questions from that prior to the meeting. The workshop and discussions then have a fairly clear focus. With experience, the ability to think critically and articulate this “as you go” will improve and therefore, there may be an opportunity to return to this activity. This change in method is a valid component of Action Research. Zuber-Skerritt, (1990) states that Action Research is about people, including the researchers, reflecting on and improving their own practice. The results and insights gained are not only important for the progression of knowledge in the area, but also for the immediate practical improvements during the research.
Number of Participants

The number of participants who actually arrived was disappointing, and could be looked at in a number of ways:

1. Something unforeseeable occurred that required their immediate attention like a pump breakdown, or harvesting problem.
2. On-farm water management is not seen as an issue.
3. Growers in that area are “over-extended” or over serviced.
4. Growers have an ill-feeling towards the Water Resources section of the DPI and don’t make a distinction between the research team and Water Resources. As such, they believed the researchers were representing Water Resources (although every effort was made to make it clear that this workshop was not run by Water Resources).
5. Growers in this area don’t socialise well together and as a result, don’t like attending small group meetings.
6. Growers look to their neighbours for advice and don’t see a need to be involved with service staff.
7. Some growers find it hard to say no to someone face to face (or on the phone).

The researchers used the options available to them to encourage participation but acknowledge that other options exist that the researchers considered were not acceptable.

Managing Workshop Directions

From the data collected and analysed, discussions about on-farm water management often diverged to criticisms of DPI Water Resources. This may be due in part to the observation that many irrigation layouts are based on long runs, to reduce labour input (meaning less changes of irrigation pipes, - long machinery runs reducing turn around times.). Therefore, it could be argued that the growers goal is to maximise profits (by reduced labour inputs), and that there is more to be gained by reducing labour costs than saving water.
With the exception of the delta growers, who do not use water directly supplied by the Water Resources group, all growers showed concern about the way the Water Resources were supplying their water.

Most growers believed that the channels could not supply the peak irrigation needs to the area, and this was costing them money in crop yield losses due to water stress. Some growers were making an attempt to overcome this problem, with the possible conjunctive use of groundwater, but again they saw that the Water Resources were restricting this, making it not worth pursuing. The Researchers are unaware of any farmer who has installed a major surface water storage to minimise this problem.

Water pricing was raised by many growers. However, the volumes of tailwater flowing down the Barratta Creek system contradicts these comments (In 1994, 25000ML was recorded from about 12000ha of farms). The significance of this figure is that rainfall total for the same time was within the driest 25% of years and so almost all the Barratta Creek water could be attributed to BRIA surface drainage.

DPI Water Resources have promoted the area as having ample water supply, in brochures showing good yields and large volumes of water. Unfortunately the limitations of the supply system are not made explicit in these brochures and an unrealistic expectation of the system by growers results. This is one of the critical issues in relation to on-farm water management (see Figure 8). Department of Primary Industries Water Resources could deal with this issue by undertaking an awareness program of the limitations of the water delivery system.

Water allocations of 125% of nominal allocation have been available since the dam was built. Growers have become accustomed to this arrangement and are growing cane on 100% of their farm, instead of the 80% the delivery system was designed for.

Provisions for on-farm storages and tailwater returns should be made during the farm layout design phase. These types of systems would take the pressure off the delivery rates of the channels. In addition, a reduction of tailwater flows would reduce the downstream effects of irrigation.
BSES research into increasing productivity on-farm through improved varieties (ccs+tonnes/ha) and system efficiencies

**PLUS**

Increased water needed for expanding areas

**PLUS**

WATER NEEDED BY EXISTING GROWERS

**MINUS**

WATER ABLE TO BE DELIVERED BY SYSTEM

**EQUALS**

**OPPORTUNITIES** e.g.,
- **ON-FARM WATER STORAGE**
- **GROUP STORAGE**
- **MORE EFFICIENT IRRIGATION SYSTEMS**
- **WATER RESOURCES EXPLAIN SYSTEM DESIGN PARAMETERS**

**PROVIDED**

- BSES & Water Resources work together
- Growers accept some responsibility for water management
- More country put to fallow
- Less labour costs
- Improved Nitrogen from legumes, less fertiliser, lower cost on plant cane

*Figure 8* The Water Resources Issues
On a few occasions, participants asked the researchers what were they going to tell the farmers about recycling. Based on the workshop focus being best on-farm water management, it could be argued that growers' perception of a major component of Best Practice is recycling. Further to this, the fact that growers were asking what the researchers were going to tell them, indicated a misconception of the purpose of the workshop, and a reaffirmation of the earlier assertion that extension agencies are fixers of problems via giving of information to a passive receiver.

Many growers expressed concerns over the development of the BRIA, with the shape of the blocks, the tree clearing, and the development of certain areas often being raised. (It should also be pointed out that many farmers were also keen to get another block at the next auction, which would have to be cleared to grow cane). Many growers also stated that the rapid development was a government money grabbing exercise - but the growers continue to pay large sums for new blocks. When they do buy these new farms, every tree is cleared and so it seems they are happy to conserve trees provided it doesn’t mean leaving any of their own land. The criticisms about the tree clearing were used as another reason to dislike the Water Resources group.

2. **The Research and Extension Groups**

At the Water Quality Research workshop, discussion was held at length on issues such as water quality trends in line with seasonal factors and developments which are occurring, sources of nutrients and the effects that these trends and nutrients have on the ecology of the area. Some discussion on possible outcomes with regard to these problems was also carried out.

Discussion revealed that the main period for nutrient and sediment losses was during major runoff events, especially during the initial phases of these events. This was mainly due to the fact that erosion from catchments was highest during that period.
The importance of wetlands, for capture, fallout and breakdown or usage of sediments and nutrients during these events was also pointed out. It was also pointed out that in most instances the wetlands and estuaries could handle the nutrients that were presently being introduced, however the turbidity appeared to have a significant effect on aquatic life.

When compared to other catchments within north Queensland, the Burdekin has the most potential for nutrient and sediment deposition, but is the most difficult to deal with in the BRIA due to its small size relative to such a large catchment and its more spasmodic rainfall and hence flows within the system.

Most of the Burdekin Falls Dam’s 114000 km$^2$ catchment is used for grazing, and therefore to improve the water quality and reduce nutrient losses during major rainfall events, erosion from these grazing lands would have to be significantly reduced. To do this would require erosion control measures to be carried out on farms, appropriate stocking rates for different soils and pastures, pasture improvement projects, improved watering facilities for stock, and so on. Property Management Planning personnel from within the Department of Primary Industries are presently addressing these issues, however to service the entire Burdekin catchment would require additional extension and advisory staff, as well as some form of government assistance to growers to carry out these erosion control measures. The continuing drought conditions experienced over most of the catchment are making these measures impossible.

Whilst the Burdekin River is the main source of water within the Burdekin Shire, very little runoff from the farms within this region are returned to the river, as most runoff actually flows away from the main river in a true deltaic style. This applies to the old delta area of the Burdekin as well as most of the area so far developed within the Burdekin River Irrigation Area (Congdon and Lukacs, 1995).

Extensive surface water quality monitoring has occurred on the left bank development of the BRIA since the commencement of the scheme in 1988.
During the period of monitoring, seasonal conditions have been spasmodic and hence no clear long term or seasonal trends could be established, however this monitoring has revealed that nutrient concentrations are higher in sites downstream of the BRIA, and that the high variability of water quality resulted in breaches of the ANZECC (1992) guidelines at virtually all test sites from time to time.

Monitoring also indicated that nutrient and sediment concentrations mainly increase during periods of high rainfall, but high concentrations (predominantly nitrates) were also recorded during periods of little rainfall where irrigation tailwater (and the leaching of nitrogenous fertilisers) is the most likely source. These tailwaters are more likely to have a greater effect on the water quality experienced in floodplain wetland areas, whereas the larger flows effect is more likely to be experienced in coastal waters.

It was also pointed out that nitrogen can be transported from cultivated lands in soluble form as nitrate (in both tailwater and storm runoff), whereas 75 to 90% of phosphorus moves with eroded soil more commonly experienced during the storm runoff events.

The monitoring of areas which have been irrigated for longer periods appeared to have a larger nutrient concentration (particularly phosphorus) than that of the newer irrigation area. This could be explained by the newer area’s soils being in a situation of absorbing nutrients, whereas the soils absorption capacity has been filled in the older areas.

The formal agreement of guidelines process was not conducted during the Research and Extension workshops. (Although it was carried out in the farmer groups). It was assumed that the participants, being professionals in research and extension, were accustomed to open challenging of colleagues as part of their work lives, and therefore didn’t require such guidelines.

In addition, the research team didn’t feel comfortable conducting the guideline development process within these groups. They felt that it may have to do with their sense of peer relativism - superiority / inferiority or confidence / uncertainty.
The workshop processes were planned in advance with only little regard for previous workshop outcomes. This was considered a function of the nature of the participants and not an oversight. It was planned in relation to purpose and outcomes, conscious of the need to satisfy our perception of the participants expectations. This was made easier by referring to the letter inviting participants to attend and telephone confirmation of the same.

Water Quality Research

The research team’s perception of the participants expectation that the workshop outcomes must relate to water quality issues, restricted moving the discussion to extension related issues. However, there were a few good opportunities (missed) where shortfalls in extension could have been discussed. It was agreed that turbidity posed an immediate threat to aquatic ecology survival. Turbidity in the Burdekin River is not directly attributable to irrigated cane production. It is attributable to overgrazing in the upper catchment. The turbid water which is caught by the dam is then diverted through man-made channels for use as irrigation. When excesses of this water are discharged from the farm, it spreads the problem to the drainage network. This is attributable to irrigated cane production.

There was comment made that awareness of environmental issues is increasing in the agricultural sector, but willingness to listen and discuss these issues is dependant on issues and groups. There was a shared belief that self-regulation through the development of voluntary codes of practice was the way forward.

There was also a feeling that conservationists weren’t aware of changed practice within the agricultural sector and vice versa, and that the success of any consultation process will be determined by individual interpretation of consultation (that is, what it means for them) and both parties being up front about their vested interests. These issues are certainly addressed in the extension model which is built on critical conversations in a learning systems framework.

The research team felt that they didn’t think clearly enough about framing critical questions which would provide the catalyst for critical conversations during this workshop. And as a result, the data generated remained mostly around quantitative research findings and not so
much on individuals contexts and underlying assumptions. The intent was there, but the execution didn’t achieve it.

**Upper Catchment Impacts**

The implication (shortfall) for extension is in the grazing practices used by graziers in the upper catchments which are leading to erosion. Theory would argue that good grazing practices (those which minimise soil loss by minimising denudation of pastures) and extension have been around long enough to reach a wide number of graziers. The same theory would argue that the observation of turbidity in rivers indicates current extension methodologies are not effective. The researcher team would agree. However, in practice, this same catchment has been under the influence of drought for more than 5 years. Again, the theorist would argue that grazing pressure should have ceased when grazing had reduced the total edible biomass produced post wet-season by 70%. The resultant ground cover would reduce sediment movement and provide a sound basis for fast regeneration following sufficient rainfall (compared with pasture production from seed). Reductionist / productionist extension colleagues argue that extension works best when seasons are good and cash flow and profits good. A few questions arise,

- How do Research and Extension groups address long term turbidity? and
- Is grazing really a sustainable use of these lands?

when rainfall history indicates above average rainfall in two out of ten years; average in two out of ten years and below average in six out of ten years.

The introduction of policies regarding discharges from farms as opposed to the possibility of using education programs as an alternative to policies was discussed.

The groups represented were not in favour of introduction of blanket policies as most government bodies don’t have the workforce to police it, and the work required to introduce it would be astronomical. It was felt that where policy is required, it would be a far more ideal situation that regional farming groups introduced self regulation, establishing base levels of acceptable performance.
Prior to any "policy" being introduced, the water quality group saw education programs as a way of self-regulation occurring. Some areas identified as requiring farmer education were:

- Establishing wetlands within the environment.
- Improved farming practices to reduce nutrient and pesticide losses from the farm.
- Limited fertiliser usage - only adding what is necessary.

The following model (Figure 9) represents a summary of issues relating to water supply and service.

![Diagram summarizing issues in relation to water supply and service]

*Figure 9* Water and Supply Service Issues

**REGIONAL DIFFERENCES**

The regional differences listed below, will uncover new insights and interpretations. This process forced the researchers to spatially lay out the issues and in doing so, identify contrasts
The contrasts then enable a richer understanding of the area, which allows richer meaning to be assigned and finally richer interpretations.

- **In the older areas**, long established practices make changing these more difficult because farmers are restricted by farm layouts and farm size which are also difficult and costly to change. The farmers in these areas felt they were being neglected by the BSES for the new area farmers.

- **In the new areas**, farmers are still trialing practices which offers opportunity to do it right from the start, therefore research and extension agencies are spending more time there.

- Where farms are a considerable **distance from town**, breakdowns are costly to repairs. However the isolation offers a better lifestyle.

- Where there are immediate and visible problems such as salinity and rising groundwater, farmers are more willing to be involved in discussions. This was demonstrated by the good attendance and open discussion in the Leichhardt group, who also had the farthest distance to travel to their meeting. This group, due to their geographic isolation (on the other side of the river), and impending threat of water logging and salinity, interact more and are more willing to take responsibility for their situation, rather than waiting for the government to rescue them.

- Where there are **different soils** there are differences in how farmers manage them. However, even within areas of similar soil type, there were differences in how they were managed. This has a significant impact on the concept of “best practice”. It means that best practice will only exist for the individual farmer and that there will not be one coalescence which is relevant to all.

The regional differences can be looked at from another perspective - a higher order. Instead of thinking of “regional” in a geographical sense, regional differences can be viewed in relation to the water flow process. In other words, Pre-farm; On-farm; and Post-farm. This in turn can be examined as the basis from which to consider best practice (see Figure 9).

The on-farm issues were the initial trigger for this project. As the project developed, the importance of both the pre-farm water and the post-farm water in understanding the on-farm issues became clear. Many farmers were expressing concern about the quality of the river
water and the ability of the delivery system to supply water when it was required - the pre-farm issues. The on-farm issues then couldn’t be properly understood without exploring where the drainage water was going and its potential and actual impacts - the post-farm issues. A summary of these is listed below. It is necessary to consider the subsets and their interrelationship to understand the complexity of farming practice and to begin to draw out what influences “best practice”.

Towards a Theoretically - Informed Learning Systems Model of Extension

Figure 10 Model of the Inquiry

PRE FARM
- Delivery system capacity - 1.42 l/sec/ha
- Water quality and turbidity
- Channel maintenance (esp. Older areas)
- Policy (surface and groundwater) and price.
- Farm Design and Farm Inspection Committee
- Supply Fluctuations Metering accuracy
- Drainage water reuse is not encouraged.
- Staffing problems at Water Resources.
• No incentives for off peak use ie like electricity
• Service/advice/extension
  - getting it right beforehand
  - Grower expectation ≠ system capacity
  - prevention easier than cure
• Salinity problems
• Overgrazing in upper catchment

ON FARM
• Soil dependent - differences based on extreme variability (furrow length, shape, slope and water supply.
• Sugar price dependant - Fertiliser application, water usage, gypsum usage, area grown.
• Economics and labour input.
• Farm design and layout
• Lifestyle/individuals’ current and expected situation
• Scheduling - experience, evapopans, moisture probes, neighbour, water availability
• Minimising water losses - evaporation (trash), runoff (recycling, scheduling), deep drainage (efficiency, scheduling)
• Improved crop yield → increased tonnages → increased water usage
• Alternative irrigation methods (ie trickle and spray) and their application to area.
• Services available
• Water quality,
• Salinity
• Rostering
• Being proactive/creative.

POST FARM
• Water quality (salinity, turbidity, nutrients )
• Quantity - source and speed.
• Wetlands (understanding of and benefits of )
• Great Barrier Reef (impacts on)
• Aquifers/watertables
• Impacts off site for example, infrastructure, roads and other farms
• Environment Protection Act - environmentally relevant activities
• Self regulation & voluntary codes of practice.
• Community environmental awareness VS community agricultural awareness
• Government/community expectations → Best management practices → Grower capability?

The problem is recognising there is a problem

PROBLEMS

The regional differences outlined, highlighted a number of problems in the BRIA. These are listed below.

• soil variability in paddock and between farms makes management difficult. Different soils require different treatment.
• ineffective grub control in older areas and lighter soils when using Suscon
• difficulty in getting water from supply channels when required especially during peak demand.
• water allocation is insufficient. It should be 12 ML not 8 ML.
• chlorotic streak in recycled water is preventing the wider use of this water management practice.
• difficulty is being experienced by farmers when trying to wet sodic soils.
• too much soil is being left on cane after harvest. This costs the farmer money due to penalties incurred on them from the mills.
• too much trash makes green cane harvesting difficult especially in plant cane which yields higher than ratoons. There is also too much trash to incorporate.
• the current pricing policy in relation to drainage water, is preventing farmers from re-using this water. This water has already been paid for by the farmers and the reduction of this water entering the downstream drainage lines and wetlands would also be of benefit.
• mill breakdowns cause the length of crushing to go on too long. This affects next year's harvest by reducing the growing time for cane and preventing the use of a manure crop in the fallow.

• the delivery system design doesn't account for the variability of rainfall. It assumes an average rainfall figure in the design calculations but both intensity and frequency don't often follow this average. The result is the system cannot meet irrigation demand.

• due to the availability of over-allocation - 125% - growers are less likely to be water conscious than when the allocation is 100%.

• long drills save money in labour but make the timing of shut-off when irrigating, difficult to judge. The result if too early will be that the cane at the end of the drills becomes water stressed; if too late, the result is excess water which either creates a waterlogging problem or is lost to drainage.

• the quality of the channel water can be a problem. The low salinity water does not wet up the soil as well as higher salinity water. To ameliorate this wetting problem the farmers have to use Gypsum. This is an extra cost on top of the water. Turbid channel water, which results when the Burdekin Dam fills from low phosphorus sub-catchments, seals off soils which then reduces infiltration; it makes the use of trickle unattractive due to the high risk of blockages in the trickle tape; and creates problems in wetland areas and natural drainage systems by blocking sunlight and thus preventing photosynthesis of algae needed by aquatic fauna.

• there is a continuing difficulty being experienced by the extension agencies in moving research results to farmers.

• not enough is known about the effects of small, frequent applications of Gypsum on total soil salt levels.

• nutrient export from the cane farms affects the downstream natural drainage systems, wetlands, and the nearshore reef, the latter which is listed as World Heritage.

• the high price per hectare being paid for farms means the farmer needs to generate a quick cashflow to meet interest costs and debt reduction. This means the land has to be developed quickly which results in the over-working of soils. This then causes severe soils structure decline which reduces infiltration and increases erosion risk. It also results in poor yields which then require more inputs to ameliorate which also increases the risk of nutrient export in drainage water.
- the high price per hectare being paid for farms also means that every square metre of the farm must be growing cane. The water delivery system was designed for 80% of each farm growing cane at any one time. This results in excessive demands on the delivery system.
- there is a lack of knowledge of nutrient tie up in the new area soils.
- there is a lack of knowledge of groundwater movement (dynamics).
- there is a lack of knowledge of bioavailability of nutrients in estuarine areas.
- there is a lack of knowledge of the losses in cane production due to Chlorotic Streak and techniques for managing it.
- there is no rapid test to determine which nutrients and how much are available to plants. This test could reduce the amount of fertiliser being applied which would then decrease the amount of nutrient being exported via drainage water.

From these problems just outlined, the next step is to identify those which are contradictory. These demonstrates the complex, fuzzy nature of the issues and demonstrate that no single remedy will suit all applications. The articulation of paradoxes illustrates the importance of context because in certain contexts each side of the paradox is true.

**PARADOXES**

- Crop water use and irrigation scheduling research shows water must be available when the plant needs it.

  versus

  Inability of the water delivery system to supply water during peak demand.

- Productivity research is identifying cane varieties which will increase tonnes/hectare and therefore megalitres/hectare, putting more demands on the system.

  versus

  Inability of water delivery system to supply crop water requirements. Limited water allocation also having an effect.
• Best of-farm water management practices.
  versus
  Price paid/hectare; water delivery system; recycling costs and disease risk; labour; lifestyle; reuse policy for both groundwater and surface water.

• Fertiliser rates suggested by companies  
  versus
  Fertiliser rates suggested by BSES

• Recycling as a water saving technique  
  versus
  Recycling as an excessive water user (farmers not as concerned to shut off irrigation)  
  versus
  Recycling as a cause of Chlorotic Streak  
  versus
  Recycling as too expensive when land prices are $10 000/hectare.

• Long drills (>600m) reduce labour costs and setting up costs  
  versus
  Long drills increasing water usage; problems during wet harvest; compaction (as harvest machinery has to go over the same ground many more times).

• More than one farm needed to remain viable  
  versus
  Difficulty in managing properly when there is distance between them and different soils.
• Government promoting the need for ecologically sustainable development
  versus
  Government allowing 100% clearing of the BRIA with no clear management plan.

• Fee for service
  versus
  Advice biased in favour of commercial service provider e.g., fertiliser rates

• Water Price: - too high and therefore prevents growing cover crop in fallow
  - too low and not valued enough, therefore prevents use of recycling

• Over allocation (125%) is needed due to dry years to grow cane
  versus
  Over allocation causing problems with supply system which reduces yield

• Long drills - positives are less cost to set up and farm; less time to harvest; less labour; and more time to do other things.
  - negatives are won’t get cane off in wet year; compaction; either excessive tailwater generated or water doesn’t reach the end of the drill because it is difficult to know when to shut off the irrigation. Both can cause yield decline either due to water logging or water stress.

• Costs more to grow cane in the BRIA due to fertiliser, gypsum, harvest and water
  versus
  Able to grow more cane/hectare (up to 257 tonnes theoretically)
  However the smaller margin means the BRIA is more sensitive to price fluctuations
• BSES service is good - it is there when needed

    versus

    BSES are looking after the new area at the expense of others; not conducting enough local variety research; are learning as they go; are indoctrinated and won’t accept a different point of view.

    versus

    Experience is the best source of information

    versus

    Too much conflict in advice given. It is possible that commercial advice is biased toward product

    versus

    Willing to pay for services

    versus

    Need for more resource management (unbiased arbitrator) on issues like: water quality, water supply, groundwater, runoff/drainage, more trees and policy development.

• Value of manure crop in fallow in terms of: minimising soil loss in flood-prone areas, improving soil organic matter, and reducing fertiliser use the following year

    versus

    Value of laser levelling to reduce water usage.

• Water is too expensive

    versus

    Farmers will take 125% allocation as long as it is available and 25000ML of surface water was measured in 1994 in the major drainage line of the BRIA. That represents $1 million of surface water lost and does not count the water lost to deep drainage.
• Information overload (too many meetings)
  versus
Not enough information getting to farmers and information delivery processes are not working - too much information bottled up in BSES.

• Acceptable nutrient and water discharge in relation to social and environmental standards
  versus
Ability of farmers to meet standards and remain economically viable.

• Legislation as a means of changing undesirable practices
  versus
Extension as a means of changing undesirable practices.

• Economy of scale
  versus
Efficiency.

• Expansion is happening too fast and is seen as a Government land grabbing exercise
  versus
Competition at auctions is strong and is responsible for demand and high prices.

• Growers’ perception of themselves as conservationists
  versus
Environmentalists’ perception of farmers as irresponsible.
In summary, the higher order findings are presented.

1. The pressure to keep labour costs down and increase productivity and thus improve profitability and maintain lifestyle, creates an environment of poor on-farm water management but outweighs the high cost of the extra water used.

2. The ‘total cost’ to the community of excess water introduced into the environment is not presented using a language familiar to farmers and is therefore not understood.

3. When change in current practice, like on-farm water management, threatens current lifestyle and perceived profitability, better on-farm water management is rejected.

4. “Best Practice” is a moving target and cannot be determined in an absolute sense. But it is a good catalyst for discussion about on-farm water management issues.

5. The need for farmers to expand the area farmed to remain viable and/or to provide for family members, affects good water management on the second farm.

6. The pressure to repay interest and debt as a result of new farm purchase and development forces farmers to overlook the medium and long-term consequences of their current practices.

7. The State Government agency responsible for the BRIA must improve its management of both the bio-physical resources and its consultative process, before farmers will respond to advice given by this agency.

8. Extension and other service agencies are good as long as they continue to spoon-feed their clients. There are some problems with conflicting advice.

9. Downstream effects are not visible to the individual farmer and are difficult to attribute to any one farmer, therefore there is little on-farm consideration of the corresponding off-farm impacts.

10. The young age of the BRIA plus the dry climatic conditions experienced for most of this time, are preventing the scientists from determining the real impacts of irrigation

This summary will now enable a number of interpretive statements to be made. These will be an acknowledgment of the influences which have been presented in this thesis so far.
INTERPRETIVE STATEMENTS

The following statements are the final step in the analysis process before moving on to generalisations. These statements have been cross checked with the raw data and other less formal influences and therefore represent a realistic interpretation of the data collected and presented in previous chapters.

Social Issues

- Too many meetings - growers are over “extended” in some areas.

- Growers like group meetings when they determine the content.

- There is ill feeling towards the Water Resources because farmers believe that Water Resources are dictatory in their dealings with farmers. Farmers don’t (either they can’t or won’t) distinguish the different sections of the Department of Primary Industries. As a result, all DPI staff are seen in a negative light which makes working with farmers in a voluntary and participative way, difficult. Regulation activities should be the sole focus of the DPI with research and extension should be the focus of the BSES. This would overcome the confusion which many farmers have when dealing with the different staff in DPI. DPI and cane don’t go together.

- Social networks are different in different parts of BRIA. These have to be understood before planning extension activities.

- Grower expectations of water delivery system are far greater than system designed for - Water Resources needs to help farmers to understand the systems limitations.

- Best practice is a function of individual’s purpose and context.

- A problem must be recognised, before it can be worked on.

- Best practice for one farmer may not be considered the same for another.

- Crisis is the best catalyst for change.
• Disagreements in best management practice requires critical questions to understand the differences.

• Learning through extension processes must not be restricted to the innovators.

• The existence of non-uniformity of best practices must also mean a non-uniformity in learning needs.

• Improve information flows from agency to farmer and from farmer to agency

• Need more women in industry and new farmers to come to the area in order to add different perspectives.

• Growers aren’t being dealt with equitably

• The way people view their world affects how they behave in that world. For example, there is an abundance of water in the dam (1.8 million ML) and so water isn’t considered a scarce resource. On-farm management reflects this.

• Past experience (successes/failures-may be greater) has significant influence on today’s and tomorrow’s decisions.

• Conflict between what should be done with struggling growers. Should public money be spent on assisting these growers or let them sink?

• Better articulation by people enables them to get their message across by putting forward a better argument. Decisions are then more likely to be in their favour. Through education and a professional environment, DPI/BSES are generally better able to articulate their views to the detriment of farmers. This causes an “us and them” situation.

• Widening gap between growers and grower service staff - educational vs. Practical experience. There is a need for both sides to acknowledge each other’s worth.

• Growers don’t understand the impacts of their actions on others.

• Conspiracy theory exists.

• Conflicts in advice given make decision-making harder.
• Lifestyle, family situation and values effect management practices.

In summary, the social issues are centred around the mis-match between a farmer needing an immediate fix for a problem and getting it, and the underlying confusion which exists for all participants in understanding the way each of them “sees” the world. The process of understanding needs to consider the individual’s purpose, values, beliefs, assumptions, lifestyle, physical resources and community networks and norms. This process must also involve communication which is honest and transparent while enabling participants to question their own and other’s assumptions.

Financial/Economic Issues

• Water policy inflexible & not responsive enough to grower needs.

• Production based extension is easier than resource management extension because much easier to demonstrate actions to improve cash flow.

• Resource management extension must demonstrate ‘$’ improvements in changing practices.

• Good cash flow doesn’t always equal best practice. And it is also influenced by the individual’s values and community’s values in which they belong.

• Commercialism affects advice given

• Smaller margin in Burdekin (due to higher input costs) means fluctuations in sugar price has greater impact then in other areas in Queensland. It results in boom/bust.

• Economy of scale at the farm level but at what cost elsewhere.

• Mills are not keeping up with development due to both the increase in production and productivity. The resultant delays in crushing cause late ratooning which prevents a cover crop being grown.
High land prices ($10,000/ha developed) force growers to focus on the $ return at the expense of many other factors especially environmental considerations.

In summary, the financial/economic issues are driven by the high cost of land, the high cost of water and the resultant narrow margins in growing sugarcane in this area. Production-based extension is more readily accepted by farmers because the bottom line is in a language they can understand. However, good cash flow and profitability don't automatically mean that good water management will occur.

**Technical/Environmental Issues**

- Mis-diagnosis of on-farm problems by both the farmer and the EO can distort discussions of these in a group. There is a need for both parties to better understand the issues being discussed. There is a role for critical discourse to address this issue.

- Water management needs to be considered as part of a complex, inter-related system.

- Quality of dam water affects on-farm water management. Therefore extension and/or assistance programs need to be improved in the catchment segments which contribute to turbidity.

- More emphasis needs to put on farm design ⇒ get it right at the start ⇒ very difficult to change once production begins.

- Soil variability down drill creates extreme management problems.

- More research on the effect of Chlorotic Streak on production and recycling.

- History of BR1A affects status quo today ⇒ only 7 years old; has been extremely dry (only 1 wet year) and so the effects of adding extra water and nutrients to the environment are not known. At present, these issues are not considered important.

- New ideas (including technologies) are difficult for growers to relate to their own situations.

- growers look to neighbours for assistance
- in the new area, BSES rely on growers to develop their extension content

- growers do not question “accepted” practices.

- Recycling encourages overuse of water.

- Delivery system shortfalls create on-farm water management problems.

In summary, the technical/environmental issues reveal that although some technologies, like laser levelling, have been widely and successfully embraced, many others remain unused. Some examples of these are trickle irrigation, tail water recycling and green cane harvesting and trash blanketing. The common theme with this apparent lack of adoption is in the farmer and the EO understanding how the technology relates to both the farmer and the farm.

DISCUSSION OF INTERPRETIVE STATEMENTS

Water

Water is a major issue in relation to price, availability and quality. But on-farm management of water is a function of the reduction in labour and infrastructure costs which is demonstrated by the long drills. These drills mean less people to change cups, less pipe to cover the same area, reduction in machinery time to carry out necessary functions and are favoured over on-farm activities which would reduce water losses and hence the need for so much expensive water. The reduction in water losses would also reduce the off-site impacts of both surface water in relation to dry season flows in ephemeral streams and eutrophication and groundwater in relation to changing the hydrological balance and salinity risk.

This discussion would seem to indicate that the reduction in water use would outweigh the need to reduce labour costs. However another element needs to be introduced which is quite significant. That element is lifestyle. Almost all cane growers own a boat and having a farm set up which reduces labour allows them time to enjoy the benefits of a coastal settlement.
Group Meetings

Meetings depend on seasonal activity, the area’s access to services and the perceived relevance of the discussion theme to their current situation. For example, the Leichhardt area growers were the most receptive but they are facing immediate and visible problems with groundwater rises and salinity; they are isolated from many services; and demonstrate a stronger sense of community than the areas on the left bank.

New Practices

Growers’ response to new or different practices are directly proportional to the demonstrable increased profitability and reduced effort (improved lifestyle) and/or legislative requirements. The response is also dependent on the growers’ purpose. If he is wanting to increase production to service debt, buy another farm, pass the farm onto siblings or just to be the best grower, then he is more likely to consider new practices which would accommodate this desire. This can also be seen in Frank, 1993.

Group Norms

An individual’s actions will re-affirm the norms of the group that person associates with. This may explain the differences between the reaction to water management by the Leichhardt growers, who are already experiencing groundwater and salinity problems, and the reaction of the new area growers. Most of the latter own farms in the Delta area where water use is unknown and so would not be considered a high priority. There will be cases when the gains from an alternative farm practice, which may conflict with the group norm, will outweigh the possible negative reaction by the group. These negative reactions could be minimised by introducing alternative perspectives (e.g., from women), new farmers coming to the area, or demonstrations of new ideas. However, each of these will be dependent on the ability of the group to enter into conversations which examine the assumptions on which the group norms are formed - that is critical discourse.
Expectations and Perceptions

There are two main elements to this. The first is expectations growers have of the water supply system. This expectation is influenced by a perception that the BRIA has an endless supply of water and that it should be available in the desired quantities when required. The second relates to expectations growers have of service providers. This was made clear during a group meeting in which one of the participants asked “What are you jokers going to tell us about recycling?” There was no mention in any correspondence when organising the group that the researchers were going to tell them anything. The is also a problem with the way growers perceive the DPI. They believe that anyone who is in DPI is from Water Resources who are not looked on very favourably in the Burdekin. The research team were required to spend time at every meeting both individual and group, explaining the project and where the impetus for it had come.

Another part of this is how growers perceive themselves in relation to Government officers. This perception affects growers’ willingness to participate in meetings with Government officers.

Extension as Crisis Management

Although there is an espoused concern in the BRIA about the effects practices like tree clearing and irrigation will have on the area, in practice there is little evidence that this is the case. Extension services are most successful where they are reacting to a situation which is immediately affecting the grower like poor yield, water logging, or water availability. If the extension officer can supply an answer, then the grower feels the service is good. If the issue is beyond a quick fix (like more water supplied to the farm) or if it requires major changes either to the farmer’s paradigm or his farm, then the farmer may be critical of the service if s/he is not able to understand the underlying issues which are responsible for the unsatisfactory current situation.

The interpretations made are useful in illustrating the synthesis of the issues outlined. The final step is to take these and to draw them out via discussion into generalisations and higher
order concepts. This process relies on critical reflections which draw on dialogue between the researcher and the many facets of the argument presented so far.
CHAPTER 6

GENERALISATIONS AND REFLECTIONS:

HIGHER ORDER CONCEPTS

The purposes of the Burdekin On-Farm Best Water Management Practices project were to:

1. Improve landholder awareness of water use to maximise cane production while minimising the likelihood of salinity and changes in the groundwater balance.

2. Facilitate the development of soil and water management practices on a range of soils in the Burdekin.

The process for achieving these was firstly to understand present on-farm practices, secondly to highlight what was considered “best” for a particular set of circumstances, and finally to investigate the differences between the two. It was the latter step in this process which yielded the richness of understanding because the researchers discovered the contextually-imposed restrictions which affect what and why a farmer behaves in a particular manner.

6.1 CURRENT PRACTICE

General

Due to the unreliable nature of rainfall in the Burdekin district, irrigation is vital to primary production. Many factors influence how irrigation is carried out in this region.

Irrigation Methods

Irrigation of cane in the Burdekin region is almost exclusively by the furrow irrigation method, with trickle irrigation and undertree sprinklers being used in the horticultural industry.
The reasons given by growers for using furrow irrigation are:

1. **Infrastructure and ongoing costs** - irrigation is a high cost in the production of crops in this region, and furrow irrigation requires the least piping of any irrigation method. This method also requires less pumping head to run and in some well set up systems requires low labour inputs to be effectively run.

2. **Climatic factors** - the Burdekin area is subject to long periods of consistent moderate to high winds (south east trade winds). Furrow irrigation does not suffer from the wind drift problems as other methods can.

3. **The results of the irrigation are visible** - with furrow irrigation, you can see where the water is at, where it's going, and supply problems are usually highly visible (ie, low water level in channel).

4. **Suits the soil** - some Burdekin soils, predominantly the cracking clay soils can get very high application efficiency using furrow irrigation.

A small number of growers are using (trialing) trickle irrigation (sub surface application) of sugar cane. The areas where this is being used is primarily in the lighter delta alluvias where it has been found that the soil is excessively permeable for furrow irrigation and hence are experiencing very low application efficiencies.

Trickle irrigation and undertree sprinklers are used in the horticultural industry as this method is recognised as providing very high application efficiency on all soils. It gives the growers extra management options and hence extra potential for increasing yields (using fertigation, timers). This method of irrigation also reduces labour inputs, with the major disadvantage being the high capital costs of the infrastructure (piping, tubing, emitters, filtration) required to service the area.
Irrigation Water Supply

All water for the district comes from the Burdekin River, which has been regulated (except high flows) since the completion of construction of the Burdekin Falls Dam in 1987.

Since the first farm was sold in the BRIA, the promotion of the area has been based on the reliability of water supply of the area. Water allocation to growers since this time has been set at 125% of nominal allocation, and channels have been able to meet the high demands as not all farms were on line. Due to this, grower expectations of the system have become very high.

With the increase in the number of farms due to the rapid development of the area, and the fact that the channel capacity in the area has not increased, the delivery to each farm is going to become more limited. In the previous two years when extreme drought conditions were experienced, the irrigation demand on the system was higher than the channel capacity and led to crops being water stressed with a resultant loss in yield. This may explain the widespread poor attitude towards the delivery system in the BRIA.

BSES staff at Brandon have carried out irrigation scheduling trials, to reduce the water stress being experienced on cane using present practices. Their figures indicate that between a 10% and 25% increase in production is possible with scheduling to reduce this stress. Discussions with growers indicated that these figures were fair enough, but the growers believed they would have difficulty in scheduling with the current delivery rate.

Because of the high expectation of the system, the growers saw this problem as being poor design, and the controlling body D.P.I. - Water Commercial, should improve the system (either by increased delivery capacity or by on line balancing storages).

In real terms, the problem is with the growers’ expectation of the system, however, this expectation is also to do with the promotion of the area by D.P.I. - Water Commercial. Promotion of the realistic expectation of the supply system should be a priority for the Water Commercial group.
Discussion with growers revealed that another major on farm water management problems is that the water being supplied “won’t soak into the soil”. There were comments that this problem has only occurred since the completion of the Burdekin Falls Dam.

The Burdekin Falls Dam was completed in 1987, with good flows (average to above average) occurring in 1989 and late 1990 - early 1991. Since that time it has been exceptionally dry.

The turbidity readings taken at Clare indicate that turbidity was significantly lower after substantial flows.

With the use of these figures, the turbidity that is presently occurring appears to be a natural phenomenon. With a return to wetter seasonal patterns, the turbidity associated with the dam water at present is likely to return to a more acceptable level.

However, to overcome the reduced soakage problems that are presently being experienced growers have had to take remedial action. The most common action is the application of Gypsum (CaSO₄) and lime (CaCO₃) to a lesser extent, with rates up to ten tonnes per hectare (for a plant and ratoon cycle) being commonly applied. This is usually spread over the growing area mechanically, but in some instances via a “dissolvinator” in the irrigation water (approximately 2 tonnes per hectare per year). Application rates are dependant on soil types which will be discussed later.

Another method to improve penetration is by mixing poorer quality water - usually groundwater with the channel water in order to raise it from a type 1 or 2 water to a type 3 (Type 3 - EC: 0.6 - 1.5 dS/cm, RA: 0 - 0.6 me/l). Effects are somewhat similar to that of using gypsum through a dissolvinator - but at present this practice is not widespread. In many instances this is not possible as groundwater supplies are not available in some areas.

A common method to improve water penetration is by deep ripping the soil, which allows direct water penetration to the depth of ripping. This is commonly carried out during the development of the new farms in the BRIA.
Another aid to improve water penetration is by incorporating organic matter to improve soil structure. However the practice of burning cane prior to harvest reduces the amount of organic matter available. Farmers who have incorporated organic matter have noticed improvements in water penetration but the time needed for observable results is usually a few seasons.

Water Usage

Irrigation of any crop is dependant on seasonal factors (such as temperature, humidity and rainfall), economic issues (the cost of water, applying that water and returns) and grower expectations. The amount of water usage is dependant on these factors plus the irrigation system efficiency (which is dependant on soils, methods and practices).

In the BRIA, the standard allocation is set at 8 megalitres per hectare (ML/ha) of suitable country, with usage more commonly around 10 ML/ha with 12 ML/ha not uncommon on the higher yielding farms. The flow rate to farm from the channel delivery system is designed at 1.2 litres per second per hectare of suitable country.

Discussion with growers in the BRIA indicated two major problems, the first being the delivery rate to farm (1.2 litres per second per hectare) as not being adequate, and the other being that the allocation of 8 megalitres per hectare being too small to effectively grow sugar cane.

Calculations as to the delivery rate to farm (Peak Irrigation Requirements [PIR]) for a 100 hectare farm are as follows. (Formula taken from :- Farm Water Supplies Design Manual, Volume II, Irrigation Systems.

\[ \text{PIR} = p f_1 f_2 f_3 0.8 E(\text{Class A}) \]

\[ p - \text{Climatic factor} - \text{Ayr's latitude } \equiv 19^\circ 45' \text{ S, therefore } p = 0.7 \]

\[ f_1 - \text{Crop Factor} - \text{Sugar Cane } f_1 = 1.35 \]
\[ f_2 - \text{Percolation losses, Surface irrigation - Loams } f_2 = 1.20, \text{ Clays } f_2 = 1.10. \]

\[ f_3 - \text{Evaporation losses, Surface irrigation - } f_3 = 1.05 \]

E(Class A) pan evaporation - Maximum Evaporation occurs in November at Ayr - E(ClassA) for November = 225 mm/month

Therefore :- \( PIR = 215 \text{ mm/month or } 7.15 \text{ mm/day (on loam soils)} \)

Peak delivery required to farm (m³/day) = 7.15 mm/day (PIR) * 100 Hectares * 10 = 7150 m³/day. This equates to a maximum delivery required of 100 l/s for 20 hours per day (1.0 l/s/ha).

In theory the delivery rate should be adequate, with approximately 20% in reserve. However, most farmers are currently farming 100% of their farms. The design of the supply system allowed for up to 20% of the area to be fallowed in any one year. This coupled with the exceptionally dry and hot periods that have been experienced in the previous three years, has meant the supply to farms has at times not met the designed delivery rate.

This problem is worse in areas where irrigation application efficiency falls below approximately 75 to 80%, which is about the maximum efficiency that could be expected with furrow irrigation. (Calculations indicate 1.2 l/s/ha will meet the PIR at 66% application efficiency). Large areas within the BRIA do not achieve this application efficiency and hence may not be able to meet their peak irrigation requirement.

As to the requirement of more allocation, - figures from BSES and D.P.I. indicate that 8 ML/ha is enough water to fully irrigate Sugar Cane in better than 75% of years. Once again, very dry times have been experienced (the driest 25% of years) in the past three years, and this 8 ML/ha is also dependant on irrigation application efficiency.
The solutions to the growers’ problems are:

1. Increase the irrigation application efficiency - possible methods include, recycling tailwater, reduced run length, change in irrigation method (e.g., trickle) and/or practices (e.g., shorter drills).

2. Reduce the area being irrigated on farm. A reduction from 100% to 80% effectively increases the allocation on that 80% being grown from 8 to 10 ML/ha and the delivery from 1.2 l/s/ha to 1.5 l/s/ha.

3. Buy further allocation - (the problem with this option is it does not increase the delivery rate to farm).

4. Increased delivery capacity or on-farm storage.

The adoption by growers of these measures is dependant on many factors, most commonly being the extra costs involved in on farm infrastructure, the extra labour requirements, reduction in crop area and the cost and the lack of taxation benefits in the purchase of additional allocation. The adoption of these measures may increase yields, but the extra costs involved may not be offset by these increases in production.

**Water Management And Farm Layouts**

The on farm water management and farm layouts are dependant on the farm shape, the topography and the soil types on the farm.

Soils in the BRIA have been mapped extensively. These soils have been divided into four major soil groups, and further sub groups. Information on the classification, characteristics, morphology, chemical and physical attributes as well as limitations to irrigation and management options of these soils is documented in the Department of Primary Industries publication “Understanding and Managing Burdekin Soils” (Donnollan 1991).

The cracking clay soils (43% of the BRIA soils) and the sodic duplex soils (35%) make up the majority of the soils in the BRIA. The water management practices used for these soils are
similar. Both of these soils have slow infiltration rates, and to allow time for soakage into these soils, irrigation runs, or drills, are long and flat. Drill lengths are commonly around 800 to 1000 metres in length, however lengths of over 1600 metres are used.

The slope (grade) on these drills is dependant on what occurs naturally, however after grading, slopes of between 1:800 to 1:1500 are usually found. Slopes less than 1:1500 have been found to give problems with waterlogging and drainage from the farm.

Due to the shallow nature of the sodic duplex soils and their highly sodic sub soils, if cuts in excess of 100 mm are to occur, it is usual to stockpile the topsoil, grade the sub soil and then replace the topsoil. Failure to do this has resulted in lands becoming virtually unproductive.

Planting of sugar cane in these soils is done on the ridge between furrows. With the sodic duplex soils, lateral movement of water to the cane set has been a problem. However when cane is planted in the furrows, waterlogging occurs reducing the strike markedly.

As the sodic duplex soils have limited Plant Available Water Capacity (PAWC), very regular irrigation is required, and in very hot periods plant stress can and does occur.

Where lateral movement is a problem, the use of gypsum is common.

The non sodic duplex soils (12%) and the Gradational and Uniform non cracking soils (10%) make up the remainder of the BRIA soils.

As these soils are far more permeable than the cracking clay and the sodic duplex soils, drills on these soils are usually shorter and steeper. These soils are regarded as similar to the alluvias found in the delta, and practices are similar to those used there.

One of the major problems with most soils in the BRIA is the lack of structure, and reincorporating organic matter into the soil is seen as the only effective way of improving the soil structure in the long term.
Green Cane Trash Blanketing (GCTB) is one way of incorporating organic matter into the soil, but it is limited in its application in the Burdekin due to the high yields experienced in the area. Growers using (GCTB) are usually doing it on sodic duplex soils, with shorter and steeper runs than would be classed as normal for this region and whilst they are doing it for the reincorporating of organic matter, another major reason is to aid moisture retention in this type of soil.

Most growers were not using GCTB for many reasons, with common reasons being that:

1. Very accurate levelling is required with no cross fall, otherwise water can jump across drills causing large areas to be missed in an irrigation.

2. The amount of trash associated with the crop, especially plant and first ratoon, is impossible to incorporate in a year - especially in the cracking clay soils.

3. GCTB lends itself to waterlogging and resultant loss of crop, again especially on the low infiltration cracking clay soils.

Most growers are now incorporating at least some amount of trash (tops), and along with the organic matter from the root system, growers believe their soil structure is improving.

Efficiency Figures for Different Soils and Run Lengths

Furrow irrigation efficiency figures for the Burdekin area have been measured and findings published by the local BSES personnel (Raine, 1995).

Copies of these figures are as follows:
## Irrigation efficiencies for commercial sugar cane production in the Burdekin Region (1994/1995)

<table>
<thead>
<tr>
<th>Site</th>
<th>Soil</th>
<th>Furrow Length (m)</th>
<th>Number of irrigations monitored</th>
<th>Total volume applied (ML/ha)</th>
<th>Average volume applied (ML/ha)</th>
<th>Average soil water deficit (ML/ha)</th>
<th>Irrigation efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mulgrave</td>
<td>cracking clay</td>
<td>1647</td>
<td>7</td>
<td>10.2</td>
<td>1.5</td>
<td>0.9</td>
<td>62</td>
</tr>
<tr>
<td>Leichhardt</td>
<td>non-sodic duplex</td>
<td>480</td>
<td>6</td>
<td>12.5</td>
<td>2.1</td>
<td>0.7</td>
<td>34</td>
</tr>
<tr>
<td>Jardine</td>
<td>non-sodic / sodic duplex</td>
<td>1263</td>
<td>5</td>
<td>7.6</td>
<td>1.5</td>
<td>0.6</td>
<td>40</td>
</tr>
<tr>
<td>Jarvisfield</td>
<td>alluvial</td>
<td>470</td>
<td>11</td>
<td>16.2</td>
<td>1.5</td>
<td>0.6</td>
<td>41</td>
</tr>
<tr>
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<td>390</td>
<td>9</td>
<td>14.2</td>
<td>1.6</td>
<td>0.6</td>
<td>38</td>
</tr>
<tr>
<td>Home Hill</td>
<td>alluvial</td>
<td>470</td>
<td>10</td>
<td>19.2</td>
<td>1.9</td>
<td>0.6</td>
<td>31</td>
</tr>
</tbody>
</table>

## Furrow irrigation efficiencies with changes in furrow length for some Burdekin soils.

<table>
<thead>
<tr>
<th>Soil</th>
<th>Application rate (l/s)</th>
<th>Furrow length (m)</th>
<th>Irrigation time (hours)</th>
<th>Water applied (ML/ha)</th>
<th>Application efficiency without recycling (%)</th>
<th>Application efficiency with recycling (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alluvial *</td>
<td>2.8</td>
<td>300</td>
<td>3</td>
<td>0.82</td>
<td>73</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td></td>
<td>500</td>
<td>7</td>
<td>0.94</td>
<td>64</td>
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<td></td>
<td></td>
<td>700</td>
<td>15</td>
<td>1.44</td>
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<tr>
<td>non-sodic duplex*</td>
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<td>100</td>
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<td>1.23</td>
<td>57</td>
<td>62</td>
</tr>
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<td></td>
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<td></td>
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<td>500</td>
<td>18</td>
<td>2.09</td>
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<tr>
<td>cracking clay*</td>
<td>2.7</td>
<td>400</td>
<td>7</td>
<td>1.19</td>
<td>76</td>
<td>91</td>
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<td></td>
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<td>23</td>
<td>1.23</td>
<td>73</td>
<td>85</td>
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</tr>
</tbody>
</table>

* Soil water deficit for alluvial = 0.6 ML/ha; non-sodic duplex = 0.7 ML/ha; cracking clay = 0.9 ML/ha.

Effect of water application rate on the efficiency of furrow irrigation

<table>
<thead>
<tr>
<th>Soil</th>
<th>Furrow length (m)</th>
<th>Application rate (l/s/furrow)</th>
<th>Volume applied (ML/ha)</th>
<th>Application efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>cracking clay*</td>
<td>1647</td>
<td>1.4</td>
<td>1.38</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>2.8</td>
<td></td>
<td>1.33</td>
<td>68</td>
</tr>
<tr>
<td>alluvial*</td>
<td>470</td>
<td>1.7</td>
<td>0.92</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>2.8</td>
<td></td>
<td>1.13</td>
<td>53</td>
</tr>
</tbody>
</table>

* Soil water deficit for alluvial = 0.6 ML/ha; cracking clay = 0.9 ML/ha.

Whilst these Research figures are extensive they are also far from complete for all soils in the Burdekin, however they certainly do give a good indication of what is occurring, and which soils are similar.

It is generally regarded that alluvials, non-sodic duplex and gradational and uniform non cracking soils (no figures are available for these) are similar and practices used to irrigate these soils are similar. The figures indicate that furrow length and application rate do have a major impact on irrigation efficiency on these soils. These figures also indicate that recycling of tailwater would only increase efficiencies minimally. This demonstrates that losses in irrigation efficiency are mainly due to infiltration beyond the root zone of the crop being grown. This is an issue which has not been recognised by farmers in the BRIA apart from those in the Leichhardt section who are already experiencing groundwater rises.

Irrigation practices for cracking clays and sodic duplex soils (no data available) are also similar, although more regular irrigations are required on sodic duplex soils. From the figures on the cracking clay soils (and mainly due to the low permeability of these soils), furrow lengths and application rates do not have a major impact on irrigation efficiency, but a significant increase in irrigation efficiency is possible with recycling. This demonstrates that only very minimal infiltration losses are experienced with these soils.
Recycling and Drainage Water Usage

Efficiency figures indicate that approximately 15% of water delivered to farms with cracking clay or sodic duplex soils is being lost as tailwater. This figure falls to approximately 5% with other soil types.

As cracking clays and sodic duplex soils make up the majority of soils in the BRIA (78%), large amounts of water can be saved and reused.

The approximate volume of water being lost is from these soils:

BRIA area (approx) 15000 hectares * 78% (cracking clay & sodic duplex soils) * 10 ML/ha (average usage)* 15% (losses) = 17550 ML.

The dollar cost of this water at the present cost of just under $40/ML equates to a loss of $0.7 Million.

To take advantage of this, some farmers in the area have installed tailwater returns, or are picking up water from the BRIA drainage lines.

Interviews with growers indicated concerns regarding the reuse of this water, with the spread of the disease “Chlorotic Streak”.

At this point in time, not a lot is known about Chlorotic Streak, except that it is spread in water, and can result in yield losses. Overcoming this disease and its associated problems would greatly enhance tailwater recycling and the reuse of drainage water.

The reuse of water from the BRIA drainage lines was also regularly discussed. Many growers were reluctant to use this water for a number of reasons, one being Chlorotic Streak, but the charge on that water, the irregularity of supply, and the fact that no significant pumping pools or storages could be constructed in the drains made this unattractive.
The issue of charges, supply and structures in the drains are issues that will have to be addressed by DPI Water Commercial.

**Environmental Factors**

Almost all farmers expressed concerns regarding the development of the BRIA, especially in regard to the wide scale clearing associated with the development of the new farms. Most growers saw this issue as a government problem, and that it has to be expected that growers (especially with the high prices being paid for the farms) will develop and grow as much area as possible.

In general, it could be said that most people wanted more area to be left to timber and native vegetation, but did not want isolated areas as this was not useful for nature corridors. It appeared that leaving trees was considered good practice as long as they didn’t compete with farmers for cane growing. Once again the growers saw the maintenance of corridors (for vermin, woody weeds) as a government issue that needed to be resolved.

Other issues seen as a concern by growers were the spread of weeds, tailwater losses and rising groundwater levels and the usage of these resources.

The spread of weeds with the irrigation water or on cane bins was a concern to a number of growers, particularly in the older areas of Clare, Dalbeg and Millaroo. The main problem weed appeared to be vine which can grow up the cane and be a problem at harvest, especially if harvesting green.

A number of growers were concerned with tailwater losses, with the main concern being the value of this water going to waste. Whilst many farmers were considering tailwater returns to overcome this, very few were actually using them.

The rising groundwater levels was of concern to some growers, particularly in the Clare, Northcote Leichhardt districts. Information from monitoring bores across the entire Burdekin indicate that levels in the BRIA are steady at present (after a long drought), but DPI Water
Commercial has recognised that there is an increase in recharge to aquifers beneath the BRIA due to irrigation, and an allocation of up to 1 megalitre per hectare is available to growers from this resource.

Few growers have pursued this additional allocation as most see the extra costs involved in drilling a bore and equipping it as unwarranted by the gain in allocation. The growers who have pursued this have done so to obtain low quality water, and then they mix it with the channel water to increase the penetration of water into the soil.

6.2 BEST PRACTICE - GENERAL

Best practice as a concept, offers an opportunity to enter into discussions with farmers and Research and Extension organisations. However, care must be taken with any definitive “best practice” due to the extreme variability: of soils on farm; of soils across the BRIA; of individual farmer’s economic situation; of individual farmer’s management style, needs, expectations; of locations with respect to water supply; and the list goes on. Therefore no deliberate move was made by the research team to pursue Best Practice. Instead, participants were asked to discuss this issue in general terms and the focus of these discussions was directed by the research team to those contextual issues individuals must accommodate when determining which practices are best for them.

Definition

Defining “Best Practice” is an extremely difficult task in any situation as there are usually large numbers of parameters that need to be taken into account. To define a “Best Practice” in an agricultural industry is no different.

An attempt to define best practice in a broad sense is as follows:- “Best practices are those which enhance or maintain economic viability of farms with a minimal or an enhancing effect on the natural environment” (Bass 1995 pers. com).
In this light, we then must look a little closer at the regional and individual effects of the economic and environmental issues of the agricultural industries in the Burdekin.

**Regional Environmental Effects**

Since the development of the BRIA, the main environmental concerns expressed by the wider community are tree clearing, the increased dry season flows in previously dry ephemeral streams (especially Barratta Creek) and wetland areas, rising groundwater levels, salinity and the spread of weeds.

The importance of preserving areas for conservation purposes has increased markedly since the initial development of farms in the BRIA.

With the more recent farm releases large areas of land (predominantly around creeks and drains) have been left undeveloped. To maintain this undeveloped land in as natural a state as possible, clearing should be actively discouraged, and where necessary, appropriate action taken to cease these activities. This could be achieved through conditions at point of sale, and purchasers undertaking procurement of bonds to cover revegetation if breaches occur.

Some call for mapping of vegetation communities has been forthcoming from the wider community, however with the extensive mapping of the soils in the area, and the fact that soil types and vegetation communities are usually interrelated, the expense to do this mapping would be difficult to justify for the increased information. Nevertheless, further developments in the BRIA should use the soils information, relate it to vegetation communities (and fauna habitats) prior to decisions on what is to be developed for farms and what remains as conservation areas. In other words, an overall environmental management plan needs to be developed and is currently in draft form.

The maintenance of conservation areas was also a major concern to the wider community. The spread of weeds (particularly rubber vine), fire risk and vermin was of great concern. Unfortunately there is no cheap and/or easy way of carrying out this maintenance, with ownership of the problem also an issue.
The two main bodies being effected by the conservation areas and their maintenance are the developers (being DPI - Water Commercial) and the growers in the area (the latter group most effected by weeds and vermin). Other stakeholders in the conservation areas are the environmentalists (represented by DEH) and the community who use this area for recreation or income. Funding for the maintenance should come from each of these bodies, with control of the maintenance carried out by a local group with an understanding of the area.

The flows being experienced in the previously dry ephemeral streams and wetlands within the BRJA are from tailwater from farms. These flows change the natural environment of these streams and wetlands and hence have a significant impact.

There are two possible responses to this problem, one being to allow tailwater to continue down these streams and allow the environment to change and the fauna and flora to adjust to a new state. The other response is to try to maintain it in a state prior to the introduction of the tailwater. This would involve catching and reusing tailwater on farm.

With the wide scale clearing and irrigation within the Burdekin and the net increase in soil water due to irrigation, runoff potential during storm events is increased. Therefore an increase in the amount of flows and flood levels in these streams is likely to be experienced. To effectively reduce this problem requires on farm storage, with a capacity approximately equal to the amount of water required to wet up the soil (on that farm) to runoff point. In any situation this would be impossible to accurately gauge as runoff is dependant on duration and rate of the rainfall, and the condition and type of soil and vegetation from that area. Nevertheless, with the detailed soil mapping, estimates on initial and long term infiltration rates are available, and could be used as an arbitrary figure for calculating a suitable capacity.

Monitoring of groundwater levels has occurred for many years in the Burdekin region. With the introduction of irrigation to a large area, a certain percentage of water will infiltrate beyond the root zone and into recharge of groundwater aquifers. The amount of recharge is dependant on the volume of water applied, the rate of application, soil permeability and condition. Interception of infiltration, such as evapotranspiration, also effects recharge into groundwater aquifers.
Overcoming the problem of rising groundwater levels requires balancing the amount of water recharging the aquifer to the volume being removed. In many areas of the Burdekin where the aquifers are located well below the natural surface level, and are porous enough to allow the use of standard pumping set ups, rising water levels should be able to be controlled by pumping from the aquifer. This could be achieved by establishing a suitable allocation policy for making this water attractive to use by growers which is not only dependant on quantity but also quality.

There are however some areas is the Burdekin where it is impossible to use standard pumping arrangements to extract this water. The best option for these areas would be to leave them in their natural condition, however where these areas are used, they will require special attention. At present, trials are being carried out using non-standard pumping arrangements to remove this water and drainage pipe has also been used effectively. The drawback to many solutions to this problem is generally the costs involved, and at times the disposal of the water. The latter will become more important as the Environmental Protection Act comes into force.

In most instances, weed problems are dealt with by the individual being affected. The spread of weeds (by water, and cane bins) is, if not kept in check, a high risk in this area. Rubber vine (*Cryptostegia grandiflora*) is a major problem in this area as it can easily out compete many of the species endemic to the area. This weed covers vast areas of riverbank, conservation areas and grazing country, and is almost impossible to control, as the Burdekin region is at the base of a very large catchment. There are many other weeds in a similar situation for example, Parthenium (*Parthenium hysterophorus*) and Nut grass (*Cyperus rotundus*).

To effectively control these weeds requires a coordinated approach across the catchment, locating major point source problems. A coordinated approach across such a vast catchment would be virtually impossible to organise, and so weed control will remain an individual’s responsibility.
Individual Economic Effects

The effect of the expansion of irrigation in the Burdekin on individuals is very difficult to analyse. This is because everyone is different.

With farming, the individual economic effects are very dependant on the individual’s debt, usually being for major purchases such as the land, capital water, on farm infrastructure (pumps, pipelines, grading) and machinery, running costs, such as annual water charges, fertilisers, planting, harvesting and milling and labour, and of course the returns to farm which are dependant on yields and commodity prices.

Of the running costs, the only real area where significant savings can be made is in labour and to a lesser extent in water, as from year to year the planting, harvesting and milling area and the amount of fertiliser needed will not vary significantly, although a drop in sugar price may reduce the amount of fertiliser used and area grown. Water usage is dependant on the season being experienced, and the efficiency of the system. In many instances growers are prepared to lose some efficiency in irrigation (through longer run lengths) to reduce labour requirements.

The best practice, therefore will be that which reduces the overall cost of running the farm, increases the quality and quantity of cane grown, all without the use of extra labour. Because these criteria are interpreted differently by the individual farmer, there is no best practice recommendation.

Individual Environmental Effects

The individual on farm environmental issues which are being addressed by growers are soil conditioning, weed problems and in some instances high water tables.

Some soils (predominantly the sodic duplex soils) in the Burdekin do not accept irrigation water easily, making them less productive than other soils. To reduce this problem, soil ameliorants such as gypsum and reincorporating of organic matter into the soil are the
methods of soil conditioning used. It is a general feeling amongst growers that the poorer soils are improving with working.

The control of weeds on farm is almost exclusively by the usage of chemicals and cultivation, as would be common to all agricultural areas of Australia.
6.3  **BEST PRACTICE - SPECIFIC**

Since the development of the BRIA began, there has been ongoing detailed and varied research and development carried out by both research professionals and farmers. Although there are still areas where sufficient understanding is missing (Chlorotic Streak) there is enough known to improve the longer term viability of irrigated agriculture in this area. However, the evidence from this research suggests that much of what is known about improving on-farm and thus off-farm water management is not being acted upon. This section will discuss this issue firstly by introducing some of the factors which may be attributing to the current state and secondly by outlining the practices which have been found to improve on-farm water management.

Best Practice can be viewed from many perspectives and therefore the expectations of best practice will vary. The underlying issues which will ultimately determine what the farmer does on farm are *purpose and context*. If the purpose of the farmer is to maximise profitability above all else, then it is unlikely that, practices relating to reducing nutrient export, reducing losses to groundwater and surface drainage, downstream effects on natural drainage systems and wetlands, will be employed unless they improve profitability. However, to complicate this, the farmer is also limited in what options are available due to a number of factors beyond his/her control. Some examples are soil type, farm shape, and access to water supply. So even if a particular farmer has a desire to change a practice to improve water management, s/he may not be able to. This incongruence is further complicated in a research sense when a farmer says that s/he is carrying out a particular activity, but in reality s/he is not. This problem arises when the farmer tells the researcher what s/he thinks they want to hear and/or to fit in with comments made by other members in a group situation. It demonstrates the tension between theory espoused and theory in practice and the influences that the need to be accepted in a group have on an individual’s behaviour.
The best on farm soil and water management practices were found to be dependant on many issues with the major ones being:

1. Economic sustainability

2. Environmental sustainability

3. Availability of water supply

4. Soil types

5. Farm layout/shape (topography).

6. Individual growers’ needs and expectations and purpose and context.

After discussions with growers and service organisations the following broad scale “Best Practices” have been drafted, however individual best on farm practices would have to be carried out on a farm by farm basis and location, dependant on: previous farming history; family status; economic position; perception of what is good or bad; age; farm design; soil types; access to information; community cultural values, and individual values.

All of the soils used for irrigation in the Burdekin have some limitations, with almost all soils suffering from some form of nutrient deficiency, landscape complexities, surface condition problems and are all susceptible to compaction in the long term.

The nutrient deficiency of all of the soils is managed by the application of fertilisers. Many growers seek soil tests to determine the nutrients that are required to grow their crop. Provided the grower remains with the recommendations, and the soil tests are accurate, this is the best practice as the required amount of nutrients for the plant are being applied and therefore losses of nutrients to less desirable areas (into river systems or to groundwater tables) is likely to be minimal.
Because of the rapid changes of soil types in the Burdekin, dealing with the landscape complexities is much more difficult. The best practice is to divide soil types within the farm into separate irrigation blocks, and manage these appropriately. However separation of different soils is not always possible and, in this case, management of those soils should reflect the soil with the lowest plant available water. Soil type variability within a drill makes this option impossible.

In many instances, the effect of the landscape complexities can be minimised over time by improving soils with the use of soil conditioners (such as gypsum), and retaining organic matter in the soils. Until a viable alternative is found, these practices should continue, however inputs to the soil are more likely during periods of high returns, with the risk of the more marginal soils becoming far less productive during the lower return periods, when inputs are usually reduced.

The surface condition of many soils in the Burdekin tend to be hard setting, and work up into large clods or break up to be a fine bulldust. To reduce these problems, the practice of using minimum tillage and the reincorporating of organic matter into the soil is considered best practice.

All soils in the Burdekin are susceptible to compaction. To reduce this problem the practices of deep ripping, reincorporating of organic matter into the soil, and minimal amount of traffic on the soil are recommended. In the longer term, some modifications may be required to farming and harvesting machinery and techniques, to reduce this compaction problem.

As mentioned previously, some soil types are developed and managed in similar ways. This is because they have similar properties and limitations. The soils which are developed and managed in similar ways are:

1. Cracking Clay and Sodic Duplex Soils

Cracking Clay and Sodic Duplex Soils

Cracking clay and sodic duplex soils can have toxic levels (to some plants) of sodium in the soil. Currently this is not a major problem in sugar cane, the main crop in the region, however any increase in sodium levels will cause a decline in soil structure, with a resultant decline in production.

To reduce this problem and/or improve the soil structure the application of easily exchangeable calcium (to replace the sodium) is necessary. This is usually done with Gypsum (CaSO₄) or burnt lime (CaO) used in large quantities (presently up to 10 tonnes per hectare). This is a suitable practice, however the use of lime (CaCO₃) is also carried out (mainly used as it is far cheaper than the other items), but as it is not a form of easily exchangeable calcium, and the fact that lime usually increases the alkalinity of soils, and cracking clay and sodic duplex soils are usually already alkaline soil, the use of lime is not recommended.

With the application of gypsum or burnt lime, and the resultant improvement in soil structure, the ability of these soils to accept water into them is markedly increased. This “water penetration” problem is a major limitation with these soils.

Many discussions regarding the “water penetration” problems were carried out with growers. Most growers believed that to reduce this problem they required water with an increased total salinity. A solution to increase the salinity of the channel water by mixing it with higher salinity groundwater was also discussed.

The mixing of different quality waters has some merit, however the introduction of salts to these very low permeability soils must be treated with extreme caution. The introduction of water high in sodium salts could have a harmful and long lasting effect on these soils, whilst the introduction of water high in calcium and magnesium salts could be beneficial. For the mixing of different quality waters to be regarded as a best practice on these soils, a full water analysis on all waters to be mixed would be required, and suitable mixing rates would then need to be determined by a soil specialist. As water quality varies in this area, regular updates on this information would also be required.
These soils, due to their high clay content, remain wet for a long period after irrigation or rain. This wetness can lead to waterlogging and resultant loss in production and also problems during working of these soils, and machinery access during harvest.

To reduce these problems minimal traffic on wet soils is required, very accurate grading is necessary and the use of appropriate run lengths so that irrigation and rainfall runoff remains on the paddock for as short a period as possible. Planting in the “hills” of the furrows is also necessary with these soils.

Some of the cracking clay and sodic duplex soils are susceptible to water erosion and scouring. To minimise this problem, velocities down the furrows must be kept at a suitable rate for these soils. Run lengths of approximately 800 metres at a slope of 1m per 1000 metres should be regarded as a maximum length. (Reference: Department of Primary Industries, Farm Water Supplies Manual - Volume II, Irrigation Systems).

BSES research figures indicate that very efficient irrigation applications are possible on these soils, with the major loss (approximately 15% of applied water) in irrigation efficiency being to tailwater. On these soil types, tailwater return and reuse systems should be used where the farm layouts allow this to occur.

Many concerns regarding the spread of the disease “Chlorotic Streak” with the reuse of tailwater have been noted. This is a recognised problem and a major blockage to the establishment of more tailwater return systems, and research into “Chlorotic Streak” should be given a very high priority.

**Non Sodic Duplex, Gradational & Uniform Non Cracking Soils and the Alluvials.**

The main shortfall with regard to on farm water management of these soils is excessive permeability and this can vary significantly from farm to farm.

BSES figures indicate that irrigation efficiencies of furrow irrigation on these soils can vary substantially, mainly dependant on furrow length and application rate (and soil permeability).
Measured application efficiencies on these soils can vary from 14% to 75%, with an average of about 40%. Most of the losses from these soils appear to be to deep percolation.

Deep percolation losses can result in intake into groundwater reserves, which in turn can lead to rises in groundwater levels. This is not seen as a problem in the delta area, as excess infiltration ends up in as recharge into the delta alluvial aquifers, which is then relifted from bores and usually used for irrigation. In the BR1A, rises in groundwater could in the longer term lead to outflow in other areas and potential salination problems in the outflow areas.

If these intake soils are to be developed, irrigation layouts must be set up to be as water efficient as possible, including the usage of trickle irrigation where appropriate. If highly efficient systems are set up, minimal surplus water will be entering the groundwater tables and fertiliser losses into the groundwater tables will also be minimal.
6.4 IMPLICATIONS FOR EXTENSION

The purposes of the project were to:

1. Improve landholder awareness of water use to maximise cane production while minimising the likelihood of salinity and changes in the groundwater balance.
2. Facilitate the development of soil and water management practices on a range of soils in the Burdekin.

In considering the purpose, the research was a success. The reasons it was a success are related to the issues identified in the literature review as well as the theories which informed the research.

Literature Review

The literature review in Chapter Two was a manifestation of the following issues in relation to extension.

- EOs need to change their thinking from lineal to recursive to better deal with the complexity of agriculture.
- The relationship between government and community needs to change to ensure communities have equal say.
- More attention should be paid to beliefs and values which guide the Extension Officer.
- More leaders are required from both government and agriculture to sustain community action and change.
- Extension needs to be self-reflective in order to determine the usefulness and relevance of its programs and make changes where necessary.
- A technology transfer system which facilitates change processes rather than specific products will have greater long term success.
- The development systems thinking in farmers requires the Extension Officer to do the same.
- Language used in communication needs to be carefully considered by the Extension Officer so that the meaning intended is understood by the farmer.
• Dialogue needs to be critical in order to go beyond the confusion of meaning created by normal conversation.
• Extension is multi-contextual and therefore should be multi-methodological.
• Extension requires an appropriate theoretical framework.
• Local knowledge is important and should be valued by EOs.
• Groups are a source of synergy and bring different perspectives to a situation.
• Individuals in a group will have different learning needs and therefore the group process used will need to reflect this.
• Processes which strive for the sharing of meaning and understanding will be important.
• Extension needs to use Adult Learning principles as well as learning how to learn.
• A useful framework could be that which facilitates learning environments where participants can challenge and support each other, innovate, evaluate, make decisions and to identify learning needs.

The implications of these issues are made meaningful by re-introducing the theories which guided the research.

Theories Guiding and Informing the Research

The theories which guide this research are:
• Critical Theory;
• Constructivist Theory;
• Critical Systems Heuristics;
• Appreciative Systems; and
• Adult Learning.

The elements of these which were used to underpin the research are:
• people are the centre of the inquiry and outcomes are interpretive (Constructivist Theory)
• adults are able to draw on past experiences and hypothesise on possible action. Learning occurs when there is a deliberate consideration (reflection) of the interaction between the hypothesis and the actual experience of it (Adult Learning Theory)
• people have the ability to select and to choose relevant information and that judgements about both ideas and events are made through experience and that these judgements are used to guide future decisions. The design then must incorporate and appreciate the
interdependence of both the judgements of the participants and the events which are the focus of the research (Appreciative Systems Theory)

- people should be given the opportunity to participate equally regardless of power, expertise or arguing skills (Critical Systems Heuristics Theory)
- people should be given the opportunity to uncover the causes of distorted communication and move towards a common point of view i.e. Best Practice (Critical Theory)
- there is a need to present the many competing realities by many people (Constructivist Theory)
- there should be acknowledgment and respect for individuals and the focus should be on providing an opportunity for people to reflect on and improve their practice (Action Research Theory)

The relevance of these theories for extension is:

- the acknowledgment and respect of the individual’s experience and the process by which participants are able to question their own practices and in doing so, better understand them.
- the process which focuses on understanding the different meanings individuals assign to the same object or situation. These meanings are distorted because the communication is distorted and so there is an emphasis in uncovering the causes.
- that in a group, there will be many legitimate and sometimes conflicting, views expressed about the situation under discussion. There will be no single “right” answer and so the EO must be able to guide the group to acceptable decisions based on the best possible information available to the group.
- the realisation that the expert acts subjectively and therefore should not have a greater claim to being right. Any participant should have an equal say and any decisions taken by the group must reflect the context of those effected by the implementation of that decision.
- understanding more about the decision making process by acknowledging that people have an ability and freedom to choose relevant information. The relevance is judged by comparing the information to a set of standards which the individual has developed over time in response to the flux of events and ideas which the person has experienced.
- in understanding that children learn differently to adults and only when they want to. The EO therefore must be able to provide opportunities where participants want to learn and to
apply a process which encourages the participants to examine the differences between their expectations of an event and what actually happens.

**Linking Theories to the Findings**

The theories used have enabled the discovery of aspects of water management which would not have been considered using reductionist theories. A good example of this is the exploration of both pre and post farm issues in relation to on-farm water management. There were critical issues identified in these “extra” areas which are having a major impact on on-farm water management. This was demonstrated by problems with the water delivery system, the water price and usage policy, and dam catchment erosion on the pre-farm side and groundwater rises and contamination, dry season flows, and nutrient movement on the post-farm side.

The realisation that ‘Best Practice’, although providing a good focus to discuss on-farm water management, was unobtainable, was acceptable through Constructivist theory. Reality, it argues, exists as multiple, holistic competing and often conflictual realities held by multiple stakeholders. Evidence of this were the many paradoxes which were uncovered in Chapter 5. In addition to this, there were the many occasions where farmers would like to do one thing but because of their own social systems, do something different.

Many significant issues, like those concerning the water delivery system, were able to be discussed because the researchers did not consider themselves as having power over the interviewees. This meant participants could converse with the researchers on an even footing regardless of their power expertise or argumentative skills. When there were differences between what an individual or a group considered best practice, and what actually happened, the dilemma was easily discussed due to the researchers’ insistence on discovering the context in which certain practices were occurring.

Generally, the research team related to the participants as adult learners by valuing each individual’s experiences, knowing that these people draw on them to inform their actions. However, the researchers noticed a clear distinction between certain farmers which could be explained in Adult Learning theory. Those farmers who were actively seeking a better
understanding of their social and/physical environments were those who were the easiest to interview and were generally in a better position than others. They were willing to share their experiences as well as hear those of the researchers. The other segment of farmers, could be considered single loop learners and therefore not willing to challenge their assumptions about their practice.

At an epistemic level the implication for extension is that extension practice must be informed by “appropriate” theory. Appropriate theory will be those which consider elements that were presented on Page 154. Considering these elements will enable extension practitioners to critically reflect on the theories used, based on action which occurred as a result of those theories. This process will highlight both the aspects of practice which worked well (and its related theory) and more importantly, those aspects which didn’t work. With the ability to go back to the theories EOs will be able to then better inform the theories informing their practice. The other major benefit is that it will provide EOs with a common language with which they can communicate critically with their own practice, other practitioners, agency management, farmers and research and development bodies.

In the past, when EOs were not informing their practice with appropriate theory, the only communication about their practices was via the case study. This was an almost meaningless activity due to the contextual limitations of case studies. Most of the time is spent describing that particular situation and shared understanding is limited to how well this is done. As soon as another situation arises, the previous case is no longer relevant. For extension to deal with this issue, it must take steps to develop itself beyond ad-hocery and the close-minded dogmatism which has it clinging to the old paradigms.

The New Extension Model

The new extension model is represented in Figure 11. It is underpinned by the following rules:

1. Learning as opposed to knowing
2. Discovery as opposed to getting it right
3. Complexity and chaos as the normal state as opposed to reducing it to clear manageable models of reality
4. Respecting local knowledge and constructions of reality as opposed to fitting existing states to a model of reality
5. Inquiry boundaries have to be set to capture the context (those above) as opposed to being determined by objectives or expectations beyond the system under study
6. Equality and humility in a co-learning process as opposed to yielding to the dominance of the expert
7. Critical reason as the countervailing point of view to expertise.
8. Deliberately identifying the intellectual vision as opposed to acting by instinct and experience alone.

These rules represent the culmination of this research work, drawn from the literature review, the data collected and interpreted as well as less formal influences which added to the richness of the many stages during the course of this work.

What is left now is to provide a conclusion and in doing so, identify those areas where future research efforts might be directed.
Figure 11 The New Extension Model

- Working Philosophy and Assumptions
  - Creating and facilitating heterogeneous group learning environments which stimulate the exploration of underlying assumptions and value indigenous knowledge

- Heuristic Outcomes
  1. Local Constructions - Context and Culture
  2. Process managed by Critical Systems Heuristics
  3. Epistemic Constructions - Complexity; Multiple and Conflicting Realities

- Methodology
- Appropriate Theories
  - Critical Systems Heuristics
  - Appreciative Systems
  - Adult Learning

- Clear Purpose
- Results

- Critical Reflection

- Theoretical Position
- TENSIONS
- PARADOXES
- BIFURCATIONS

- Without beginning
- Real World
CHAPTER 7

CONCLUSIONS AND FURTHER WORK

The conclusion will be divided into three sections. Section One will discuss the on-farm water management practices. Section Two will concentrate on the wider extension issues, and Section Three will identify those areas requiring more investigation.

SECTION ONE - ON-FARM WATER MANAGEMENT

Best practice as a concept, offered an opportunity to enter into discussions with farmers and Research and Extension organisations. However, care was taken with striving for a definitive “best practice” due to the extreme variability: of soils on farm; of soils across the BRIA; of individual farmer’s economic situation; of individual farmer’s management style, needs, expectations; of locations with respect to water supply; and the list goes on. Therefore no deliberate move was made by the research team to pursue Best Practice. Instead, participants discussed this issue in general terms and the focus of these discussions was directed by the research team to those contextual issues which individuals must accommodate when determining the practices which are best for them.

Generally speaking the present soil and water management practices used in the area appear to be close to what farmers would consider best practice. However the researchers uncovered a number of practices which are contributing to poor water management on-farm and later poor water management off-farm. These are:

1. the long furrow lengths used for irrigation;
2. burning cane;
3. the use of flood irrigation;
4. allowing tail water to leave the farm;
5. timing of irrigation by observation; and
6. fertiliser application based on experience only.
The reason farmers use long irrigation runs is, to reduce the costs of labour related to changing waters, reduce the infrastructure, like pipes, to get the water to the area, and the time saving benefits (in reduced turn around times) when using machinery on the paddocks.

The use of long furrow lengths for irrigation with the cracking clays and the sodic duplex soils is not of major concern as irrigation application efficiencies are not highly effected, and hence have little or no off site effects, provided tailwater recycling is used. Unfortunately, Chlorotic Streak is of concern to growers, and the major reason farmers are not recycling tailwater. Without this recycling, the effect on other areas can be significant as previously dry ephemeral streams and wetlands are now becoming permanent streams and wetlands, changing the ecology of those areas.

On the other soil types experienced in the Burdekin (the alluvials, non sodic duplex and uniform and gradational non cracking soils) the application efficiencies decreases markedly as run lengths increase. As most of the losses in efficiency are due to infiltration beyond the root zone, off site effects due to water table rises and nutrient infiltration are much more likely on these soils. The main benefit to the growers using efficient irrigation systems in this area are cost savings on pumping and/or water charges. However, most farmers are reluctant to use trickle irrigation technology citing the cost to establish and the short life of the trickle tape as reasons for staying with flood irrigation.

Many growers believe that the results from soil tests and plant tissue analysis to determine application rates of fertilisers are clouded by commercialism, with a large proportion of growers remaining with application rates that they have used in previous years. This testing is done away from the area with the results sent back, with little or no discussion on the real needs of the crop being grown (for example - a 150t/Ha crop requires more fertiliser than a 100t/Ha crop).

There is no full time irrigation scheduling service available in the Burdekin (as is available in some irrigation areas), however the BSES is available at any time (via the telephone) with advice to assist growers in determining when to irrigate. The BSES has also introduced “mini evaporation pans” calibrated to crop growth, which are available to growers to assist them in
their irrigation scheduling. These pans were mentioned by many growers with those not using one themselves referring to their neighbour’s pan. These farmers found that there was only a few days difference between the farmer with the pan and the one without.

The simplest way to make large improvements in irrigation efficiency in the BRIA and reduce environmental damage due to increased flow into previously dry ephemeral streams and wetlands is to make the use of tailwater returns and the use of drainage water attractive.

In the present situation, tailwater returns are attractive to growers simply on the amount of water being saved, however the risk of spreading chlorotic streak is always a concern. A major effort into establishing what chlorotic streak is, and what is required to overcome this disease is required. The use of drainage water could also be made more attractive by a simple change in pricing policy.

Since the first releases of farms in the BRIA, a large amount of resources has been put into the development, production improvement and soil structure on the sodic duplex soils with good success. Unfortunately this level of activity has not been carried out on the (groundwater) intake soils, usually the non sodic duplexes and the gradational and uniform non cracking soils, and the prevention/reduction of possible off site water table rises.

The Burdekin area does not readily accept new technology in the irrigation field. Evidence from other cane growing areas relying on irrigation indicates that the use of trickle irrigation can significantly improve yields without increasing water usage (ie increasing application efficiency). Whilst trickle irrigation may not suit all farming applications in the Burdekin, it certainly has a place and could easily be expanded. A major promotion on the benefits of this irrigation method is required.

A high percentage of flows experienced in the Burdekin system come from a number of small catchments in the upper reaches of the river. With these catchments being such high contributors to flows, small changes in management practices can substantially effect flow volumes and water quality experienced in the entire Burdekin River. For this reason resources
to monitor flows and water quality, should be of high priority, as should extension services to assist landholders on decision making.

SECTION TWO - EXTENSION

Whilst extension services in the BRIA seem to be good, the continuation of poor on-farm water management suggest that there are some shortfalls. The reliance of extension on the transfer of technology model and associated diffusion theory is failing to address the more complex issues concerning the interrelatedness of pre-farm, on-farm and post-farm water management.

If the extension service is limited to that of reacting only to client need, it will be successful in terms of keeping the client satisfied today, but it won’t satisfy their need to continue to learn. It will not satisfy the EO’s need to continue to critically reflect on his/her assumptions used to make decisions when planning an extension program because the desire of the client is driving the process not the critical systems heuristic. The grower will not be exposed to new ideas and different perspectives which EO’s bring to the farm which, if used, may improve their current and future operations. And it won’t satisfy the Government’s responsibility for the long-term health of the State’s natural resources.

Extension practice needs to be informed by appropriate social theories such as Critical Systems Heuristics, Appreciative Systems, and Adult Learning if it is going to address the complexities of situations in which exist multiple and often conflicting realities.

The determination of “appropriate theory” should follow these rules.
1. Learning as opposed to knowing
2. Discovery as opposed to getting it right
3. Complexity and chaos as the normal state as opposed to reducing it to clear manageable models of reality
4. Respecting local knowledge and constructions of reality as opposed to fitting existing states to a model of reality
5. Inquiry boundaries have to be set to capture the context (those above) as opposed to being determined by objectives or expectations beyond the system under study

6. Equality and humility in a co-learning process s opposed to yielding to the dominance of the expert

7. Critical reason as the countervailing point of view to expertise.

8. Deliberately identifying the intellectual vision as opposed to acting by instinct and experience alone.

SECTION THREE - FURTHER WORK

The outcomes of this research suggest that epistemologically and theoretically, the new extension model proffered is sound. However, methodologically there is scope for improvement. In other words the “how to act” aspects of this type of work needs more investigation.

The thesis argues clearly, the need to develop meaningful relationships so that EOs may create and facilitate group learning environments for critical dialogue. However, there is a question here about whether an Extension Officer can physically and emotionally handle the many relationships which would be expected to be developed and maintained during the course of their work. This area requires further investigation.

Finally, on a technical matter, the use of tailwater recycling systems would have a major benefit for both on-farm and off-farm water management. However, the use of this by farmers is being hindered by the threat of Chlorotic Streak. The causes, spread, identification and management of this requires further investigation.
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APPENDIX ONE: DETAILED DESCRIPTION OF THE BURDEKIN REGION INCLUDING LOCALITY MAPS

THE BURDEKIN AREA OF NORTH QUEENSLAND

The main centres of the Burdekin Shire are Ayr and Home Hill, which are located approximately 100 kilometres south of Townsville. Other centres that serve the Rural community are Brandon, Clare, Dalbeg, Giru and Millaroo.

The main rural industries in the Burdekin are Agriculture, Horticulture and Grazing, with a small amount of Aquaculture presently being trialed.

With the last rice crop being grown in the Burdekin in 1992, the only significant agricultural crop grown now is Sugar Cane, which has been grown in this area for approximately 120 years.

Expansion of this industry in recent years has been dramatic. Sugar production from the area has increased from approximately 600 000 tonnes of raw sugar in 1984, to just over the 1 million tonnes in 1994 (6.64 million tonnes of cane), with estimates that over 1.5 million tonnes (10 million tonnes of cane) will be produced nearing the turn of the century. The gross value of sugar cane grown in the Burdekin in 1992 was estimated at $177 million.

This expansion of the sugar cane industry is primarily due to the development of new farms with water being supplied from the Burdekin River Irrigation Scheme (B.R.I.A). The first farm in this area was released in 1988, with 128 farms being sold up until May 1995. Approximately 55 000 hectares of cane was grown in the Burdekin in 1994, of which approximately 13 000 hectares is from within the B.R.I.A.

Prior to the B.R.I.A. sugar cane was grown in the Burdekin Delta with irrigation waters coming from underground sources and surface water managed by the North and South
Burdekin Water Boards. These boards pump water from the Burdekin River into a system of channels, recharge pits and existing drainage lines. Other sugar cane growing areas prior to the B.R.I.A. were located along the Burdekin River, predominantly Clare, Millaroo and Dalbeg (approx. 5000 hectares) as well as areas adjacent to the Haughton River at Giru.

Irrigation of sugar cane in the Burdekin is almost exclusively by furrow irrigation, although small areas of trickle irrigation are now being trialed by some growers.

Four raw sugar mills service the Burdekin cane growing area. The oldest mill in the district, Kalamia Mill commenced crushing in 1884, as did Pioneer Mill. Inkerman Mill commenced crushing in 1915, and Invicta commenced in 1919.

These mills are owned and run by CSR Limited.

Raw sugar from these mills is transported to the Townsville Bulk Sugar Terminal. This terminal was constructed in 1959, and has a capacity of 285 000 tonnes.

Horticulture is also an important industry in the Burdekin with tree crops, cucurbits, beans, corn, solanaceae commonly grown. These crops are generally sold to southern markets, however the Burdekin's proximity to Asia as compared to most small crop growing districts in Australia, makes exports to this area very attractive. This export potential is presently being investigated.

Tree crops grown in the area include mangoes, bananas, lychees, avocados and small amounts of other various tropical fruits, with mangoes being the predominate crop. The gross value for the area from these crops was estimated at $25 million in 1992.

These crops are mainly irrigated by using undertree sprinklers, however the use of furrow irrigation is still evident in this area.
Cucurbits commonly grown in the Burdekin include zucchini, cucumber, melons, pumpkins and squash, with rock melons and pumpkins being the major crops grown. The gross value of these crops in 1992 was estimated at $30 million. These crops are grown using either trickle tape and plastic mulch, or by using furrow irrigation.

Sweet corn and beans are also commonly grown in the Burdekin. These crops are exclusively grown using furrow irrigation, with an estimated gross value to the area in 1992 of $10 million.

The solanaceae crops grown in the area are capsicum, chillies, peppers and eggplants. Only a very small area of these crops is grown in the Burdekin, hence the value to the area is difficult to assess.

Performance trials of cotton, sugarbeet and peanuts in this area are being carried out, with some encouraging results forthcoming.

Sources

Information sources for the previous data was sourced from:

ABS statistics
Sugar Notes (1991 & 1986) - Queensland Sugar Corporation
Direct information from Department of Primary Industries personnel, particularly Peter Elliott - Extension Agronomist, Ayr

CLIMATE

The Burdekin is a part of the dry tropics, and therefore has large variations in rainfall from year to year, dependant mainly on cyclonic and monsoonal influences. The major centre of the Burdekin, Ayr, has an annual average rainfall of 1080mm, with the highest annual recorded rainfall being just over 2400mm, and the lowest being 260mm. Rainfall is definitely seasonal,
with an average rainfall between November and April being 933mm (86% of total), and between May to October 147mm.

Cyclonic influences in the area are common, with a 50% probability of a cyclonic influence in the zone between Bowen and Ingham, and a Cyclone likely to cross the coast in the Burdekin region in about 20% of years.

The Burdekin experiences warm to hot summers, with a mean maximum daily temperature during January at Ayr of about 32°C and night time average minimum of 23°C.

Winters are very mild in the Burdekin, with a mean maximum daily average in July of 25°C and a night time average minimum of 11°C. Inland areas of the Burdekin do experience light frosts on occasions during the winter months.
Annual evaporation in the Burdekin region averages between 1800 to 2000mm, with the months of October, November and December being the highest evaporation months.

Besides cyclonic influences, winds tend to be from the north east during summer and are generally light, with winds during winter being from the south east, with wind speeds up to 20 knots being common. This wind makes the use of spray forms of irrigation difficult.

Most of the Burdekin shire is contained within the flood plain of either the Burdekin or the Haughton Rivers. In very large rainfall events (ie 5% of years) almost the entire shire is covered with water.

The climate experienced in the Burdekin, along with its more than adequate supply of irrigation water, allow for long growing seasons, the possibility of double cropping in the horticultural industries, as well as the production during winter for southern markets.

Sources

Information sources for the previous data was sourced from:
Department of Primary Industries rainfall records
Bureau of Meteorology
IRRIGATION WATER SUPPLIES

Water supplies in the Burdekin come from the underground alluvial supplies (bores) and surface water via natural and artificial watercourses, however both are directly related to the Burdekin River. The older irrigation area within the Burdekin is referred to as the Burdekin Delta, with the newer developing area the B.R.I.A.

Burdekin River

The Burdekin River has a large catchment extending from north of Greenvale to south of Alpha. The total catchment to the Burdekin Falls Dam is 114 240km², and 129 760km² to Home Hill approximately 150 kilometres further downstream.

Rainfall across the catchment varies considerably, with average rainfalls of 1200mm/year being experienced in the wettest areas of the catchment in the Paluma Ranges, to less than 500mm/year in the Alpha area.

Due to the rainfall extremes across this large catchment, flow variations can be extreme. In recent years the maximum annual flow experienced has been approximately six times larger than the average (historically - many larger floods have been experienced), and the minimum being 20 times less than the average.

With the flow extremes experienced, and the variable soils and conditions of sub catchments within the greater catchment, highly variable water quality is experienced in this river system.

Burdekin Delta

The sediments of the Burdekin Delta are an excellent source of groundwater, with an estimated annual safe yield of about 200 000 megalitres from these aquifers. Recharge of these aquifers naturally occurs from the seasonally high flows that occur in the Burdekin River.
Usage for irrigation far exceeds this annual safe yield from these aquifers. To overcome this shortfall, artificial recharge is carried out by pumping flows from the Burdekin River and spreading this water over the delta area through natural watercourses and artificial channels. The artificial recharge commenced in 1965.

The recharge infrastructure, operations and maintenance are controlled and administered by two local boards being the North and South Burdekin Water Boards. Revenue for the Boards’ operations are obtained by a sugar cane levy which is set annually.

The amount of infrastructure controlled by the North Burdekin Water Board (1994 figures) was 4 river and 7 relift pump stations, 150 kilometres of open channel and pipeline, as well as 2.5 kilometres of pipeline and 7 kilometres of open channel on Rita Island. A benefit area of 40 000 hectares is estimated, of which approximately 25 000 hectares is used for sugar cane. Approximately 180 000 megalitres was pumped by the North Burdekin Water Board in 1993/94 for recharge purposes as compared to 110 000 megalitres in 1983/84.

The amount of infrastructure controlled by the South Burdekin Water Board (1992 figures) was 3 river and 3 relift pumping stations, 11 kilometres of pipeline, 110 kilometres of open channels, with a benefit area of 27 500 hectares, of which approximately 12 000 hectares is used for sugar cane. 83 000 megalitres was pumped by the South Burdekin Water Board in 1993/94 for recharge purposes as compared to 66 000 megalitres in 1983/84.

Some of the major problems that the boards have are weed and algal problems, and the turbid water pumped from the river reduces recharge and causes siltation of the recharge pits and channels. Mechanical methods to remove the weed and silt problems are most commonly employed by the boards to overcome these problems. However, the turbidity remains a problem.

**SOILS**

Similar to the irrigation water supplies, the soils of the Burdekin can once again be divided into two main areas, being the alluvials experienced in the delta and directly adjacent to the
Burdekin and Haughton Rivers and a variety of soils including cracking clays, sodic and nonsodic duplex soils, and gradational & uniform non cracking soils in the Burdekin River Irrigation Area.

**Burdekin Delta**

The Burdekin delta soils are fertile alluvial soils. Being alluvial soils however means that variability from almost pure sands to clays over a short distance can be common. To overcome the problems of soil variations and to make them more suited to irrigation layouts, extensive levelling has been carried out in this area for many years.

These delta soils have been used successfully to grow a wide variety of crops for 120 years.

**Burdekin River Irrigation Area (including Clare, Millaroo, Dalbeg and Giru areas)**

Extensive soil mapping in the B.R.I.A. was carried out and continues to be carried out by the Department of Primary Industries in line with the development of new farms in the irrigation area.

The soils in the B.R.I.A. have been broken into four major groups, with subgroups from each of these. The four major groups are:

1. Cracking clays (approx. 43% of B.R.I.A soils)
2. Sodic duplex soils (35% of B.R.I.A soils)
3. Non sodic duplex soils (12% of B.R.I.A soils)
4. Gradational & uniform non cracking soils (10% of B.R.I.A soils)

Besides mapping, documentation of all of these soils and their limitations, (including development and management options to decrease the effects of the limitations of these soils)
have been carried out by the Department of Primary Industries. This is summarised in the Departmental publication - Understanding and Managing Burdekin Soils.

**B.R.I.A Development**

The investigation, planning, design and construction of all of the works associated with the development of the Burdekin River Irrigation Area are being carried out by the Department of Primary Industries - Water Commercial.

The large scale subdivision of lands within this area for new farms takes into account topography, soil types, drainage, existing infrastructure as well as the environmental issues at the time and the ecology of the area. Significant amounts of lands have been left undeveloped, predominantly along existing watercourses, for nature reserves and corridors.

On farm development is solely left to the purchaser of any new block, however advice is available from private consultants, the Bureau of Sugar Experiment Stations and the Department of Primary Industries.

In line with the on farm development that is occurring in the B.R.I.A., widespread clearing of lightly timbered country has occurred. Once clearing is completed, the farms are then graded and laid out to commence farming operations. The time frame for this occurring and for the first crop to be in the ground is usually only a matter of months after the purchase of the block.

This rapid development is necessary as the selling price of BRIA farms has become high (in line with recent high market prices for sugar - land prices of up to $10000 per hectare undeveloped have been paid), and with high outlays the purchasers must get a return on their investment as soon as possible.

A number of project committees were also set up as consultation groups for this development. These Project Committees are:
* The Burdekin River Irrigation Area Advisory Committee (BRIAAC). This group is concerned with the provision of advice on the formulation and implementation of policy initiatives related to this development. This group has representatives from all major client groups, relevant industry, local government and landholder bodies.

* The Burdekin River Irrigation Area Technical Advisory Committee (BRIATAC). This group’s role is to review and oversee the scientific and technical aspects of the development. This group is made up of the major scientific and technical bodies active in the field of irrigated agriculture and the area of environmental impacts.

* The Farm Inspection Committee (FIC). The role of this group is to review the planned farms and associated infrastructure from a farming point of view and to ensure sustainable economic viability. This group contains representatives from the major agricultural industries and the banking community.

* The Farm Development Group (FDG). This group was formed to assist purchasers or potential purchasers of farms in the BRIA as to development methods and practices pertinent to the area and the likely costs involved.

Development of any new farm blocks is carried out using input from government specialists, grower representatives and mill representatives.

**Surface Water - B.R.I.A.**
Allocations and delivery rates are calculated based on the area of suitable country for irrigation. Allocation is set at 8 megalitres per hectare (of suitable country) and a delivery rate of 1.2 litres per second per hectare (of suitable country). If the grower deems it necessary, extra allocation can be purchased from the Water Commercial group (dependant on availability and ability to supply).

Monitoring of water supply to farm is carried out by the Water Commercial group using various types of water meters and measuring wheels.
Water quality testing is also carried out by the hydrographers within the Department of Primary Industries but other tests and assessments on water quality are also carried out by Department of Environment and Heritage, Australian Institute of Marine Science and James Cook University.

**Surface Water - Delta area**

The management of surface water within the delta areas is controlled by the North and South Burdekin Water boards. These boards control the development and maintenance of major water supply channels, pipelines and pumps within this area (except for on farm developments).

The management and development is controlled by water levels being experienced in the different areas in the delta.

Whilst the boards’ main charter is to provide the shortfall in irrigation water by artificial recharge of the groundwater aquifers, surface water from the boards’ channels is used for irrigation purposes. No metering of water usage is carried out in this area and no maximum usage allocation is placed on irrigators, however the board does restrict pump sizes and hence delivery rate onto farms, dependant on the property size.

**Groundwater**

The predominate groundwater supply within the Burdekin District is within the delta area. Usage from this resource has no government restrictions and hence no metering occurs within the delta area.

To ensure that the quality and recharge of this aquifer is maintained, the Department of Primary Industries - Resource Management section maintains and monitors a network of test bores through out the area. Information and trends from the monitoring of these bores is distributed to growers via media releases, grower organisation and local bodies and services. This information is also used by the boards to determine areas of need and possible areas for future developments.
Other areas within the Burdekin are also monitored by a network of bores. Information interpolated from these bores is also distributed to growers using the same methods.

The areas within the B.R.I.A. whereby monitoring indicates that a benefit is received from the distribution network, require government control by licensing any bores drilled. Detailed groundwater modelling was carried out in this area to calculate the likely benefit, available allocations, and possible withdrawal rates. A policy on issuing licences in this area was drafted and licences are now issued in accordance with that policy. Metering of extractions is carried out in these areas.

Other
Water quality testing, with recommendations on its use (usually its suitability for irrigation), is carried out by the BSES, and to a lesser extent the Department of Primary Industries. This is an important service to the area, as water quality does have seasonal variations and usage of different quality water on different soils can have large impacts on yields and soil sustainability, which in turn can affect farming practices.

Water quality monitoring and treatment is carried out by the Shire Council, and the water boards also do a small amount on an as required basis.

Sources
Burdekin Farmers
ABS statistics
Department of Primary Industries personnel & publications
Burdekin Canegrowers Executive
Canegrowers publications
Bureau of Sugar Experiment Stations personnel & publications
APPENDIX TWO

SAMPLE LETTER SENT TO PHASE TWO POTENTIAL ATTENDEES

7 July 1995

«Initials» «Surname»
«Address1»,
«City», «State». «PostalCode»

Dear Sir,

This letter is to acquaint you with The National Landcare Funded Project “Burdekin Best On Farm Water Management Practices”.

The purpose of this project is to establish, document and promote the best on-farm water management practices using the indigenous knowledge from the area. This project is not limited to any specific crop type, as practices used in one area, may have benefits in another.

To date there have been 30 individual meetings with randomly selected growers from within the region, to establish normal on farm practices, variations of practices within the region, and to identify issues within the region.

It is now proposed to set up a number of small workshops to further identify, and promote ideas of what is regarded as “Best On-Farm Water Management Practices”. The intended time for these workshops is in mid August, with a duration of 3 to 4 hours.

As it is a very busy time in the Burdekin, it is understood that attendance at this type of workshop may be inconvenient, however if at all possible your attendance would be
appreciated. You will be contacted in early August to confirm exact time and location of this workshop.

If you require further information or have any queries relating to this letter, please contact Bruce Bass at the Ayr District Office, corner of Little Drysdale and Leichhardt Streets - Phone 832355.

Yours sincerely

Bruce Bass

Extension Officer
APPENDIX THREE

LETTER SENT TO THE POTENTIAL WATER QUALITY ATTENDEES

14 July 1995

Dear Sir,

This letter is to confirm a recent telephone discussion with Bruce Bass of this department. The discussion was dealing with water quality monitoring and its relationship to the National Landcare Program’s funded “Burdekin Best On-Farm Water Management Practices” project which I am carrying out.

The purpose of this project is to establish, document and promote the best on-farm water management practices for the area, using local knowledge and skills that already exist in the area. This project is not aimed at any specific crop type or irrigation method, but has a slant towards promoting economic and ecological agricultural practices for the area.

To establish, document and promote the ecologically sustainable practices, we must be aware of acceptable water quality standards for discharge from and use on agricultural lands. It is believed that your input would be invaluable to this project.

A small workshop is presently being organised to be held at the Department of Primary Industries office (Abbott Street) on the room at the Oonoonba August 1995, commencing at .

The intended completion time for this workshop is .

The parties contacted regarding this meeting are:

1. Department of Primary Industries
2. Department of Environment and Heritage
3. Australian Centre for Tropical Freshwater Research - JCU
4. Australian Institute of Marine Science
5. Great Barrier Reef Marine Park Authority.
It is hoped that all parties represented can do a small presentation of the work that they carry out regarding water quality, with a group discussion on items like acceptable standards and trends to follow. If any special needs are required for a presentation (that is, slide or overhead projector), these items can be organised.

If you have any queries relating to this letter, please contact Bruce Bass at the Ayr Department of Primary Industries. You will be contacted in early August to confirm availability and organise any final details.

Yours sincerely,

Bruce Bass
Extension Officer
APPENDIX FOUR   GROUP GUIDELINES

1. DO YOU UNDERSTAND WHAT IS BEING SAID?

2. IS THE SPEAKER BEING SINCERE?

3. IS THE SPEAKER'S POINT ACCEPTABLE FOR YOU?

4. DO YOU AGREE WITH THE SPEAKER'S USE OF INFORMATION AND/OR EXPERIENCES?
APPENDIX FIVE  STATISTICAL ANALYSIS

Although there was no intention to gather quantifiable data, there was enough data offered by the interviewees to present here.

Yield and Water Use

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>117.5 t/ha</td>
<td>26.9 t/ha</td>
</tr>
<tr>
<td>Water Use</td>
<td>9.75 ML/ha</td>
<td>1.9 ML/ha</td>
</tr>
</tbody>
</table>

The survey also indicated that growers who yielded above average used at least 8 ML/ha, with the top 25% of growers in terms of yield (134t/ha) using at least 9 ML/ha.

The yield figures are down approximately 5% on BSES figures, but these figures are probably lower due to the fact that the delta area was not targeted, which is generally regarded as the most productive area of the Burdekin for sugar cane.

Water use appears to be about right, but most growers pointed out that they have used more in the last few years as it has been so dry.

Drill length

The survey indicated that drill lengths varied from one area to the next, but in general did not vary significantly from one farm to the next.

Average drill lengths are as follows:

- 700m - Mona Park, Mulgrave & Jarvisfield
- 550m - Clare, Millaroo & Dalbeg
- 565m - Giru & Selkirk
- 750m - Leichhardt
400m - Brandon & Delta areas.

**Gypsum & Lime Usage**

The usage of gypsum to improve the penetration of water into the soil is high in the area, with 59% of growers interviewed using gypsum only, 11% using a mixture of lime and gypsum, 4% using lime only, 4% using other methods to improve penetration and the remaining 22% not using anything on a regular basis.

Of the growers interviewed 8% were using a dissolvinator to apply the gypsum, and 15% of the growers were applying gypsum selectively (ie on the poorer soils).

Most people surveyed found that gypsum assisted the penetration of the irrigation water, but were concerned about the affordability of the gypsum, especially if the price of sugar falls.

Other concerns in regard to gypsum were the differences between natural gypsum and chemical gypsum, is gypsum just another salt being introduced to the area and the sustainability of using it.

Of the top 25% of surveyed growers in regard to yield, 75% of these growers used gypsum. These growers water usage averaged 10 ML/ha, as compared to those not using gypsum being at 12 ML/ha.

**Trash Blanketing**

The usage of trash blankets is a practice presently being undertaken by some growers in the Burdekin. Of the growers surveyed, 40% had tried trash blanketing, 15% were using trash blanketing, 7% were using trash blanketing in a lesser form (ie tops only), 11% had tried but won't be using it any more, & 7% were still undecided whether the practice suits them.

Comments on trash blanketing were that slope and crossfall on drills had to be right & most growers felt that it did not suit heavier clay soils. Growers who were happy with trash
blanketing found the practice good for tonnages, CCS & early water usage - even on the heavier soils.

Of the top 25% of surveyed growers in regard to yield, two fifths (40%) were using trash blankets. The average water use of these growers was 9.8 ML/ha, as compared to an average of 11.1ML/ha without the trash blankets.

Cover Crops

Of the growers surveyed, 33% of growers were using/growing a cover crop between plough out & plant.

Most people interviewed regarded growing a cover crop as a good practice, but did not do it for a number of reasons. One fifth (20%) of growers did not do it as they were lasering the ground during this period and about one twelfth (8%) said that it was too late to plant effective cover crops by the time that crushing had finished.

No correlation was possible with regard to cover crop usage & yield.

Mini Pans

BSFES have trials using mini pans to assist farmers in determining irrigation scheduling. Of the growers surveyed, 30% were using these pans, with another 15% either comparing results with neighbouring properties and/or considering getting one for themselves.

Some comments regarding the use of the mini pans, was that the soil must be in good condition and the benefit is restricted by the delivery of water to the farm. Farmers using the pan said that it was good especially restarting irrigation after rain or when you get busy it is a good quick check.

Tailwater Return Systems
30% of growers surveyed had tailwater return systems in place, with another 15% of growers saying that they would be in the near future. All growers that had return systems were larger (bigger than 100 hectares) properties.

**Laser Levelling**

95% of growers surveyed had laser levelling done on their property at some time. 15% of growers were not happy with the end results, with problems like poor soil being exposed and/or releveling being required.

**Fertiliser Usage**

Soil tests to determine which fertiliser to use are used by 77% of growers in this survey. The test and recommendations are carried out by the local Fertiliser suppliers. Recommendations are also carried out by BSES staff.

From this survey, it is obvious that nitrogen based fertilisers are used with good results. Growers with above average yields supplied at least 220kg/ha of nitrogen to the soil, with the top 25% of growers in terms of yield supplying between 240 to 310 kg/ha of nitrogen to the soil.

The other fertiliser elements were applied erratically, however of the growers in the top 25%, all used greater than 40 kg/ha of potassium.
APPENDIX SIX

FIRST ATTEMPT TO CONDENSE MY NOTES
AND BRUCE’S NOTES FROM THE
INDIVIDUAL INTERVIEWS

- Water price - (we are subsidising other areas with pumping and pipeline required)
  - Price based on Electrical Tariff Price
  - WR should enter agreement with QEC in price guarantee and price reduction for power.
  - Over committing.
- No pumps in channel - should be below wheel.
- Getting and keeping water officers up river a problem - maybe contract them to a minimum time?
- Vandalism on pumps can be a problem (that is, shot at).
- Tram line cost up river - a major cost to growers.
- Proximity of farm to town and residence determines service given.
- WR doing minimum amount of maintenance work in old area especially - just keeping it going.
- No young people coming to area (up river).
- Excessive channel losses - if growers were pinching that much water - they would be prosecuted.
- Supply of equipment can be a problem at times (ie ordered pump 3 months to receive).
- Labour problems ie irrigation does not fit standard hours.
- Fines a joke - $200 fine will not deter people in need of water.
- Better to grow less cane and water properly.
- Cheap interest loan to encourage people to recycle.
- Accountability for decision/lack of decisions made (that is, poor design).
- Groundwater policy - change in consultation with grower?
- Salt water intrusion (Jarvisfield) over would be unproductive without dam water.
- Rising water table/salt problems (iron bark, gums, tea trees).
- Flood inundation - big production loss.
- Damage from harvest - pulling out stools(cutterbox too far back).
• Better tonnages after long term fallow.
• Too may DPI cars.
• Better soil management will be required in future.
• Soil abrasiveness and implement decline.
• Trialing liquid compost.
• Soil mapping and description to descriptive - encourage identification by 1d, 2a, 3b.
• Contractors can be a problem to get work done as required.
• Soils can be modified with long term working - allocation based on suitable soil, will this change association does not consider improvement to soils when soils chance.
• Burnt cane versus green cane - ie cost harvest versus loss of CCS.
• Why the need to give 48hrs notice to WR.
• Record keeping or lacking.
• More input - more yield, less input - less yield.
• Most farmers are aiming at higher tonnages (and not so much CCS).
• Nut grass a problem.
• Expansion too fast - are all issue being taken into account - ie serving existing blocks?
• Harvesting of long blocks/drills is an expected problem during wet crush.
• Fire management of long block is also a problem.
• Rush to minimum till on heavier soils in response to soil properties (wet too cheesy - dry too lumpy).
• Input to farm and cash flow linked (ie high use of Gypsum now, but will be lower if sugar price falls).
• Proximity to existing farms is an issue in expansion.
• Home block management is more efficient than external block efficiency.
• Big farmers making it difficult to get in for the smaller farmers.
• WR looking after the major farmers and forgetting the smaller farmers. Probably easier and more efficient for WR to serve the bigger farmers, but the smaller farmers are more reliant on their single farm to supply their income!
• Nature strips between new blocks?
• Getting balloting started to encourage new people and ideas to the area.
• New block and high purchase price - will government prop these growers up during low prices? using evapopan - very pleased.
• Promoting BRIA to investor, not farmer (glossy brochures).
• Stop charging for drainage water already been paid for (going to sea) - should be encouraging people to use.
• Must be flexible - people become set in ways to easily. Always learning on job!
• Info overload and conflicting info.
• Inequity throughout area - new farmers get 8ML, old farmers 6ML.
• Penalising farmers who stick to allocation when re-allocating water on previous usage.
• Re-introduce Heptachlor (for grub control), but with heavy government control - suscon does not work.
• Allocation not sufficient.
• Using poorer quality bore water instead of Gypsum.
• Wants level playing field (that is, all bores metered in area).
• Inequities in land and water payments - is some people pay bills late with no interest.
• Lifestyle is important.
• Minimal chemical usage where possible.
• Water officers should be paid more to maintain good staff.
• Value of water (ie complain of cost but do not know usage!)
• Practice of 100% of area during high returns - less during poorer returns.
• Concern that recycling seen as labour saving tool - not water saving tool (not many with storages).
• No advantages in long drills see 800m as about right.
• Dolichos possible host plants for nematodes in fallows (Mulgrave).
• Production in new areas not to total - still learning.
• Production decline from plant to ratoon and on (2 ratoons best)
• Location on channel effects irrigation management (ie at end of channel therefore have to order earlier rather than later).
• Small mill up river crucial to take pressure of larger mills (ie earlier crush finish).
• Heavy clays ideal for cane growing/irrigation (ease of management).
• Farmers watering in 3 or 4 days - then going away (ie shorter cycle is better for lifestyle, but harder on channel system).
• Minimum till - good for production (overworking common).
• New areas require minimal grading - very flat.
• Excessive laser levelling can expose poorer quality soils - resultant yield loss.
• Getting water to gate - can be the most water efficient farmer, but losses due to availability to water can be excessive ie 2t/ha each time water is not available.
• Cover crop and their usage/good practice.
• Furrow length and scope/soil type.
• Trash blanketing wet harvest.
• Expansion of area/effect on existing infrastructure and demands.
• Size and location of waterwheels.
• Milling - late crush/yield decline
• Differing tram line gauge - should be standardised.
• Must become more efficient - in line with increased productivity and gross area.
• Soils variability - yield variation.
  - penetration differences.
• Water price
• Levelling and late milling, drought (not prepared to water) has reduced the usage of cover crops.
• Dam has prevented "flushing" of river - more weeds, dirtier water.
• Supply of water from channel is a problem.
• Spears clogging up (electrolysis).
• Channels increasing flood inundation area and some natural drainage.
• Lack of consultation - during development.
• Land improving with use and time (for cane growing).
• Groundwater quality problems.
• Groundwater rises and pumping - too many restrictions regarding pumping of this water.
• Better water penetration using salt water.
• Ratoons - open stool and salt water do not mix - Sodium burns.
• Delivery rates to farm from channel.
• Forced to pump due to channel head fluctuations/variations/lack of consistent supply.
• Water resources dictate terms of usage (time/amount)/(WR are GOD!)
• Wheel and meter accuracy (volume) with channel variation - ie wheel spins at same rate with less head of water.
• No trees left.
• Government land grab - sold every bit of land.
• Happy with the present situation/lifestyle.
• Experience is important - ie watering, planting, ratooning.
• Farm shapes - more square.
• Block designs have not considered soil patterns and topography.
• Continuously irrigated due to limited availability.
• Conspiracy theory exists (ie levellers leaving the odd dip (aerial sprayers spreading weeds)).
• Evapopans - looking at people using, timing only a day or 2 different.
• Intergeneration transfer - need to buy new land.
• Sugar price has not kept up with input costs.
• New variety only real way of increasing productivity.
• Mistakes by WR have to be paid for by farmers (ie wheel location).
• Better consultation at all levels required between WR and landholders (ie advising of pump being stopped; farm shapes ).
• Tonnage/CCS relationship ie better to aim at higher CCS than higher tonnage? Not as reliable as many years ago - 1CCS increase approximately = 5t cane.
• Is variety research targeting tonnage or CCS?
• Extra Services (unaware of Groundwater advisory service available)
  - Leaf analysis.
  - Anyone worthwhile will be good here.
  - Unaware DPI (besides water) did anything in sugar areas.
• Existing Services - Good
  BSES - very important to new people.
  Fertiliser co.
  Farm development group - make design free with new block.
  Other farmers.
  DPI financial services
  own experiments
  canegrowers.
  Mill reports.
• Nematodes (Dicks Bank)
• Drainage pipes work but very expensive
• Rain and evaporation - Restarting - some find good - some bad
• Drainage - appears to be a problem associated with wet season, clearing and irrigation
• **BSES**
  - view on industry different to growers
  - too much handholding
  - Push for higher tonnage - resultant higher fibre (hence harvest, transport and milling cost increase and uses more water and nutrients)
  - Very stereotyped officers.
  - Can’t challenge BSES views
  - Need to break BSES up
  - Where possible make service industries private (everything except controls)
  - Sugar industry too isolated from mainstream agricultural practices
  - Big industries attract most Government effort, but smaller industries are much more productive and efficient in terms of output versus dollars spent.
  - Need to separate Political issues from Economic Issues
  - Like to see more farmer input into variety selection - varieties available not really suited to Burdekin
  - Mills have too much say in BSES activities (funded roughly 50% by mills)
• Old infrastructure (delivery not suited to today’s larger farms)
• High winds limit irrigation practices to furrow or trickle
• Water efficiency is dependant on soil management (to a fair degree) —> very important to keep sodics wet i.e. rough surface helps with wetting up soils
• The end of large crushing season prevents the growing of suitable legumes in fallow (i.e. after November)
• The cost of crushing (not too many realise the equation for crushing)
• Seed infestation from can bins a problem
• GYPSUM - Does it really improve soil condition, or does it just bomb the soil like fertilisers?
• Ease of management v’s Loss of Productivity
• 40t/acre break even point - > 60t/acre should be target
• Number of Ratoons - Ratooning cheap but loss in Productivity?
• Continue education of Young Farmers - but with broader outlook
• Capital Gains Tax - Problem for young farmer entering industry
• Submersible v’s Centrifugal pumps (advantages and disadvantages of each)
• Trickle would not be good in wet years because contractors would bury the tape when they ran over it.
• Irrigation needs to be more automated (major cost for irrigation is labour!)
• Unexplainable Variations in yield - problems (neighbour and his yield varied inversely)
• Power surges
• Believes mixing poor water with good water better as it is not importing salts i.e. Gypsum, lime - this should be done by Water Resources.
• Variation in available supply to property should be set at a standard
• Very good water - must pay for water + the cost of getting water to penetrate
• Be more productive in legislative changes ie make the rules for ourselves before they are made up for us i.e. Health and Safety Act - (Fire Extinguishers!); environmental issues.
• Respect for water
• Easy to plan/budget (due to climate and security of water)
• Margins are less than in areas more reliant on rainfall/ Sugar price drop - major impact in Burdekin - first to feel
• Large farms cannot be as water efficient (can’t get around as easy)
• Commercialism obviously cloud advice i.e. Fertiliser Company - Learning through the pocket
• DPI understaffed in Field Officers - especially in Environmental Issues
• Deep ripping gives better results than trash blanketing in heavier soils
• Evapopan - Soil must be in top condition before considering
• Clean Plant - more locations required
• Quality Control on equipment from suppliers
• Near limit re yields
• River rises and pumping
• Optimum length 4 - 500m (Leichhardt)
• Lime on red - Gypsum on black
• Laser exposing poorer soils/decrease in yield
• Non tax deductibility of increase in allocation
• Decision making v’s advice received
• Pig/vermin problems and woody weed/rubervine on riverbank
• Capital required to get set up/cash flow
• Water holding capacity of soils
• Women don’t seem to be involved in the industry (decisions)
• Pipe and pump selection and economics of sizing
• Balloting - should restrict sales after for 10-15 years to prevent speculators.
• Visibility of affluence is common in area (vanity)
• Bank not prepared to support with capital although assets were there
• Invent something to do with trash
• 125% allocation won’t last forever - bank on 100% average
• Drill too long to suit trickle
• Ideal drill about 800 m
• Evapopan - good indication for restart after rain
• BSES - As much following as leading
• More services available now
• General misunderstanding of Crop Nutrient requirements - Leaf Analysis and Soil Analysis
• Dissolvenator - Happy with results
• Surrounding reserves asset of property
• Sesbania and Vine a problem
• Penalty for burnt cane at mill
• More high tech fertiliser application i.e. get fertiliser on to specific soil type requirements
• Plenty of room for improvement in water use efficiency (W.U.E) in BRIA efficiency is up to 70-80%, in Delta as low as 30%
• “Excellent opportunity”
• Margin less on BRIA, but well and truly offset by size
• Designers - no practical experience

(Noticed group by major soil types mainly only a few by subgroup )

• Significant drop in production from plant to 1st ratoon(25% approx) in new area.
• More monitoring of Tailwater areas required
• Stealing water - No real effect on W.R., but hurts neighbours
• If you go to WR, you have to be beyond reproach
• Dangerous situation when intellectuals think for farmers
• Trash blanketing reduces the effect of Sodics
• Green Harvest (no vires) - only suited to specific area
• More small workshops - very good to gain ideas.
• Drill shape important
• Should take to harvesting contractors
• Green harvest inevitable in future
• Need more water storages in Australia - it's the driest country
• Tend to focus on newer areas / developing area and then forget them
• Not enough maintenance staff for the area
• Evapopans - good for monitoring when you get busy
• Soil left on cane needs to be addressed (different harvest techniques?)
• Trash fire worse than cane fire (that is, smoke thicker and stays lower)
• Cover crops reduce the need for fertiliser
• Summer grass a problem
• Plant cane too heavy for green harvest - but green harvest ratoons
• Evapopans - soils specific, some bad soils require water prior to pan indications
• Water Board - Water availability at end of line (very limited)
  - Trying to please too many people
  - Needs more direction to run efficiently
  - At least WR treats everyone equally
• Ratooning not worth it after October
• Sorghum, itch grass and guinea grass problems
• DPI & BSES have blanket policies on a lot of issues, need to be more site specific
• Q124 very pleased with results (slow to strike) Q117 over-rated and over advertised
• Variation in CCS reports from mills (even from same paddock & Harvest time)
• Variety trials often done only on the best land
• Trees are a haven for grubs, with figs and bananas being the worst trees
• Red deposits (iron) in pumps, clogging pipelines - work needs to be done in this area
  (would be significant problem for trickle)
• Lateral movement of water in duplex soils
• Work needs to be done on gypsum/lime selection and application
• Soil tests should be part of the level
• Long runs/wet harvest/burnt cane - after 5 days cane condemned
• Compaction is a big problem - harvest techniques
• Allocation is too small to grow cane - should be up to 12ML/ha
• Develop the better country first, before sodics
• Pigs a problem in the trash blanket
• Trash blanket reduces grub damage, but required good drainage and no cross slope
• Can’t take advantage of free flow in River due to channel capacity
• once bores reach a high level, treat similar to free flow in river to reduce water table problems.
• Build up and movement of sand in the river - possible future flood problems
• Soil sampling/mapping would be useful in delta area
• Leave odd shape blocks to trees
• Easement left for tramlines, power, road, channel, drains - but none for trees (10m would be enough near the channels)
• WR - poisoning new tree growth / regrowth
• WR - using same design criteria now as they were previously, which was obviously unsatisfactory for cane
• Dirty water restricts underground recharge by sealing off soils and silting up creeks
• People at WR were fine, but the policies and directions were not right
• If we don’t make a stand, will it turn out like other irrigation areas
• Evaporans - not using any more water but getting better growth
• Requires a cover crop more suited to heavy country (too much trouble hoeing in Dolichos)
• Concerned about long term compaction.
• Why persist with cane on sodic soils - grass doesn’t even grow there
• WR not community conscious enough (that is, did not supply water to a Landcare tree block)
• Concern with chemical residues - use and timing of spray vital - Integrated Pest Management.
• Worried about the safety of channels (that is, swimming in, chemical used/drinking of )
• Trash blanket winner in CCS, water saving and tonnage
• Cane varieties too big - don’t suit green harvest
• Excess water from channel system, drained away from old areas where it may be of benefit, because no one will pay for it
• Policies need to have incentives
• WR staff turnover has problems with previous decisions (info. not coordinated)
• Grower representation of Boards needs closer scrutinization
• Pesticides - concerned with form they come in, usage of
• Need for more education of farmers, especially in regard to new technologies
• Trees being pushed down and burnt - why not woodchip even if only suitable for garden
• Government services being cut - too much money being given to minority groups
• Suscon okay in New Country, but effectiveness lost quickly after that
• Parthenium on river?
• Services lifeline of information
• One person doesn’t know everything, but everyone knows something
• Must be able to demonstrate we are doing something for the environment
• Too much information is bottled up in BSES - also source information from further a field
APPENDIX SEVEN

GROWER COMMENTS IN RELATION TO MAJOR THEMES FROM PHASE ONE

1. Policy and Development

- Nature strips between new blocks.
- Expansion is too fast - are all issues being taken into account, ie serving existing blocks.
- Dangerous situation when intellectuals think for farmers
- Develop the better country first, before sodics
- Water Resources - using same design criteria now as they were previously, which was obviously unsatisfactory for cane
- Accountability for decision/lack of decisions made. ie poor design.
- Water Resources staff turnover has problems with previous decisions (info. not coordinated).
- Grower representation of Boards needs closer scrutinization
- Channels increasing flood inundation area and some natural drainage.
- Better consultation at all levels required between Water Resources and landholders re advising of pump
- Farm shapes - more square.
- Block designs have not considered soil patterns and topography.
- Designers have no practical experience
- Lack of consultation - during development.
- Proximity to existing farms is an issue in expansion.
- Why persist with cane on sodic soils - grass doesn't even grow there
- Expansion of area/effect on existing infrastructure and demands.
- Easement left for tramlines, power, road, channel, drains - but none for trees (10m would be enough near the channels)
- Tend to focus on newer areas / developing area and then forget them
- Supply to property should be set at a standard, variations are common.
- Surrounding reserves asset of property
- Cheap interest loan to encourage people to recycle.
- Groundwater policy - change in consultation with growers?
• Excess water from channel system, drained away from old areas where it may be of benefit, because no one will pay for it

• Drainage - appears to be problem associated with wet season clearing and irrigation

• Stop charging for drainage water which has already been paid for - should be encouraging people to use this resource before it goes to sea.

• Groundwater rises and pumping - too many restrictions regarding pumping of this water

• Dam has prevented “flushing” of river - more weeds, dirtier water.

• If we don’t make a stand, will it turn out like other irrigation areas

• Once bores reach a high level, treat similar to free flow in river to reduce water table problems.

• Policies needs to have incentives

• Be more productive in legislative changes. In other words, make the rules for ourselves before they are made up for us. For example, Health and Safety Act - (Fire Extinguishers!)

• Water price - we are subsidising other areas with pumping and pipelines required.

• Water price based on Electrical Tariff Price - Water Resources should enter agreement with Queensland Electricity Commission for a guarantee and a price reduction for power.

• Value of water - people complain of the cost but do not know their usage.

• Inequities in land and water payments - that is some people pay bills late with no interest.

• Wants level playing field, that is all bores metered in area.

• Water price & penetration - cost of water + getting it to soak (gypsum) a double cost!

• No pumps in channel - should be below wheel.

• Fines a joke - $200 fine will not deter people in need of water.

• Soils can be modified with long term working - allocation based on suitable soil, and does not consider improvement to soils which occur over time.

• Allocation is too small to grow cane - should be up to 12ML/ha

• Allocation not sufficient.

• Excessive channel losses - if growers were pinching that much water - they would be prosecuted.

• Penalising farmers who stick to allocation when re-allocating water on previous usage.

• Size and location of waterwheels.

• Inequity throughout area - new farmers get 8ML, old farmers 6ML.
• Mistakes by Water Resources have to be paid for by farmers (for example, water wheel location).

• Water Resources looking after the major farmers and forgetting the smaller farmers. Probably easier and more efficient for Water Resources but the smaller farmers are more reliant on their single farm to supply their income!

• Promoting BRIA to investor, not farmer (glossy brochures).

• Getting balloting started to encourage new people and ideas to the area.

• New block and high purchase price - will government prop these growers up during low prices?

• Big farmers making it difficult to get in for the smaller farmers.

• Balloting get started again but restrict resale until after for 10-15 years

• Small mill up river crucial to development of area take pressure off larger mills (that is earlier crush finish).

• Milling - late crush/yield decline

• differing line size on tramways/standardisation.

• Water Board - Water availability at end of line (very limited)

• Trying to please too many people

• very inefficient in terms of dollars spent to work done

• At least Water Resources treats everyone equally

• People at Water Resources were fine, but the policies and directions were not right

• Re-introduce Heptachlor (for grub control), but with heavy government control - Suscon does not work.

• Government land grab - sold every bit of land.

• Sugar industry too isolated from mainstream agricultural practices

• Big industries attract most Government effort, but smaller industries are much more productive and efficient in terms of output versus dollars

• Need to separate Political issues from Economic Issues

• New areas require minimal grading - very flat.

• Green harvest inevitable in future

• Government services being cut - too much money being given to minority groups

• Soil tests should be part of the levee

• Non tax deductibility of increase in allocation
• Mills must become more efficient - in line with increased productivity and area.

2. **Water Supply - Pre Farm Gate**

• Not enough maintenance staff for the area
• Water Resources doing minimum amount of maintenance work in old area especially - just keeping it going.
• Why the need to give 48hrs notice to Water Resources.
• Getting water to gate - can be the most water efficient farmer, but losses due to availability to water can be excessive, that is 2/t/h each time availability.
• Delivery rates to farm from channel unable to meet irrigation demands.
• Forced to pump due to channel head fluctuations/variations/lack of consistent supply.
• Continuously irrigated due to limited availability.
• Supply of water from channel is a problem.
• Can't take advantage of free flow in River due to channel capacity
• Larger volumes means less water (maybe a water saving).
• Farmers watering in 3 or 4 days - then going away (ie shorter cycle is better for lifestyle, but harder on channel system).
• Old infrastructure (delivery not suited to today's larger farms)
• Location on channel effects irrigation management (ie attend channel order earlier rather than later).
• Size and location of waterwheels.
• Wheel and meter accuracy (volume) with channel variation - ie wheel spins at same rate with less head of water.
• Believes mixing poor water with good water better as it is not importing salts especially Gypsum, lime - this should be done by Water Resources.
• Water just won't soak
• If you go to Water Resources, you have to be beyond reproach
• Stealing water - No real effect on Water Resources, but hurts neighbours
• Water officers should be paid more to maintain good staff.
• Over committing the supply
• People at the Water Resources are fine, but the policies and direction are not right.
• Water Resources staff turnover has problems with previous decisions made.
• Getting and keeping water officers up river a problem - maybe contract them to a minimum time?
• Value of water (ie complain of cost but do not know usage!)
• Water Resources dictate terms of usage (time/amount) (Water Resources are GOD!)
• Worried about the safety of channels (ie swimming in, chemical used/drinking of)

3. **On Farm Management, Practices and Trials**

• Non tax deductibility of purchasing increase in allocation
• Bank not prepared to support with capital (although assets were there)
• Labour problems ie irrigation does not fit standard hours.
• Easy to plan/budget (due to climate and security of water)
• More input - more yield, less input - less yield.
• Input to farm and cash flow linked (ie high use of Gypsum now, but will be lower if sugar price falls).
• Sugar price has not kept up with input costs.
• The cost of crushing (not too many realise the equation for crushing)
• Capital Gains Tax - Problem for young farmer entering industry
• Irrigation needs to be more automated (major cost for irrigation is labour!)
• Better to grow less cane and water properly.
• Ease of management v’s Loss of Productivity -
• t/acre break even point - > 60t/acre should be target
• Near limit with yields
• Ratooning not worth it after October (too late to get a good crop next harvest)
• Margin less on BRIA, but well and truly offset by size
• Water price and penetration - cost of water + getting it to soak (gypsum) a double cost!
• Value of water (ie complain of cost but do not know usage!)
• Concern that recycling seen as labour saving tool - not water saving tool (not many with storages).
• practice of growing cane on 100% of the available area of the farm during high sugar prices - less during poorer prices.
• Trialing liquid compost.
• Fire management at long block is a problem.
• Evapopan - very pleased.
• Evapopans - looking at people using, timing only a day or 2 different.
• Evapopan - Soil must be in top condition before considering
• Evapopan - good indication for restart after rain
• Evapopan - good for monitoring when you get busy
• Evapopans - soils specific, some bad soils require water prior to pan indications
• Rain and evapopan - Restarting - some find good - some find bad
• Drill shape important
• Trash blanketing & wet harvest a problem.
• Deep ripping gives better results than trash blanketing in heavier soils
• Trash blanket reduces grub damage, but required good drainage and no cross slope
• Pigs a problem in the trash blanket
• Trash blanketing reduce the effect of Sodics
• Trash blanket winner in CCS, water saving and tonnage
• Dissolvenator - Happy with results
• Cover crops and their usage/good practice.
• Cover crops reduce the need for fertiliser
• Dolichos possible host plants for nematodes in fallows (Mulgrave).
• Better tonnages after long term fallow.
• The end of late crushing season prevents the growing of suitable legumes in fallow (that is, after November)
• Levelling and late milling, drought (not prepared to water) has reduced the usage of cover crops.
• Excessive laser levelling can expose poorer quality soils - resultant yield loss.
• Compaction is a big problem - harvest techniques
• Minimum till - good for production (overworking common).
• Rush to minimum till on heavier soils in response to soil properties (wet too cheesy - dry too lumpy).
• Land improving with use and time (for cane growing).
• Heavy clays ideal for cane growing/irrigation (ease of management).
- New areas require minimal grading - very flat.
- Record keeping
- Harvesting of long blocks/drills is an expected problem during wet crush.
- No advantages in long drills see 800m as about right.
- Furrow length and slope/soil type relationship
- Minimal chemical usage where possible.
- Stealing water - No real effect on Water Resources, but hurts neighbours
- Flood inundation - big production loss.
- Soils variability - yield variation.
- Soil tests should be part of the levee
- Better soil management will be required in future.
- More high tech fertiliser application that is, get fertiliser on to soil type requiring
- Water efficiency is dependant on soil management (to a fair degree) -> very important to keep sodics wet
- Water holding capacity of soils
- Drainage - appears to be problem associated with wet season clearing and irrigation
- Gypsum - Does it really improve soil condition, or does it just bomb the soil like fertilisers?
- Lime on red - Gypsum on black soil
- Using poorer quality bore water instead of Gypsum.
- Lateral movement of water in duplex soils
- Red deposits (iron) in pumps, clogging pipelines - work needs to be done in this area (would be significant problem for trickle)
- Large farms cannot be as water efficient (can't get around as easy)
- Experience is important - ie watering, planting, ratooning.
- Happy with the present situation/lifestyle.
- Location on channel effects irrigation management (ie attend channel order earlier rather than later).
- High winds limit irrigation practices to furrow or trickle
- Trickle would not be good in wet years
- Drills too long to suit trickle
- Green Harvest (no vines) - only suited to specific area
• Green harvest inevitable in future
• Plant cane too heavy for green harvest - but green harvest others
• Long runs/wet harvest/burnt cane - after 5 day cane condemned
• Penalty for burnt cane at mill
• Room for improvement in water use efficiency in BRIA less as efficient up to 70-80%, in Delta as low as 30%
• General misunderstanding of Crop Nutrient requirements - Leaf Analysis and Soil Analysis
• Surrounding reserves asset of property
• Number of Ratoons - Ratooning cheap but loss in Productivity?
• Submersible v’s Centrifugal pumps (advantages and disadvantages of each)
• Optimum length 4 - 500m (Leichhardt)
• allocation won’t last forever - bank on 100% AV
• Respect for water
• Ideal drill about 800 m (Mulgrave)
• Unexplainable Variations in yield - problems (neighbour and his yield varied inversely)
• Significant drop in production from plant to 1st ratoon(25% approx) in new area.
• Margins are less than in areas more reliant on rainfall - Sugar price drop - major impact in Burdekin (first to feel)
• Must be flexible - people become set in ways too easily. Always learning on job!
• Home block management is more efficient than external block efficiency.
• Production in new areas not to total effect - still learning.
• Tonnage/CCS relationship ie better to aim at higher CCS than higher tonnage?
• New variety only real way of increasing productivity.
• Drainage pipes work but very expensive
• Power surges are causing pumping problems
• River rises and resultant pumping problems
• spears clogging up (electrolysis)

4. **On Farm Services and Advice**

• DPI understaffed in Field Officers - especially in Environmental Issues
• Unaware DPI (besides water) did anything in sugar areas.
• DPI financial services a useful service
• Groundwater advisory service - unaware of its availability
• Farm development group - make design free with new block.
• Soil mapping and description too descriptive - encourage identification by 1d, 2a, 3b.
• Pipe and pump selection and economics of sizing advice required.
• DPI & BSES have blanket policies on a lot of issues, need to be more site specific.
• BSES: - Always willing to help
  - Good & unbiased advice
  - Very important to new people.
  - As much following as leading
  - View on industry different to growers
  - Too much hand holding
  - Push for higher tonnage - resultant higher fibre (hence entire harvest,
    - transport and milling cost increased and uses more water and nutrients)
  - Very stereotyped officers.
  - Can’t challenge BSES views
  - Need to break BSES up
  - Like to see more farmer input into variety selection - varieties available not really
    suited to Burdekin
  - Is variety research targeting tonnage or CCS.
  - Mills have too much say in BSES activities (funded roughly 50% by mills)
• Cane varieties too big - don’t suit green harvest
• Too much information is bottled up in BSES - also source information from further a field
• Variety trials often done only on the best land
• Tend to focus on newer areas / developing area and then forget them
• Where possible make service industries private (everything except controls)
• Sugar industry too isolated from mainstream agricultural practices
• Big industries attract most Government effort, but smaller industries are much more
  productive and efficient in terms of output versus dollars
• Need to separate Political issues from Economic Issues
• Anyone worthwhile will be good here.
• Fertiliser Co. using soil tests to determine fertiliser requirements.
• More services available now than at start of BRIA development
• Designers - no practical experience
• Proximity of farm to town and residence determines service given.
• Info overload and conflicting info.
• Quality Control on equipment from suppliers
• Supply of equipment can be a problem at times (for example, ordered pump and took 3 months to receive).
• Commercialism obviously clouds advice
• Contractors can be a problem to get work done as required.
• Conspiracy theory exists (that is, aerial sprayers spreading weeds).
• More small workshops - very good to gain ideas.
• Need for more education of farmers, especially in regard to new technologies
• Continue education of Young Farmers - but with broader outlook
• Leaf analysis service may be useful.
• General misunderstanding of Crop Nutrient requirements - Leaf Analysis and Soil Analysis
• Gypsum - Does it really improve soil condition, or does it just bomb the soil like fertilisers?
• Requires a cover crop more suited to heavy country (too much trouble hoeing in Dolichos)
• Red deposits (iron) in pumps, clogging pipelines - work needs to be done in this area (would be significant problem for trickle)
• Dirt on cane needs to be addressed (different harvest techniques?)
• Work needs to be done on gypsum/lime selection and application
• Soil sampling/mapping would be useful in delta area
• Irrigation needs to be more automated (major cost for irrigation is labour!)
• Submersible versus Centrifugal pumps (advantages and disadvantages of each)
• Services lifeline of information
• One person doesn’t know everything, but everyone knows something
• Damage from harvest - pulling out stools (cutterbox too far back).
• Better tonnages after long term fallow.
• Better soil management will be required in future.
• Soil abrasiveness on implements
• Burnt cane versus green cane - ie cost harvest versus loss of CCS.
• Other farmers assistance and advice in setting up farm exceptional.
• Carrying out our own experiments.
• Most farmers are aiming at higher tonnages (and not so much CCS).
• Government services being cut - too much money being given to minority groups.
• Suscon okay in New Country, but effectiveness lost quickly after that.
• Variation in CCS reports from mills (even from same paddock & Harvest time).
• New variety only real way of increasing productivity.
• Intergeneration transfer - need to buy new land.
• Mill reports are useful to see how you’re going.
• Excessive laser levelling can expose poorer quality soils - resultant yield loss.
• Decision making versus advice received

5. **Environmental Considerations**

• Nature strips between new blocks?
• No trees left.
• Leave odd shape blocks to trees.
• Rising water table/salt problems (iron bark, gums, tea trees).
• Salt water intrusion (Jarvisfield) over would be unproductive without dam water.
• Groundwater quality problems.
• Dirty water restricts underground recharge by sealing of soils and silting up creeks.
• Pig/vermin problems and woody weed/rubber vine on riverbank.
• Clean Plant (are more locations required).
• Sesbania and Vine a problem.
• Sorghum, itch grass and guinea grass problems.
• Nut grass a problem.
• Summer grass a problem.
• *Dolichos* possible host plants for *nematodes* in fallows (Mulgrave).
• Parthenium on river.
• Seed infestation from can bins a problem.
• Nematodes.
• Re-introduce *Heptachlor* (for grub control), but with heavy government control - Suscon does not work.
• Pesticides - concerned with form they come in, usage of them and disposal of containers.
• Concern with chemical/residues - use and timing of spray vital
• Must be able to demonstrate we are doing something for the environment
• Invent something to do with trash - we really don’t want to burn but we have to
• More monitoring of Tailwater areas required
• Flood inundation - big production loss.
• Practice of 100% of area during high returns - less during poorer returns.
• Trees haven for grubs, figs and bananas worst
• Trash fire worse than cane fire (that is smoke thicker and stays lower)
• Need more water storages in Australia - it’s the driest country
• Water Resources - poisoning new tree growth / regrowth
• Water Resources not community conscious enough ie did not supply water to a Landcare tree block
THE EXTENSION NEED: LEARNING THROUGH DIALOGUE

A Theory-Informed Extension Practice

by: Daniel Peter Cloonan

A Thesis submitted to the School of Agriculture and Rural Development, University of Western Sydney, Hawkesbury

for the degree of Master of Science (Honours)

September 1996
CONTENTS

DECLARATION ................................................................. Page iii

ACKNOWLEDGEMENTS ......................................................... Page iv

ABBREVIATIONS ............................................................... Page v

LIST OF FIGURES ............................................................. Page vi

CHAPTER 1 INTRODUCTION ................................................. Page 7

CHAPTER 2 REVIEW OF LITERATURE ..................................... Page 13

CHAPTER 3 THE PROBLEM AREA AND EMERGING ISSUES

3.1 THEORIES GUIDING THE RESEARCH ................................ Page 47

3.2 PROPOSITIONAL QUESTIONS ......................................... Page 54

CHAPTER 4 METHODOLOGY ................................................. Page 57

CHAPTER 5 RESULTS, ANALYSIS AND INTERPRETATIONS ............. Page 83

CHAPTER 6 GENERALISATIONS AND REFLECTIONS/HIGHER
ORDER CONCEPTS:

6.1 CURRENT PRACTICE ...................................................... Page 128

6.2 BEST PRACTICE - GENERAL ......................................... Page 141

6.3 BEST PRACTICE - SPECIFIC ......................................... Page 146

6.4 IMPLICATIONS FOR EXTENSION .................................... Page 153

CHAPTER 7 CONCLUSIONS .................................................. Page 160

REFERENCES ........................................................................ Page 165

APPENDICES ....................................................................... Page 184
DECLARATION

Except where the contribution of others has been acknowledged, this thesis is the result of my original research. This thesis has not been submitted for any other degree either at this university or any other.

30 September 1996

Daniel Peter Cloonan
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# Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTFR</td>
<td>Australian Centre for Tropical Freshwater Research</td>
</tr>
<tr>
<td>AIMS</td>
<td>Australian Institute of Marine Science</td>
</tr>
<tr>
<td>ANZECC</td>
<td>Australian and New Zealand Environment Conservation Council</td>
</tr>
<tr>
<td>BRIA</td>
<td>Burdekin River Irrigation Area</td>
</tr>
<tr>
<td>BSES</td>
<td>Bureau of Sugar Experimental Stations</td>
</tr>
<tr>
<td>CCS</td>
<td>Commercial Cane Sugar</td>
</tr>
<tr>
<td>CSR</td>
<td>Colonial Sugar Refineries</td>
</tr>
<tr>
<td>DEH</td>
<td>Department of Environment</td>
</tr>
<tr>
<td>DPI</td>
<td>Department of Primary Industries</td>
</tr>
<tr>
<td>EO</td>
<td>Extension Officer</td>
</tr>
<tr>
<td>GCTB</td>
<td>Green Cane Trash Blanketing</td>
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<tr>
<td>GBRMPA</td>
<td>Great Barrier Reef Marine Park Authority</td>
</tr>
<tr>
<td>ML</td>
<td>Megalitres</td>
</tr>
<tr>
<td>NLP</td>
<td>National Landcare Program</td>
</tr>
<tr>
<td>RCD</td>
<td>Rural Community Development</td>
</tr>
<tr>
<td>RD&amp;E</td>
<td>Research, Development and Extension</td>
</tr>
<tr>
<td>T&amp;V</td>
<td>Training and Visit</td>
</tr>
<tr>
<td>TOT</td>
<td>Transfer of Technology</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure 1  The Effect of TOT on the Farming Population ......................... Page 19

Figure 2  The Reactive Model (Covey, 1991) ........................................ Page 32

Figure 3  The Proactive Model (Covey, 1991) ....................................... Page 32

Figure 4  The Basic Structure of an Appreciative System (Checkland and Casar, 1986) ................................................................. Page 52

Figure 5  The Different Research Perspectives .................................... Page 58

Figure 6  The Research Process .......................................................... Page 60

Figure 7  The Farmer Group Workshop Process ................................ Page 76

Figure 8  The Water Resources Issues ................................................ Page 102

Figure 9  Water Supply and Services Issues ..................................... Page 108

Figure 10 Model of the Inquiry .......................................................... Page 110

Figure 11 The New Extension Model .................................................. Page 159