LEARNING TO DEVELOP PARTICIPATIVE PROCESSES TO IMPROVE FARMING SYSTEMS IN THE BALONNE SHIRE, QUEENSLAND

BY

NICHOLAS CHRISTODOULO

A thesis presented to the University of Western Sydney Hawkesbury in fulfilment of the requirements for the degree of Master of Science (Honours)

October, 2000

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ACKNOWLEDGMENTS

In a thesis of this kind it is difficult to identify the source of all the ideas within it but I am indebted to many of the leading researchers on the philosophy of learning and participatory processes of which many are referenced throughout the text. However I make particular acknowledgment to the works of Gregory Bateson, John Dewey, Paulo Freire, Jurgen Habermas, Malcolm Knowles, Jules Pretty and Geoffrey Vickers whose insights have challenged and inspired my thinking.

I am particularly indebted to those colleagues and friends who have been instrumental in assisting and encouraging me during this work.

Firstly I would like to acknowledge all my colleagues in the Western Farming Systems Project (Queensland). I am particularly grateful to S. Cawley, R. Dalal, D. Freebairn, J. Lehane, G. Thomas and E. Weston. I commend their professionalism and commitment to agricultural development. This professionalism has been a consistent role model that has encouraged and challenged me to extend the boundaries of my own professionalism. I must also thank you all for putting up with my idiosyncratic methodological notions as we all struggled to confront the challenges of improving the conduct, application and the efficacy of agricultural research, development and extension.

I would like to thank David Lawrence of the Queensland Department of Primary Industries, Toowoomba. Dave spent many hours with me in refining our thinking on the characteristics and modes of participation, which greatly assisted me in completing my research work.

I am especially indebted and grateful to my supervisors Professor Peter Cornish of the University of Western Sydney, Hawkesbury and Dr N.A. (Gus) Hamilton of the Queensland Department of Primary Industries, Dalby. Throughout my research both Peter and Gus provided perceptive criticism and guidance that encouraged and challenged me to develop my understanding of participative processes and their application beyond my expectations.

I acknowledge Jenny Foxton of the University of Queensland, Gatton and Keith Codrington of St George for editorial assistance. I also extend my special gratitude to John Gray of the Queensland Department of Natural Resources, Warwick, for his encouragement and support over the first two years of my appointment. I would also like to extend my special appreciation to Robin Galagher and the staff at the DPI Library who provided a professional and invaluable research service.

I also extend my special gratitude to all the grain farmers in the Balonne Shire, in particular to the farmers of the Nindigully Farming Group, Rockyacrossing Farming Group, Boolba Farming Group and the Balonne Management Group. Without their support, and pro-active, interest and commitment to agricultural development this study would not have been possible.

To my parents George and Dane I extend my immeasurable appreciation. Especially for providing me with the early life experiences that have enabled me to see that the individuality we so revere is embedded in the labours of people past and present. This has been a constant reminder, which has fed my motivation to continually broaden my boundaries.

Finally to my wife Meegan, who I gratefully acknowledge for her enduring support and love throughout the duration of this research, and for persevering with me when I was often immersed and preoccupied with my work, thanks.
GLOSSARY AND ACRONYMS

Action Learning (AL) A philosophical framework for integrating people’s existing knowledge with their emergent understandings of a particular issue through group learning (Revans, 1997).

Adaptation Emerging through transition by adjusting to a particular condition or ways by alteration or modification.

Adoption To take up or accept a practice or view evolved by another.

Andragogy The art and science of helping adults learn.

APSRU Agricultural Production Systems Research Unit. An integrated team of QDPI, QDNR and CSIRO researchers situated in QDPI Toowoomba.

BD Bulk Density. The mass of dry soil per unit bulk volume including the air space.

Communication The process of establishing meaning.

Construct Something that is construed or interpreted by a process of mental synthesis. Often this process is constituted by the ordering or systematic uniting of experiential elements and of terms and relations.

Constructivist Approach Adopts an ontological position that assumes reality is constructed by the individual, which is socially and experientially based - thus multiple constructions exist. Constructions are more or less informed and/or sophisticated. The epistemological basis assumes the researcher and the researched object are inter-actively linked.

CSIRO Commonwealth Scientific and Industrial Research Organisation, an organisation devoted to basic and applied research, funded by the Commonwealth Government of Australia.

Decision Making Is a state of reflection between knowledge, planning and action, and which often reflects the nature of one’s reality.

Detailed Complexity The association of many related variables often in intricate combination.

Double Cropping The practice of planting a crop shortly after the previous crop has been harvested. This means the fallow is usually less than three months duration.

Dynamic Complexity When understanding of an issue changes through time and space and is dependent upon the observer. That is, situations of biophysical and socio-economic proportions that are often subjective in nature.

Efficacy The ability to produce a desired effect in an effective and efficient manner.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Effectiveness</td>
<td>To evaluate the quality of an activity’s influence on improving learning</td>
</tr>
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<td></td>
<td>and thus decision making and practices.</td>
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<td>Efficiency</td>
<td>The capacity of an activity to produce desired results with the most</td>
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<tr>
<td></td>
<td>suitable use of time and resources available.</td>
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<tr>
<td>Emergent</td>
<td>The process by means of which a number of divergent elements are</td>
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<td></td>
<td>synthesised and organised into a new form (Oxford concise dictionary of</td>
</tr>
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<td></td>
<td>sociology, 1994).</td>
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<tr>
<td>Empathy</td>
<td>The ability to identify with and understand others, (particularly</td>
</tr>
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<td></td>
<td>priorities, conditions and emotions).</td>
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<tr>
<td>Epistemology</td>
<td>The relationship between the knower or would be knower and what can</td>
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<tr>
<td></td>
<td>be known (Guba and Lincoln, 1994).</td>
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<tr>
<td>Experiential</td>
<td>Learning from experience</td>
</tr>
<tr>
<td>Learning</td>
<td></td>
</tr>
<tr>
<td>Fallow</td>
<td>The period between harvest of a crop and the planting of the next crop or</td>
</tr>
<tr>
<td></td>
<td>pasture.</td>
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<tr>
<td>FGA</td>
<td>Focus Group Analysis.</td>
</tr>
<tr>
<td>Focus Group</td>
<td>An interactive interview conducted with a small group of people</td>
</tr>
<tr>
<td>Analysis</td>
<td>(usually four to ten).</td>
</tr>
<tr>
<td>GRDC</td>
<td>Grains Research and Development Corporation funds research using grain</td>
</tr>
<tr>
<td></td>
<td>grower levies and Australian Government matching contributors.</td>
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<tr>
<td>Hermeneutics</td>
<td>The study of the methodological principles of interpretation and</td>
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<tr>
<td></td>
<td>explanation. Essentially meaning to translate or to interpret.</td>
</tr>
<tr>
<td>Improving</td>
<td>Making something more purposeful (or better).</td>
</tr>
<tr>
<td>Indigenous</td>
<td>Refers to practices that have evolved within a community group in</td>
</tr>
<tr>
<td>Knowledge</td>
<td>response to a specific problem or issue that is often site specific in</td>
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<tr>
<td></td>
<td>nature (local knowledge).</td>
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<tr>
<td>IK</td>
<td>Indigenous Knowledge.</td>
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<tr>
<td>Interdependence</td>
<td>A collaboratively structured state that recognises and appreciates the</td>
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<td></td>
<td>mutual dependence among different knowledge cultures.</td>
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<tr>
<td>Intuitive Learning</td>
<td>Learning developed through cultural beliefs, values and traditions.</td>
</tr>
<tr>
<td>Knowledge</td>
<td>The residual of learning</td>
</tr>
<tr>
<td>Learning</td>
<td>A process in which one tests ideas and generalisations relevant to some</td>
</tr>
<tr>
<td></td>
<td>problem, interest and/or issue.</td>
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<tr>
<td>Ley Pastures</td>
<td>A period of pasture containing legumes between periods of crops, for</td>
</tr>
<tr>
<td></td>
<td>rejuvenating cropping land.</td>
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<tr>
<td><strong>Meta Learning</strong></td>
<td>A reflective learning process that internally examines and explores an issue if concern where by knowledge on content and process develops through the transformation of experience (Kolb, 1984).</td>
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<tr>
<td><strong>Methodology</strong></td>
<td>The process a researcher uses to find out whatever he/she believes can be known.</td>
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<tr>
<td><strong>Minimum or Reduced Tillage</strong></td>
<td>Some mechanical tillage operations during the fallow are substituted with herbicides and/or grazing (to reduce mechanical tillage).</td>
</tr>
<tr>
<td><strong>Ontology</strong></td>
<td>Is the form and nature of reality and therefore what is there can be known about it (Guba and Lincoln, 1994).</td>
</tr>
<tr>
<td><strong>Pedagogy</strong></td>
<td>The art and science of teaching children.</td>
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<tr>
<td><strong>PAWC</strong></td>
<td>Plant Available Water Capacity. The water held in the soil that can be readily absorbed by growing plants after drainage.</td>
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<td><strong>PLAR</strong></td>
<td>Participatory Learning and Action Research.</td>
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<td><strong>POFR</strong></td>
<td>Participatory on farm research</td>
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<td><strong>Positivist Approach</strong></td>
<td>(Adopts an ontological position that) Assumes a concrete reality exists that can be captured, or governed by natural laws and mechanisms. Thus knowledge consists of verified hypotheses that can be accepted as facts or laws. The epistemological basis assumes the researcher and the researched object are independent entities.</td>
</tr>
<tr>
<td><strong>Practical Learning</strong></td>
<td>Learning from doing</td>
</tr>
<tr>
<td><strong>Propositional Learning</strong></td>
<td>Learning from instruction</td>
</tr>
<tr>
<td><strong>QDPI</strong></td>
<td>Queensland Department of Primary Industries, an organisation devoted to applied research, development and extension in primary industries, funded by the Queensland Government.</td>
</tr>
<tr>
<td><strong>QDNR</strong></td>
<td>Queensland Department of Natural Resources, an organisation devoted to applied research, development and extension in natural resources, funded by the Queensland Government.</td>
</tr>
<tr>
<td><strong>Soil classification</strong></td>
<td>The systematic arrangement of soils into groups or categories on the basis of their characteristics.</td>
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<td><strong>TOT</strong></td>
<td>Transfer of Technology.</td>
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<tr>
<td><strong>WFSP</strong></td>
<td>Western Farming Systems Project.</td>
</tr>
<tr>
<td><strong>Zeitgeist</strong></td>
<td>The general intellectual, moral and cultural state of a period.</td>
</tr>
<tr>
<td><strong>Zero tillage</strong></td>
<td>No mechanical tillage in the fallow phase. Chemical control of weeds.</td>
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ABSTRACT

This thesis develops two related themes. The first is that participatory approaches to agricultural research and extension can provide a sound process for all stakeholders to learn how to develop more sustainable agriculture. The second is that appropriate levels of participation can be used to link knowledge from three important sources: local knowledge, scientific knowledge and experiential knowledge. The result of appropriate participation is an interdependent\(^1\) multi-method approach to research, development and extension which is more efficacious for improving stakeholder’s decision making than any single inquiry approach alone.

The thesis develops these two related themes by examining the inconsistencies between espoused theories of participatory approaches (ie intended behaviour) and theories in action (ie what is actually practised). This examination required the development of techniques for challenging the predetermined roles of scientists, farmers and advisers in R, D and E programs. The objective was to encourage the development of dialogue\(^2\) and dialectical\(^3\) communication that may lead to the emergence of beneficial synergistic effects between different learning cultures.

The study was based upon the work of a major research, development and extension (R, D and E) project known as the Western Farming Systems Project (WFSP), which was concerned with the development of sustainable rotations and cropping practices in south western Queensland and north western N.S.W between 1994-1999.

The research area. The study was conducted in Balonne Shire, centred on the town of St George. The Balonne Shire is the western most grain cropping area in south western Queensland covering an area of 31,119 km\(^2\) of which 5.5% (171,000 ha) is currently under cultivation. Crops are predominantly produced in dryland agricultural production systems. The climate is variable, often resulting in a shortage of rainfall in the growing season for winter crops (May-Oct) and thus leading to a dependency on fallowing to conserve moisture from summer rainfall.

Wheat is the pillar of the cropping industries in the region. Other grain and fibre crops include barley, sorghum, mungbeans, chickpeas and cotton.

Issues for the grains industry. Four related issues affect the future viability of Australian grain farmers, including those in the Balonne-Maranoa region (Anon, 1995; Cornish, 1997; Hamblin and Kyneur, 1993). These are:

- the need to increase productivity to remain internationally competitive;
- the need to address a growing list of environmental issues;

\(^1\) Interdependency refers to a higher ordered ontological position that appreciates mutual dependence among different knowledge cultures and aims to utilise the emerging synergy from co-working and co-learning to improve decision-making.

\(^2\) Dialogue development is a process of communication for building common understanding.

\(^3\) Dialectical is the comparison and contrast of opposites through discussion and reasoning by dialogue as a method for developing more sophisticated constructions.
• the need to maintain or improve grain quality to ensure the competitiveness in sophisticated markets demanding high quality; and
• the need to address declining soil fertility, which is reducing both the growth in productivity and grain quality.

**The problem addressed by the WFSP.** In the Balonne-Maranoa region, increases in productivity since the 1970s have been amongst the poorest in Australia, apparently because of declining soil fertility leading to inefficient use of rainfall (Cornish, 1997). The WFSP was designed to address the declining levels of grain quality and yield observed in the region.

The WFSP adopted a participatory approach (Martin et al, 1996) with the expectation that this would improve the adoption of sustainable cropping practices. Participation was viewed as a means of involving farmers to make research more relevant and extension more effective.

**The research issue for this thesis.** My challenge was to advance participation from mere involvement to becoming a process of development for the participants. Development here is understood to mean improving the way participants learn to learn, which requires stakeholders who are directly influenced by R, D and E programs to have increased control over the learning process (Pretty, 1995).

There are alternative views of participation. Participatory processes may be viewed as a means to achieve predetermined end points including the adoption of technology. Alternatively, participation may be viewed as a fundamental right (Pretty, 1995) where all stakeholders have the opportunity to influence process and content from the outset.

Participation, in this alternative view, is a means to improve decision-making through collaborative identification of needs, planning, action and analysis (ie a focus on dialogue development in an interdependent framework). However, since levels of participation vary markedly between activities that claim to be participatory in nature (Pretty, 1995), it follows that not all participation is necessarily of equal value.

The goal of my research was to develop participation from a means to improve adoption whilst preserving control, to a means of improving the learning process for making more informed decisions and sharing control.

**The problem addressed by the thesis.** There is little information on approaches that focus on improving the quality of participation in R, D and E programs in agriculture (Hamilton, 1995). There are no guidelines to suggest appropriate levels of participation for any situation. Furthermore, given the various definitions and practice of participatory approaches, I anticipated that attempts to improve the quality of participation in the WFSP would encounter serious difficulties as increased participation would challenge the worldviews of stakeholders.

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4 Adoption is to take up or accept a practice or view evolved by another.
5 Quality of participation refers to an appropriate level of interaction between stakeholders in a given context that is determined by dialogue and dialectical reasoning amongst all participating stakeholders.
6 Worldview refers to a person’s basic set of beliefs that guide their actions.
The aim of the research is reflected in the question:

*Does the level of participation of stakeholders in R, D and E processes lead to more informed decision-making?*

Three sub-questions were used to complement the above main question.

a. Is Pretty’s (1995) typology of participation adequate to identify levels of participation?

b. Who does increased participation impact on, and how does it impact?

c. What are the costs and benefits of increased participation?

**The research methodology.** The research was undertaken within the general framework suggested by Checkland (1985). This framework identifies the need for a framework of ideas and concepts (the conceptual framework), an appropriate methodology for applying these ideas and concepts in an application area (the problem situation), and the learning which emerges about framework, methodology, method and the problem situation.

The research was essentially an emergent process that utilised eight major case study activities that ranged between high and low levels of intervention and participation. This was a multi-method approach with both qualitative and quantitative aspects. The methodology incorporated both biophysical and socio-economic interpretations.

The research was undertaken from a constructivist position, which used the principles of grounded theory (Strass and Corbin, 1990) to follow a participative action research (PAR) methodology (Reason, 1994). The methods included participatory and non-participant observation, quantitative surveys and focus group analysis. These methods were part of a multi-method tool kit which utilised transfer of technology (TOT) (Roling, 1998), action learning (AL) (Revans, 1997) and participative action research (PAR) (Greenwood, et al. 1993). These three methodologies reflected a mixture of predetermined, opportunistic, and unexpected discoveries, respectively, and were designed to integrate knowledge derived from different sources and inquiry positions.

*Findings from the case studies.*

a) Identifying levels of participation

Pretty’s (1995) typology of participation was a useful framework for developing my understanding of participation by providing general descriptions of various levels of participation. However, it was difficult to determine the level of participation in any activity using Pretty’s (1995) typology alone. Therefore, I developed criteria to help assess the levels of participation in learning activities. Four discriminant criteria were used in this process: a) communication (eg unilateral versus bilateral); b) types of learning culture (eg local, propositional and/or experiential knowledge); c) process or content orientation (eg predetermined and/or emergent outcomes); and d) the decision-making process (eg co-working/co-learning versus unilateral/predetermined).

Effective participation emerged and changed over time. The case studies revealed that there is not a case “for” or “against” a particular level of participation, because no single level alone encouraged interdependency among stakeholders or improved learning efficacy. All levels of participation appeared to be mutually dependent. Therefore practitioners need to develop
skills in understanding and appreciating the usefulness of various levels of participation in different situations.

b) The impact of increased participation

The TOT activities studied comprised of a consultative process (ie a level of participation, Pretty, 1995) used to create awareness of technologies and information that may be useful in addressing farming system problems. These activities played a valuable role in providing timely information to a broad and widely dispersed stakeholder group. TOT activities also contributed to learning development by providing scientific information on cause and effect relationships of biophysical phenomena which, in later activities, were the foundation for improving stakeholder's understanding. They helped to develop interdependency, by indicating to all stakeholders that the prescription of information alone is not sufficient for learning to adapt to change.

TOT had a role in the development of participatory processes, mainly in the opportunity it provided for the communication of both propositional knowledge and local knowledge. However, the communication and decision making on learning objectives was unilaterally controlled. This level of opportunity (ie unilateral versus bilateral planning, acting, observing and reflecting) was later recognised as a critical factor influencing dialogue development, the level of participation, and learning efficacy (ie co-working and co-learning) in all case studies.

The AL activities were used to extend the consultative processes in TOT programs and incorporate co-learning by providing opportunities for all stakeholders to influence learning outcomes. The AL activities were a more co-operative learning process but knowledge still resided in the realm of the scientists. It was concluded that, although AL activities espouse to be more interactive than TOT activities, in reality they were mainly used to communicate propositional knowledge. In practice, AL activities provided farmers with the opportunity to discover what the scientist already knew and, as a result, are more synonymous with adult education. AL activities largely operated at a functional level (Pretty, 1995) of participation. This process allowed participants to have some influence over content but goals and process were essentially pre-determined. AL activities did, however, have the potential to function at higher levels of participation (eg interactive level of participation). The distinction between the two levels of operation reflected stakeholders' poor initial understanding of process application.

PAR activities were designed to extend beyond the consultative and functional levels of participation by providing all stakeholders with the opportunity to influence both process and content as opposed to degrees of content in AL and TOT activities. Increased participation in these activities led to a focus on dialogue development to encourage and create environments for co-learning and co-working. This provided stakeholders with more opportunity to influence both process and content. Emphasis was then given to developing communication (ie dialogue development) and utilising multiple constructs in the learning process. Utilising multiple constructs helped to refine and develop more sophisticated constructions by reflecting on what is learned and how it is learned. However, programs with high participation did not deal with stakeholder's multiple goals or develop clear learning outcomes to assist participants decision-making.
An overall observation throughout the activities was that increased participation required interdependency between processes (ie TOT, AL and PAR) and knowledge cultures (ie local, propositional and experiential knowledge) to utilise the potential learning outcomes from increased participation. For example, TOT activities provided valuable propositional insights for AL activities, which raised unexpected questions and insights for further investigation in subsequent PAR activities.

c) The costs and benefits of increased participation

Improving the quality of participation had increased demands on limited human resources in establishing collaborative relationships between stakeholders. Further difficulties were encountered dealing with unclear directions and outcomes. For some participants these difficulties de-motivated their learning and interaction in group activities. Dealing with these difficulties remains a challenge.

The costs of increased participation reflect the emergent\textsuperscript{7} nature of participatory approaches. Generalisations were difficult to establish because stakeholders were often dealing with multiple issues and problems that were not always disclosed. Although the emergent nature of participatory approaches can be detrimental for learning development, the emergence of unforseen issues (ie not predetermined) may serve as an indicator of group maturity in dialogue development. Such maturity was observed in participants’ level of reasoning as they compared experiences, while building common understandings in group learning activities.

Despite these costs, the interaction between stakeholders and the mixture of TOT, AL and PAR approaches led to a range of beneficial synergistic effects. This resulted in an appreciative outlook upon the whole farming system, rather than a focus on biophysical and production aspects only:

- Farmers developed an impressive ability to incorporate newly acquired concepts into their own experiences which generated a higher level of dialogue. The outcome of this is observed in farmer's behaviour ie where they seek not one solution but discuss multiple strategies and their implications, which is more supportive in dealing with change;
- Scientists had the opportunity to develop their understanding of the local area, while at the same time enjoying a more diverse audience with which to interact, test, adapt and disseminate their research results. This supported scientists’ understanding of the implications of research outcomes for site specific situations;
- Growing stakeholder appreciation that the efficacy of R, D and E programs may be improved through the interdependence of knowledge cultures and learning processes; and
- Stakeholders appreciated the value of developing a common language, which improved dialogue between participants.

One of the major benefits from increased participation was that stakeholders increasingly recognised that developing and improving learning approaches requires individuals to suspend their judgements, to understand their predispositions and to challenge the coherence of their own mental models.

\textsuperscript{7} Emergent is the process by means of which a number of divergent elements are synthesised and organised into a new form (Oxford concise dictionary of sociology, 1994).
The challenge for improving participatory approaches rests on a continuum of understanding and dealing with successive changes. Unlike traditional pedagogical approaches, participatory approaches often led to a state of uncertainty and absence of clearly directed action, that makes its practice difficult and costly when applied to R, D and E programs.

The study showed that to improve the quality of participation it is necessary to:

- establish a learning environment (ie group development for co-working and co-learning);
- develop transparent processes for bilateral planning and acting;
- encourage mutual diagnosis of learning needs;
- develop clear learning objectives;
- designing and implementing learning activities;
- foster collective interpretation and evaluation of outcomes (ie both process and content); and
- refine learning outcomes to better inform decision making and future goals.

**Conclusions.** TOT approaches alone are ineffective in addressing the dynamic complexity associated with sustainable development. However, TOT activities were adequate for explaining biophysical cause and effect relationships when stakeholders had an understanding of each other’s context. TOT played an important role in increasing the efficiency of R, D and E programs. Participatory approaches (AL and PAR) were considered more appropriate in understanding and addressing dynamically complex situations (ie situations of biophysical and socio-economic proportions that are subjective in nature). However, AL and PAR alone are inefficient in dealing with the detailed complexity of situations (ie organising a systematic order of associated variables for clear explanation) compared to TOT, AL and PAR in combination.

Participation alone does not guarantee improved efficacy of learning or practice. Often, participatory approaches deal with multiple goals and issues, some of which are undisclosed and therefore make learning outcomes more difficult to identify. Participation can also be manipulative, passive, or participants could be co-opted to meet external goals and there may be issues of equality and equity of knowledge and understanding, which affect communication and act as barriers to efficacious learning.

A critical element for improving decision-making and consequently improving the efficacy of the R, D and E programs was, according to all stakeholders, the *understanding of principles and concepts*. Stakeholders who “learnt with understanding” achieved progressive improvements in dialogue, that is, skills in communication and the capacity to address learning needs. Therefore learning with understanding was considered to have more efficacy than rote learning.

Meaningful participation requires more than simple involvement. Various levels of participation can reside in all processes (ie TOT, AL, or PAR). Determining the appropriateness of these levels in different situations, and recognising when to improve the quality of participation, appears to be the major challenge for developing interdependent approaches and improving the efficacy of R, D and E programs.
The study suggests that future research needs to be directed at developing processes for operationalising interdependent concepts, by challenging stakeholders' predispositions through dialogical and dialectical practice.

In conclusion the learning outcomes of this research are summarised. Participation is a complex issue and greater participation may not always result in better (ie more effective or efficient) learning outcomes. Participation is simply not an “on off” switch. All types of inquiry approaches have levels of participation which can be enhanced to improve learning efficacy depending on the situation. Interactive participation was found to be the critical level for encouraging double loop learning⁸. However, this level is also mutually dependent on stakeholders’ understanding of other levels of participation and their interaction.

Pretty’s (1995) typology of participation provided a useful reference point for understanding the dynamic complexity of participation and for benchmarking levels of participation. However, Pretty’s (1995) typology required the development of more detailed criteria to differentiate between levels of participation operating in specific situations.

This research demonstrates the significance of the ontological⁹ appreciative system. That is, all approaches and knowledge cultures contribute to improving stakeholders’ decision making and therefore have a valuable role in the development of participatory R, D and E programs. The cost of such a perspective is that people may see this assertion as a justification for not challenging their predispositions and may essentially result in shallow levels of participation. For example a multi-method approaches that excludes participatory development results in traditional TOT, which is a process that controls, shapes and changes behaviour (Knowles, 1984). A multi-method approach that includes participation but ignores the significance of ontological progression results in a participatory approach used as a means to improve TOT. The outcome is a process that manipulates change in behaviour and is essentially pedagogical in nature.

Improving the efficacy of R, D and E programs and stakeholders’ decision-making may not necessarily depend only on a stakeholder’s ability to mix and match methods to relative situations (ie content orientated). The extent of the tool kit (ie methods) itself does not ensure ontological progression (ie process development). What does matter is that the approach in use can constructively challenge stakeholder’s predispositions. This may allow stakeholders to recognise how their underlying assumptions influence what, and how they learn and therefore provide a process for developing more informed decision-making. The outcome is a learning paradigm, which has an interdependent characteristic and is more efficacious for learning to manage change.

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⁸ Double loop learning is a systemic process that submits values, beliefs, methodology and outcomes to critical review. Its purpose is to highlight inconsistencies in peoples behaviour which they are not aware of and use this reflective learning to improve decision-making (Agyris, 1976).

⁹ Ontology is the form and nature of reality, which influences how one relates between what is researched and how knowledge is gained about the world. It shapes how we see the world and how we act in it (Bateson, 1972).
1. **Introduction**

This thesis explores the notion that improved participation (by all stakeholders) in research can enhance the outcomes desired by all stakeholders (collectively or individually). The research is conducted within a major agricultural R, D & E project in the Balonne Shire from 1995 which focuses on improving the sustainability of cropping in south western Queensland.

The earliest records of cereal crop production in the Western Downs and Maranoa date from the late 1800’s (Barker, et al. 1988). Whilst this region has capitalised on the high natural fertility of its soils and survived the hazards of an erratic climate (droughts occur 1 year in 5), the profitability and sustainability of cropping has been brought into question over the past thirty years. Hamblin and Kyneur (1993) and Cornish et al. (1997) report that increases in productivity in the Western Downs and Maranoa since the 1970’s have been amongst the poorest in Australia and grain protein is falling.

1.1. **The Biophysical Problem**

The low crop productivity has been attributed to declining soil fertility (Dalal et al. 1986) leading to inefficient use of rainfall (Cornish et al. 1998). Australian farmers must increase productivity to remain internationally competitive (Anon 1995, Cornish 1997). At the same time, they must address a growing list of environmental issues, plus compete in sophisticated markets demanding high quality (Hamblin and Kyneur, 1993 and Cornish, 1997). In the Cornish (1997) analysis, management of soil nitrogen and water are at the heart of productivity and environmental sustainability. These issues had been identified in the 1960s, when cropping expanded rapidly in the region, and have been identified as key issues many times since (Dalal et al. 1986). So the issues have been ‘known’ for over thirty years, yet soil fertility has still declined, water is used inefficiently, and production is said to be unsustainable. As Cornish (1997) suggests “without major changes in farming practices, crop production in the area will be neither environmentally sustainable nor economically sustainable”.

1.2. **An Alternate View of the Problem**

The scientific understanding of the soil water/soil nitrogen relationship has been well researched and the findings reported. The poor response by agriculture to the findings of research suggests that (i) there is something seriously wrong or irrelevant with the research, (ii) the extension process is flawed or under resourced and/or (iii) farmers do not have the skills or technical and financial resources to utilise technological developments.

This dilemma is not new and has been extensively researched. The outcomes of this research suggest that the R, D and E paradigm in use, commonly known as the Transfer of Technology or TOT, is inadequate to address the complexity of problem situations facing today’s agricultural development (Pretty, 1995, Hamilton, 1995). The problems should not be regarded as simple biophysical cause and effect relationships leading to “one solution fits all” outcomes. Rather, these problems are increasingly being regarded as complex situations where the biophysical relationships are embedded in the individual’s socio-economic milieu and the improvements to any one situation pertain to that situation and no other ie. location specificity. Clearly, the traditional TOT approach is incapable of addressing these (many) complex situations, although it can provide important information to help inform the situations. The emerging success of systems approaches, with a strong requirement for
participation by all actors in the process, held promise of more rapid improvement in the problem situation. Pretty (1995) developed a typology to describe various levels of participation that may occur in these approaches. The current culture is, however, experiencing difficulty with the application of participatory approaches, highlighting the need for research into the participatory process itself (Bateson, 1979 and 1987, and Guba, 1990).

1.3. A Project to Improve the Sustainability of Cropping.

To redress the poor development of sustainable cropping practices, and to address the urgent need to create more sustainable and productive farming systems in the region, a project called the Western Farming Systems Project (WFSP) was commissioned\(^{10}\).

The objective of the project was to develop sustainable rotations and cropping practices for the marginal cropping areas of north-western N.S.W. and south-western Queensland. In designing the project, it was recognised that the changes required could be complex, and therefore demanding on farm management. It was also recognised that extension resources were scarce and likely to diminish. Therefore a new approach to research and extension was taken, with a strong emphasis on participation of farmers in the design and conduct of research, development and extension (R, D and E).

The participatory approach was taken with the expectation that it would accelerate adoption of sustainable cropping practices. I was employed within the WFSP with the responsibility of working with key farmers to integrate research outcomes into local farming systems and to extend the important messages to the wider farming community.

The project was organised into four interrelated sub-systems (referred to as modules) which were intended to be complementary to the wider project by integrating different skills and knowledge systems (Martin et al. 1996 and Cornish, 1998). These sub-systems or modules were:

- **Module 1**: the core research component, to address strategic issues related to the most efficient management of water and nitrogen under various continuous cropping and crop/pasture systems. Operation and management were conducted by scientists and a coordinating committee made up of scientists, private consultants and farmers.

- **Module 2**: the on farm research component, designed to address tactical issues related to the farming systems by establishing on-farm trials or demonstration plots. Operation and monitoring was to be coordinated by growers and project staff in partnership. The major objective was to promote the adoption of relevant technologies and other technologies developed from the core site.

- **Module 3**: the adult learning component designed to establish participative action learning groups. Current technological knowledge and local knowledge were to be used in a co-working and co-learning environment to improve participant’s decision-making.

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\(^{10}\) The Grains Research and Development Corporation (GRDC), Queensland Department of Primary Industries (QDPI), Queensland Department of Natural Resources (QDNR), New South Wales Agriculture (NSWA) and the University of Western Sydney, Hawkesbury funded and operated the ‘WFSP’ collaboratively to help develop participative linkages amongst scientists, farmers and agribusiness.
- **Module 4:** the decision support component, to integrate all modules by assisting with data interpretation and analysis, by educating participants in the use of models and by monitoring information to aid decision making.

Research outcomes would potentially result in stakeholders collaborating in the improvement of farming systems thereby improving the profitability and sustainability of current farming systems.

**1.4. Locality Description**

This study was conducted in the Balonne Shire, (Figure 1) which is situated adjacent to the southern border of Queensland. The administrative centre of the Shire is the town of St George, which is situated 529 km west of Brisbane.

The area of the Shire is approximately 31,119 km² of which 5.5% (171,000 ha) is currently under cultivation. The area under grain production is 130,000 ha, and increasing. In 1974 the estimated area under cultivation was only 2% of the Shire (62,000 ha).

Crops are predominantly produced in dryland agricultural production systems. The climate is variable resulting often in a shortage of rainfall in the growing season for winter crops (May-October) and thus leading to a dependency on fallowing to conserve moisture from summer rainfall.

In this environment, evaporative demand is high and exceeds rainfall contribution for every month. Droughts, an extreme condition of poor plant available moisture and are a common feature of this environment resulting in reduced crop production or crop failures. Although moisture is perceived to be the main limitation to crop production in this environment, in years of adequate moisture, yield and quality of production are threatened by other factors, like crop diseases or frosts.

Wheat production in the Balonne Shire is widely regarded as the pillar of the cropping industries in the region. Minor areas of other grain and fibre crops, such as sorghum, mungbeans, chickpeas, barley and cotton, are grown but unless there are some extensive changes, wheat will continue as the foundation of rotations upon which sustainable crop production will depend (Cornish, 1997). Refer to further biophysical information in Section 2.8.
Balonne-Maranoa Study Area

Prepared by the Graphics Unit, January 1998

- Main Study Area - Balonne Shire
- Balonne-Maranoa Land Systems Area
- Roads
- Rivers
- Shire Boundary
- Railway

Figure 1: The Balonne-Maranoa Land Systems Study Area

Introduction
1.4.1. Linkages between this thesis and the Western Farming Systems Project

This thesis is grounded within the Western Farming Systems Project (WFSP). The WFSP provided me with the opportunity to explore the possibilities for capturing greater benefit from the project by improving the level of participation. This project served as a platform to investigate avenues of improving research and extension practices. The processes and activities I coordinated and developed in association with this project form the basis of this study. These include developing farmer learning groups, action learning activities and on-farm research studies.

Farmer participation has a long history of involvement with traditional research programs (Sumberg and Okali, 1997; Rhoades and Booth, 1982). However, this participative relationship often does not develop beyond a consultative level (Pretty, 1995) where researchers consult farmers to identify relevant issues, negotiate areas of land on which to operate on-farm trials and develop technologies in isolation from the wider client group (Chambers, 1981 and Farrington and Martin, 1988).

My study was guided by the view that, to improve R, D & E practices, scientists would have to take into account farmers’ needs, objectives and problems. But more importantly, that farmers need to be involved in the whole process from the outset and equally accept and incorporate their local knowledge in the process. The underlying principle was to develop all stakeholders’ ownership of R, D & E programs and encourage the sense of community responsibility needed for sustainable development.

It was anticipated that adoption of this principle would see learning needs and research objectives emerge through the process rather than be identified by an outside agent. It was proposed that synergy between different knowledge systems would to result in better R, D & E practices. It was envisaged that this interaction between knowledge systems could lead to higher levels of learning whilst improving participatory approaches, improving the efficacy of research and extension and achieving better outcomes for farmers.

The work reported in this thesis had three broad objectives:

i) developing and using action learning tools\(^\text{11}\) to promote participants’ learning;
ii) Improving decision making through improved learning approaches; and
iii) Developing better inquiry processes by encouraging and supporting participatory approaches.

These objectives complement those of WFSP by focusing on increasing participation\(^\text{12}\). Experiential learning methodology was adopted to enhance the WFSP and significantly increase the opportunity for all stakeholders to critique practices and processes and to address individual site-specific issues compared to transfer of technology approaches alone.

\(^{11}\) Action learning tools are learning activities conducted by groups of individuals into specific areas of interest, that are concerned with the development of more effective action through collective or self reflective inquiry.

\(^{12}\) Increasing participation refers to the quality of participation, which is an appropriate level of interaction between stakeholders in a given context that is determined by dialogue and dialectical reasoning amongst all participating stakeholders.
1.5. The Aim of this Research

The primary research aim of this thesis was to "learn to develop participatory processes to improve farming systems in the Balonne Shire". The thesis uses questions to address the primary theme.

The objective of using research questions rather than a hypothesis is based on the notion that in situations where problems are 'complex' (ie dynamic complexity\textsuperscript{13}) it is not possible to have definitive solutions. Rather, the researcher is required to assist stakeholders to develop improved understandings leading to more informed decisions which may result in multiple solutions.

This theme was addressed with the following research question:

- Does the level of participation of stakeholders in R, D and E processes lead to more informed decision-making?

Through reading and reflection, the research question was refined and expanded to include the following sub questions:

a. Is Pretty's (1995) typology of participation adequate to identify levels of participation?

b. Who does increased participation impact on and how does it impact?

c. What are the benefit and costs of increased participation?

To explore these questions, the definition of participation and possible indicators of participation are examined and analysed. The participatory approaches are further examined to determine whether the potential of such processes is merely as a means to improve the adoption of technology or alternatively, to facilitate higher learning for self-actualisation.

Knowledge can come from three sources, indigenous, propositional and experiential frameworks. In this research, a participative approach was adopted to integrate these three types of knowledge. These multiple levels of experience (ie multiple constructs) can improve stakeholders' understanding of biophysical relations and learning processes so they can make more informed decisions. To explore the potential for developing and utilising an interdependent ethos, two dominant inquiry positions (ie positivism and constructivism) are examined to understand the benefits and costs of different inquiry positions within an interdependent, multi-method R, D and E model.

An interdependent approach is considered to be a higher order of learning and participation. It is concerned not solely with content outcomes but also with reflecting on the implications of values and beliefs for dealing with the adaptation to change. Taking this approach, sustainability incorporates a more holistic view compared to conventional approaches to R, D & E because it integrates biophysical issues, socio-economic issues, technological development and human development (ie learning and self-direction).

\textsuperscript{13} Dynamic complexity occurs when understanding of an issue changes through time and space and is dependent upon the observer. That is, situations of biophysical and socio-economic proportions that are subjective in nature.
Hence the focus is not just on the prediction of cause and effect phenomena of the independent biophysical parts of a farming system, but rather on understanding the interdependency of the sub-systems within the wider context.

Throughout this thesis, I refer to this concept as ‘sustainable development’. This is not an end point but an emergent property. For this concept to emerge, an evolving ‘Zeitgeist’ of current R, D and E practices is also required.

The research questions were addressed using case studies combined with reflection and critique in an action research approach to personal learning. These case studies are represented as transfer of technology activities, action learning activities and participative action research activities.

The potential benefit of this study derives from the development of better ways of creating interactive partnerships between different ‘knowledge cultures’, and through encouraging greater and higher levels of learning (ie double loop) through improved participation. The closer integration of different knowledge systems may result in the emergence of synergy between the stakeholders. This infers that an untapped resource may reside between indigenous knowledge and scientific knowledge which can be facilitated to emerge through participation. Good participation results in the development of an interdependent multi-method R, D & E model. Application of this model may improve participants’ learning, not simply through adoptive responses of technology but through adaptive learning processes (ie experiential learning).

1.6. Thesis Structure

The thesis structure follows the general research framework of Checkland (1985) outlined on page 41 and 42. Figure 2 illustrates the structure of this thesis and the application of Checkland’s (1985) general research framework.

Chapter two-The Conceptual Framework-reviews the literature concerning inquiry paradigms and their influence on learning processes and research methodology. This review provides the overall foundation for chapter 3-The Research Methodology-applied in this study, which are the major principles guiding the research area in chapter 4-The Case Studies. Chapter 5-Reflections-presents the learnings developed about participatory processes from the case studies presented, the methodology used and a critique of my experiences in relation to the literature reviewed. The discussion in chapter 5 also presents the developments for improving participatory processes from this study and highlights principles that have emerged as a result of my learning for future investigation.

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14 Zeitgeist is a term used in this thesis to reflect the general intellectual, moral and cultural state of a period.

15 Double loop learning is a systemic process that submits values, beliefs, methodology and outcomes to critical review. Its purpose is to highlight inconsistencies in peoples behaviour which they are not aware of and use this reflective learning to improve decision making (Agyris, 1976).
Figure 2: Structure of Thesis
(Source: modified from Checkland, 1985)
2. CONCEPTUAL FRAMEWORK

The concepts underpinning this thesis focus on improving the way we go about understanding the world’s complexity (ie detail complexity\textsuperscript{16} and dynamic complexity\textsuperscript{17}) by improving the way we learn to learn. I explored the variables that influence our knowledge and ways to improve learning. These key concepts include how we may perceive reality (paradigms), how we may go about testing our notions of reality (ie methodologies) and how to take action (ie methods). This study investigates the potential for benefits to emerge by facilitating the links, and promoting improved communication through dialogue development (Senge, 1990) between various agricultural stakeholders in a participative process.

This chapter reviews the literature on research and learning processes to provide a conceptual framework for developing a hybrid inquiry methodology to improve the efficacy of participative approaches and R, D and E programs. It explores the notion that a hybrid inquiry approach (ie an interdependent\textsuperscript{18} multi-method approach\textsuperscript{19}) may be much more effective in understanding and addressing complex agricultural issues than any single approach.

2.1. Research Paradigms

The following section provides an overview of the characteristics and principal underpinnings of the two major inquiry positions in R, D and E programs - positivism and constructivism. The objective is to reveal the characteristic differences and areas of overlap between the paradigms. This may provide insights into the potential benefits of interdependent multi-method approaches and address how a framework may be developed.

2.1.1. Constructivism

The aim of an inquiry from a constructivist perspective is developing participants ‘understanding’ (ie learning) and ability to deal with ‘change’. Guba and Lincoln (1994) in describing the ontological position of the constructivist say, “realities are apprehensible as multiple, intangible mental constructions; socially and experientially based; and which are local and specific in nature”. These constructions are often shared among many individuals. That is “understanding and reconstructions of the constructions that people (including the inquirer) initially hold, aim toward consensus but are still open to new interpretations as information and sophistication improve”.

The reconstruction of constructions is concerned, not with using information for its own sake, but information is used provocatively to loosen up rigid patterns. It seeks to open up other pathways. Richness is important in this process, not rightness (De Bono, 1970). Essentially it aims at developing insights through the rearrangement of patterns to develop more effective patterns. The criterion for progress is that “one can make better informed decisions and become more aware of the content and meaning of competing constructions” (Guba and Lincoln, 1994).

\textsuperscript{16} Detailed complexity is the association of many related variables often in intricate combination.

\textsuperscript{17} Dynamic complexity is a situation of biophysical and socio-economic proportions that are subjective in nature.

\textsuperscript{18} Interdependent refers to a higher ordered ontological position that appreciates the mutual dependence among different knowledge cultures and aims to utilise the emerging synergy from collaborative interaction to improve decision-making.

\textsuperscript{19} Multi-method refers to the integration of different ways of knowing (ie inquiry approaches) to develop more informed and efficacious constructions.
The constructivist paradigm adopts an ontological position where, "knowledge consists of those constructions about which there is relative consensus among those competent to interpret the substance of the construction" (Guba and Lincoln, 1994). "Multiple knowledge can coexist when equally competent interpreters disagree. Constructions are subject to continuous revision, with changes most likely to occur when relatively different constructions are brought into juxtaposition in a dialectical context" (Guba and Lincoln, 1994). For the constructivist researcher to achieve higher levels of constructions they become very attuned to, what Bryman (1988) describes, "as viewing life as involving interlocking series of events." So constructivists place high emphasis on process. Bryman (1988) suggests that the constructivist’s concern with process is based on their "concern to reflect reality". Reality in this context "takes the form of streams of interconnected events". In addition, this is how "people experience reality, so the inclination to emphasise process is part of the researcher's commitment to the participant's views". This is the key to helping research stakeholders better inform their constructions of reality. Therefore improving the learning process is often the main objective for the constructivist approach.

The epistemology of the constructivist "assumes that the researcher and research object are inter-actively linked, so that the findings are literally created as the investigation proceeds" (Guba and Lincoln, 1994). Values play an intrinsic role in constructivism because of the effect values and beliefs have on one's initial constructions, and their influence on refining constructions. This is important because the constructivist expresses a commitment to viewing and understanding events, from the perspective of people who are part of the study situation.

This methodological approach requires flexibility as one of the main keys to understanding for the constructivist’s strategy. This can make the research relatively open and unstructured, rather than pre-imposing boundaries before one understands the situation (Bryman, 1998). Consequently this emergent nature of constructivism depends on what Keeton (1976) describes as "advocacy and activism". Advocacy is the appreciation of individualism and support of risk taking. Activism signifies that it is experientially based and learning, information and knowledge are captured through experience and dialogue. This further indicates that the testing of theories continues in tandem with data collection.

### 2.1.2. Positivism

The aim of positivist inquiry is "explanation, ultimately enabling the prediction and control of phenomena", often referred to as 'cause' and 'effect' focus (Guba and Lincoln, 1994). Hesse (1980) suggests "the ultimate criterion for progress in this paradigm is that the capability of the 'scientists' to predict and control should improve over time". The researchers in this paradigm portray themselves as the 'experts'.

Graziano and Raulin (1993) note that positivism has several basic assumptions about nature and the role of the methodologies it employs in understanding nature:

1. A true, physical universe exists;
2. While there is variability and uncertainty in the universe, it is primarily an orderly system;

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20 Ontology is the form and nature of reality.
21 Dialectical is the comparison and contrast of oppositions through discussion and reasoning by dialogue.
22 Epistemology is the nature of the relationship between the knower or would be knower and what can be known.
3. The principles of this orderly universe can be discovered, particularly through scientific research; and
4. Our knowledge of the universe is incomplete, and new knowledge can alter current knowledge. Therefore all knowledge is tentative.

Bryman (1988) notes that the principles that underlie positivism are:

- ‘Methodological monism’: is a belief that the methods and procedures of science are appropriate to all forms of knowledge.
- ‘Phenomenalism’: states that only those phenomena that are observable to the physical senses are validly warranted as knowledge.
- ‘Inductivism’: knowledge is arrived at through the accumulation of verified facts.
- ‘Deductivism’ seeks to extract specific propositions from general accounts of reality.
- ‘Objectivity’: the research remains distant from the researcher’s investigation. Its intention is to purge the researcher of values that may impair objectivity and undermine the validity of knowledge.

The principles of positivism highlight certain ontological and epistemological positions. Guba and Lincoln (1994) describe these positions below:

The ontology is described as “realism.” This suggests that a “concrete reality exists” and is governed by “natural laws and mechanisms”. Knowledge in this paradigm consists of verified hypotheses, accepted as either facts or laws. This knowledge develops with each fact, when placed in its proper position, and as a result it adds to the growing edifice of knowledge. Facts can be summarised into generalisations, which then become useful for prediction and control. This highlights the “reductionist and deterministic” nature of this paradigm.

The epistemology is described as “dualist and objectivist”. In this context the researcher and the subject under study are considered to be “independent entities”. This suggests that the researcher is capable of studying the object “without influencing it or being influenced by it.” If any influence does occur it is believed to impair one’s objectivity and undermine the validity of knowledge. In essence, it devotes itself primarily to achieving the intellectual aim of improving what it perceives as knowledge, in a way that is dissociated from others constructions.

### 2.1.3. Strengths, weaknesses, opportunities and threats (SWOT) between the paradigms

The basic belief system of positivism is based in a realist ontology, that is, the belief that there exists a reality, driven by immutable natural laws. The objective of science is to discover the “true” nature of reality and how it “truly” functions. This realist ontology is constrained to practice an objectivist epistemology. The inquirers must behave in a way that detaches them from the subject so they can discover nature’s secrets without altering them. It pursues cause and effect relations to control and predict phenomena. Therefore this paradigm ignores the dynamic complexity of problem situations that emerges from the interaction of external forces of nature’s tendency to confound and the possibility that problems are partly the result of different worldviews. The strength of positivist science lies in its systematic and structured investigations, which clearly define objectives and goals and which provide direction for the
inquirer. However, this is also positivism’s weakness because it “predetermines” the outcome and may ignore other emergent learning outcomes. Table 1 provides a summary of comparisons between the two paradigms.

For the constructivist, “reality” exists only in the context of a mental framework (construct) and that there can be many constructions. Therefore inquiries cannot be value free. The strength of constructivist position lies in its flexible ontology, which can accommodate dynamic complexity because it recognises that problem situations, which are socially and experientially based, are continually changing. The undetermined nature of constructivism offers opportunities for new insights to emerge and continually refine constructs. The weakness of this approach is that solutions and learning are time consuming and resource demanding. Outcomes are often unclear because constructivism leads to multiple outcomes because of the number of worldviews23 in complex situations.

Table 1: Comparison between Constructivism and Positivism

<table>
<thead>
<tr>
<th></th>
<th>Constructivism</th>
<th>Positivism</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>- Flexibility</td>
<td>- Investigations are systematic and orderly</td>
</tr>
<tr>
<td></td>
<td>- Accommodates complexity</td>
<td>- Goals and objectives are clearly defined</td>
</tr>
<tr>
<td></td>
<td>- Co-working / Co-learning</td>
<td>- Findings are often repeatable</td>
</tr>
<tr>
<td></td>
<td>- Maintains an awareness of relative theories</td>
<td>- Often more time efficient</td>
</tr>
<tr>
<td></td>
<td>- Improves theory from well informed practice</td>
<td>- Findings should be generalisable</td>
</tr>
<tr>
<td></td>
<td>- All stakeholders are active participants</td>
<td>- Explanation, prediction, and control of</td>
</tr>
<tr>
<td></td>
<td>- All stakeholders knowledge is valued</td>
<td>phenomena</td>
</tr>
<tr>
<td></td>
<td>- Emergent nature</td>
<td></td>
</tr>
<tr>
<td><strong>Weaknesses</strong></td>
<td>- Time consuming</td>
<td>- Naive realism</td>
</tr>
<tr>
<td></td>
<td>- Unclear outcomes / solutions</td>
<td>- Authoritative</td>
</tr>
<tr>
<td></td>
<td>- Difficult to generalise outcomes</td>
<td>- Inflexible process</td>
</tr>
<tr>
<td></td>
<td>- Emergent / lack of clear direction</td>
<td>- Prescriptive / predetermined</td>
</tr>
<tr>
<td></td>
<td>- Experiential learning base</td>
<td>- Exclusion of values</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td>- Continual refinement of constructs</td>
<td>- Quantification of outcomes</td>
</tr>
<tr>
<td></td>
<td>- Multi method</td>
<td>- Ability to acquire facts through observation</td>
</tr>
<tr>
<td></td>
<td>- Rich descriptions of complex situations</td>
<td>- Developing predictions and explanations</td>
</tr>
<tr>
<td></td>
<td>- Double loop learning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Empowering</td>
<td></td>
</tr>
<tr>
<td><strong>Threats</strong></td>
<td>- Seen as a provisional research approach</td>
<td>- Prescriptive</td>
</tr>
<tr>
<td></td>
<td>- Time requirement</td>
<td>- Top-down</td>
</tr>
<tr>
<td></td>
<td>- Experiential dependency</td>
<td>- Predetermined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Theory dependent</td>
</tr>
</tbody>
</table>

(Source: modified from Hamilton, 1995)

Although positivist research approaches have been under intense scrutiny from opposing positions, the debate concerning the benefit and cost of these approaches can be taken too far. It would be wrong to assume that farmers and other agricultural stakeholders have not benefited from traditional research. For example new high yielding crop varieties, disease resistance, and developments in agronomic practices are just a few of the results of formal research approaches. It would also be wrong to assume that constructivist approaches only offer preliminary research avenues for more rigorous approaches to follow.

23 Worldview is a term used in this thesis to refer to a person’s basic set of beliefs that guide their actions.
2.2. Adult Learning

Learning is often described as a phenomenon that eludes precise definition (Knowles, 1984, Hilgard and Bower, 1966) because of the dynamic nature of experience and the interpretation of the experience. Definitions of learning are further confused by the multiple uses of the term, such as: "the acquisition and mastery of what is already known about something; the extension and clarification of meaning of one's experience; or an organised, intentional process of testing ideas relevant to problems" (Knowles, 1984)

In summary it is "a description of a product, a process, or a function" (Smith 1982). As Knowles (1984) points out, the controversy is not between theories, rather it is "over fact and interpretation, not over definition". Knowles concluded that two distinct themes appeared among the diverse range of definitions. Knowles notes the distinction between the learning theories as "a process by which behaviour is changed shaped, or controlled" (as in pedagogy), compared to learning being more related to "growth, development of competencies and fulfilment of potential" (as in andragogy).

2.2.1. Pedagogy

Knowles (1984) defines pedagogy as the "art and science of teaching children" and delineated the major assumptions of the pedagogy model as:

- Education is viewed as the transmittal of knowledge and skills that have proven credible over time;
- The learner's position is based on dependency on the teacher, expert or a figure of authority in the particular field;
- 'What', 'when', 'how' and 'if' something is to be learned is decided by the position of authority and motivation is generated through a reward or punishment system;
- Individual experience receives little if any recognition; truth and knowledge is only conceived from a recognised body of authority;
- Learning is organised into a hierarchal format (top-down), constructed logically and sequentially; and
- Learning is subject and content orientated and is assumed to be beneficial later in life.

2.2.2. Andragogy

Knowles (1984) defines andragogy as "the art and science of helping adults to learn" and delineated the major assumptions of the andragogy model as:

- Learning or education is based on developing people's self-direction;
- It is emphasised that education and learning is experiential; as a result experience is highly valued as a form of knowledge;
- Techniques often used to nurture and encourage self-direction are problem solving cases, critical thinking and field experiences; and
- Learning programs under this system are collaboratively planned according to individual needs in relation to competency development requirements.

Comparing the two learning approaches shows that the pedagogical model is a somewhat more inflexible approach which excludes the andragogical assumptions. The andragogical model is a system of assumptions that includes the pedagogical assumptions. This means that
in practice a facilitator of adult learning (andragog) has the potential to use multiple approaches according to the circumstances of the situation. Where the pedagog attempts to maintain the learner’s dependencies, the andragog’s goal is to develop autonomous learners. Thus an andragogical learning approach is fundamental to a multi-method approach to R, D and E.

### 2.2.3. Conditions for learning

Gagne (1965) suggests learning is greatly influenced by one’s dependence on environmental circumstances. Kidd (1966) notes that learning is based on a balanced relationship between practice and theory. He viewed learning as the “active”, rather than “passive” part of the process. He described it as a process where “one extends themselves both physically and mentally to incorporate new experiences, relate previous experiences, recognise the experience and to express what is within one”.

Argyris (1982) asserts that the principles of learning are closely associated with one’s underlying values and belief structure. He suggests that in order to improve learning, one must challenge their predispositions through constructive dialogue amongst individuals. This would refine people’s constructs by allowing them to identify the differences that exist between their espoused theories and their theories in action. By identifying differences, values are revealed and can be challenged or changed – a process which Argyris (1982) refers to as “double loop learning”.

Bawden (1989) identifies various methods of knowing as:

- “Propositional learning” (learning from instruction);
- “Experiential learning” (learning from experience);
- “Practical learning” (learning from doing) and;
- “Intuitive learning” (learning developed through cultural beliefs, values and traditions).

Bawden also notes that the distinctions between the various forms of knowing “add to the richness of the process of learning”. This different emphasis “in philosophies and in methods provide useful and alternative perspective’s to guide strategies for education and research”.

### 2.3. Adult Learning and Cognition

Habermas (1971) identifies three distinct but interrelated domains of adult learning and presents them as the “three primary cognitive interests, ...the technical, the practical and the emancipatory”. Mezirow (1981) points out that each of Habermas’s learning domains suggests different modes of personal learning and different learning needs. A summary of Habermas domains of adult learning (cited in Mezirow 1981) is as follows.

- **Technical cognitive interest**: Refers to methods of control and manipulation of the environment involving “instrumental action” based upon empirical knowledge, and which are governed by technical rules. Cause and effect and the predictions of observable events of both physical and social action are the basis for validity of knowledge. Therefore, it is based on the methods of empirical-analytical science, ie interpretation and explanation.

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24 Espoused theories refers to a person’s stated or intended behaviour.

25 A theory in action refers to a person’s actual practices.
- **Practical cognitive interest**: Refers to "interaction or communicative action". It involves the development of dialogue among actors "governed by consensual norms that define reciprocal expectations about behaviour and must be understood and recognised by the actors". This suggests the development of ontological appreciation as the basis to improving learning processes. Validity of knowledge is based on "inter-subjectivity of the mutual understanding of intentions and secured by general recognition of obligations". Here the focus is on systemic inquiry that seeks understanding of meaning rather than establishment of causality.

- **Emancipatory cognitive interest**: The concern here is with interest in self-knowledge, that is the knowledge obtained through self-reflection. It involves critical self-awareness in developing insights so one is able to recognise the correct reasons for his or her problems, issues or concerns. Essentially it can be described as "a mind that watches itself" (Grundy, 1982). It requires the development of a critical consciousness of one's notions of reality and how these influence what one observes, experiences and believes.

Mezirow's (1981) interpretations of Habermas’ ideas have provided the basis for judging the validity of knowledge from the perspective of the different paradigms governing research and interventionist approaches used today. Habermas also infers through his characterisation of adult learning that a relationship exists between improving participation (ie interaction) and developing more informed decision-making. This inference is also consistent with Kolb (1984) and Knowles (1984) findings for improving the process of learning.

In the following section two distinct, but also related, learning approaches are investigated. They are propositional learning and experiential learning, also referred to as information assimilation and learning by doing (Keeton, 1976).

### 2.3.1. **Propositional learning**

Bruner (1966) recognised that the propositional learning model, also referred to as the learning instruction model, includes four primary elements:

1) "Specify how to implant a predisposition toward learning;
2) Specify the optimal structuring of the concept of knowledge to be learned;
3) Specify the most effective sequencing of materials;
4) Specify the nature and pacing of rewards and punishments".

Colman (1976) also noted that these elements imply certain assumptions about the learning processes that a person undergoes, as well as the nature of what is being learned. These assumptions and the elements above relate to the principles of the pedagogy model.

**Propositional learning model stages**

**Receiving information**: This stage of the model is when communication occurs through a symbolic medium (usually a book, lecture and/or instructor) by way of general principles and/or specific examples of study area. Information is then committed to memory.

**Assimilation**: At this stage information is organised to clarify and understand the general principles of the information communicated (identification of relevant information). The assumption made at this stage is that the learner has learned the meaning of the information to be assimilated (Keeton, 1976). This also includes the learner testing the espoused theories...
against their experiences. Therefore the intention is to go beyond mere commitment to memory, but to progress towards understanding.

*Cognition:* This stage identifies the relevant application of the general principles. The aim is to apply the relevant principles to abstract scenarios and to prepare for action.

*Action:* At this stage the information received is applied to a real world situation; this serves to verify the usefulness of the information and the completion of the learning phase.

![Propositional Learning Model](image)

Figure 3: Propositional Learning Model

### 2.3.2. Experiential learning

Experiential learning is a process whereby knowledge is created through the transformation of experience. Kolb (1984) notes that, *"experiential learning theory offers a fundamentally different view of the learning process as compared to behavioural and cognitive learning theories based on empirical epistemology"*, because of the role experiences play in the learning process. Experiential learning emphasises three important points and contrasts them with the alternative approaches proposed by behavioural and cognitive learning:

- First, focus is upon the process of adaptation and learning, compared to content and outcome;
- Second, knowledge and learning lead to continual refinement of personal constructs, compared to having only one apprehensible reality;
- Third, learning transforms experience to knowledge that is both objective and subjective, compared to objectivity as the basis of valid knowledge.

Experiential learning allows one to challenge traditional constructs of reality, by challenging notions of reality, as others or we perceive it. It provides this challenge by encouraging us to question and test our constructs of reality, which then informs and refines our theories which in turn can lead to more informed constructs and consequently more informed decision making and improved practice.

Experiential learning is *"a continuous process, by which we learn from the experiences we come across in our everyday lives"* (Kidd 1966). Its principles are concerned with critique, questioning and refining of constructs, not simple regurgitation of facts of other traditional
learning processes. However, as Kolb suggests, experiential learning is not an alternative process, but rather “a holistic integrative perspective on learning that combines experience, perception, cognition and behaviour”.

Kolb’s (1984) model of experiential learning is based on earlier developments of Lewin (1951), Dewey (1938) and Piaget (1970) and continues the commonality of all three learning models with the “emphasis on the development toward a life of purpose and self direction as the organising principles for education”. Kolb also suggests that “learning is continuously modified by experience, hence no two thoughts are ever the same, since experience always intervenes”. Kolb’s learning model states that learning processes are better developed through awareness of varying propositional constructs (ie theories, principles and opinions), combined with one’s experience. This results in improving self-knowledge and “the residuals (ie reflection on content and process) provide improved theories and principles” (Houle cited in Keeton, 1976).

Kolb (1984) noted that the experiential learning process is a “four stage cycle” involving “four adaptive learning modes” (Figure 4). To “be effective learners, we need to be competent at all four activities”.

Figure 4: Kolb’s Experiential Learning Model

- Diverging is the exploration and expansion of experience. Through reflection, experiences are ‘rich pictured’, which can help to loosen up rigid construct patterns. This process generates alternatives on the issue or problem at hand. The strength during this phase is holistic vision and the generation of alternatives. The deficiency is that it is difficult to focus on specifics or to make decisions.

- Assimilating is characterised by developing order. Order is introduced by reflecting upon the rich picture and identifying useful ideas, focusing on fundamental issues concerning one’s desires. Essentially it is a critique upon the experience of diverging on the initial experience. This can produce new ways of looking at a particular situation and can develop concepts to challenge the initial notions of reality. The weakness is that it is abstract and often intuitive.
• The convergent stage focuses on planning and preparing to address specific issues or problems. Models and questions are developed to test theories. By identifying relationships, generalisations can be constructed and plans developed to test these notions.

• The accommodative stage uses the developed principles and generalisations to refine and better inform one’s actions and so the cycle continues.

However, this representation is the ideal and may imply the approach is ordered and hierarchical. In reality order does not exist, one tends to jump around in an irregular fashion, perhaps concentrating in areas that feel more comfortable. The challenge is to operate effectively in all learning stages (Bawden, 1989).

2.3.3. Reflective learning

Central to the experiential learning model is the notion that experience plus reflection equals a higher level of learning and knowledge. Boud et al. (1985) suggested that it is the “ingredient of reflection that turns experience into learning”. This raises the potential of learning from experience, by refining previously held constructs and applying them in a new context in future actions.

Dewey (1933) explains the process of reflective activity as involving the perception of relationships and connections between the parts of an experience that enable effective problem solving to take place. Dewey suggested that this improves the effectiveness of learning, “reflection on experience is a learning loop, continually feeding back and forth between the experience and the relationships being inferred”.

Reflective learning is a “process that internally examines and explores an issue of concern, problem or interest. Reflection is activated by an experience that creates and clarifies meaning with self, resulting in a change in conceptual perspective” (Boyd and Fales, 1983). The implication drawn from the reflective learning process is that it is the main difference between whether a person learns and grows from their experiences or continues on repeating the same experience. Familiarity seems to generate a complacent attitude. Unless there is a feedback mechanism in place that allows one to examine their actions and behaviour in such a way that challenges the individual, the experience is self-serving.

Reflective learning is the fundamental key in the experiential learning process by providing a form of rigour and validity and in developing future learning experiences (Mezirow, 1981). The process prompts one to critique their experiences, to re-examine underlying principles, values and assumptions, to encourage self-questioning about the purpose of actions, outcomes and processes. This stimulates insight into the effectiveness or impact of ‘how’, ‘when’ and ‘what’ we set out to do. This occurs through various levels of reflection that can provide a refining process for our decision-making, practices and knowledge as we continually prepare to publicly validate our theories.

Mezirow (1981) (cited in Boud et al., 1985) identifies various levels of reflective activity that influence the level and content of learning.

- “Reflectivity is being aware of a specific perception, meaning or behaviour of our own or of habits we have, of seeing, thinking or acting.”

Conceptual Framework
- "Affective Reflectivity is becoming aware of how we feel about the way we are perceiving, thinking or acting, or about our habits of doing so."

- "Discriminant Reflectivity: is assessing the efficacy of our perceptions, thoughts, actions and habits of doing things." Essentially it is recognising the reality contexts in which we are functioning and identifying our relationships in the situation.

- "Judgemental Reflectivity: is becoming aware of our value judgements about our perceptions, thoughts, actions and habits with being liked or disliked, beautiful or ugly, positive or negative."

Mezirow (1981) also claims that there are higher levels of reflectivity that relate particularly to perspective transformation and to our critical consciousness. Essentially this is a higher level loop which extends beyond the second loop by recognising how we know what we know which in turn can allow for ontological transformation.

- "Conceptual reflectivity" questions the constructs we are using during our evaluation.

- "Psychic reflectivity is recognising in oneself the habit of making precipitant judgements about people from limited information and recognising the interests and anticipations that influence the ways we perceive, think or act".

2.3.4. Double loop learning

The continuous looping back and forth between experience and various levels of reflection is what Argyris (1976) refers to as the "double loop learning" process. Double loop learning is a systemic\(^2\) process that submits values, beliefs, methodology and outcomes to critical review. However, this does not only equate to self-review, but also to public critical review which is critical to the functioning of participatory learning groups.

Argyris (1976) explains that the importance of double loop learning is that most people are not aware of the inconsistencies in their behaviour. These inconsistencies arise between stated or intended behaviour (ie espoused theories) and what is actually practised (ie theories in action). These inconsistencies are said to reflect our pedagogical programming that inhibits us from utilising reflective experience.

Argyris' (1976) diagnosis of inconsistencies in behavioural patterns is explained in his account of espoused theories versus theories in action, where he identifies two components within theories in action that restrict reflective and accommodative growth - the "governing variables" and "behavioural strategies".

* Governing variables:
  - unilateral planning;
  - aim to succeed and not to fail;
  - suppression of feelings; and
  - emphasis on intellectual aspects.

\(^{2}\) Systemic is a term used to refer to a co-creating process of more refined constructs through participation of experience, thinking and action.
* Behavioural strategies:

- advocate a false positionality to unilaterally control others (ie win them over);
- unilateral control of projects or tasks;
- unilaterally decide what, how, when and if at all something is learned, or communicated.

These variables and strategies lead to more displays of defensive behaviour, single loop learning (ie “we tend to learn what others want us to learn and learning tends to be self sealing”) and ineffective problem solving techniques for complex situations.

Effective learning processes use and encourage reflection to help learners become aware of inconsistencies between their espoused theories and their theories in action. This assists problem solving activities by learning to inquire into how the problem solver inquires. Griffin (1980) described this process as “learning how I learn how I learn.”

Reflection operates in tandem with experience (Figure 5). It does not continue in sequence, nor is it independent of experience, but is part of a continual cycle back and forth between elements. The double loop process also illustrates the effect of Mezirow’s (1981) ideas on the levels of reflective operation.

![Diagram of Double Loop Learning Model](image)

Figure 5: Double Loop Learning Model
2.4. Comparison between Propositional and Experiential Learning

Table 2: Comparison of Propositional and Experiential Learning

<table>
<thead>
<tr>
<th></th>
<th>Experiential Learning</th>
<th>Propositional Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strength</strong></td>
<td>• Action Orientated</td>
<td>• Time efficient</td>
</tr>
<tr>
<td></td>
<td>• Learning has more self meaning</td>
<td>• Gain a broad range of experiences</td>
</tr>
<tr>
<td></td>
<td>• Encourages insights/new thinking</td>
<td>• Organised/structured</td>
</tr>
<tr>
<td></td>
<td>• Generates motivation to learn</td>
<td>• Clear outcome/quick solutions</td>
</tr>
<tr>
<td><strong>Weakness</strong></td>
<td>• Time consuming</td>
<td>• Symbolic framework</td>
</tr>
<tr>
<td></td>
<td>• Difficult to generalise learnings</td>
<td>•Incomplete understanding</td>
</tr>
<tr>
<td></td>
<td>• Focus becomes too broad</td>
<td>• Too rigid in its framework</td>
</tr>
<tr>
<td></td>
<td>• Quick or clear solutions are difficult</td>
<td>• Learning can be easily forgotten</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td>• Learning is continuous</td>
<td>• Generalisation of learnings</td>
</tr>
<tr>
<td></td>
<td>• Double loop learning</td>
<td>• Quicker/clearer solutions to problems</td>
</tr>
<tr>
<td><strong>Threats</strong></td>
<td>• Lack of symbolic understanding</td>
<td>• Passive receptivity of learner</td>
</tr>
<tr>
<td></td>
<td>• Requires more time</td>
<td>• Learning lacks relevance</td>
</tr>
<tr>
<td></td>
<td>• Needs flexibility</td>
<td>• Differences in interpretation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Persuasively motivated</td>
</tr>
</tbody>
</table>

Propositional learning processes tend to be more time efficient in learning something and discovering solutions to non-complex problems (ie dynamic complexity\(^{27}\)). The use of language (symbolic medium) as its major learning instrument means that propositional learning can incorporate a broad range of experiences and knowledge during its communication of information. This serves in aiding the learner by developing inferences and understandings of general principles much earlier. However, the learner in so doing, is conforming to the instructor’s notions. Without this form of learning Keeton (1976) and Colman (1976) note that “each generation would have to traverse the whole path of civilisation again”.

Propositional learning’s main strength lies in its organised and systematic structure. This makes it much easier to identify learning outcomes and to solve problems. Because of its reliance on symbolic mediums, information is subject to defects in interpretation. Coleman (1976) describes this as the “critical dependence of learning through information assimilation on the symbolic medium of language”. The translation from a symbolic framework of understanding and thinking makes it difficult for one to act upon the understandings gained (Coleman 1976). Therefore knowledge acquired without adequate action orientation is more likely to have less self-relevance and be more easily forgotten. Furthermore, because of the directive and abstract nature of this process, there is difficulty in maintaining motivation for learning. Generally the emphasis is on the use and the production of technology, rather than on improving the learning process and peoples’ ability to deal with situations.

Experiential learning on the other hand is very time consuming because of its action orientation. Often this form of learning is described as chaotic because of its flexible and changing processes, that it lacks rigour, is of mediocre quality and that it is only useful in providing a basis for more traditional learning processes. This focus on action requires continuous experience and reflection to be confident in the generalisation of information and

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\(^{27}\) Dynamic complexity is when understanding of an issue changes through time and space and is dependent upon the observer. A situation of biophysical and socio-economic proportions that are subjective in nature.
to critique and refine understandings. This process relies on observation of an event during and after the action. This can be ineffective when outcomes of an action are separated in time or space from the action itself (Coleman, 1976). However, when effective connections are made between observation and action, this process directly benefits future action.

In experiential learning processes, the symbolic medium takes a subordinate position and consequently, a person can often be observed acting and progressing on their actions but find it difficult to verbalise the process (Knowles, 1984). This can suggest that there is deficiency in the process’ ability to capture the learning methodology. This further suggests a person is unaware of how they learn. This problem makes it exceedingly difficult to generalise about the information produced in practice and to apply it to other situations. Therefore the process appears even less efficient.

Since action occurs at the beginning of the process rather than at the end, the subjective need for learning exists from the outset (Keeton, 1976). Motivation is intrinsic to experiential learning. This flexible and reflective learning approach creates avenues of alternative thinking on an issue, which may provide useful insights into understanding or developing new knowledge. Its greatest contribution to learning is that it uses both subjective and objective interpretations and becomes a continuous refining cycle. It is obvious that both approaches have their benefits and limitations and as Keeton (1976), Coleman (1976), Kolb (1984), Bawden (1989) and many others have suggested, neither is sufficient as the sole process for human learning.

2.5. Change Processes – Role (and Definition) of Extension

In the previous section, various theories were provided to develop an understanding of how different learning processes influence the development of problem solving skills. In this section the focus is on the relationship between learning theories and the practice and the conduct of research and extension programs.

What is the role of extension? There are those who believe the role of extension is to provide a bridge between new knowledge and traditional knowledge, or, to provide a bridge between researchers’ knowledge and farmers’ knowledge (Saito and Spurling, 1992). There are others who believe the role of extension is to empower the people it serves. Roling (1988) calls for the need to utilise the larger agricultural knowledge and information resource systems, which gives respect equally to research knowledge and the knowledge of other actors. This enlarges the role of extension to facilitating the fusion of local knowledge and technical knowledge (Engel, 1990). Chambers (1989) describes indigenous knowledge as the untapped resource in agricultural development today. Sumberg and Okali (1997) noted that our failure to utilise such resources within our extension and research programs reflect government organisations’ commitment to continuing with the specific task of disseminating results of research, to ensure the continuation of the pedagogical-driven TOT paradigm, and to suppress interdependency.

The definition and use of the term extension are numerous. Roling (1988) notes a number of interpretations of extension and in his conclusions identified four major differences. These features are described as:

- "advisory work" (ie solving specific problems);
• “education activities” (ie teaching people to solve problems by extending information);
• “human development” (ie assisting people to find their own way); and the
• “simplification of information” (ie providing simplified information so that it is easy to understand and adopt).

Differences in the meaning of extension reflect the different objectives and purposes of the function of extension. Roling (1988) suggests four classifications of extension, which further reflected ontological differences between the classifications. Hamilton (1995) makes similar contrasts in the classification of extension systems within the QDPI. Bloome (1991) (cited in Hamilton, 1995) classifies extension under four paradigms (technology transfer, problem solving, informal education and human development). Bloomes’s classification also paralleled Roling’s concept of four main extension systems (persuasive extension, informative extension, formative extension and emancipatory extension) described below.

• **Persuasive extension**: Extension is used as a policy instrument for achieving societal objectives or interveners’ goals. It is based on the TOT concepts where emphasis is placed on adoption of new technology or a change in management practice through persuasion from perceived ‘experts’.

• **Informative extension**: This extension concept is based on the ideology of reactive extension. Support is provided to an individual through consultancy in assisting them to find solutions to their problems and to make better the decisions in satisfying their needs. The individual is seen free to either use or not to use the information. Many of the concepts of the TOT model are inherently used, such as information and technology are developed and delivered by ‘experts’ to solve problems.

• **Formative extension**: The objective is to develop people’s abilities: in making better decisions; to learn; to manage; to communicate with others more effectively; and to better analyse their environment. This will assist people to take action in improving their situation. Hamilton (1995) describes this as pro-active educational extension that utilises adult learning concepts to assist people to make better decisions to improve their situations.

• **Emancipatory extension**: This is a process of liberation and refinement of people’s constructions. It is extension that facilitates people to take the initiative in achieving their own and societal objectives. The focus is on improving people’s autonomy so that individuals or groups can better deal with changes and problems.

Below, I will examine the transfer of technology (TOT) and participative action research (PAR) models. In so doing I will highlight the operative framework and the potential of improving research and extension approaches through an interdependent multi-method system.

**2.5.1. Extension process in the QDPI**

The extension program within the QDPI, since its early development, has been aimed at providing farmers with knowledge and guidance on issues relevant to the operation of their farming systems. Operationally this has meant that technology developed by research is transferred through field staff (extension staff) and extended to farmers. Farmers were then expected to adopt this information within the operation of their farming systems, if they wanted to continue to progress. This extension program uses two main types of strategies.
Firstly the consultancy strategy requires field staff to respond to individual requests, issues or problems raised by farmers, often referred to as ‘reactive extension’. The extension programming strategy involves the dissemination of timely and useful information to farmers. This could occur through media channels (newsletter, radio, etc), field days, group meetings or on-farm demonstration sites. Some people would see this as pro-active extension work.

The transfer of technology (TOT) approach has been the most widely used extension and research strategy in QDPI and other similar public and private organisations for a long time. The TOT paradigm has serviced the QDPI’s research and extension programs very well, providing valuable information to farming communities for many years. However, this image of agricultural extension as a communication medium to disseminate information and to fulfill the intervener’s predetermined goals has been the focus of many debates (Biggs 1990, Fliegel & van Es 1983, Goss 1979, Roling 1988). The argument is that this system is completely inadequate in dealing with the complex problems of agriculture today. The criticisms are directed towards the TOT credibility and efficiency in developing effective relationships between stakeholders in agriculture. Developing effective relationships between stakeholders in agriculture is considered as the foundation in addressing ‘complex’ issues in today’s environment (Dunn et al. 1996). Senge (1990) refers to this type of relationship and communication movement as ‘dialogue development’ which is recognised in this study for its potential to improve the quality\textsuperscript{28} of participation.

2.5.2. Transfer of Technology

The technology transfer (TOT) system is based on the one-way transfer of information to farmers. The major emphasis is on the transfer of knowledge and technology from research institutions through extension to farmers (illustrated in Figure 6).

The TOT approach sees the farmer as an actor within a farm and local community. The model depicts technology transfer as a linear process in which the researcher generates knowledge that is then transferred on to farmers through an extension system. Essentially the model places the researcher in the position of being the sole source of knowledge and technology development, while the farmer is seen as the passive recipient of information. In this system the “good” farmer is the one who adopts innovations early. However Drew (1974) suggests that the best farmer from the point of view of the TOT position, “is the one most malleable in the hands of the intervener”.

Figure 6 depicts the top-down and hierarchical structured nature of the TOT process. This position considers farmers as technology adopters, who have problems or issues that are fed back to extensionists and researchers to find solutions (Biggs, 1990). The feedback mechanism occurs through what is sometimes described as the training and visit system (Rolling, 1998) (ie training the trainer). This involves workshops that are organised by research institutions on specific issues, or through general extension and research meetings, to discuss field issues or problems. This information provides the basis for generating new information by researchers and provides the opportunity for researchers to transfer knowledge to extensionists.

\textsuperscript{28} Quality of participation refers to an appropriate level of interaction between stakeholders in a given context that is determined by dialogue and dialectical reasoning amongst all participating stakeholders.
Figure 6: Transfer of Technology Model

The research institutes in this model represent the ‘pinnacle of knowledge’. Problem diagnosis, knowledge and technology developments are generated at the research level. Solutions are then transferred to the extension system for dissemination through diffusion processes, such as field days and using progressive farmers to demonstrate new technology. This is based on the assumption that the information will trickle down to other farmers throughout the community. Information and technology are developed and delivered as generic packages that are multifaceted to allow its application in a wide range of situations.

In this ‘top down’ paradigm information or knowledge produced from the top of the system is considered useful and worthy in the development of innovations. Informal research or information that has derived from local knowledge sources is considered as less significant and unlikely to contribute to the development of innovations.

The consequence of the TOT paradigm is to divide knowledge amongst researchers, extensionists and farmers through a one way flow of information. These divisions are caused by the way the TOT paradigm presents the notion of valid knowledge - that is, the “creators of ‘real’ knowledge are thought to be superior to the propagators of knowledge” (Drew, 1974). Through these experiences and the resistance experienced in changing people’s behaviour, (eg adopting new technology), a two-way flow of information was recognised as necessary to improve the effectiveness of adoption.

It was further recognised that some farmers had always been at the forefront of technological developments (Rhoades and Booth 1982). This association between resistance to change and highly innovative farmers saw the emergence of the progressive farmer strategy, within the TOT paradigm, which attempted to create participative linkages between farmers, researchers
and extensionist. Although it did develop some level of participation between these stakeholders through involvement, scientists still unilaterally controlled the process and outcomes, thus working against the concept of double loop learning (Argyris, 1976).

The theory of the progressive farmer strategy is based on the assumptions that:

- Extension is faced with homogeneous populations of farmers;
- Those population members produce the same product and cannot individually influence the price of the product;
- Some farmers are more entrepreneurial than others; and
- Other farmers will copy more progressive farmers (Roling 1988).

The driving forces for this strategy are profit, generated through technological adoption, and the assumption that the information would continue to trickle down to other farmers (Roling 1988).

A consequence of the “progressive farmer strategy” was that extension staff worked with particular groups of farmers, who where most likely to use new innovations (ie the early adopting farmers) but who, as Roling (1988) suggests, probably need the information the least. The main problem with the progressive farmer strategy is the failure of its major underpinning assumption. That is, that information adopted early by progressive farmers would be copied by other, later adopting farmers (ie the trickle down effect or diffusion theory). Reasons for the poor “diffusion” of ideas are identified by Goss (1979) who states that there are three major assumptions that are often and indiscriminately applied to many different situations in which they do not apply.

These assumptions are:

- “communication itself can generate development, regardless of socio-economic and political conditions”;
- “that increased production and consumption of goods and services constitute the essence of development” and that the
- “key to increased productivity is technical innovation”.

Roling (1988) also discusses in detail the “imperfections” of diffusion, that he identified as an important attribute in understanding the “social consequences” of the adoption or rejection of an innovation.

Despite the imperfections and the doubtful assumptions of the TOT approach, it still remains the main extension system within the QDPI and agribusiness organisations. The perceived success of the progressive farmer strategy is, as Roling (1988) notes, based on at least six main assumptions, which are listed below.

Progressive farmers:

- have the resources and economic means to implement the latest information and technology;
- are experienced in understanding and controlling their environment, so they are eager for information;

_Conceptual Framework_
• are interested in extension advice and extension workers don’t feel they are wasting time convincing them;
• are highly demanding and can complain if they are neglected. This could potentially threaten extension workers’ careers;
• can easily communicate with extension workers (on the same ‘wave length’);
• are model representations of good farming enterprises, which can be professionally challenging to the extension worker.

The TOT paradigm functions from a technical cognitive mode based on Habermas (1971) theories of adult learning. It delivers interpretation and explanation of biophysical relations that are intended to help with the prediction and control of phenomena. However, it is pedagogical by nature and this reflects its propositional learning style. The implication of this approach for human development is that it undermines self-direction by dismissing the value of indigenous knowledge and encourages conformity and dependence to the logic of its system (Bateson, 1972). Instead of creating an atmosphere that challenges various notions of reality, it overlooks the value of reinvention within the innovation process of adaptation. It also neglects the importance of critical reflectivity between personal experience and propositional knowledge. In its contribution towards the continuous refinement of personal constructs, it rejects the value of subjective meaning in assisting people to deal with change and to improve their learning processes.

Despite these criticisms one cannot dismiss the transfer of technology method entirely. The method has proved very successful over the past, will probably continue to be used in certain situations and may be much more effective if it can operate in an interdependent multi-method system.

2.5.3. Participative action research (PAR)

PAR is defined as a “form of collective self reflective inquiry undertaken by participants in social situations to improve the rationality and justice of their own social or educational practices and the situation in which those practices are carried out” (Kemmis and McTaggart 1982). Lewin (1946), who is regarded as the architect of action research, suggested a need to move beyond the limitations of traditional research methods, which he saw to be incomplete because they did not include self-critique mechanisms. Lewin focused on the idea of learning by doing, and claims that research should always include critical reflection and be subjected to change (Russel, 1987). Essentially, Lewin (1946) recognises a need to consciously bridge the gap between concrete experience and abstract ideas. According to Lewin the objective of action research is to provide a way to solve practical problems while recognising and appreciating how attitudes and beliefs govern the way we respond to problem situations.

Lewin (1946) therefore suggests that the aim of research should be to help people in dealing with problem situations. To achieve this objective, research had to include propositional knowledge (ie what is already known) of a specific situation, practical knowledge (local knowledge) and to develop an environment to encourage experiential knowledge (ie praxis being the integration of propositional and local knowledge).

PAR may be considered to integrate the three knowledge systems (Kolb, 1984). Attention is then given to the importance of understanding the background and context that actors
themselves use to acquire meaning from their experiences of their social environment (Peters and Robinson, 1984). In this thesis I use PAR as the means for developing interdependency among stakeholder knowledge systems. The aim is not to integrate different epistemologies with the view to form one, but to utilise multiple constructs in the learning process to develop more informed constructions.

Lewin (1946) saw action research as advancing in a spiral of learning cycles, which would incorporate action, and the evaluation of the results of the action. Lewin’s action research model recognises that it is necessary for research to incorporate five key principles:

- To be flexible and responsive to action plans;
- To make provisions for the emergence of unexpected or unforeseen events and issues;
- To adapt changes in plans and actions;
- To ensure learning is continuous;
- To be participative and collaborative (multiple perspectives).

PAR allows people or groups of people to organise the conditions under which they can learn from their experience, and make this experience accessible to others (Kemmis and McTaggart, 1982). The intention of PAR is to give persons the power to act to bring about change (action) by generating knowledge through rational reflection on personal experience (Grundy, 1982).

In a review of fifteen PAR characteristics, Peters and Robinson (1984) investigated the espousals of eleven action researchers, including Lewin (refer to appendix 10 for the consensual summary). Their objective was to provide a range of different action research characteristics by authors they considered have attempted to develop and/or refine the approach. In their review Peters and Robinson note that in Lewin’s writing there are two versions of action research. Firstly, most people see it as a “research methodology”, while three authors (Argyris 1980, Kemmis 1981, and Elliot, 1978) have attempted to “develop an underlying conception of social science”. Their ideas emphasised the emancipatory potential of social research and the central importance of the participants’ beliefs, values and intentions.

Three minimal requirements are shared by both versions and are identified by Peters and Robinson (1984) as:

- “problem focused and directed toward the improvement of some existing social practice;
- a series of systematic cyclical or iterative stages of fact finding, reflection and planning (organic process characteristics);
- a joint, cooperative endeavour among the participants”.

The view of PAR as a research methodology satisfies these minimal requirements by providing a problem solving methodology. PAR viewed as a social science method goes beyond the mere consideration of methodology, but makes a central commitment on the participants’ values, beliefs, purposes and intentions. The focus is on equal participation (see Table 3 for typology of participation) among group members in all aspects of the research process, from the initial problem formulation to the implementation of strategies.
PAR favours a constructivist epistemology, maintaining that theory and practice develop together in a series of evolutionary steps designed to lead to improvements in learning and practice (Peters and Robinson, 1984). However, whilst the research methodology adopts a constructivist position, positivism is but one position within the constructivist paradigm and such an ontological nature is more beneficial for the development of interdependent\textsuperscript{29} multi-method approaches.

2.5.4. The distinction between AR, AL and PAR

Action research (AR), action learning (AL) and participatory action research (PAR) have various methodological and philosophical distinctions. These differences are discussed below.

2.5.4.1. Action research.

Dick (1993) notes the two main objectives of AR as: action, to bring about change in some community or organisation, often determined by the ideas of an authoritative figure (Grundy, 1982); and, research to increase understanding on the part of the researcher or the client or both. However, participation is not necessarily part of the process. Learning can be individually based where issues or project direction is unilaterally planned, operated and analysed. Emphasis is given to change in the form of action and collectively these factors distinguish AR from AL and PAR.

2.5.4.2. Action learning

Revans (1997) describes AL as a philosophical framework for combining people’s existing knowledge with their emergent understandings of a particular issue. It emphasises learning as a continual reflective process between experience and propositional knowledge where learning outcomes can be both individually and collectively relevant. AL emphasises collective based learning where individuals support each others’ learning development in group situations. However there is no emphasis on agreement on direction, planning or analysis which are subjectively based and emerging (Grundy, 1982).

2.5.4.3. Participative action research

Greenwood et al (1993) define PAR as a form of AR in which professional researchers operate as full collaborators with members of a community or organisation in co-learning and co-working environments. Similarly Reason (1994) outlines that the essence of PAR is a concern for equality and equity of people. Emphasis is given on multiple constructions by valuing and honouring the experiences of people. In addition emphasis is placed on the process of genuine collaboration focusing on dialogue development\textsuperscript{30} where propositional and local knowledge works from a dialectical\textsuperscript{31} mode to produce more informed understandings.

2.5.5. Levels of participation

Participative approaches have an extensive history in developing countries where they have been tried, studied and refined (Farrington and Martin, 1988 and Chambers, 1983) and even in developed countries aspects of participatory approaches have evolved within farming systems.

\textsuperscript{29} Interdependency refers to a higher ordered ontological position that appreciates mutual dependence among different knowledge cultures and aims to utilise the emerging synergy from co-working and co-learning to improve decision-making.

\textsuperscript{30} Dialogue development is a process for building common understanding.

\textsuperscript{31} Dialectical is the comparison and contrast of oppositions through discussion and reasoning by dialogue as a method for developing more sophisticated constructions.
research approaches (Rhoades and Booth, 1982). Bentley (1994) suggests that the interest in participatory approaches has evolved not because of its proven ability but rather from the dissatisfaction with the efficacy of traditional R D and E approaches. However there is varying experience with participative R, D and E in Australian agriculture, which suggests a risk associated with the confidence which GRDC had in backing the participatory approach, the basis of the WFSP. Furthermore, whilst general principles for participative approaches have been published widely (Bawden, 1989, Grundy, 1982, Kemmis and McTaggart, 1982), there are few agreed principles specific to the successful use of participative approaches in rural contexts in developed western economies.

It may be anticipated that the implementation of ‘participative approaches would encounter serious difficulties, some of which are highlighted by Cornish (1998) and Bentley (1994). Participative approaches confronts the conventional R, D and E model, is confronting to scientists and extension workers, and assumes that farmers are not empowered and want to be involved, and reflects the difficulty in dealing with embedded cultural norms.

Furthermore, Pretty (1995) asserts that the term ‘participation’ has become part of the normal language of many R, D and E programs, including non government organisations and government departments, and as a result has created many paradoxes with its definition and use.

Pretty (1995) asserts two schools of thought and practice have evolved concerning participatory approaches:

“Both have attempted to involve people in some aspect of planning and implementation” of R D and E programs. “One views participation as a means to increase efficiency, the central notion being that if people are involved, then they are more likely to agree with and support the new development or service.” The other sees participation as a “fundamental right, in which the main aim is to initiate mobilisation for collective action, empowerment and institution building”.

The philosophical basis for participative approaches in this study is consistent with Pretty’s (1995) second view, and therefore suggests a different role for the scientist, farmer and adviser in R, D and E programs compared to the more traditional approaches. This role of participation suggests that to improve stakeholder’s learning and the efficacy of R, D and E programs, participative approaches require more than mere stakeholder involvement. Often farmer’s involvement in R, D and E programs is only a means for research and extension agencies to validate and meet predetermined ends or to strengthen findings.

This alternative view of participation requires that all stakeholders have the opportunity to influence both process and content from the outset, and that stakeholder’s predispositions are constructively challenged through dialectical and hermeneutic processes. This view of participation also reflects a distinction in the approach taken between the project which

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32 Dialectical and hermeneutic processes. Dialectical is discussion and reasoning by dialogue as a method of intellectual investigation which compares and contrasts opposition through discussion and reasoning. Hermeneutic is to represent or describe individual constructions as accurately as possible, while the dialectical process compares and contrasts these individual constructions so each participant confronts the constructions of others and comes to terms with them. The aim is for participants to develop more sophisticated constructions.
employs me (ie WFSP) and this thesis. The distinction lies in the use, definition and vision of participatory processes. In the sense used in this thesis stakeholders (ie active participants, farmers, scientists and advisers) interact in groups to seek understanding. Participation from this position calls for multiple perspectives, collective analysis, co-working and co-learning.

In my research I have incorporated Pretty’s (1995) participation typology (Table 3) as a framework for developing my understanding of the modes of participation during my case study activities. To assess the level of participation and its influence on stakeholder learning, I developed through my research, specific criteria for differentiating modes of participation.

Table 3: A typology of participation

<table>
<thead>
<tr>
<th>Typology</th>
<th>Characteristics of each type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Manipulative participation</td>
<td>Participation is simply a pretence with “people’s” representatives on official boards but who are unelected and have no power.</td>
</tr>
<tr>
<td>2. Passive participation</td>
<td>People participate by being told what has been decided or has already happened. It involves unilateral announcements by administration or project management without any listening to people’s responses. The information being shared belongs only to external professionals.</td>
</tr>
<tr>
<td>3. Participation by consultation</td>
<td>People participate by being consulted or by answering questions. External agents define problems and information gathering processes, and so control analysis. Such consultative process does not concede any share in decision making, and professionals are under no obligation to take on board people’s views.</td>
</tr>
<tr>
<td>4. Participation for material incentives</td>
<td>People participate by contributing resources, for example, labour, in return for food, cash or other material incentives. Farmers may provide the fields and labour, but are involved in neither experimentation nor the process of learning. It is very common to see this called participation, yet people have no stake in prolonging technologies or practices when incentives end.</td>
</tr>
<tr>
<td>5. Functional participation</td>
<td>Participation seen by external agencies as a means to achieve project goals, especially reduced costs. People may participate by forming groups to meet predetermined objectives related to the project. Such involvement may be interactive and involve shared decision-making, but tends to arise only after external agents have already made major decisions. At worst, local people may still only be coopted to serve external goals.</td>
</tr>
<tr>
<td>6. Interactive participation</td>
<td>People participate in joint analysis, development of action plans and formation or strengthening of local institutions. Participation is seen as a right, not just the means to achieve project goals. The process involves interdisciplinary methodologies that seek multiple perspectives and make use of systemic and structured learning processes. As groups take control over local decisions and determine how available resources are used, so they have a stake in maintaining structures or practices.</td>
</tr>
<tr>
<td>7. Self-mobilisation</td>
<td>People participate by taking initiatives independently of external institutions to change systems. They develop contacts with external institutions for resources and technical advice they need, but retain control over how resources are used. Self-mobilisation can spread if governments and NGOs provide an enabling framework of support. Such self-initiated mobilisation may or may not challenge existing distributions of wealth and power.</td>
</tr>
</tbody>
</table>

(Source: Pretty, 1995)

Four discriminate factors were used to develop criteria for differentiating between Pretty’s (1995) modes of participation. These included: a) communication (eg unilateral versus bilateral); b) types of learning cultures used (eg local, propositional and/or experiential
knowledge); c) process and/or content orientated (eg predetermined and/or emergent outcomes); and d) decision making process (eg co-working/co-learning versus unilateral).

The challenge is not merely to theorise about how participatory approaches would help develop the efficacy of R D and E programs, but through experience to critique their application and refine practice by improving the level of participation within the WFSP.

2.6 Systems Thinking

According to Checkland (1990) "any subject concerned with rational intervention in human affairs, theory must lead to practice, but practice is the source of theory, neither theory nor practice is prime." The problem that confronts traditional science and learning approaches is that they have made too sharp a distinction between theory and practice, and this has fuelled their inability to cope with complexity. Traditionally when we study or investigate some issue, we divide the topic into separate parts so it is easier to manage and understand. The assumption imposed by science regarding the division of the whole is that the parts of the whole are the same when examined singly as when they are within the whole system (Checkland, 1990). This assumption (basis of reductionism) has served traditional science very well. However, this is an artificial division that can help us understand, make predictions, control and deal with the difficulty associated with comprehending, and observing, the whole.

It is the successful systematic, structural nature of basic science that has seen it surge ahead and lead to huge technological developments, that also distorts the richness of the natural biophysical and sociological interactions within nature. According to Checkland (1990) it is this emergence of new phenomena at higher levels of complexity that poses the major problem for the traditional scientific approaches. The ‘messy’, complex nature of social systems cannot be understood by reductionist thinking with regularities, prediction and control. This means that as human beings, who in principle are autonomous, we can act in a way that could either confirm or refute any supposed ‘laws’ which are subjected to the individual’s perception of past experiences and their knowledge on the phenomena under investigation (Checkland, 1990). The irrefutable laws that assist science in understanding, prediction and control of biophysical variables, do not apply within situations where biophysical variables are at play with the human activity system (ie dynamic complexity), because of the autonomic nature of this system.

A farming system consists of many biophysical relations that operate within its whole, and science has provided valuable understandings of these biophysical elements. However, the existence of any farming system depends on human intervention, the one element that can react to predictions in many ways, has freedom of choice, can make rational or irrational decisions. Therefore farming systems are shaped by “real world problems”. These are the ‘messy’ problems of decision making faced daily by the human management system that involves biophysical, ecological, socio-economic and political relations. In contrast, traditional science is more controlled, defined and limited and is intended to improve the chances of finding solutions.

The recognition and appreciation of a whole system exemplifies the need for different levels of observation, description, understanding and intervention that can utilise different constructs of reality. The association between systems thinking and PAR is a recognition of a appreciative need for multiple constructions of reality. This serves as a mechanism for
developing synergy between inquiry approaches and stakeholders’ constructions. By learning to understand and appreciate the value of individual realities we can refine our constructs of the world, which in turn can assist with decision making and problem solving.

2.7. Sustainability Concepts

In the late 1960s the term ‘sustainability’ surfaced (Grundy, 1997) as a vogue expression and has evolved to become a major theme in agricultural research. Three decades have passed and the concept of ‘sustainability’ still dominates the vocabulary and focus of agricultural research. However, it is ironic that ambiguous notions still reside in our understanding of “sustainable” (Pezzey, 1991). In Webster’s dictionary (1971), sustainable is defined as “capable of being sustained”. In relation to agriculture, sustained is the “recurrent increment of biological resource such that the portion removed by one harvest is replaced by growth or reproduction before another harvest occurs”. During the Paris Biosphere conference in 1968 a notion of sustainability was introduced that emphasised human interdependence with the biosphere. It was noted that the definition of sustainability needed to include the rational use and conservation of the resources of the biosphere, but to also incorporate human development (Caldwell, 1984).

Modern agriculture is marked by some systems in which there is emphasis on intensification of technological inputs and land use to increase economic and commodity outputs. Alternatively there is the realisation that it is a necessity to develop agricultural systems that are more resource sensitive. This would ensure resources are not exhausted, but managed to maintain long-term human needs and ecological stability.

Lovering and Crabb (1998), Grundy (1997), Pretty (1994) and many other researchers point out, that the issues concerning sustainability adhere to our notions of what is perceived as a problem or sustainable over time and space. That is, what may be sustainable today, in one point in time or in a certain situation, may be a problem in future or in a different situation.

As knowledge is imperfect and solutions are prone to various degrees of error, how we go about learning and using our experiences have profound implications on how we shape and manage the present and future. The implication is that “sustainability is not an end point or a prize, but a process” (Williams, 1993). It can be viewed as an interdependent process that incorporates participatory concepts in a multi-method framework for improving, and continually refining stakeholders’ learning and decision-making on content and process related issues. The deeper and more fundamental issues concerning sustainability are now challenging our narrow interpretations and actions of the past, and provoking us to question our espoused notions of sustainability and to critique those notions in relation to how we inform our actions.

Palmer et al (1997) hold that the present challenge concerning sustainability should involve the synthesis of four main elements - economic growth, nature and resource conservation, and human development. This view suggests that we are not just dealing with biophysical

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33 Interdependency is a higher ordered ontological position that appreciates mutual dependence among different knowledge cultures and aims to utilise the emerging synergy from co-working and co-learning to improve decision-making.

34 Multi-method refers to the integration of different ways of knowing (eg TOT, AL and PAR) to develop more informed and efficacious constructions.
sustainability but with the perplexing issue of sustainable development. This view recognises the importance of intellectual growth, to help people make better decisions, the development of communities to maintain life styles for us in the present and for future generations. It implies as Hediger (1997) notes, the “necessity for a holistic approach” and the integration of a diverse range of basic principles of sustainability from different disciplines, such as economics, ecology, agronomy and social values plus the systems that emerge as these elements interact. Such a view supports the notion that unless the potential for synergism between different knowledge systems is recognised, ideological differences will continue to strangle what should be the common objectives of all stakeholders in agriculture, (ie sustainable growth).

Hediger (1997) notes such holistic approaches can help overcome professional isolation and inequality between farmer, scientist extensionist and other stakeholders who are interested in participating. Therefore sustainable development involves systems that have interdependent parts (human and biophysical) that are mutually dependent, making it a dynamically complex system (Hediger, 1997). If we accept this holistic view of sustainability, we clearly require appropriate approaches to research, development and extension. Holism is the principle employed in this study.
2.8. Key Biophysical and Socio-Economic Factors in this Study Area

2.8.1. Topography
The topography of the Balonne Shire is mainly flat to undulating with a predominantly southern and western gradient. The major feature of the topography is the Balonne and Moonie River system. The majority of the soils in the region are formed from alluvial material with small residual outcrops. Because the alluvial material can vary over a short distance, this has a direct influence on the variations of soil characteristics. This also indicates the distinction between ancient and recent alluviums; ie the Maranoa River and tributaries are associated with the older land types and the Balonne-Moonie rivers reflect the more recent alluviums.

2.8.2. Soils
The soil characteristics associated with the region are generally related to several main vegetation types:

- *Brigalow-Belah forests*. Gilgai grey brown cracking clay soils. These soils are generally deep with good water holding capacity, with a moderate phosphate and nitrogen content;
- *Gidée lands*. Soil characteristics are similar to the brigalow-belah landscapes except that they mainly occur in the south west of the district and are generally associated with lower rainfall environments;
- *Coolibah woodlands*. Alluvial cracking grey clay soil associated with the Moonie and Balonne River Systems. Similar soil characteristics as the Brigalow-Belah landscapes;
- *Poplar Box, Kurrajong, Belah and Wilga mixes*. Duplex red earths have generally a loamy surface soil with a clayey sub soil with moderate fertility and water holding capacity;
- *Yellow Jacket, Mulga, some Wilga*. Massive red earths, low water holding capacities, hard setting soil surface that can attribute to high run-off on shallow slopping soils. Soil fertility is generally low;
- *Poplar Box, Silver Leaf Ironbark, and Mulga mixes*. Massive red earths similar characteristics to the yellow jacket environment, although these soils tend to be much deeper;
- *Leopard wood, Boonaree, Whitewood, Wilga, Vinetree and Emu apple*. These soils are texture contrasts alluvium, with a loam surface over a clay subsoil and are subjected to wind erosion, are hard setting with poor fertility and PAWC and generally less suited for cropping.

Within the texture contrasts alluvium are areas of cypress pine, silver leaf iron bark and poplar box associated with sandy massive red earths. This group is generally not considered as a favourable crop production environment because of the climate associated with the landscape, and poor fertility and plant available water capacity (PAWC) (Weston, Nason, and Armstrong 1975).

2.8.3. Climatic patterns
The major characteristic of the climate is that it is highly variable. As a result the average annual rainfall is of little value as an index of the environment, although it can reflect levels of risk in relation to north-south and east-west. The district has a predominant summer rainfall (October to March). The wettest month is generally January and the driest is August. Summer
rainfall tends to be associated with storm activity. Winter rains are generally less intense and are usually associated with southern influences (Epworth, 1973; Gentilli, 1972). Temperatures range from a mean maximum in summer of 35.8°C to a mean minimum of 4.0°C in July. The hottest month on average is January and the coldest is July. Summer days are likely to exceed temperatures of 32°C in the afternoon. After the summer months, day temperatures may continue to be high but night temperatures can fall very rapidly. Frosts can vary from mild to severe. The possibility of frost continues until late August or early September.

2.8.4. Issues concerning the industry

The prominence of wheat production in the region has been due to its successful adaptation to a range of various land types over vast areas throughout the region. In addition farmers have become very experienced in growing wheat, prices are generally more favourable than other winter cereals, such as barley and oats, and it is much easier to grow than pulse crops or oilseed crops. Pulse and oil seed crops are frequently considered much more risky by growers within the region, because of either climatic variation from season to season, soil characteristics, pests, machinery modification and volatile markets.

The questions concerning the sustainability of wheat production in the region have arisen because of the general monoculture systems and from static yields and declining quality of grain production (ie reduction of prime hard PH wheat) (Hamblin and Kyneur, 1993, and Cornish, 1997). Continuous cultivation and cereal crop production have led to decreases in soil fertility (N) (Dalal et al, 1991), and the degradation of soil structure which affects soil infiltration and PAWC, and is threatening the potential of successful crop production in this region (Freebairn et al, 1986 & 1991 and Connolly et al, 1997).

The trend in protein concentration in grain (Figure 7) illustrates the state of wheat production in the district. Less of the total crop harvested meets the requirement for prime hard class each year.

![Graph showing protein % from 1985 to 1994.]

Figure 7: District protein trends in the Balonne Shire
(Source: Hamblin and Kyneur, 1993)

It is suggested that today’s farmers are forced into high cropping intensity because of heavy economic pressures. However, many also believe that adoption of the current technology available to farmers (crop varieties, machinery and information) should improve their operations and reduce the risk factors associated with farming. This highlights four important issues:
- Is research focusing on realistic issues?
- Do farmers know what resources and technology are available?
- Is technology the only solution? and
- Are we utilising the full potential of all current knowledge systems?

![Graph showing wheat yields from 1960 to 1993.]

Figure 8: Wheat yield trends between 1960 and 1993 in the Balonne Shire

**2.8.5. Problem Situation**

In the 1990-91 crop year the international wheat market underwent a dramatic decline following record wheat yields being recorded in almost every major producing country in the world, and most importantly in the two biggest importers - USSR and China. Wheat prices fell to historically low levels and the weak demands from buyers provoked a trade war between USA and the European community. Each employed aggressive export subsidies to maintain their market share. The high protein ‘prime hard’ wheat has found markets in Japan, Malaysia and Indonesia, as well as our domestic market. These markets are least affected by trade war and are most likely to react favourably instead to the forces of supply and demand.

In a federal government report, Hamblin and Kyneur (1993) note that Australia’s wheat industry is under threat of becoming unviable because of static yields and declining grain quality. Australian wheat yields over the past forty years have risen from 1.12t/ha to 1.45t/ha. In comparison to other countries “such as Argentina, Turkey, Morocco and the west Asian nations which produce wheat under similar conditions to Australia, Australia’s rate of increase is among the lowest”. This is despite Australia’s “advancement in agricultural research and greater reliance on mechanisation which allows more rapid and uniform planting and harvest operations”.

In August 1997 at the “Big Grain Day” conference in Roma the keynote speaker Professor P. Cornish, asserted that Australian wheat yields “have only grown slowly over the past twenty five years and much more slowly than that of our competitors”. Furthermore, within Australia itself, “the western Downs and Maranoa / Balonne have shown little or no increase in the last twenty-five years despite improved varieties and technology”. It was said, “the conclusions are clear. On the world stage, Australian grain growers are losing their competitive edge because of slow improvement in yield” (Cornish, 1997).

Lovering and Crabb (1998) report that Australian agricultural industries have been an important part of the country’s economy since its earliest beginnings to the present day and
should continue to do so in the future, provided we can meet the challenges that confront us today.

Figure 9: Australia’s rural GDP % as of total GDP trends between 1901-1995  
(Source: Lovering and Crabb, 1998)

Lovering and Crabb (1998) note that there is a major decline in agriculture’s gross domestic product (GDP) although they also acknowledged that, (while the real net value of farm production indicates a decline) there have been substantial increases in gross and net values of farm production. Much of this has been related to the growth of indirect industries that depend on agricultural production, such as food processing, manufacturing and other processing industries. Furthermore, agricultural rural export earnings have rapidly declined in their contribution to total export earning, but the value of exports (generally) has substantially increased (Lovering and Crabb, 1998).

Another factor evident in the problems of agriculture is the substantial decline in farm numbers, although this does not correspond with a reduction in the area of farmed land, but rather a substantial increase in the average farm size (Lovering and Crabb, 1998). This is a reflection of economic pressures that are forcing many farmers to either expand or sell out and is becoming increasingly evident in the Balonne region. Employment in agricultural industries directly accounts for 5% of Australia’s workforce. However in combination with many dependant indirect industries, it may account for as much as 27% (Fergusion and Simpson, 1995, cited in Lovering and Crabb, 1998). This clearly indicates the importance of agricultural industries to the country’s economy and the possible loss in economic growth as well as life styles if it continues to decline.

Modern agriculture provides many examples of “endemic paradoxes”. The successes attributed to scientific discoveries and technological developments are also the basis of many present and future problems. For example, Lovering and Crabb (1998) note that the success that came with the use of superphosphate and other fertilisers for crop and pasture production is now recognised as contributing to the growing problem of soil acidification. The use of agrochemicals has greatly improved crop and livestock production, but has resulted in chemical residues in crops, livestock, soils and water, as well as the emergence of chemical resistance by pests which further exaggerate the problem. Such evidence is only a representation of a few examples amongst many that testify to the fact that agricultural development in its present form continues to be at a ecological and human cost. Even in the Maranoa / Balonne with its relatively short history, developmental gains as we know them
today are at a long term cost to the resource base, the environment and human development. Dryland salinisation has recently emerged as an issue in isolated cropping areas due to the rising water table (POFR observations). Decline in soil fertility, soil structural degradation (Dalal et al. 1986 and 1991) and chemical resistance of pests, are all threatening the long term viability of agricultural enterprises and associated industries in the region.

2.9. Conclusion

This review highlighted the ontological and epistemological underpinnings of the two major inquiry paradigms (positivism and constructivism) and their effect on learning, extension and research practices.

The literature suggests that a constructivist, learning-based approach is more efficacious than a positivist pedagogical TOT approach for dealing with dynamically complex issues. Constructivism is about encouraging multiple constructions of multiple problems, through dialectical process. Constructivism allows for multiple solutions to a problem. Multiple solutions are important in addressing the problematic issues concerning sustainable agricultural development, because people’s realities are socially and experientially based and local and specific in nature (Guba and Lincoln, 1994). Hence, learning to make more purposeful decisions requires interdependent development\(^{35}\) between various knowledge cultures.

The review of TOT and PAR processes indicated that the difference between them was more ontological (ie the notion of reality) rather than method based (ie tools for action) as some authors would suggest (Robson, 1995). This indicated that it is not simply a case of mixing and matching methods to suit the predetermined needs of a project. This is because any methodological approach is tainted by one’s view of reality which inevitably influences the operation, analysis and learning interpretations of the activity. This identifies a very important issue concerning the development and application of multi-method approaches. That is, it is not the method that governs the efficacy of research and learning process but the ontological underpinnings of the framework in use.

Therefore the purpose of multi-method approaches is to encourage the integration of different ways of knowing (eg TOT, AL, PAR) for stakeholders to develop more informed constructions. The challenge for participatory approaches is not just a case of developing working partnerships between knowledge cultures but to create constructive environments where participants can disclose and challenge their assumptions. Some fundamental differences were also considered between the two major views of participation as well as the impact of modes of participation on stakeholders’ learning efficacy for improving decision-making. It was postulated that to improve the practice of participatory approaches all stakeholders require the opportunity to influence both process and content from the outset.

\(^{35}\) Interdependent development refers to a higher ordered ontological position that appreciates mutual dependence among different knowledge cultures and aims to utilise the emerging synergy from co-working and co-learning to improve decision-making.
3. RESEARCH METHODOLOGY

3.1. Introduction

The difficulty confronting sustainable development throughout Australia is centred on the effectiveness\textsuperscript{36} and efficiency\textsuperscript{37} of research and extension programs in their ability to address issues in a progressively complex environment. Senge (1990) proposes that to date, solutions often merely shift problems from one part of a system to another, which at first may go undetected because those who solve the initial problem are different from those who inherit the new problem. Research and extension processes can function in two ways. Firstly, as a persuasive mechanism that incorporates stakeholders into the logic of its system and by doing so increase stakeholders’ dependency and lessen their ability to solve their own problems. Secondly, research and extension processes can provide opportunities for all stakeholders’ to improve their skills in dealing with issues confronting sustainability by being responsible for the development of R, D and E and hence provide ways for people to make more informed decisions.

This section presents a synthesis of the theories examined in the review, then tests and evaluates its application through the case studies presented in chapter 4.

The research is directed at developing the farmer’s role in R, D and E programs by participating with other stakeholders (ie scientists and agribusiness) in identifying issues, process planning, monitoring, data collection, analysis and interpretation. This was done while also developing the participating scientists’ position in appreciating multiple constructs, and developing their communication and relationships with farmers and agribusiness.

The following points were identified in chapter 2 as the key elements that need to be incorporated within the research methodology structure:

- Action orientation;
- Appreciation, understanding and utilisation of multiple constructs;
- A continuous learning framework;
- Participation and collaboration; and
- Utilisation of both systemic and structured learning processes.

Pretty and Chambers (1994) suggest that the assumptions that underlie the participatory framework are:

- "Participatory approaches and methods support local innovation and adaptation, accommodate and augment diversity and complexity, enhance local capabilities, and so are more likely to generate sustainable processes and practices;"
- "An interactive learning environment encourages participatory attitudes, excites interest and commitment, and so contributes to jointly negotiated courses of action; and"
- "Multiple learning approaches can encourage a range of external resource support"\textsuperscript{38}.

\textsuperscript{36} Effectiveness refers to evaluating the quality of an activity’s influence on improving learning and thus decision making and practices.

\textsuperscript{37} Efficiency refers to the capacity of an activity to produce desired results with the most suitable use of time and resources available.

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3.2. What is Theory?

Science is concerned with cause and effect, and defines theory as "the collection of ideas about how and why variables are related to one another. Theory is usually built on empirical observations and is validated by making predictions deduced from the theory, which are then empirically tested" (Graziano and Raulin, 1993). By contrast Webster's dictionary (1971) defines theory as "the imaginative contemplation of reality (ie insight), a judgement, conception, proposition or formula formed by speculation or deduction or by abstraction and generalisations from facts". Marshall (1990) highlights three dominant views concerning theory. Theory is "generalisations about, and classifications of, the social world". Alternatively, theoretical statements should be translatable "into empirical, measurable, or observable propositions, and systematically tested". The final argument is "that theory should explain phenomena, identifying causal mechanisms and processes which, although they cannot be observed directly, can be seen in their effects".

The definition I find useful to help set my research framework is described by Herbert Feigl (in Schwandt, 1994) who defines theory as "a set of human constructs that have meaning by virtue of the relation to the soil of experience". Essentially this definition incorporates aspects of Marshall's (1990) view of the three dominant perceptions of theory because it is concerned with the generalisations made by people about the world, testing propositions and explaining phenomena by direct observation and measurement, or indirectly through their effects. Therefore the concept of theory no longer resides in the realms of science alone but extends its boundaries to be developed and used (and tested) by scientists and non-scientists alike, by acknowledging the credibility of different forms of knowledge systems. Such a definition of theory can be more effective in the development of participatory processes than any one definition alone because it acknowledges the value of multiple knowledge cultures.

3.3. F.M.A.L the Research Framework

The concept of grounded theory is the basis of the methodology used in this study. Grounded theory aims to critique the logic that makes a particular action meaningful, to refine the theory and future practices (Strass and Corbin, 1990). Checkland (1985) suggests that all practical action is theory laden.

Figure 10: The General Research Framework
(Sourced: modified from Checkland, 1985)
According to Checkland (1985) the main concept of the model above is to link ideas and their use in action by distinguishing between a basic set of ideas (ie the framework), and a process for applying those ideas in an organised way to some particular area of application. Essentially Checkland is suggesting that the key to making the world more manageable is to use our collective ideas and concepts in refining the methodology, which can better inform our practices, and the residual of improved practice will lead to better theory. “Framework (F) represents a framework of ideas and concepts, the methodology (M) is a way of applying these ideas in an application area (A)” Checkland suggests that “A” represents the human systems and that distinct boundaries should be avoided to encourage the emergence of unforeseen learning, or issues.

This study uses the FMAL model, which is characterised by:

- **F** - the framework of concepts and ideas is based on the idea that participatory approaches can be improved by developing an interdependent multiple method process which would be more efficacious than any single approach towards R, D and E;
- **M** - the methods used are both quantitative and qualitative, incorporating systemic and structured learning processes;
- **A** - the area of application is focused on encouraging the emergence of synergy between farmers’ knowledge systems and scientific knowledge systems; to improve the sustainable development of farming systems by developing environments that encourage co-working and co-learning about issues which are important to the farming system;
- **L** - learning outcomes are to improve the practice of participatory processes, increase the effectiveness of R, D and E programs, assist farmers to become better learners and make more informed decisions, while developing my own learning concerning research processes and the conditions and priorities that influence farmers’ decision-making processes.

3.4.   The Primary Research Direction of this Study

Figure 11 illustrates the participative and double loop learning structure of this research. Figure 11 indicates that the research in this thesis focuses on researching how we learn while investigating the application of participatory processes in addressing biophysical and socio-economic issues. This characteristic of the research direction is represented by the two interactive F.M.A.L cycles illustrated in Figure 11.

The cycle highlighted as the biophysical and socio-economic framework represents the case study activities used to address biophysical and/or socio-economic issues. Learning at this level is focused on developing or refining understandings or principles by sharing experiences of the activities conducted amongst stakeholders.

The cycle highlighted as the process framework reflects on the usefulness of the processes in action at the application level. Hence the learning of this study focuses on process development by reflecting on the benefits and costs of the process in use. The objective of this approach is to submit to critical group review, both the conceptual framework in use with stakeholders’ values and the potential outcomes. Participants can then become aware of the inconsistencies in their behaviour and develop ways of improving their practices by refining the learning process in use. This is illustrated in the call out where both cycles link, which is the focus of this study.

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Figure 11: Research Framework for this Study
(Source: modified from Checkland, 1985)

There are three main sources of information and insight that apply within this research:

i. Literature that focuses on the various inquiry processes, and the relationship between processes, learning and decision-making (ie L₁);

ii. Research activities conducted in the Balonne shire between 1995 and 1998 aimed at developing participative research and learning groups amongst various stakeholder groups (ie L₂);

iii. Reflection of my personal and professional experiences based on my experience as an extension agronomist and research officer (with the Queensland Department of Primary Industries) and a community member in the St George district (ie L₃).

The potential outcome represents my personal reflection between the propositional information used to guide research and extension activities, the experiential learning developed and the refined learning that emerged during reflection on the application of participatory processes.

3.5. The Framework: A Constructivist Approach

Three sets of criteria are used to justify my choice for using a constructivist stance to address the objectives of this study. Guba and Lincoln (1994) highlight these under three fundamental questions, that define the paradigm in use by the responses given. Constructivism is compared with positivism under these three criteria, as related by Guba and Lincoln (1994)

i. The ontological question. "The form and nature of reality and therefore what is there that can be known about it?" The distinction drawn here is between a concrete reality (positivism) which exists and is apprehensible through knowledge of the way things are, versus realities that are apprehensible in the form of multiple constructions (constructivism), socially and experientially based, local and specific in nature.
ii. The epistemological question. "The nature of the relationship between the knower or would be knower and what can be known?" The distinction identified here is between "objective detachment (positivism) or value freedom in order to be able to discover how things really work" versus "subjectivity (constructivism) where the investigator and object of investigation are interactively linked and value bound".

iii. The methodological question. "How can the inquirer (or would be knower) go about finding out what can be known?" The distinction drawn here is between experimental and high control (positivism) to verify hypotheses by empirical tests versus hermeneutical and dialectical communication (constructivism) amongst participants, in order to develop more informed and sophisticated constructions.

Constructivism is an epistemological position which concentrates on utilising emergent findings derived through co-working and co-learning activities. From this position learning emerges (ie understanding, appreciation of individual beliefs and refining practices) as dialogue develops amongst participants.

The methodological position aims for flexibility in the framework so information and knowledge can emerge and be refined through interpretive and dialectical communication. This position incorporates a multiple method approach by utilising multiple construction to refine and develop more sophisticated constructions, thereby enabling the development of a more informed decision-making process.

The ontological characteristics of constructivism support the provocative use of information to stimulate re-patterning of constructs which can encourage alternative insights to emerge. "The major criterion for progress is that one can make better informed decisions and becomes more aware of the content and meaning of competing constructions" (Guba and Lincoln, 1994). In addition this framework places great emphasis on reflecting from the stakeholder’s perspective and in so doing presents reality in the form of interlocking events that depict a holistic vision. This ultimately serves as a valuable assessment tool in understanding the impact of change from a range of perspectives.

In contrast, positivism adopts an ontological position which assumes that a single concrete reality exists, which is primarily an orderly system. It assumes research can discover this reality and use understanding to control and predict natural phenomena. Positivism adopts an objectivist epistemology that assumes the researcher and subject area are independent entities (ie dualistic). This undermines the development of dialogue, co-learning and the discovery of emergent properties by discouraging the provocative use of information. The methodology used is experimental and highly controlled. Knowledge is validated by constructing hypotheses which are authenticated by empirical examination under carefully controlled (manipulated) conditions. Values and individual experiences are not incorporated in this approach.

The review in chapter two suggested that the constructivist approach is more efficacious in dealing with dynamically complex situations because it acknowledges the interactions of the whole farming system (biophysical and socio-economic) and endeavours to represent these understandings in a form that can continually refine constructs and improve practices. Hence definitive solutions are not possible but rather there is a concern for developing processes to encourage continuous learning. This continuous learning process is seen as very important to
the objectives of this study, which deals with the dynamic complexity associated with sustainable development. Because of the multi-faceted nature of sustainability (Pretty, 1995), it is imperative that it be linked to a multiple method inquiry approach that can account for and appreciate all of the components involved in sustainable development (i.e. ecological stability, economic efficiency and human development). The challenge is to improve R, D and E processes so all stakeholders have a responsible role in the sustainable development of agricultural practices.

3.5.1. Rules of rigour

3.5.1.1. Positivism

Methodology is “experimental and manipulative.” In this paradigm, research questions and hypotheses are constructed and substantiated by empirical examination. “Confounding conditions are carefully controlled (manipulated) to prevent outcomes from being improperly influenced” (Guba and Lincoln, 1994).

Guba and Lincoln (1994) describe the rules of rigour associated with positivism, as the “conventional benchmarks of rigour”.

These include:
- internal validity (isomorphism of findings with reality);
- external validity (generalisability);
- reliability (in the sense of stability); and
- Objectivity (distanced and neutral observer).

3.5.1.2. Constructivism

Rigour in the constructivist approach has two main sets of criteria (Guba and Lincoln, 1994):

- Trustworthiness, criteria of credibility
  - transferability (paralleling external validity);
  - dependability (paralleling reliability); and
  - conformability (paralleling objectivity).

- Authenticity, criteria of fairness
  - ontological authenticity (enlarges personal constructions);
  - educative authenticity (leads to improved understanding of constructions of others);
  - catalytic authenticity (stimulants action); and
  - tactical authenticity (empowers action).

With the constructivist approach, learning validity is determined through dialectical and interpretative communication in which participants have the opportunity to hear, influence and challenge others views. Enlightenment is reached through logic and understanding rather than having to rely on authoritative and controlling management (Guba and Lincoln, 1994).
3.6. The Methodology

3.6.1. Participative action research

This thesis employs participatory action research (Reason, 1994) as its core methodology. Reason (1994) identifies three key elements that underlie the practise of PAR as a process that transforms experience into individual and collective learning through co-working and co-learning. These key elements are the basis of PAR as it is used in this thesis:

i. Enlightenment and awakening: A concern for equality and equity of people;

ii. Experiential: Utilising the experiences of people to develop more sophisticated constructions. The emphasis is on valuing and honouring the experiences of people;

iii. Participation: Emphasis is placed on the process of genuine collaboration. The focus is on dialogue development where propositional and local knowledge function in a dialectical process to develop more informed understandings.

The aim of PAR is to produce knowledge and action directly useful to a group of people through research, adult learning and action. It also aims to empower people in becoming more self-motivated by encouraging the use of collective constructs to develop better local knowledge. It requires stakeholders, whose direct livelihoods are affected, to develop the capacity to continually learn and adapt to changing conditions.

Two distinct variations are identified in PAR that directly influence the efficacy of its operation and practices (Reason, 1994). The first level is associated with problem solving. This is summarised as “teaching and training” and/or adult education (often referred to as learning by doing), and it occurs through an independent expert and a client group who want to improve an existing practice (Reason, 1994). This level of PAR is synonymous with single loop learning (Argyris 1976). This process often tends to be unilaterally controlled; objectives and issues are pre-determined by external experts; and learning is technically bound and often self-sealing, reflecting unsustainable collaboration.

The second level includes and extends the first by valuing and honouring all stakeholders’ values, experiences and intentions. This is referred to as double loop learning by Argyris, (1976) where external agents act as facilitators of learning and self-discovery. The focus is on equity and equality of participation for all stakeholders at all levels of the inquiry process.

Bilateral control, the opportunity to influence the process and others views combined with a high level of commitment for genuine participation also distinguishes between the different uses of PAR. Hamilton (1995) also differentiates between the different uses of PAR and asserts a more comprehensive approach in ‘participative learning action research’ (PLAR), which incorporates both levels of learning and claims that the two approaches exist on the one continuum. This indicates that they are not mutually exclusive but are interdependent.

Grundy (1982) made similar distinctions in the definition of PAR but also identified a third dimension, which she describes as emancipatory. This includes and extends beyond the previous levels by incorporating them within a higher ordered level of reflection that focuses on understanding how value systems affect what is known and how it is known, which parallels Pretty’s (1995) concept of self-mobilisation. In this thesis these distinctions are referred to as the ontological appreciative system.
PAR is used in this thesis to facilitate conditions for double loop learning and to assist participants’ in making more informed decisions. A key aspect of this process is the participatory planning, process development, action and evaluation of learning outcomes.

Pretty and Chambers (1994) highlight six decisive factors that underpin and influence the reliability of participatory research approaches and reflect how PAR is used in this thesis:

- **A defined methodology** - attention is on cumulative learning by all participants through genuine participation;
- **Multiple perspectives** - a central objective is to seek diversity therefore implying that reality is apprehensible only in the form of multiple construction, socially and experientially embedded;
- **Group inquiry process** – participants recognise that the complexity of the world will only be revealed through group inquiry;
- **Context specific** – the approaches are flexible enough to be adapted to suit each new set of conditions and actors and so there are multiple variants;
- **Facilitating experts and stakeholders** – learning is facilitated to encourage stakeholders to improve their own circumstances by carrying out their own study and achieving their desired outcomes; and
- **Leading to sustained action** – the inquiry process leads to debate about change, and debate changes the perceptions of actors and their readiness to contemplate action. Action is agreed, and implementable changes will therefore represent an accommodation between different conflicting views. The analysis both defines changes which would bring about improvement and seeks to motivate people to take action to implement the defined changes”.

These principles will be used in chapter 5 to develop criteria for assessing levels of participation and to analyse the experiences described in the case studies.

### 3.6.2. Experiential learning

Experiential learning is used in the research as the core process within PAR approaches. Experiential learning utilises “grounded theory” (Strauss and Corbin, 1994) principles within its applications. Theory (ie propositional knowledge) from this perspective helps to inform our intentions (ie plans) and our subsequent actions. Through critical reflection we can critique the value, appropriateness and validity of the theories and our actions as they interact during our practices (ie plan, act, observe and reflect).

This interaction between propositional knowledge and informed action results in reflective learning (ie meta learning\(^{38}\)). This is the main principle behind grounded theory and experiential learning creating knowledge grounded in experience. It is an interactive process, which suggests that the key to better practices is better-informed actions and the key to better theory is to continually improve practices by challenging the theories that inform our practices.

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\(^{38}\) Meta learning refers to a reflective learning process that identifies inconsistencies between what a person may state they believe or are going to do and what is actually practiced. By identifying these inconsistencies one aims to understand how values, perceptions and habits of doing things influence learning and decision making.

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This interaction between theory, practice and critical reflection occurs at three levels:

- By identifying useful techniques to use and our evaluation of their usefulness;
- By identifying underlying assumptions that influence practices and learning interpretations; and
- By providing self-understanding which then serves as the basis to refine constructs and develop greater insight into the subject area.

This process was used as a framework to test theories in group learning activities and refine stakeholders' constructs that are based on the descriptions and explanations individuals produce while they answer and research questions such as "how do I improve my practice".

3.7. Methods

3.7.1. Case Studies

A case study approach is used in this thesis as a strategy for doing research which involves quantitative and qualitative investigations of particular issues (Robson, 1995). Therefore it is used to develop understanding and improve decision-making concerning issues in a real life context using multiple sources of evidence. In the context of this thesis case studies include a two-fold approach:

- Group development case studies - used to explore possible causes of problems (i.e. biophysical), determinants, factors, processes and experiences (i.e socio-economic) contributing to stakeholders’ decision-making practices.
- A structured and emergent process - used to develop site specific learning where previous work has developed the basic principles. It is also used, as an explorative process where participants explore issues and information to refine their decision-making.

The case study approach is introduced in Figure 11 where the research framework was described. Case studies occurred in the biophysical and socio-economic cycle of the framework (Figure 11). Below I describe the methods used in the various case studies presented in this thesis.

3.7.2. Participant and non participant observation

Observational research is often described as the central strategy concerning the researcher's ability to develop their understanding of actors' meanings and interpretations (Bryman, 1988). The objective is to pay attention to stakeholders' perspectives, interpretations and meanings by placing oneself within the stakeholder’s setting. It is a useful process in developing insights, hunches, understanding and appreciation.

In the context of this study observational techniques were used during a range of activities involving farmers and scientists. These activities included workshops, field days, farm visits and social gatherings where I could observe how people interacted, planned and implemented activities; that is observing the distinctions between espoused theories and theories in action.

Methods used included:

- Individual and group unstructured interviews;
- Letters to determine interests in certain subjects;
- Diary, recording experiences, peoples views and daily events; and
- Listening to clients.

My objective was to focus on developing a rich description of the study area while improving my understanding of the culture and behaviour of the people, their groups and how individuals interact with others. I believe that understanding the language and culture is very important in dialogue development because often people develop their own jargon or localised interpretations. This understanding may encourage common language to develop which can be an very important element in getting deeper access within the research setting.

In a non-participant observation role, I reflected upon my actions and the actions of others in situations where I participated minimally or not at all, for example attending meetings or field days as a silent observer. In a participant observer role I reflected upon the event I participated in as a researcher, extensionist and as a group member. I watched myself and other actors in public, noting what I did and how others responded, according to the interactions that occurred. Interpretations of observations were based on my general cultural understanding, including my intuition, propositional and practical knowledge.

Initial observations were primarily descriptive in nature but became more focused on specific interests over time by observing behaviour, feelings and peoples’ interests. This helped in developing a clearer research focus and clearer questions.

The main criticism of observational research techniques is that, without the benefit of the subject’s analyses, interpretations are based on the researcher’s perceptions. This process does not operate in isolation from other methods but is one of a range of research tools used to cross-reference each other’s interpretations. For example, incorporating multiple observers and then debriefing each other’s findings, strengthens validity.

3.7.3. Quantitative and qualitative

Other methods used in conjunction with observational techniques were quantitative surveys, focus groups and individual interviews. Collectively these methods increase the reliability and rigour of observational techniques.

Quantitative methodology usually refers to the collection and analysis of numerical data, and is often related to empiricist ontology. Qualitative methodology is generally associated with interpretative ontology and tends to be used to refer to forms of data collection and analysis that rely on understanding with an emphasis on meanings. It can refer to research about human systems, lives, behaviour, but also about organisational functioning, social movements and/or the interaction of those relationships.

The debate of ‘for’ and ‘against’ between these approaches has effectively arisen from the different ontological positions. Bryman (1988) claimed that a great deal of “qualitative research shares an empiricist streak with quantitative research; much quantitative research shares a concern for subjects’ interpretations, which is the province of the qualitative researcher”.

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Therefore constructivism and positivism are not always necessarily synonymous with qualitative and quantitative research concepts. A qualitative researcher may investigate certain phenomena from either a constructivist or positivist position, as can a researcher employing quantitative methodologies. It is the ontological position of one’s paradigm (ie the nature of their reality) that influences how one applies a certain methodology, method and the subsequent analysis of the outcomes arising from the investigation.

3.7.4. Quantitative surveys

Mail surveys were used to evaluate a series of soil nitrogen and soil water workshops. The surveys were conducted in 1996 following the workshop series and involved four geographically separate groups in the Balonne Shire. The surveys were conducted to collect data on the effectiveness of various workshop activities and to develop some insight into whether stakeholders were interested in continuing with similar processes in the future. These quantitative surveys (see appendix 4 and 5 for details) had a structured format with a preset and exploratory purpose. This means that other activities such as field days and discussion meetings with farmers helped to develop insights into the important issues and context of the surveys. The quantitative surveys helped to quantify these insights and improve the rigour in the overall process.

3.7.5. Focus group analysis

The term ‘focus group’ is applied to a situation in which the interviewer asks group members very specific questions about a topic after considerable research has been completed (Fontana and Fray, 1994) often to validate findings or to seek underlying explanations. However, the term may also apply to a situation where an interviewer is encouraging people to converse on a particular subject to help direct research.

In the context of this study the primary use of focus groups was to evaluate and benchmark improvements in learning and to help develop a vision for future programs. Focus group analysis was used as an ongoing activity throughout the case studies and also used as a formal evaluation activity for the WFSP (see appendix 6 for details). The advantages of this approach are that it can potentially provide rich descriptions of cumulative and elaborative detail. It is flexible, and it stimulates dialogue amongst stakeholders. The disadvantages are that the discussion may become dominated by one person, may interfere with individual expressions, and that it is difficult to inquire into sensitive issues (Fontana and Fray, 1994).

The method used for focus group analysis was based on Knowles (1984) four essential criteria that are required for effective assessment of a program. These steps involved encouraging dialogue to enable participants to communicate learning on:

- skills development (eg management, communication and learning processes) acquired by stakeholders;
- how stakeholders are responding to a program as it takes place (eg likes and dislikes or positive and negative feelings);
- changes in behaviour (ie before and after changes) in attitude and/or practice;
- enterprise indicators, such as production efficiency, costs, yield, quality or management changes.
The above criteria were used to evaluate the experiences presented in the case studies by providing:

- Preliminary feedback on the current processes and activities;
- Direction and focus for future activities;
- Some priority for future issues and activities.

3.8. Research Questions

The primary theme of this study is *learning to develop participatory processes to improve farming systems in the Balonne Shire* (section 1.5 page 6). This theme will result in addressing the following primary research question:

Does the level of participation of stakeholders in R, D and E processes lead to more informed decision-making?

This research question was refined and expanded to include the following sub-questions.

- Is Pretty’s (1995) typology of participation adequate to identify levels of participation?
- Who does increased participation impact on and how does it impact?
- What are the benefits and costs of increased participation?

The assumptions are that informed decision-making is a result of client learning and that more informed client decisions lead to enhanced client practice.

An additional underlying assumption is that participation is the basis for developing dialogue\(^3\), which is the fundamental component in learning to improve learning skills through dialectical\(^4\) interaction. This approach is considered more efficacious compared to any single inquiry approach in addressing the complex nature of sustainable development (Pretty, 1995).

3.9. Positionality

My research has placed me into three roles that have inevitably influenced my observations, thoughts and analysis and my presentation style. These roles include non-participant observer, participant researcher and participant learner. As a non-participant observer, I have drawn upon my observations in situations where I participated minimally or not at all, (eg attending a meeting). In the role of participant researcher I draw upon my objective and subjective experiences in group meetings (on-farm research and group activities). In participant learning I observe my behaviour, my spontaneous actions based on feelings at particular times and attempt to analyse these acts to develop my own self-understanding and reflect upon how they influence my other positions.

During my experiences in the Walgett district (as an undergraduate) I had the opportunity to be involved with farmer groups, which helped to develop the direction for my final graduation project. It was then I became interested in the observations I made of the differences in knowledge and views between different stakeholders in agriculture and how it influences individual practices.

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\(^3\) Dialogue development is a term used to indicate a process for building common understanding.

\(^4\) Dialectic is the comparison and contrast of oppositions through discussion and reasoning by dialogue as a method for developing more sophisticated constructions.
This developed my early interests in participative approaches in improving agricultural practices. By my definition, then, I was engaged in participatory research because my clients were providing me with information I requested, and they also had the opportunity to be involved, although the process and outcomes were essentially unilaterally controlled. Participants may have gained some satisfaction from the sense of contribution to the research and perhaps later in some way, recognise the usefulness of the information. At the time I had not yet envisaged the impending tensions between R, D and E approaches (ie paradigms) nor the distinction between levels of participation and the subsequent implications on the quality of participation for improving stakeholders’ decision making.
4. **CASE STUDIES**

This chapter reports on the case study activities which are presented under the headings of:

- Transfer of technology;
- Action learning activities; and
- Participative action research.

Together these activities reported in the case studies concentrated on improving participants’ understanding (ie ability to answer questions on ‘why’ and ‘when’ as well as ‘what’ and ‘where’) of biophysical and socio-economic issues that influence the viability of grain production enterprises. The case studies also encouraged and supported participants to challenge their understandings and help them make more informed decisions.

Case studies explored the benefits and costs of participatory processes, with a specific focus on improving the practice of participatory approaches. In the discussion of these case studies, I explore what is required to develop and practise effective participatory processes and the potential learning advantages that can emerge. The definition of participation and criteria for identifying modes of participation are examined to highlight the benefits and costs associated with increasing participation.

The underlying assumption is that participation is the basis for developing dialogue\(^{41}\), which is the fundamental component in learning to improve learning skills through dialectical\(^{42}\) interaction. This approach is considered more efficacious compared to any single inquiry approach in addressing the complex nature of sustainable development (Pretty, 1995).

The case studies are reported using an experiential learning framework under the sub-headings of ‘planning’, ‘action’, ‘observation’ and ‘reflection’. This method is part of the multi-method nature of the research framework. The conclusion of this chapter is my reflection on the interdependent relationship between the various activities, methods of learning and the emerging issues for improving participatory approaches.

### 4.1. **Transfer of Technology Activities**

The TOT activities presented in the following section were used to create awareness of technologies and information that may be useful for farmers or other stakeholders in addressing problems in their farming systems. Although unilaterally managed, my research examines the proposition that these processes have a valuable role to play within a wider and more dynamic multi-method process. The following case studies show how TOT approaches were used within this study and their influence on improving participatory approaches.

#### 4.1.1. **Case Study I. Climatic Analysis**

4.1.1.1. **Introduction**

Water is generally thought to be the most limiting factor in crop production systems in the Balonne Shire. The objective of this case study is to investigate the diverse climatic

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\(^{41}\) Dialogue development is a term used to indicate a process for building common understanding.

\(^{42}\) Dialectic is the comparison and contrast of oppositions through discussion and reasoning by dialogue as a method for developing more sophisticated constructions.
conditions within the Balonne Shire and use the information to improve my own understanding of the biophysical conditions that affect yield and quality of grain production. The analysis is a compilation of quantitative data, which I use to help me understand the farmers' environment and make informed inferences about the conditions that underpin some of their decision-making.

4.1.1.2. Planning

The specific objectives of the study were to:

- Examine the long-term trends in annual rainfall across nine major locations within and outside the study area;
- Examine temperature trends for three sites (St George, Irrigation Station & On-farm research site);
- Calculate seasonal variability between nine rainfall stations; and
- Calculate the probability of receiving critical amounts of rainfall.

4.1.1.3. Actions

The examination of the climatic patterns of the study region included the follow analyses:

- Five-year moving average analysis across nine locations;
- Examining seasonal variation of rainfall throughout the region. Using a coefficient of variation analysis for monthly and seasonal rainfall;
- Variation in monthly temperatures and evaporation; and
- Weekly rainfall probability analysis.

Details and results of the analysis are provided in appendix 2.

4.1.1.4. Observations

Observations in this case study are based on my personal development. This involved using participant observation which focuses on the activities impact on participation, skill development and changes in stakeholders' behaviour. Implications of these observations in relation to the development of participatory processes are examined in the reflection section.

- The impact on participation:
  - The activity was initiated by the scientist (Christodoulou) to meet individual needs;
  - The activity provided awareness of information and clarification of climatic patterns; and
  - The activity involved no participation with farmers.

- The impact on skill development (management, communication, and learning):
  - Personal skills were developed in using techniques to examine climatic trends (ie transforming climatic data into information);
  - Developed my broad understanding of environmental conditions (eg understanding the risks associated with high input operations and the importance of fallow efficiency because of the dominant summer rainfall and often dry growing seasons); and
  - Quantification of climatic variables proved useful for localising (ie transforming information into my knowledge) other farmer based activities. (eg understanding the difficulties confronting farmers with timing of ground operations, such as planting, weed control and cultivation to ensure efficient rainfall use).
For example, information about rainfall was organised and analysed in such a way that my knowledge about crop water requirements was combined with information about Balonne Shire climate. This gave me an understanding of how climate can be managed, and then enabled me to explain to others the significance of climate and its variation.

- The impact of stakeholders’ responses (likes, dislikes and usefulness of information):
  - It emphasised the usefulness of maintaining paddock records for comparing practices over time and space;
  - Farmers regarded the information as only quantification of local experience. That is, there was no transformation for them of information to new knowledge about either the climate or how it might be managed better.

- The influences in behaviour, attitude and practices:
  - The knowledge I developed emphasised the conditions which influence farmers decision-making.

4.1.1.5. Reflection

The information was considered by farmers to be too complicated in its current format. Components of the information were utilised in other farmer-based activities that dealt with soil water and soil fertility.

The benefit of this study is that it provided an efficient reductionist process to develop a broad understanding of the climate in the study region. However, its constraint concerning the development of participatory processes was that it did not directly benefit other stakeholders. Indirectly the information assisted with refining other farmer-based activities. In terms of Pretty’s (1995) typology on participation, its impact on participation was passive and only served as a process to meet my predetermined goals. However the objective was to develop my background understanding into the climatic trends of the study region and use this understanding as information to be refined through future activities with clients. Indirectly the analysis improved my credibility through my broad understanding of the environment, which could be used by me in discussions or the analysis of research activities in subsequent activities. Even more important was that through this process climatic data were transferred into information about the climate that I was able to then make locally relevant. This empowered me to be a more effective participant in other research activities with farmers.

4.1.2. Case Study 2. The Balonne Broadcaster (Newsletter)

4.1.2.1. Introduction

Wete (1991) proposed that a clear relationship exists between information, agriculture, progress, and information transfer. Furthermore, he implies that information transfer is the main function of extension. In the context of this study the transfer of information is acknowledged as an important component of extension within a wider framework of adult learning processes. The Balonne Broadcaster is a newsletter published by the QDPI and designed by me to disseminate information. The participatory element of this activity was to provide the opportunity to farmers to influence what material was published and how it is presented.
4.1.2.2. Planning

The need for a newsletter was suggested by local farmers who believed that it would improve communication between farmers, agribusiness people and scientists by maintaining a regular communication medium. Therefore the objective was to provide a communication medium and to develop linkages amongst various industry bodies across all rural sectors in the region.

A second objective was to generate stakeholders' motivation to become involved through awareness of activities or highlighting activities that could be organised in the district. The purpose was to encourage participation in the WFSP program by keeping stakeholders informed of activities and relevant information. The benefits and costs of the newsletter were evaluated through focus group analysis and individual informal interviews to assess the usefulness of the publication (Cawley and Lawrence 1998 unpublished report).

4.1.2.3. Actions

The 'Balonne Broadcaster' is published quarterly by the QDPI St George with private sponsorship from local agribusinesses. Based on the needs I observed from the community I initiated the project in 1996 and developed the layout and design. My position as editor requires me to act as project leader. I am responsible for coordinating the production of the newsletter by liaising with agribusinesses, QDPI authors and farmer groups, and for ensuring the relevance and timeliness of the information. Informative articles are contributed by local private agronomists, agribusiness agents, farmers, QDPI officers, Australian Wheat Board grain buyers and other local community groups.

![Image of the Balonne Broadcaster Newsletter]

Figure 12: Front cover of the Balonne Broadcaster Newsletter

The information in the newsletter includes coming events and activities, project reviews, and technical information from a range of sources including farmers. A circulation of 700 copies is distributed quarterly targeting primary producers throughout the Balonne shire. It is designed for easy reading and includes written material, photographs and illustrations. It is considered an inexpensive method of disseminating a message to a diverse and scattered population.
4.1.2.4. Observations

Data on this case study are based on my observations as a participant during group meetings and are also drawn from the qualitative evaluation of the WFSP, developed by the WFSP team of which this case study was part (summary of methodology presented in appendix 6). Observations are based on the activity’s impact on participation, stakeholders’ skill development and changes in behaviour and therefore understanding the newsletters role as a tool for developing the networking linkages between farmers, scientists and agribusiness. My reflection examines the implications of these observations in regards to improving the quality of participation, the benefits and costs of increasing participation and the adequacy of Pretty’s (1995) typology for benchmarking modes of participation.

My observations were:

• The impact on participation:
  - Scientists participated by contributing resources (ie information, financial sponsorship and writing articles) to help achieve some predetermined goals;
  - Farmer participation ranged from having no input into the content, (ie passive recipients of information), to initiating and producing information (ie co-working and co-learning).

• The impact on skill development (management, communication, resources and learning):
  - Changes in communication practices are evident by farmers increased contact with resource people who write in the newsletter when there was no previous contact (Cawley and Lawrence 1998 unpublished report);
  - Farmers stated that they used the newsletter to access other resources by following up on interest topics and information requirements directly by accessing authors and by visiting other farmer group activities.

• The impact of stakeholders responses (likes, dislikes and usefulness of information):
  - Farmers felt they were more informed of activities, technologies and available resources (Cawley and Lawrence 1998 unpublished report);
  - Farmers appreciated quick and clear information, although many did indicate that some information lacked relevance to their situations and was not always timely; and
  - Farmers believe that the newsletter serves as a major communication medium between them and the QDPI and QDNR (Cawley and Lawrence, 1998 unpublished report). (“Before we had the Balonne Broadcaster we had to rely on other media which were not always pitched at the local level...” “The newsletter is a great way to keep us informed...”).

• The influences on behaviour, attitude and practices:
  - Agribusiness representatives developed closer working relationships with QDPI officers in other activities, when this was difficult to establish in the past;
  - The activity impact on stakeholders communication relationships evident by more material written collaboratively between scientists and farmers;
  - Increased demand by agribusiness industries to advertise in the newsletter (ie from one major sponsor to six major sponsors);
Farmers are contributing articles on their research experiences, management practices and group activities (Three farmers groups have written five articles in the past four editions); and

The number and range of contributors from QDPI and QDNR personnel has progressed initially from only five local representatives to include over twenty scientists throughout south-west Queensland who alternatively contribute articles for publication.

4.1.2.5. Reflection

The transfer of technology process underpins this activity. However, because it was not intended to operate independently of other activities, but was part of a wider program, it influenced the development of participative processes. It achieved this by providing the opportunity for communication of both "propositional knowledge" and "local knowledge". This was recently evident where farmers published articles in editions 11, 12 and 13 where none had produced articles in the previous 10 editions, despite an open invitation to do so.

This change in behaviour may be attributed to the relationship between the role of the newsletter and stakeholders developing roles in other participative activities. The role of extension from this position extends beyond a simple information tool to part of a wider process that facilitates utilising systemic and structured learning processes.

By providing stakeholders with timely and helpful information the newsletter also served as a reminder of the availability of activities, information and other resources. In effect it provided the explorative stage in the learning process. Although it was predominantly controlled unilaterally, external stakeholders did have the opportunity to influence what was published and to actively contribute as they have done increasingly.

Experience with the Balonne Broadcaster shows that TOT activities have various modes of participation, which are governed by the level of opportunity provided to stakeholders to be involved.

The weaknesses of this activity are that it ignores potential structural constraints like illiteracy; information can be too theoretical; there is a lack of individual relevance, and people have other preferred learning styles which may not be accommodated by the newsletter. Newsletters, however, have always been rated as an important source of information by landholders (Lesleightner et al 1990). What remains uncertain is how technical information is used by farmers. It is not clear whether information is used to verify practices or to provide support for change? That is, does it empower farmers or merely inform them but not empower to deal with change?

Participation occurred at three levels - internally (between scientists), externally (between farmers and private industry) - and cooperatively (between all stakeholders) and in terms of Pretty's (1995) typology, participation extended across two modes (passive and functional). The observations indicated that by providing the opportunity for a wider stakeholder group to influence content it can have a significant affect on the activities effectiveness and efficiency. This occurred by providing opportunities for stakeholders to collaboratively communicate their experiences, which builds relationships and can have a positive impact on stakeholders learning skill development.
By increasing participation in a simple TOT activity such as a newsletter it can have a significant impact on the efficacy of the program. But also develop vital networking linkages between stakeholder, which can serve as the foundation for improving the efficacy in other R, D and E programs.

4.1.3. Case Study 3. Exploring soil activity

4.1.3.1. Introduction

"Exploring your soils" is a field activity that was designed to communicate some general principles on soil structure, fertility and soil water processes through informal and practical presentations. The activity was organised in association with producer groups. It usually arose from an interest that emerged from previous field activities or workshops.

Sometimes, the exploring soils activity was used as a focusing mechanism to give producers from a specific locality an opportunity to initiate future activities through awareness of common interests. The information was presented in such a way that it allowed participants the opportunity to discuss their experiences and inspire interest in developing future activities.

The activity was technically oriented to cause and effect relationships, and communicated generalised information to suit the land type on which the activity is based.

The activity was developed by Mike Foale, Senior Soils Research Scientist with APSRU in Toowoomba and was run by Mike Foale and Cliff Thompson, retired CSIRO Soil Scientist. Cliff Thompson usually begins the program with an interesting overview on the geomorphological process and soil formation in the area. Mike Foale then presents the key structural and textural characteristics of the soil profile that influence PAWC and crop production. My role was to identify the need for the activity with stakeholders, organise it, facilitate questioning during the activity and gather data on the activities impact on participation, stakeholders responses and influences on behaviour.

The activity was conducted four times during this study with the Balonne Management Group, Boolba Farming Group, Rocky crossing Farming Group and the Nindigully Farming Group between 1995 and 1998. The activity was held to initiate group development or to follow up on stakeholders interest areas highlighted in previous activities.

4.1.3.2. Planning

The technical objectives of this activity included:

- An explanation of land type formation;
- A field texture assessment and its relevance to cropping potential;
- Examining soil texture, structure and its relationship to PAWC and rooting depth;
- An interpretation of pH and its relevance to crop potential and soil fertility; and
- The development of participants' awareness of the links between soil management, crop production, and sustainability issues.

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43 PAWC, Plant available water capacity. The water held in the soil that can be readily absorbed by growing plants after drainage.
Other objectives included using the activity as an explorative process in initiating or building on group development between farmers, scientists and agribusiness agents. The rationale for this objective was to gather people in a situation to explore areas of common interest, where attitudes and behaviours can be influenced by highlighting the value of learning from a range of experiences.

4.1.3.3. Actions

The instrument used during the activity is a simple, manually operated soil-coring tool. The soil corer is a thin walled mild steel tube with a hardened cutting tip, 2.5cm in diameter and 100cm in length. It is pushed into the soil using a heavy mallet and is extracted out of the soil using a jack and chain instrument. Once the tube is extracted from the soil a complete soil core is removed from the tube, usually one metre in length. This allows the presenters to make some general observations of the soil profile. Field texture tests are also demonstrated which can provide farmers with skills in examining soil structure and estimates of soil PAWC.

A pH kit is also used to measure soil acidity and/or alkalinity. Soil pH can be a critical indicator in determining plant growth. For example, if a soil is highly acidic in the lower part of the profile, toxic aluminium and manganese effect the soil water solution. This can effectively reduce PAWC of the soil by reducing rooting depth.

4.1.3.4. Observations

Data are based on my participant observations and are also drawn from the qualitative evaluation of the WFPS of which this case study was part (summary of methodology presented in appendix 6) (Cawley and Lawrence 1998 unpublished report). Observations are based on the activity’s impact on participation, stakeholder’s skill development and changes in behaviour. My reflection examines the implications of these observations in regards to improving the quality of participation, the benefits and costs of increasing participation and the adequacy of Pretty’s (1995) typology for benchmarking modes of participation.

- The impact on participation:
  - Good attendance at each activity (15-20 farmers, approx. 80% of group members);
  - Communication was predominantly controlled by scientists asking questions to get participants to focus on specific issues;
  - Farmers were given some opportunity to indirectly influence information by volunteering their observations of the soil profile (this occurred on a periodical basis throughout the activities); and
  - The predetermined focus and structured learning process, which operated in an informal setting, was very effective in persuasively motivating farmers to interact between themselves and scientists.

- The impact on skills (management, communication, resources and learning):
  - Farmers got access to scientific information and communicated with scientists while scientist received information on local conditions;
  - The activity raised awareness concerning the significance of deep soil sampling for fertility and PAWC measurement, compared to previous practices of only surface sampling to determine inputs such as fertiliser application (evidence to indicate interest in this is reflected by farmers high attendance at the soil nitrogen workshops, a farmer based activity that operated).

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• The stakeholders responses (likes, dislikes and information use):
  - Farmers found the activity interesting and very informative;
  - Farmers liked the informal and practical setting of the activity; and
  - Farmers would have preferred more relevance of the propositional information to the
    local situation (ie the material presented was received as information and not
    transformed into knowledge. The farmers were not empowered to change what they do,
    but they were better informed).

• The influence on behaviour, attitude and practices:
  - The activity developed relationships between farmers and scientists reflected in
    farmers’ suggestions of follow up activities (eg group paddock visits);
  - Farmers began to recognise the value of group interaction, sharing experiences and the
    group’s ability to capture external resources, reflected in the continuation of group
    activities; and
  - Farmers developed a more pro-active attitude for future liaisons.

Photo 1: Participants discussing soil formation
(Rockycrossing farming group, 1995)

4.1.3.5. Reflection

A transfer of technology process governed the operation of this activity. However, presenters
provided the opportunity for participants to get involved by discussing their experiences in
light of the information presented. For example at the Boolba group activity farmers
experiences with cropping on marginal red earths was beyond scientists perceptions of the
long term cropping potential of these particular soil types. Scientists then had the opportunity
to receive local information on farming practices and feedback on the information they
presented but were are under no obligation to take on board people’s views. Communication
is often one way; scientists control discussions by asking questions and as a result, control the
direction and analysis of the issues.

Using a TOT approach can therefore have a significant impact on stakeholders’ skill
development in terms of learning and communication and is an essential element to
developing common ground between stakeholders. This is evident by farmers’ comments that stated they enjoyed listening and having the opportunity to liaise with scientists.

Farmer’s comments on this include:

“A great day, presented in a practical way which created great discussion”.
“Group activities are the best way to learn because of the variety of experiences”.

This type of activity served as a platform for developing farmer groups and group processes by providing a way for stakeholders to recognise that learning experiences can be a mutual undertaking between group members.

Essentially this occurred because the content of the activity assisted in focusing discussions. The social interaction between farmers, scientists and other industry people helped to initiate interaction between stakeholders, which later provided a basis for dialogue development. The science provided participants with general principles that could be developed over time. However, the activities did not elaborate on how to better utilise multiple resources (ie propositional and experiential) to improve stakeholder’s understanding of general principles for site-specific conditions.

The weakness of this activity is that it did not account for multiple constructs. Validity of knowledge was based on scientific authority and the predetermined and prescriptive framework that initially detracted from dialogue development. However, this predetermined and prescriptive nature helped to provide clear and informative outcomes which farmers appreciated.

In terms of Pretty’s (1995) typology (Table 3 page 31) the mode of participation resided at a consultative level. Where the process was essentially unilaterally determined, “experts” communicated knowledge and the activity was dependent on external guidance to function. However the activity also provide the opportunity for farmers to influence content by communicating their experiences. This was particularly important in encouraging dialogue by increasing enthusiasm for involvement in other farmer-based activities. Pretty’s (1995) typology of participation identifies adequate benchmarks. However, there are operational gaps in this typology that make it difficult to clearly identify differences between the “modes” or benchmarks of participation. There is a need to develop more specific indicators or discriminating criteria to assist stakeholders for making more appropriate assessment of the level and impact of participation.

Participation also impacted on scientists learning and appreciation of farmers’ priorities and conditions. This was evident when farmers communicated their various experiences concerning fallow management and fertiliser application. The multiple constructs highlighted dynamic complexity beyond scientists’ initial perceptions.
4.2. Action Learning Activities

The action learning activities presented in this section were used to encourage the development of dialogue between different knowledge cultures, and in so doing to assist stakeholders in making more informed decisions. The characteristics shared by all the case studies in this section include:

- They are problem oriented, often on predetermined issues by scientists but they are flexible enough to provide the opportunity for emergent themes and learning;
- Methodology involves utilising both propositional and experiential knowledge systems; and
- Activities are intended to be a collaborative endeavour among stakeholders.

In this study action learning activities included pre-planting and post-harvest meetings (eg soil nitrogen and soil water workshops), and in crop activities (eg rainfall simulator activities and crop tours).

4.2.1. Case Study 4. Pre-planting and post harvest meetings

4.2.1.1. Introduction

Pre-planting and post harvest workshops have been operating in the Balonne Shire since 1995, at the beginning (April) and end of every winter crop season (November or February) to assist farmers and other stakeholders in identifying and addressing issues concerning grain yield and quality.

The meetings coordinated over the period of this study (1995-1999) have involved 110 grain producing enterprises, 85 percent of the total grain producing farms in the region. These farming enterprises were geographically widely distributed throughout the region and constitute five farmer groups, referred to as the Nindigully Farming Group, Rockycrossing Farming Group, Balonne Management Group, the Boolba Farming Group and the Wycombe/Begonia Farming Group.

4.2.1.2. Planning

The pre-planting workshop series were initially developed to help grain producers with their nitrogen management (Lawrence et al, 1997) because of the increasing recognition of the declining levels of soil fertility. The process was designed to develop awareness of the problem of declining soil fertility and to assist farmers in improving their nitrogen budgeting decisions. Lawrence et al (1997) described the main objectives of the workshops (the "Nitrogen workshop series"), as to:

- "help people understand the basic nitrogen processes in their farming systems,
- help people develop immediately applicable 'answers' to ensure the workshop was seen as relevant;
- empower people by helping them develop a process for interpreting their own nitrogen responses making their own future nitrogen decisions; and
- Improve participants' understanding of the basis of nitrogen recommendations from others".

In the Balonne Shire many farmers operate a low input farming operation compared to the more eastern districts like the Darling Downs. This low input strategy is due to the low and
highly variable rainfall, especially over the growing season (May-Oct) and makes increased resource inputs into farming apparently economically unattractive to many farmers. Therefore many farmers do not consider soil nitrogen as a priority issue inspite of declining levels of grain protein and poor yields in good seasons. Traditionally, the risk of nitrogen fertiliser application is considered too high and often the option of going back into a long-term pasture phase and clearing new country for cropping is more attractive. However, in more recent times the high cost of clearing country, less suitable cropping country, legislation controlling tree clearing and declining wool and livestock prices is resulting in increased farming intensity on land for longer periods.

To accommodate farmers' needs, the nitrogen series workshops were modified to incorporate soil water and soil nitrogen budgeting methods. These workshops included the original objectives of the nitrogen workshop series, but also linked soil nitrogen and soil water from the outset and harvest results were examined in post harvest meetings.

4.2.1.3. Actions

The method is described in detail by Lawrence et al. (1997) and summarised below. Soil sampling was done by the DPI St George and analysed by Incitec Laboratories in Brisbane. The soil tests included:

- 0-10 cm nitrate nitrogen, bicarbonate (Colwell) phosphate, DTPA extractable zinc
- 10-60cm nitrate nitrogen, electrical conductivity (1:5 water)
- 60-90cm nitrate nitrogen, electrical conductivity (1:5 water)

Farmers were encouraged to participate in the sampling to give them an opportunity to examine their own soil profiles. Farmers also used a push probe\(^44\) to measure the depth of wet soil to compare the latter to soil core PAW\(^45\) results, which may help them to relate calculated plant available water with depth of wet soil. It was important to have real paddock data to provide farmers with something tangible for discussion especially after harvest when they could compare the science with potential outcomes and actual outcomes. An example of the workshop format is shown in appendix 3, which illustrates the structure and topics covered during the initial meetings.

The main goal of these meetings was to improve group development processes by placing greater emphasis on understanding the fundamentals of the nitrogen cycle and soil water processes in farming systems so farmers could make better decisions, rather than highlighting only the cause and effect relationships. These objectives were achieved by helping farmers integrate scientific and local knowledge through the use of work sheets and farmers own paddock data (i.e. yield and protein history). The aim was to help participants recognise the usefulness of group learning to improve decision-making.

4.2.1.4. Observations

Observations in this case study are based on my participant observations, quantitative survey evaluation (see appendix 5) and are also drawn from the qualitative evaluation of the WFSP of which these case studies were part. Observations were made on the impact of the activity on participation, stakeholders’ skill development and changes in behaviour. My reflection

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\(^44\) A push probe is an instrument designed to manually test for depth of wet soil.

\(^45\) PAW is plant available water.
examines the implications of these observations in regards to improving the quality of participation, the benefits and costs of increasing participation and the adequacy of Pretty’s (1995) typology for benchmarking modes of participation.

Eighty percent of participants returned the mail out evaluation. This high response rate was the initial evidence to support the usefulness of the pre-planting meetings. All respondents agreed they would like to see similar activities continue in the future. Ninety five percent of respondents believed that a follow up meeting after harvest combined with next seasons pre-planting workshops would be very useful in aiding future decision-making. This suggested that the process used in workshops was relevant to farmers because it provided participants with the information and the skills on the application of technology in their own situations.

Ninety-five percent of the respondents agreed that the workshops were a very effective way of examining soil water and nitrogen. Comments on the workshop process included:

"A very useful day at which I learned to calculate the risks of planting a winter crop with regards to moisture and fertiliser needs", and

"The workshop was excellent, presented in a most practical and useable form, and will be further improved when expected yield and protein is compared to actual at a follow up meeting”.

My observations included:

- The impact on participation:
  - Scientists initiated participation and was dependent on scientists to function;
  - A structured learning process that allows the opportunity for modification by partial integration of propositional and local knowledge; and
  - Communication varied between a systematic contest of opposing views (ie debate) to developing consensus or more informed constructions (ie dialogue development).

- The impact on skill development (management, communication, resources and learning):
  - 78 percent of respondents agreed that they could now make much more sense of nitrogen soil tests;
  - 44 percent of respondents said they reused the work sheets to recalculate results, or to calculate nitrogen requirements on other paddocks, or check recommendations;
  - A change in farmers communication from passive recipients of information to a position where they have the opportunity to influence outcomes. Farmer’s comments included:
    "...I enjoyed having the opportunity to listen and discuss with other farmers our experiences and problems, the group activities have helped us in formalising this and to pool our experiences…"
  - Farmers had the opportunity to learn to access a more diverse resource pool (eg other scientist, information, computer decision support packages); and
  - Farmers had a greater appreciation of the importance of developing more localised understanding about their soil characteristics to improve their decision making. A farmer’s comments included:

    "If we could establish the amount of soil moisture available to plants in our soils, this information will be invaluable for grain growers planning their next crop.”

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The stakeholders responses (likes, dislikes and information use):

- Farmers and scientists enjoyed the opportunity to interact as a group;
- Farmers enjoyed the levels of discussion motivated by the group environment;
- Farmers felt more confident (ie empowered) to converse with scientists and consultants on issues concerning soil fertility and soil water;
- Farmers appreciated the group’s capacity to ‘pull’ or attract resources from QDPI/QDNR and from other private resource groups. Farmer’s comments included, “...groups are the best way to work for all involved...”
- Farmers would prefer more focus on economic implications concerning nitrogen management.
- Farmers also suggested that the problems with group work are:
  - the demand on their time;
  - the effort required for coordinating group activities;
  - the difficulty in getting clear outcomes;
  - the need for good facilitation skills; and
  - the tendency for some vocal group members to lead the group.”

The influence on behaviour, attitude and practice:

- The scientist’s position changed from an instructional or teacher position towards a facilitator and in some instances co-learner;
- Farmers volunteered their issues and concerns more freely; and
- Farmers and agribusiness gave “widespread support for the focus on ‘learning’ and ‘understanding’ basic principles and an endorsement of the trend towards group mechanisms and away from ad-hoc advisory services” (Cawley and Lawrence, 1998 unpublished report). Participants’ comments which support these views are:
  “...the information that’s coming out through workshops is probably far greater than you’d pick up in a one to one situation walking round the paddock in your particular crop... I think you’re looking at a lot wider range of situations through the group ... and probably making better use of time and resources...
  ...Yeah, and I’ve got to like it, whereas at first I didn’t like it...”

4.2.1.5. Reflection

The usefulness of the workshops and group meeting is reflected in the continuation of group based activities where no previous group based activities occurred. Farmers’ high response (ie 78 percent) in agreeing that they could now make much more sense of soil nitrogen tests reflected the process used in the workshops allowed for scientific information to be transformed into something farmers could use and understand. Furthermore this process appeared to support change in that it provided opportunities for farmers to test and re-evaluate information which supports the development of localised information.

The usefulness of this process is that it contributes to stakeholders learning by making available scientific resources while providing the opportunity for participants to influence outcomes, which can develop more informed site specific understandings.

This approach encourages dialogue development beyond the traditional TOT approach and was the basis for developing more informed decisions.
The nitrogen and soil water issues provided the focus and through group dialogue and active involvement, insights and challenges emerged for both scientists and farmers beyond initial expectations, which became the basis for future activities (eg soil characterisation and nitrogen management studies).

In terms of Pretty’s (1995) participation typology (Table 3 page 31), participation occurred at a function level during these activities. This mode of participation is where the activity was initiated by scientists and the process was unilaterally determined by the scientists who communicated information in semi-formal presentations on biophysical cause and effect relations. The distinction made on the quality of participation between this type of activity and the previous TOT activities is that in the TOT activities the objective was to provide awareness of information for farmer adoption. In the AL activities the process allowed farmers to develop their own answers although the scientists may have already known the solution.

The activity therefore provided opportunity for farmers to influence content. This level of influence on content also provided opportunity to change process under the guidance of the facilitator. This was observed by the liberal discussions that often diverted from the focal theme. This was particularly important in developing dialogue beyond merely manipulative discussions by sharing control between stakeholders and providing opportunity for all stakeholders to speak. This reflected a commitment by scientists to partial integration of knowledge between propositional and local knowledge and indicated an experiential learning process by incorporating multiple information, action and reflection to allow individuals to develop more informed constructions. Farmers’ support for developing the quality of participation is reflected in the following comments:

- “There is a lot to be gained from group activities and it is important that farmers, QDPI and agribusiness all have the opportunity to participate;
- Workshop activities have provided the initial steps into understanding and generating enthusiasm for group participation;
- “Group activities provide a practical learning environment”.

The workshop activities played a major part in:

i) Encouraging and motivating participants involvement in other activities; and

ii) The development of other activities such as in crop tours, rainfall simulation activities, participatory on-farm research and the development of local crop monitoring groups.
4.2.2. Case Study 5. Rainfall simulator activity

In-crop activities were used to either follow up on issues raised during previous group meetings (eg pre-planting workshops) or to introduce farmers to group learning concepts and to determine if there is any interest in future group meetings. The aim was to change habits by creating new experiences not to change habits by new arguments or new information (Vickers, 1984).

4.2.2.1. Introduction

The rainfall simulator is a transportable machine that simulates rainfall with drop size and energy similar to natural rain. “Rainfall” is applied to two adjacent plots with different surface treatments, upon which rainfall infiltration, soil moisture and run-off can be compared at the same time.

Rainfall simulators have had a long history as research tools and more recently as extension tools. Cawley et al. (1992) noted that the initial motivation to use rainfall simulators as an extension tool was to overcome heavy reliance of extension on written material and oral presentations. Cawley et al. (1992) and Hamilton (1995) have documented in detail the impact of the rainfall simulator as an effective extension tool and process for informing farmers’ decision making. Methodology and operation is also described in detail by these authors.

4.2.2.2. Planning

The activity was designed to ensure participants would be involved throughout the process by providing opportunity for farmers to influence process and outcomes through practical involvement. This was intended to improve ownership over learning which was considered more effective in improving decision-making.

In marginal cropping environments like the Balonne Shire, successful crop production depends on the farmer’s skills in conserving rainfall as well as its efficient use. The rainfall simulator activity was designed to provide valuable insights into moisture conservation and tillage practices that can be easily compared and analysed by participants on the day.

The activity aimed at providing participants with a specific focus on the biophysical and management issues concerning tillage, rainfall infiltration, stored soil moisture and soil types. The aim was to provide the opportunity to test local knowledge and scientific principles that could lead to either the validation of current understandings or recognising new insights. This could assist people in learning how to change their behaviour by creating an atmosphere which supports change within a secure setting, while generating awareness of existing attitudes and their consequences.

The rainfall simulator process involved five main steps which were:

- Investigate soil structural characteristics that influence crop production, rainfall infiltration and soil water processes;
- Farmers to suggest and establish tillage treatments;
- Run simulation and record run-off and rainfall infiltration between treatments;
- Discuss observations as a group and plan alternative treatments; and
- Repeat process and reflect on learning outcomes.
4.2.2.3. Actions

The rainfall simulator was used over four workshops during the first two years of this study across four different land types with four farmer groups. The four demonstrations conducted during this study tested a range of options that included stubble cover, rough tillage, and fine tillage and stubble mulch.

Actions included:
- Farmers to design treatment plots to test their experiences in surface management;
- Scientists maintained a facilitative role and only contributed to farmers discussions either to motivate further discussion or to provide needed scientific input;
- Investigating differences between local experiences and scientific knowledge and how these differences may contribute to refining principles and better informing future decision making; and
- Exploring stakeholders’ feelings or thoughts on the value of working in a group environment by discussion the potential for running similar activities in the future.

Photo 2: Group participants discussing their observations
(Rockycrossing Farming Group, 1995)

4.2.2.4. Observations

Observations in this case study are based on my participant observations and some insights into farmers’ views about the activity are also drawn from the qualitative evaluation of the WFSP (Cawley and Lawrence, 1998 unpublished report). Observations are based on the impact of the activity on participation, stakeholders’ skill development and changes in behaviour. My reflection examines the implications of these observations in regards to improving the quality of participation, the benefits and costs of increasing participation and the adequacy of Pretty’s (1995) typology for benchmarking modes of participation.

Farmers’ involvement in setting the criteria and preparing the treatments during the demonstrations while discussing biophysical variables revealed many underlying issues that influence decision making. This mainly related to the way farmers integrated the experience of the rainfall simulator with their previous experiences on fallow management. It provided participants with the opportunity to discuss their own experiences in relation to the outcomes demonstrated by the rainfall simulator.
The process involved the assimilation of scientific and local knowledge by communicating different viewpoints of soil moisture conservation on varying land types. For example, the simulations conducted on red earths and red brown duplex soils (ie Rocky crossing, Wycombe and Boolba) indicated that rough tillage was more efficient in conserving moisture than stubble cover. Participants’ experiences were that zero tillage on a bare surface resulted in high run off and significantly reduced rainfall infiltration, because of the hard setting nature of these soil types (although zero tillage with stubble cover reduced run off). Under simulated rainfall, reduced tillage that incorporated a cultivated surface layer with stubble mulch resulted in the best infiltration at these sites as farmers had observed.

This was no surprise to farmers, but was unexpected by scientists. This revealed ‘what’ and ‘how’ farmers understood about the biophysical relations concerning soil water processes, tillage practices and the implications concerning their decision making. The activity encouraged dialogue development by highlighting differences between local experiences and propositional knowledge on soil moisture conservation, tillage and varying land types. Discussions revealed issues or interests for future activities like the workshop series on soil water and nitrogen, computer simulation workshops and to investigate issues through on-farm research studies.

At the Dirranbandi site (cracking grey clay), zero tillage practices (stubble cover) resulted in the best infiltration. This surprised farmers who believed that stubble incorporation would result in better infiltration but was consistent with scientists’ knowledge. Farmers used a manual soil corer to observe the depth of wet soil between the two treatments. Farmers discovered that soil water in the cultivated treatment had collected mainly in the top 30 cm which was more subject to evaporation, as compared to the zero tillage treatment where soil water infiltrated beyond 50 cm and was less likely to be lost by evaporation.

Participants learned that surface cover and the type of soil surface conditions have a significant impact in improving rainfall infiltration. In this region, run-off can account for a significant loss of moisture (Freebairn et al. 1986) under intense or prolonged rainfall events. However evaporation would account for most moisture losses caused by surface ponding due to the high temperatures over the fallow period (Freebairn et al. 1986). It highlighted the potential to participants for co-learning and co-working.

My observation also included:

- The impact on participation:
  - The exercise encouraged farmer ownership over learning evident by enthusiasm in planning preparing treatments, and discussing observations;
  - The scientist initiated the activity and determined the process, but farmers had the potential to influence content with some potential to change process;
  - Farmer involvement combined with the practical and visual impact of the exercise captured farmers’ attention and enthusiasm throughout the process; and
  - Participation was through a semi-structured process that provided the opportunity for partial knowledge integration46.

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46 Knowledge integration is a term used to indicate collaborative learning when different stakeholders recognise the value of their multiple experiences and knowledge. Therefore it reflects a developing ontological appreciative system amongst stakeholders.
• The impact on skill development (management, communication, resources and learning):
  - It encouraged the development of group cohesion through individual self-disclosure in a supportive climate;
  - The process allowed for multiple views and outcomes. For example the simultaneous comparison between treatments and the ability to repeat or set up new treatments encouraged a range of views and discussions;
  - Farmers developed skills in comparative analysis and in communicating their observations.

• The stakeholders responses (likes, dislikes and information use):
  - Farmers appreciated the emphasis on valuing farmer knowledge by incorporating them in the planning and seeking their interpretations; and
  - The complexity associated with multiple constructs (ie the varying views of the benefits and costs of different tillage practices) made it difficult to define clear outcomes and this frustrated participants. For example farmers expected to obtain definitive solutions to their problems but when varying levels of complexity emerged (ie socio-economic implications) it became more difficult to obtain a single solution and this made it more difficult to reach clearer learning outcomes.

• The influence in behaviour, attitude and practice:
  - Scientists developed a more conscious appreciation of farmers’ conditions and priorities, reflected by their position as facilitators compared to experts;
  - The process motivated individuals to remain and further develop group processes, evident by farmers’ commitment to future activities and suggestions for future venues;
  - There was increased acceptance of individuality amongst stakeholders; and
  - Increased involvement by farmers in planning and acting, improved dialogue development.

4.2.2.5. Reflection

The usefulness of this form of activity is its focus on group development through working and learning together, a principle that gives priority to improving learning skills.

The development of group based activities provided a mechanism for farmers to communicate with each other and with scientists. There has been widespread support for group-based activities and the focus on developing learning skills to support farmers’ decision-making practices. Farmers have also acknowledged that participative group learning is more valuable than traditional advisory processes, because they are actively involved in the group learning process (Cawley and Lawrence 1998 unpublished report). Participants’ comments that support these views are:

"...groups are a great way for benchmarking WUE, financial indicators, etc against others...
...groups are a good way to integrate information between scientists and farmers..."

The constraints of this activity, in relation to the validity of participation, are that farmer involvement occurs only through a predetermined and externally initiated process. Although it allowed the opportunity for farmers to be involved and define aspects of the content, to some degree the answer or knowledge was already preconceived and owned by the scientists, in some instances, and by the farmers in other situations.
The most prominent change was the release of some control by the scientists, which lead to the development of relationships amongst farmers, scientists and private consultants. The other major influence was that it offered the emerging potential for scientists to recognise distinctions between their perceptions and farmers’ perceptions of sustainability. For example, although all stakeholders agreed that moisture conservation is the most important issue for sustainable grain production in the region, some farmers considered chemical farming used in reduced tillage operations as equally unsustainable in relation to its possible effects on stock, family, watercourses and the general environment. Therefore a more systemic dimension of sustainability was revealed.

In terms of Pretty’s (1995) typology (Table 3, page 31) on participation the mode of participation varied between consultation and functional. These differences depended on the facilitator’s ability to share control and allow farmers to take a self-directing position. A consultative mode dominated when the facilitator would directly answer questions and guide farmers in the design of plot treatments. In this situation the major decision-making was the authority of the facilitator, the activity and outcomes were dependent on them to function. These observations suggest that Pretty’s (1995) typology on participation does provide some guide for benchmarking participation.

A functional mode of participation developed when the facilitator was more comfortable and open to influence by farmers’ suggestions and inputs. The facilitator did not present himself as an information resource but rather redirected questions back to the group for discussion. The design of tillage treatments, that is planning, observations and analysis was left entirely up to the farmers who on occasion resourced the facilitator’s experience.

Increased participation therefore impacted on farmers’ ability to reflect upon their collective experiences and learn from these experiences. In this activity it helped farmers to analyse and interpret the observations they made during the activity. Although the impact of learning did not directly change management decisions concerning tillage practices, some farmer’s decisions not to change was based on a more informed construction. A farmer comment that supports this includes:

- “All the experts say zero tillage is the way to go, but I haven’t been able to convince myself that it would really be more beneficial. The rainfall simulator verified that our current practice of reduced tillage is the better option on our red soils”.

It appears therefore that improving the quality of participation in R, D and E process improves the quality of information and also supports decision making for adapting to change. For the scientist this quality of information can assist them in developing the relevance of generalised information to more locally specific conditions and lead to unexpected learning.

The cost of improved participation is learning to deal with the dynamic complexity associated with multiple constructions of varying value systems. This cost is associated with constraints on resources for improving participation. For example, the time required for encouraging dialogue and group development, identifying and meeting multiple learning needs, dealing with emerging and changing goals have implications on the efficacy of R, D and E programs.
4.2.3. **Case Study 6. Crop tours**

### 4.2.3.1. Introduction

Crop tours such as field walks or bus tours were used to build on the development initiated by the pre-planting activities by adding another “practical dimension” (Knowles, 1984) to the group learning process through informal discussions on topical issues. The activity is categorised as action learning because it provided opportunities for integrating stakeholders knowledge with emergent understanding of a particular issue (Revans, 1997). It is a learning activity that emphasises dialogue\(^ {47} \) development where group members support their learning development through active reflection. Farmers were required to take the leading position in organising itineraries and preparing presentations of their farming systems.

Crop tours included field visits, when group members would visit a number of properties during the growing season to discuss topical issues. It also included bus tours where several properties were visited during a single activity and on-farm research field days where members observed and discussed specific experimental treatments amongst themselves and visiting scientists.

### 4.2.3.2. Planning

The objective of these activities was to further encourage development of dialogue amongst group members (i.e., farmers, scientists and other industry representatives) by creating a comfortable and supportive environment for communicating. By creating a situation where stakeholders could comfortably converse and articulate their theories while also providing the opportunity to observe how they test their theories in action.

Participants were encouraged to:

- Discuss learning needs: That is, “what they want to find out and why?” “What are their current experiences?”;
- Discuss their farming system operation and issues;
- Discuss strategies to assist individuals to act on ideas, interests and/or problems raised. That is, what process can be used or developed to accommodate learning needs;
- Present research activities and findings;
- Discuss and interpret seasonal issues or problems. What has been learned, does it differ from the initial learning objectives, why/why not?; and
- Discuss how to continually improve practices. That is, what will change as a result of the outcomes?

### 4.2.3.3. Actions

In the Balonne Shire crop tours have been an annual event over the last three years and were carried out with farmers in the Nindigully Group, Rockycrossing Group and Boolba Group. Scientists from the WFSP also attended these tours. All tours involved visiting participatory on-farm research (POFR) sites and examining a diverse range of management practices. Each host farmer was encouraged to present a brief overview of their farming system, an outline of their research activities and highlight issues or interests concerning the successes and challenges of their operation. The facilitator would encourage other participants to comment

\(^{47}\) Dialogue development is the process for building common understanding and appreciation of alternative viewpoints. It is considered as the foundation for co-working and co-learning.

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on presentations and to present their experiences concerning the issue being discussed. As the facilitator I would also stimulate ideas in the discussions by introducing different points of view or putting up ideas for participants to think about, rather than answering questions.

4.2.3.4. Observations

Observations in this case study are based on my participant observations and some insights into farmer’s views about the activity are also drawn from the qualitative evaluation of the WFSP (Cawley and Lawrence, 1998). Observations are based on the impact of the activity on participation, stakeholders’ skill development and changes in behaviour. My reflection examines the implications of these observations in regards to improving the quality of participation, the benefits and costs of increasing participation and the adequacy of Pretty’s (1995) typology for benchmarking modes of participation.

Observation made during these activities indicated that farmers are very active in identifying and addressing issues. Many farmers had established their own trials which included crop varieties, alternative crops (eg quandongs, peanuts, dryland cotton), fertiliser trials and tillage experiments. Farmers’ methodology for investigating issues often involved across-paddock comparisons, split paddocks or non-replicated strips.

Photo 3: Boolba Crop Bus Tour (1997)

My observations included:

- The impact on participation:
  - Good attendance at all tours throughout the study period (ie from farmers, scientists and private consultants);
  - There was bilateral activity initiated between scientists and farmers although it was dependent on the scientist for its continuation. For example the planning of the tours and organising activities was shared between the scientist and farmers but was still dependent on the scientist for motivating this interaction;
  - There was recognition of the value in integrating propositional and local knowledge. For example farmers indicated that they were much more comfortable interacting with scientists in this type of activity compared to a closed forum in a hall. They also indicated that seeing POFR studies conducted on their neighbours paddocks in
commercial situations while having the opportunity to liaise with scientists and peers made information more meaningful and inspired their own motivation to try something new; and

- There was a high level ownership over activities amongst all participants reflected by all stakeholders enthusiasm to make these type of activities a regular seasonal practice.

- The impact on skill development (management, communication, resources and learning):
  - Farmers tested and adapted theories picked up in other activities, and developed skills (eg nitrogen management and crop monitoring) to help them improve their decision making;
  - The level and quality of dialogue reflected maturity in group cohesion compared to observations made in more formal workshop activities. This was reflected in open sharing of experiences, appreciation of individual views, and by assertive listening and questioning; and

- The stakeholders responses (likes, dislikes and information use):
  - Farmers enjoyed presenting and discussing their experiences;
  - Farmers appreciated that scientists valued their experiences and knowledge;
  - All stakeholders reported that they enjoyed the opportunity of the informal and open interaction these activities offered. This was reported by Cawley and Lawrence (1998 unpublished report) as one of the most important and enjoyable activities for farmers in the WFSP.

- The influence in behaviour, attitude and practice:
  - The activity developed stakeholders’ commitment to activities;
  - It continued to encourage farmers to behave as pro-active communicators who have valuable knowledge, rather than passive recipients of information; and
  - Group members’ self-esteem was enhanced and promoted effective outcomes in co-working and co-learning. This was evident by the increased motivation observed in farmer’s behaviour such as in conducting POFR studies. For example during the first bus trips in 1997 only one POFR activity was observed per group which were initiated by scientists. In 1998 and 1999 POFR activities multiplied up to five per group and many of these activities were initiated by farmers in collaboration with scientists and other farmers.

4.2.3.5. Reflection

This activity provided a way of assisting stakeholders to diagnose needs, gain insight into each other’s issues and to utilise the various experiences in the group. Each farmer’s experience was greatly extended through in-depth discussions with other growers sharing their experience. It also provided the opportunity to discuss tentative plans for refining future activities after observing and analysing various farming practices and research activities. The activity also indicated how farmers were using information and skills developed from other activities in their own environments. The learning developed during the soil workshops on nitrogen management and the adaptation of crop monitoring programs are two examples of technology that is being applied on-farm and discussed on "crop tours”.

The most prominent change was shared control by the scientists, in organising and conducting the activities. This further strengthened the relationships amongst farmers, scientists and
private consultants and improved the level of interaction amongst stakeholders. The other major influence was that it offered the potential for scientists to recognise farmers’ innovation in adapting scientific principles and experimenting, and also highlighted the importance of understanding the site-specific nature of sustainable development. For example, although most stakeholders agreed that soil fertility (ie nitrogen) is an important issue for sustainable grain production, the way farmers’ managed this issue varied from:

- Using nitrogen budgeting techniques to improve yields and protein;
- Applying a standard rate of nitrogen fertiliser each season;
- Targeting higher yields and accepting lower protein;
- Using ley pasture rotations for rejuvenating soil conditions;
- Planting pulse crops (eg chick peas, mungbeans); and
- Opportunity cropping (ie double cropping).

Therefore the dynamic complexity of sustainable development was revealed and scientists’ appreciation of sustainability was evolving beyond a mere biophysical focus but to include socio-economic and human development issues.

In terms of Pretty’s (1995) typology (Table 3, page 31) on participation the mode of participation varied between consultative and interactive. The mode of participation fluctuated according to particular stakeholder needs. For example a consultative mode existed when either the farmer or scientist was inquiring for explanation or to obtain information. When stakeholders participate in joint analysis and developed plans for future activities by seeking multiple perspectives, participation became interactive. For example during the Boolba tour in 1998 the group planned future workshops and made arrangements for future POFR sites. Under this situation the group took control over local decisions and determined how available resources are to used (Pretty, 1995). It appears Pretty’s (1995) typology provides adequate benchmarks of participation. However, the criteria for differentiating between these benchmarks require more specific indicators for appropriate assessment of the level and impact of participation.

This indicates that as participation increases there is interaction between different modes of participation and a more dynamic relation develops. In relation to process efficacy, developing interdependent multi method approaches requires stakeholders to recognise the appropriate mode of participation for different situations.

Increased participation impacted on farmers’ ability to reflect upon their collective experiences and learn from these experiences. In this activity it helped farmers to analyse and interpret the observations they made during the activity. Although this activity did not result in direct changes to farming practices it influenced how farmers and scientists behaved in future activities. For example, as a result of the level of interaction from these activities, farmers developed a more leading role in R, D and E activities. This is evident more recently were farmers organise their own paddock visits and crop monitoring activities on topical issues and invite appropriate resource people to attend, and may in part account for increasing farmer contribution to the Balonne Broadcaster newsletter. A farmer’s comment that supports this changing attitude is, “...we probably have to grow up one day and do our own thing...”

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4.3. Participatory Action Research (PAR) and POFR

The POFR\textsuperscript{48} studies presented in this section focus on improving research and learning approaches through a participatory action research process. This involves farmers, scientists and agribusiness advisers, collaboratively utilising their particular knowledge and interests to develop better informed constructs. Participation from this perspective is a means to improve a stakeholder’s decision making and learning to learn along an evolving continuum.

This concept of participative research was first discussed in the WFSP at a series of workshops and group meetings in 1995 and 1996 across four groups of farmers. Farmers, scientists and agribusiness advisers discussed issues and problems concerning the farming systems in the region and the potential for developing on-farm research processes to help address them. These issues included soil fertility, soil moisture, tillage management, grain marketing and alternative crop rotations. Essentially, the aim was to identify opportunities for improvement by developing activities to create new experiences, and to develop processes for POFR projects. This meant developing a methodology that could allow research on biophysical issues, but which also accommodated a bilateral exchange between stakeholders when identifying issues and developing approaches and research questions, whilst encouraging co-working and co-learning.

4.3.1. Case Study 7. Soil characterisation study

4.3.1.1. Introduction

The most critical biophysical variable in cropping systems of the Balonne Shire involves the management of soil moisture, so the plants can obtain their requirements for nutrients and water. This requires farmers to have a considerable understanding of their soils and the impact their decision making has on the loss or gain of soil moisture. They must be aware of the importance of efficiently storing soil moisture, to reduce the risk of crop losses and to increase the efficient use of soil water and nutrients. Understanding soil physical and chemical properties is an essential part of understanding the movement, distribution and availability of soil water to plants.

The specific focus of this case study was to help stakeholders to improve their understanding of soil water processes, and develop more relevant information on the PAWC\textsuperscript{49} of local soils. This issue emerged from scepticism of the generalised information discussed in the soil workshops in 1996, where there was an apparent contrast between scientific understanding and local experiences. The potential outcome for developing localised soils information for farmers was to help them make more informed decisions concerning areas of planting, timing, crop choices, fallow management practices and yield budgeting. From the perspective of scientists, the potential outcome would be to improve the local relevance of research and extension work and generate more farmer involvement, develop or refine crop monitoring and promote the use of participatory action learning tools.

An evaluation conducted after the workshop series in March 1996 (reported in the AL case studies) further supported these observations and indicated that:

\textsuperscript{48} POFR refers to participatory on farm research

\textsuperscript{49} PAWC Plant available water capacity. The water held in the soil that can be readily absorbed by growing plants after drainage.
- Seventy percent of farmers agreed that accurate measurement of stored soil moisture is important in aiding management decisions. They also indicated most decision making concerning planting was based on the reliance and amount of planting rainfall;
- Seventy percent of farmers said they were not confident in estimating PAWC of soils; and
- Farmers did not clearly understand the relationship between depth of wet soil and the relationship between mm of PAWC and the potential soil water storage limit of the soil profiles. This limited the relevance of other indicators such as WUE.

4.3.1.2. Planning

The aim of this activity was to improve local and scientific understanding of the characteristics of cropping soils in the region (specifically PAWC) that influence crop production. Furthermore the objective was to initiate a program that required farmers and scientists to collaborate in a co-working and co-learning setting and use the learning process to develop a more sophisticated participatory process for future activities. The study involved twelve grain growers from four geographically dispersed farmer groups in the Balonne Shire, myself and other scientific resources. Site selection was based on group and individual discussions amongst farmers and researchers.

The stakeholders' (ie farmers and scientists) involvement included:
- Brainstorming information and learning needs;
- Bilateral planning (ie site selection, land type descriptions, presentation);
- Co-working (ie establishment and management of sites, monitoring and sampling);
- Discussing observations (ie data interpretation, presentation of information); and
- Reflection on experiences (ie what was learned and how does it change previous knowledge).

The technical objectives of the study involved the classification of soil types (Isbell, 1996) using vegetation and land type descriptions provided by farmers. Soil physical properties where assessed and described in the field according to structural and texture assessments (McDonald et al. 1990). This was considered important because of the relationship between physical properties and water holding capacity of soils (Craze and Hamilton, 1994; Dexter, 1997) and could assist other farmers in assessing their own soil properties and PAWC in the future. The additional objectives included:
- To examine the relationship between PAWC (mm) and depth of wet soil (cm).
- the measurement of bulk density (BD) (ie the weight of dry soil per cubic centimetre)
- Soil chemistry analysis to identify relationships between chemical properties, PAWC and physical description that may affect PAWC (Baker et al, 1993).

4.3.1.3. Actions

The materials and methods used for this experiment are described in detail by Dalglish and Foale (1998) who refer to the system as the trickle irrigation method. The diagram in Figure 13 illustrates the design and materials used at each site (see Photo 4). Monitoring of the wetting up or drainage is recorded every month, using a neutron moisture metre, which over time is used to detect changes in water content and when the upper limit is reached (Dalglish and Foale, 1998). Two hundred litres of water is applied once a week until the upper limit is reached. Dalglish and Foale (1998) describe the method used for sampling as the "mechanical sampling method":

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This method uses a hydraulic sampling rig combined with special large diameter coring tubes with thin walls (90 cm in length, and diameters are 75, 100, 125mm)

The procedure involves the following steps:

1. "Push tube into the soil using a hydraulic rig, (usually beginning with the larger diameter tube);
2. Remove the soil core from the tube; and
3. Cut samples accurately into appropriate lengths and process."

Samples are used to calculate both bulk density and drained upper limit and are weighed wet in the field using specialised field scales and a field work table. It is recommended that samples are then dried at a 105°C for 48 hours (Dalgliesh and Foale, 1998). Samples are then processed for gravimetric soil moisture content and bulk density calculations, which is described in detail by Dalgliesh and Foale (1998). Bulk density (BD) calculation is based on BD = dry soil weight (g)/volume of soil core. Gravimetric soil water = dry soil wt/(change in wt.- container wt) x 100. Results are also expressed as volume of water per cubic centimetre of soil referred to as volumetric percentage. The calculation is Vol% = (Gravimetric % x bulk density) (Dalgliesh and Foale 1998).

Figure 13: Diagram of a soil characterisation site
(Source: Dalgliesh and Foale, 1998)

The thirteen land types analysed were grouped according to their major classifications (Isbell, 1996) where trends in PAWC and critical chemical and structural properties were compared and grouped to develop generalisations. A further sub classification was determined based on land type descriptions where trends in PAWC; chemical and structural properties were compared within major classifications.

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Soil analysis results are summarised and presented under five major soil groups - grey vertisol, grey vertisol Gilgai, red sodsol, grey dermosol and red kadosol presented in appendices seven to nine.

4.3.1.4. Observations

Observations in this case study are based on my participant observations in farmer group discussions and some insights into farmer’s views about the activity are also drawn from the qualitative evaluation of the WFSP (Cawley and Lawrence, unpublished report 1998). Observations are based on the impact of the activity on participation, stakeholder’s skill development and changes in behaviour. My reflection examines the implications of these observations in regards to improving the quality of participation, the benefits and costs of increasing participation and the adequacy of Pretty’s (1995) typology for benchmarking modes of participation.

Observations regarding soil characteristics were that PAWC of soil types used for crop production in the region ranges from 80mm at 1.0 metre depth to 200mm at 1.5 metres depth.
With an annual average rainfall ranging from 580 mm in the north to 400 mm in the south west, and 450 mm in the west to 550 mm in the east, soil types and fallow practices play a decisive role in crop production.

Rate of infiltration and speed of wetting were found to be variable. Depending on surface conditions, soil type and the age of the cultivation, there can be considerable variation in rainfall infiltration rates into the soil profile. A heavy grey vertosol for example, in a highly receptive condition to accept rainfall (ie relatively dry and cracked), initial infiltration rates can easily exceed 50+ mm/hr. However, after the initial up take of moisture, infiltration rates can decrease anywhere between 20 to 5 mm/hr or less. Permeability is therefore described as slow after the initial moisture intake in these soils, because of poor internal drainage. To fill the soil profile in these situations took in access of eight months. This was beyond farmers and scientists preconceptions.

In other soil types such as red sodosols and red kandosols without any surface limitations (ie relatively dry without a hard setting surface condition), initial rainfall infiltration rates can be similar to those of the grey vertosols. After the initial wetting period, infiltration is generally more constant ranging between 10 to 25 mm/hr. Often these soils are considered moderately permeable because of better internal drainage (observations made from OFR “soil characterisation”). Some farmers expressed surprise that PAWC didn’t match their experiences.

“...I was surprised how little soil water our soil holds...”

My observations included:

- The impact on participation:
  - Farmers were enthusiastic to be involved – reflected in their communication and attendance at meetings and field days;
  - Scientists initiated the activity and developed the research process;
  - There was shared decision-making concerning site selection, land type descriptions and some interpretation of data;
  - The activity promoted contact between farmers and scientists; and
  - It challenged stakeholders’ predispositions because it required the development of appreciation of each others needs, issues and a higher commitment to co-working.

- The impact on skill development (management, communication, resources and learning outcomes):
  - Farmers developed their own learning. For example they developed a ratio between depth of wet soil (cm) and millimetres of PAWC of soils (ie 1:1 that is for every centimetre of wet soil 1mm of PAW or 1:0.8 when every centimetre of wet soil provides 0.8 of a mm of PAW);
  - It integrated both propositional and practical experiences to develop more relevant sitespecific information. For example combining farmers land type descriptions with scientific information;
  - Interaction between farmers and scientists developed foundations for future relationships in on-farm research. For example it inspired further POFR work into crop nutrition and fallow management described in the on-farm studies section; and

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- Scientists and farmers developed their understanding of local cropping soils characteristics and produced better scientific information.

- The stakeholders responses (likes, dislikes and information use):
  - Farmers who were directly involved in the research enjoyed having an active role in the program;
  - During the early stages of group development, the program isolated individual farmers who were directly involved in the POFR activity from the rest of their group. This was evident in the group dynamics in meetings where there appeared to be some communication barrier between farmers who were directly involved and farmers not directly involved;
  - Unequal commitment and involvement was an issue throughout group activities. Farmers resented that some participants devoted energy and time to group activities while other members only used the group to source information and did not contribute to the process or activities. A farmer’s comment on this issue was “...to be a good group member you have to contribute to the group, you can’t take, take, take...”; and
  - Farmers believed that the benefits of POFR are “...its relevance to the local situation and that it includes farmers needs and views...”.

- The influence on behaviour, attitude and practice:
  - Documenting information and presenting learning outcomes was still considered the scientist’s role “...QDPI needs to take a leading role in recording and organising activities...”;
  - The challenges identified by farmers were “more involvement needed by farmers in planning activities, analysis and discussing results” and “keeping it simple but effective”; and
  - The program served as a preliminary step in developing more sophisticated POFR processes by getting participants to experience the commitment required to work collaboratively in a learning situation.

4.3.1.5. Reflection

The aim of this activity was to develop localised information on cropping soils, specifically on PAWC. This physical information provided some essential baseline data on soil characteristics that could help farmers make more informed decisions on fallow and/or planting management practices, as well as the interpretation of on-going research activities. It also helped to localise action learning tools such as the nitrogen workshop series, the soil water workshop series and later the pre planting and post-harvest meetings. Other examples included measuring fallow efficiency (FE), using calculation of target yield and protein to manage crop nutrition, and paddock monitoring to help farmers better inform their decision making. This change is evident by the continuation of farmer groups who are utilising and developing learning networks to improve their decision making.

A farmer’s comment that supports this learning focus is “...we’ve always known what happened but know we are learning why and how to take better action...”.

This activity supported stakeholders in taking action and developing learning needs, by providing resources and utilising local knowledge and scientific skills in developing locally relevant soil information. In effect, it showed to both scientists and farmers the potential for
integrating experiences and co-learning, and proved to be an essential preliminary step in developing foundations for ongoing participatory on-farm research activities. An example of a co-learning is the localised rules of thumb that relate depth of soil moisture to PAWC (mm).

Although the activity provided the opportunity for stakeholders to influence outcomes, farmers did not generally change decision-making. That is, farmers were more confident in assessing PAWC and in understanding the implications of store soil water on crop production but it did not necessarily change farmers’ practices concerning areas of planting or timing. A farmer’s comment that reflects this view is “...the activity provided me with information relevant to my country which helped me understand the risks involved with planting on different levels of plant available water and fertiliser application...”. Therefore farmers chose not to change practices based on more informed decision-making. Indirect changes as a result of the activity were observed in the farmer’s practice of paddock monitoring through localised farming groups who are beginning to use water use efficiency (WUE) and economic benchmarks to examine the benefits and costs of their management techniques.

The slow rate of infiltration and speed of wetting up in a grey vertisol meant over six months was needed for moisture to reach drained upper limit during several experiments. When compared to average fallow rainfall it indicated that, even under the best conditions (ie above average fallow efficiency of 25%), a soil profile with the potential of storing 180 mm of PAWC would only reach half its potential. This was beyond farmers and scientists preconceptions and indicated a possible area of research for the future.

In terms of Pretty’s (1995) typology on participation (Table 3, page 31) the mode of participation varied between functional and interactive and fluctuated during different stages of the activity. For example the program was initiated by scientists after emergent learning outcomes from previous farmer based activities that indicated a need to refine local soil information. Therefore the learning need evolved through bilateral analysis and dialogue between farmers and scientists and this indicates an interactive mode of participation. However, the activity’s process (ie experimental design) was predominantly predetermined by scientists but open to influence by farmers, for example as in selecting land types and developing land type descriptions, indicating a more functional mode of participation. When stakeholders participated in joint analysis, participation became interactive and was evident by the acceptance and understanding of differences reflected by how farmers and scientists communicate which indicated strengthened ownership and shared decision making. This suggests that participation is a fluctuating process and different modes of participation can reside in most approaches.

The implication of this reflection concerning the adequacy of Pretty’s (1995) typology of participation is consistent with my previous observations in the TOT and AL case studies. That is, the modes of participation are adequate benchmarks for understanding the complexity of participation. However the criteria for differentiating between benchmarks require the development of more specific indicators. This would assist stakeholders in making more appropriate assessment of the level and impact of participation, and hence learning efficacy. Increased participation therefore impacted on farmers’ ability to relate learning to their situation, liaise with peers and other resource persons to make more informed decisions. However, a cost of increased participation was the requirements to deal with the difficulties of unclear outcomes, and internal group conflicts involving multiple needs and goals.
4.3.2. Case Study 8. On-farm studies

4.3.2.1. Introduction

Participatory on-farm research (POFR) activities in this section involved investigations on crop production issues like crop varieties, management of soil fertility, benefits and costs of different tillage systems, weed control trials, ley pasture rotations, green manuring break crops and long fallow systems. These studies were coordinated with farmer groups, often motivated by either current problems or emerged through other farmer-based activities.

These POFR studies have three main objectives:

- To develop knowledge and action that is directly useful to the farmer’s situation; that provides the opportunity for all stakeholders to learn the principles of cause and effect relations, as opposed to prescription alone;
- To empower people in developing localised communication networks by integrating local and propositional knowledge to develop more sophisticated constructs; to develop a process that explores ‘what is known’ (ie propositionally and indigenously) through dialectical exchange and investigates ways of refining learning about content and process.
- To develop individuals awareness of how peoples values influence how they know what they know to develop a greater appreciation for the value of utilising multiple constructs for making more informed decisions.

4.3.2.2. Planning

The aim of these activities included:

- To develop a process to help stakeholders identify and address issues while learning to access and use a wider resource pool;
- To assist stakeholders in recognising the benefits and costs of various research and learning approaches, and how they influence decision making;
- To develop a supportive framework for farmers and scientists in dealing with change; and
- To create an environment where stakeholders recognise differences between their espoused theories versus theories in action by supporting reflective learning.

Preparation also includes the planning of experimental design, identifying the key indicators and developing monitoring methods, as well as negotiating various stakeholders’ roles. Essentially the activity attempts to help stakeholders achieve their learning needs but also challenge their predispositions in a subtle but significant way by encouraging dialogue on intended action compared to actual actions through group discussions.

There is a wide range of methods that can be used for on-farm research. The combination of relevant design with clear learning needs coupled with stakeholder participation in determining the issue/s, process, and active involvement in collective discussion of outcomes is the foundation for effective participatory on-farm research activities.

The process used to help set direction and guide on-farm research in this study included:

1) Identifying learning needs (Planning): That is, “what do we want to find out and why?”
   What is already known? What is the issue or question that requires more information?
2) **Learning process (Actions):** How do we want to find out? What process can be used or developed to help address learning needs? This could be propositional, experiential or a combination. What are the indicators used to judge progress?

3) **Observations in light of context (ie environmental social and economic):** What was observed and what happened?

4) **Analysis and interpretation (content reflection):** What are the results, conclusions and learning drawn from the program?

5) **Reflective learning (process reflection):** That is evaluating outcomes in relation to objectives. Did the program answer the original intentions or fulfil learning needs? What was learned about methods? What needs clarification and why?

6) **Future vision (Re-planning and revisiting the learning cycle):** What will change as a result of the outcomes?

This framework was used to develop research and learning proposals, and to evaluate learning progress. It emerged from the needs identified by the WFSP team to develop the precision of POFR Studies in drawing out learning outcomes. The issues identified could be common to the group or specific to an individual. The only criterion for participation was that individuals must present their methodology, observations, findings and interpretations to the group. This provided all group members with the opportunity to influence outcomes and to highlight the possible new learning that could improve decision making.

4.3.2.3. Actions

**Experimental Design**

Traditionally farmers use the paddock comparison method when doing experiments because it is easily established and managed. This method involves comparing different management techniques or technology between paddocks. For example, comparing crop varieties or fertiliser application between paddocks. Another common method is within paddock comparison or the split paddock method. This method involves dividing a paddock into two or three areas to compare different treatments. Both methods are easily operated and managed, but require careful interpretation because of the natural environmental variation in soil types, rainfall and the timing and type of management that occurs across and between paddocks.

The natural variation experienced in many land types often results in yield variation across paddocks. This variation is referred to as experimental error. When designing POFR programs it is important to keep experimental error to a minimum to ensure confidence in the learning outcomes.

It is important to develop methods that can help distinguish between elements of variability. The development of such methods has been one of the challenges for POFR programs. That is, to develop methods that are practical for both farmers and scientist that can operate under commercial conditions and be challenging and beneficial to all stakeholders' learning.

In this study POFR method involves the use of strips (or experimental units) in part of a paddock, which run the length of the paddock (approximately 1km) and one or two planter widths wide (13 to 26 metres). These experimental units are representative of the larger area. The inclusion of random replication is to provide an indication of how much variation there is between experimental units of the same treatment. This variation could be due to different
positions in the paddock, events at sowing or harvest, isolated rainfall events or other unexplained causes. It is used to prevent confounding the experimental units with the location. For example, if a trial is designed so that each experimental unit runs from left to right, plot ‘A’ may always be confounded with specific environmental variables, like isolated rainstorms, fertility gradients, land slope, etc.

Figure 14 illustrates a design with three systems replicated twice and randomised within a paddock. Although this method does reduce some level of experimental error and improves confidence in potential outcomes, it has low statistical precision (ie few degrees of freedom\(^{59}\)).

![Diagram of POFR Design Method 1]

Figure 14: POFR Design Method 1

An alternative design may incorporate three random replications of a system, which further reduces the level of experimental error and improves the confidence in outcomes. However, given the size and distance across the experimental units, the effect of increasing the replications by one is minimal. Furthermore this design is very time consuming and resource demanding during planting and harvest operations and may not suit all situations.

Another method involves two random replications of treatments within a system of multiple controls (C) (Figure 15). This is illustrated in the diagram below. The advantage of this method is that it is more easily operated and managed compared to three or more replications but also improves statistical rigour through its use of multiple and randomised controls where controls represent farmer’s normal practice. Theoretically this lowers the potential for bias and raises the levels of confidence in the results and learning interpretations. It also requires considerable resources and time to apply.

\(^{59}\)The degree of freedom is an indicator of the appropriateness of the statistical analysis, based on the replication and independence of samples.
Figure 15: POFR Design Method 2

Recording and monitoring

Recording sufficient information from which to analyse and interpret significant learning outcomes while developing generalisations to help make comparisons with other systems across seasons and area, is an essential part of all POFR activities.

Data collection includes:

- Site and soil characterisation (scientist and farmer):
  - These are the soil physical descriptions, common name, longitude, latitude, vegetation, slope, soil chemistry and PAWC.

- The diary of activities (farmer and scientist):
  - This is recording of all soil, crop and animal activities (eg tillage practices, fallow management practices, weed control chemicals used and rates, grazing practices, crop conditions, planting times and rates, fertiliser application, rates and method, and the timing of activities). Intended actions versus actual actions are also recorded.

- Weather (farmer):
  - A rainfall and temperature station is located near sites. Daily rainfall, incidence of frosts or any other unusual conditions are recorded.

- Regular soil sampling (scientist and/or farmer):
  - Soil water (0-150cm) nitrate (0-120cm), phosphorus (0-15 cm) and other relevant elements are recorded. Sampling should occur just prior to planting and at the beginning of the fallow phase.

- Measuring crop, pasture and grazing (farmer and scientist):
  - Emergence date and plant population, date and dry matter at flowering, date of maturity, harvest date, yield and protein, grazing days or DSE are recorded.

- A focus group meeting on collective interpretation and analysis of POFR investigation is held annually (farmers and scientists).
4.3.2.4. Observations

Observations in this case study are based on my participant observations in group activities and some insights into farmers’ views about POFR are also drawn from the qualitative evaluation of the WFSP (Cawley and Lawrence, 1998 unpublished report). Observations are based on the activity’s impact on participation, stakeholder’s skill development and changes in behaviour. My reflection examines the implications of these observations in regards to improving the quality of participation, the benefits and costs of increasing participation and the adequacy of Pretty’s (1995) typology for benchmarking modes of participation.

Table 4: Conditions and characteristics of POFR activities

<table>
<thead>
<tr>
<th>Condition</th>
<th>Research Characteristics</th>
</tr>
</thead>
</table>
| Subject of investigation | • Crop variety  
• Planting time  
• Soil fertility/fertiliser/pulse crops/pasture leys/green manuring  
• Land preparation/tillage  
• Crop residue management  
• Fallow management  
• Soil characteristics influencing PAWC  
• Weed control |
| Motivation | • Pro-active inquiry; critique new information, trying new ideas  
• Reactive inquiry; attempting to address current problems  
• No information; developing learnings in an area with little information |
| Methods used | • No obvious ‘control’ comparison is over space (ie across paddocks).  
• No obvious ‘replication’ comparison is over time (ie over seasons).  
• Dividing paddock into 2 or 3 large areas may include a control.  
• Dividing paddock into large strips (1-3ha plots) including a ‘control’, monitoring of key variables (eg soil nutrients, soil water, plant population, rainfall, temperature).  
• Dividing paddock into large strips including ‘control’ and ‘replication’ monitoring of key variables (eg soil nutrients, soil water, plant population, rainfall, temperature).  
• Dividing paddock into large strips, which includes replication of comparisons and multiple controls for added rigour in interpretations. Monitoring of key variables (eg soil nutrients, soil water, plant population, rainfall, and temperature). |
| Origin or initiation of idea/technology | • Copying - trying something that was observed or suggested  
• Trying something that has been actively promoted  
• Modifying a number of ideas  
• Own idea |
| Actual/potential outcome | • Adaptation and reinvention of known techniques modified for site-specific conditions  
• Problem solving  
• Adaptation leading to new techniques and new learnings  
• More informed decision-making practices  
• New innovations |

(Source: modified from Sumberg and Okali, 1997)
Twenty-five cases of POFR investigations were coordinated and recorded during this study. These research activities varied quite considerably in their objectives, method and outcomes (Table 4) but all shared one common element. This element for both scientists and farmers was doing something ‘new’ or different. However, it may not have been necessarily new from a technological perspective. It was different in that stakeholders were attempting to learn together.

All stakeholders were able to give some account of both the process details and the outcomes from the experience. For the purpose of illustration five of these POFR studies are presented in the table below which is an account of the collective interpretation of the research focus, process and learning outcomes by stakeholder groups.

Table 5: Examples of POFR projects.

<table>
<thead>
<tr>
<th>Te</th>
<th>Aim</th>
<th>Approach</th>
<th>Interpretations</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>Want to maintain fertility and reduce nitrogen decline</td>
<td>Replicated and randomised</td>
<td>Replication/randomised design gave more confidence in results</td>
</tr>
<tr>
<td>m</td>
<td>Explore the sustainability in applying nitrogen</td>
<td>Used target yield &amp; protein principles to determine inputs &amp; potential yield outcomes</td>
<td>Did not observe any physical differences</td>
</tr>
<tr>
<td>s</td>
<td>Better understanding of the usefulness of soil tests and target yields and protein concepts</td>
<td>Group discussion</td>
<td>Nitrogen not used by the crop can remain in the sub-soil. Provides more confidence in the use of fertilisers</td>
</tr>
<tr>
<td>u</td>
<td>Explore the strengths and weaknesses of zero tillage and conventional tillage on red soils</td>
<td>Replicated and randomised</td>
<td>If protein levels are 13% or higher, yield is limited by other factors</td>
</tr>
<tr>
<td>ly</td>
<td>Economic benefits and costs</td>
<td>Used target yield &amp; protein principles to determine nitrogen requirements</td>
<td>Could not see any differences between ZT and CT</td>
</tr>
<tr>
<td>1</td>
<td>Explore the potential of improving yield and quality through nitrogen fertiliser application on this land type</td>
<td>Developed target scenarios based on soil tests</td>
<td>More stored soil water recorded in CT</td>
</tr>
<tr>
<td>&amp;</td>
<td></td>
<td>Group facilitation</td>
<td>Red country goes hard under ZT practices</td>
</tr>
<tr>
<td>stration</td>
<td></td>
<td>Individual consultation</td>
<td>Nitrogen application was not sufficient need to look at applying higher levels</td>
</tr>
<tr>
<td>u</td>
<td>Could not see any differences between ZT and CT</td>
<td>Crop monitoring</td>
<td>Verified own intuition about ZT on red soils</td>
</tr>
<tr>
<td>ly</td>
<td>Economic benefits and costs</td>
<td>Group facilitation</td>
<td>Need to investigate over 2 to 3 years</td>
</tr>
<tr>
<td>2</td>
<td>To explore the benefits and costs between long fallow and normal fallow practice.</td>
<td>Individual consultation</td>
<td>Learned to do trials better</td>
</tr>
<tr>
<td>rement</td>
<td></td>
<td>Crop monitoring</td>
<td>Exceeded original yield targets</td>
</tr>
<tr>
<td>t</td>
<td></td>
<td></td>
<td>Need to increase yield by 30 %</td>
</tr>
<tr>
<td>g</td>
<td></td>
<td></td>
<td>Increase in protein</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>Need to repeat over a number of seasons</td>
</tr>
<tr>
<td>y</td>
<td>To assess crop variety suitability to specific land type conditions</td>
<td>Non replicated 26ha plots</td>
<td>Need to replicate to increase confidence</td>
</tr>
<tr>
<td>trial</td>
<td>Indicators, crop height, yield &amp; quality</td>
<td>Farmers own idea</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>To explore the viability of increasing yield and protein on highly nutrient-deficient soils</td>
<td>Non replicated 26ha plots</td>
<td></td>
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<tr>
<td>l</td>
<td></td>
<td>Group facilitation.</td>
<td></td>
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<tr>
<td>on</td>
<td>To localise target yield principles</td>
<td>Crop monitoring</td>
<td></td>
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<td></td>
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<td></td>
<td>Difficult to extrapolate information beyond the site-specific situation</td>
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<td></td>
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<td></td>
<td>Need to repeat for a number of seasons to improve confidence in outcomes</td>
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<tr>
<td></td>
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<td></td>
<td>Replication difficult on management because of machinery. Not considered important, large areas provide enough confidence in outcomes</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Actual yields were similar to targets.</td>
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<td></td>
<td></td>
<td></td>
<td>Developed some confidence in theory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Not economical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Need to repeat over a few seasons</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Need to explore other options (eg ley pasture, pulse crops)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Does unused nitrogen remain in the soil?</td>
</tr>
</tbody>
</table>

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My observations included:

- The impact on participation:
  - Activities were predetermined by scientist, self initiated by farmers or initiated by collaborative interaction;
  - In most POFR activities attendance was good with 70 percent of group members attending activities;
  - Development of farmer ownership over activities. Evident by farmers enthusiasm in developing and conducting their research, and organising monitoring and field days. For example farmers coordinated crop tours and actively presented to other group members the objectives and outcomes of their work where before they relied on scientists;
  - Stakeholders were comfortable with sharing experiences and openly disclosed their views concerning the issues being studied, what they were hoping to learn as well as how they used the information to reinforce their decision making process; and
  - Two-way communication and the open and honest expression of both ideas and feelings indicated growing group development.

- The impact on skill development (management, communication, resources and learning outcomes):
  - The exercise brought about a partial integration of knowledge (ie propositional and local);
  - Farmers had the opportunity to interpret results and discuss the strengths and weaknesses of the processes in use;
  - There was a change in farmers research skills (eg making notes during meetings, researching information from outside the direct group, using comprehensive crop monitoring methods and more interest and questions in using computer programs for yield and economic budgeting); and
  - There were more acceptances of multiple interpretations of outcomes. Each stakeholder made some interpretation of technical results. This ranged from not making any sense initially but through discussion helped to highlight the learning that could be drawn from a no response outcome.

- The stakeholders responses (likes, dislikes and information use)
  - Unequal commitment and involvement emerged again as an issue for farmers and scientists. A farmer’s comment was “... I am disappointed that some groups members don’t devote much time to POFR activities but expect information from others...”;
  - Ambiguity of aims and outcomes in some activities frustrated all stakeholders and is an apparent barrier to POFR progress with all groups. “...we need better clarification of objectives to develop better outcomes...”;
  - Many farmers indicated that POFR activities are demanding on their time and resources and to date, have offered very little in regards to developing clear solutions. “...I reckon you need these on-farm trials. They need to be simple. They don’t need to be a whole lot of complicated things...”;
  - Farmers and scientists appreciate the opportunity POFR offers towards generating more in depth understanding of issues and the opportunity to openly discuss experiences. “...the benefit of on-farm research is that it provides us access to
resources like you guys, its relevant to our situation and I feel that I can relate to what we are trying to achieve... ".

- The influence on behaviour, attitude and practice:
  - There has been an increase of farmer initiated research activities. For example in 1996 POFR activities were all initiated by scientists in 1998 and 1999 over half of the POFR programs were either farmer initiated or jointly initiated between farmers and scientists; and
  - There has been more open discussion in group meetings compare to past meetings were farmers expected scientists to present outcomes. With the incorporation of collective analysis through focus groups farmers take a leading role in presenting their observations and learning outcomes.

Photo 6: On-farm research harvest with commercial equipment, recording yield and protein.
(Rocky Crossing farming group)

4.3.2.5. Reflection

The methods used in the operation of POFR activities varied from no obvious control or direct comparisons (ie comparing over time and space) to side by side comparison (split paddock), to sites that included controls with side by side comparisons with replication of treatments. The former methods often occurred when individuals acted on their own resources, outcomes tended to be confounding and relied on unquantifiable observations. As a result determining cause and effect phenomena or even drawing sufficient learning to inform decision making was extremely difficult.

However, I found that these type of experiments were often repeated over time and some farmers appeared to make an intuitive analysis which they used to reinforce their decision-making in light of their experiences. It appears reasonable to accept that these unorthodox methods provide some valuable site-specific information to farmers with minimal input and cost. It may also be acceptable that farmer's own experiments may be an invaluable resource to POFR processes. For some other participants (eg some scientists) these types of methods do not provide adequate confidence in the information nor do they fulfil the scientists' learning needs. At best they may highlight issues for future research activities. Even the more detailed on-farm research methods tend to have confounded outcomes, often arising from the variability associated with large plots, no replication and/or lack of controls.
Traditionally on-farm research was generally initiated, designed, managed and evaluated by scientists. Participation amongst other stakeholders was passive. Often involvement included providing the area for the trials, attending field day activities to receive information on research results or providing scientists with information on local conditions (Farrington et al 1988). This process predetermined farmers' needs and the scientist unilaterally controlled the focus, problem diagnoses and technology development. Scientists would then demonstrate the technology through on-farm research activities. Participation between stakeholders did not extend beyond providing information awareness and/or teaching or training on the adoption of technology.

Fundamentally, past on-farm research activities were about promoting change in a socially favourable way based on the assumption of generalised value systems. In the context of this study POFR studies aimed at fulfilling a different range of criteria which moves away from traditional adoption strategies by emphasising process learning to assist stakeholders to making more informed decisions in dynamically 'complex' situations.

The objective of POFR investigation is therefore not simply a process to understand cause and effect relations but to deal with and manage change. The definition of POFR therefore evolved to include the actual context where our interest lies, that is on farm. Participatory refers to its human development process through co-working and co-learning groups. These groups involve farmers, scientists (extension and research) and agribusiness advisers all bringing with them their own particular knowledge and interest. Research refers to finding out about something and finding out how we go about learning. This aspect is a form of evaluation that attempts to provide information about 'content' and how we may improve the way we learn about content (ie process learning).

In terms of Pretty's (1995) typology on participation (Table 3, page 31) the mode of participation initially started at a consultative level where there was dependency on scientists for activities to function. For example monitoring on-farm research experiments and documenting and presenting outcomes indicated a predominantly unilateral communication and decision making process.

By increasing the opportunity for involvement (ie for process and content) the quality of participation improved to functional and interactive modes which fluctuated during different stages of operation. At a functional mode decision making, problem diagnosis, and process development was determined by scientists but open to influence by farmers. At an interactive mode research was still initiated by scientists but farmers develop higher levels of ownership over the activity and their learning. This was evident by farmers changing practices in initiating research activities and in group meetings where they presented research objectives, observations, outcomes and their individual interpretations in group discussion. The benefit of POFR is that "farmers are included in the research process".

The implication of this reflection concerning the adequacy of Pretty's (1995) typology of participation is again consistent with my previous comments in other case study activities. That is, the modes of participation are adequate benchmarks for understanding the complexity of participation, however the criteria for differentiating between benchmarks require the development of more specific indicators. This would assist stakeholders in making more appropriate assessment of the level and impact of participation, and hence learning efficacy.
The most prominent impact from increased participation was on farmers’ ability to relate learning to their situation and make more informed decisions. "...POFR is good because it addresses the issues that are relevant and is a good communication mechanism, to get people involved in doing...".

However, the cost of increased participation is dealing with the difficulties of unclear outcomes. For example dealing with the multitude of observations and interpretations during focus group discussions on POFR made it difficult to draw out clear learning outcomes.

Stakeholders identified the main points that need to be improved when developing POFR programs as:

- Developing a clear focus on learning needs;
- Developing practical research questions;
- Selecting appropriate methods;
- Organising the operational logistics;
- Collecting data;
- Communicating experiences; and
- Investigating the potential of findings for other situations.

Four emerging differences were identified with farmer groups between different POFR activities. Stakeholders variously considered POFR as:

- Complementing traditional research approaches (ie integrates propositional and local knowledge) (ie interdependent); or
- An alternative approach to traditional research, requiring a structured and explicit framework (ie independent); or
- An approach with a primary focus on methods (ie technological packaging); or
- A consultative process where researchers should only act as a consultant to the farmer (ie information awareness).

POFR assisted stakeholders in refining their constructs through a multiple method processes. The focus was on improving learning outcomes (ie understanding principles concerning biophysical and socioeconomic phenomena) while encouraging stakeholders to inquire into how they inquire through reflective learning to identify differences between their espoused theories and theories in action.
4.4. Emerging Issues from the Case Studies

In the TOT activities, the primary objective was to disseminate a quick and clear message that may influence the adoption of new technology or give farmers information to improve their practices. Learning from this position is a structured or propositional process where one learns from instruction by another who predetermines the issues and endpoints of the learning exercise. From this position, the validity of knowledge itself is the prominent domain of the scientist.

Action learning (AL) activities involved a more cooperative learning process. Under this framework the identification of issues and the processes used to address them still resided with the scientist, although farmers did have the opportunity to influence the outcomes by being involved. However, the scientist was under no obligation to consider the outcomes or farmers views. Essentially under this scenario the scientist “knows the answer” and participation is used to help farmers understand what the scientist knows.

PAR approaches emphasise co-learning and co-working, similarly to action learning activities, but PAR is more concerned with extending learning beyond content by overtly acknowledging process learning as its primary objective. Therefore the main distinction drawn between TOT, AL and PAR is that TOT and AL are concerned with communicating and transferring information and skill training, whereas PAR is concerned with collaboratively developing procedures for acquiring information and skills (Knowles, 1984). Emphasis is given to utilising multiple constructs to help refine and develop more sophisticated constructions while reflecting on what is learned and how it is learned.

TOT, AL and PAR programs were processes in which stakeholders interacted to accommodate each other’s learning needs. They either reinforced or refined existing constructs, or led to the emergence of new insights.

A major learning outcome from the application of these processes is that the efficacy of R, D and E practices is shaped by sources of power and authority and that power is either available or unavailable to the various stakeholders involved in the activities. This level of authority and power directly influenced the quality of participation. For example, participation was used as a means to improve adoption or as a means to improve learning and the efficacy of decision making.

The discussion on reflection throughout the case studies was concerned with the impact of the activity’s content and process on participation, skill development and changes in stakeholders’ behaviour. I was comparing the operational and process elements of TOT, AL and PAR processes to develop the understanding needed for an interdependent multi-method process.

From these case studies I observed that the development of interdependency requires:

- Establishing a learning environment;
- Developing processes for bilateral planning;
- Mutual diagnosis of learning needs;
- Developing objectives for program activities;
- Designing learning activities;

Case Studies
- Collaboratively working and conducting activities;
- Collective interpretation and evaluation of outcomes; and
- Refining learning outcomes and future needs.

Knowles (1984) suggests that understanding the distinction between methodologies is the key to process development. The distinction between activities is primarily based on whether they are focused on process or content. These characteristics of the R, D and E approaches are summarised in Table 6 – based on information from the case studies.

Table 6: Analysis of Characteristics of TOT, AL and PAR

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>TOT</th>
<th>AL</th>
<th>PAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Impact on quality of participation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive - consultative</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Functional - interactive</td>
<td>[✓]</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Self mobilisation</td>
<td>[✓]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Impact on skill development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focused on problem solving, adoption of technology</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Focused on facilitating understanding of principles to improve adoption</td>
<td>[✓]</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Focused on facilitating mutual understanding to improve learning and decision making process</td>
<td>[✓]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Stakeholder responses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little or no opportunity to influence outcomes</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Opportunity to influence outcomes only</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Opportunity to influence outcomes and processes</td>
<td>[✓]</td>
<td>[✓]</td>
<td></td>
</tr>
<tr>
<td>* Impact on behaviour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undisclosed assumptions</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Opportunity for transparency</td>
<td>√</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Transparent assumptions</td>
<td>[✓]</td>
<td>[✓]</td>
<td></td>
</tr>
<tr>
<td>* Ontology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reality defined by authority figure</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acknowledgment of multiple constructs</td>
<td>[✓]</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Appreciation and utilisation of multiple constructs</td>
<td>[✓]</td>
<td></td>
<td>[✓]</td>
</tr>
<tr>
<td>* Learning cognition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical cognition (propositional)</td>
<td>√</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Practical cognition (experiential)</td>
<td>[✓]</td>
<td>[✓]</td>
<td>√</td>
</tr>
<tr>
<td>Emancipatory cognition (double loop)</td>
<td>[✓]</td>
<td>[✓]</td>
<td>[✓]</td>
</tr>
</tbody>
</table>

A check in brackets [ ] indicates inconsistencies between the espoused and actual practices, where espoused potential is inhibited by insufficient ontological appreciative capacity.
A number of underlying assumptions influenced the analysis of the characteristics of TOT, AL and PAR approaches. These assumptions and their significance towards learning efficacy are described below:

- **TOT: Assumptions**
  - Authority orientated;
  - Formal delivery or presentation of information equals learning;
  - Passive learning can develop decision making processes;
  - Knowledge can be discovered and transferred;
  - Participants need to be directed to learn; and
  - Authority figure predetermines needs and evaluates impact.

- **AL: Assumptions**
  - Learning is facilitated by experts through semi-formal presentations;
  - Participation is a means to obtain solutions to problems;
  - Participation is a means to transfer technology;
  - Commitment to learning is based on short term rewards;
  - People learn from instruction;
  - Authority figure predetermines needs and evaluates impact; and
  - Content based with the opportunity to integrate.

- **PAR: Assumptions**
  - People learn by doing – informal
  - Self-initiated learning is more efficacious in improving decision-making;
  - Participation is a means to improve learning skills;
  - Learning improves through shared involvement and collaboration;
  - Mutual diagnosis and evaluation;
  - Co-working and co-learning; and
  - Content and process based major focus on integration.

The characteristics of TOT and AL programs, essentially operated under a predetermined framework (ie an ontological underpinning) that controlled the issue or problem, as well as the knowledge and skills to be adopted. Knowledge was sequentially arranged and presented by an authority figure through a step-by-step process. Although both TOT and AL are content-based processes, subtle differences exist between them. For example TOT offers none or very little opportunity for participants to influence process and outcomes compared with action learning which provided participants with some opportunity to influence outcomes under the guidance of the facilitator.

In contrast PAR claims to be more process-focused. This means that PAR activities are concerned with establishing a learning environment conducive to developing mutual participation in meeting learning needs. The distinction between PAR, TOT and AL programs is that PAR offers participants the opportunity to influence outcomes and processes which can be more effective in improving decision making compared to learning what others want us to learn.

The main difference between these approaches is that the content methodologies are concerned with communicating and transferring information and skill training, whereas the process methodology is concerned with providing procedures and resources for helping stakeholders acquire information and skills (Knowles, 1984).
Observations made on the operation of TOT and AL activities during the case studies indicated that giving out information as in field day or workshop presentations was efficient in providing farmers with quick, timely and interesting information that can assist them in problem solving. However in more dynamic situations such as site-specific conditions when socio-economic issues influence the relevance of generalised information, simply transferring information and skills does not provide the support farmers require to adapt to change. Under these dynamically complex conditions the process needs to be concerned with facilitating change in attitudes and behaviour which are notoriously difficult to change and are seldom susceptible to logic, new information or even contradictory experience (Douglas, 1983).

To facilitate change in attitude and behaviour, the case study activities collectively worked together to develop learning groups between farmers, scientists and agribusiness to help people learn how to adapt to change. Therefore the analysis of the case studies does not debate “for” or “against” certain approaches, because the strengths and weaknesses of various approaches need to be captured by allowing them to function interpedently to improve the efficacy of R, D and E programs.

Johnson and Johnson (1994) assert that individuals in groups are not necessarily conducive to effective or efficient improvements in decision making processes. In the case studies, this view was reflected in the difficulties (and complexity) of developing effective and efficient co-working and co-learning environments. These difficulties were directly attributed to the low quality of participation and the distinction between whether the activity was based on educating or learning. Therefore techniques for assessing the appropriateness of participation emerged as an important issue for improving the operationalisation of participatory approaches.

This distinction between education and learning and efficacy of R, D and E programs is summarised by Boyd (1980). “Education is an activity undertaken or initiated by certain agent/s, that is designed to effect changes in the knowledge, skills and attitudes of individuals and/or groups”. This emphasises that the “educator is the agent of change, who introduces stimuli and reinforcement for learning and designs activities to induce change”.

Educating (ie teaching) is an imposed unilateral structured process that conflicts with most adults natural tendency to be self-directed. In contrast learning emphasises “the person in whom the change occurs or is expected to occur. It is based on change through acquisition” Boyd (1980).

The final chapter draws on the observations and this preliminary analysis of the case studies for my reflection on the research questions.

The aim will be to clarify my learning about the main theme of this thesis, that is the development of participatory processes for improving farming systems in the Balonne Shire.

Learning developed from the case study experiences has highlighted the multitude of ways knowledge is formed. Accordingly it suggests that procedures for validating knowledge and the efficacy of learning outcomes vary according to values and beliefs. This implies that the quest for knowledge as if it existed and waited for discovery is actually composed in a complex process involving social, situational, cultural and biophysical interaction, of which knowledge emerges. Therefore it is a world which the actor rather than the observer, defines.
5. Reflection on Research Process and Practice

5.1. Introduction
This thesis incorporated eight major R, D and E (the case studies – Chapter 4) activities embracing three major extension and research approaches (ie TOT, AL and PAR). These activities ranged between high and low levels of intervention and participation. The framework for inquiry was a multi-method approach which had qualitative and quantitative aspects. This integrated approach was necessary to address the complex issues involving social, situational, cultural and biophysical interaction in the research environment.

The structure of this discussion is based on the general research framework proposed by Checkland (1985). The framework is used to discuss and analyse my learning about improving participatory approaches. It also examines the implications of levels of participation for the development of group learning, extension practice and the development of participatory processes for improving R, D and E programs.

5.2. Review of Research Questions
The primary theme of this study has focused on learning to develop participative processes for improving farming systems in the Balonne Shire. This theme was focused by the following research question:

i) Does the level of participation of stakeholders in R, D and E processes lead to more informed decision-making?

This research question was refined and expanded to include the following sub-questions.

a) Is Pretty’s (1995) typology of participation adequate to identify levels of participation?
b) Who does increased participation impact on and how does it impact?
c) What are the benefits and costs of increased participation?

There are three main assumptions that underlie the research focus. Firstly, informed decision making is a result of client learning and more informed client decision making leads to enhanced client practice. Thirdly, participation is the basis for developing dialogue, which is essential for learning to improve learning skills through dialectical interaction (Senge, 1990). This approach is considered to have greater efficacy than any single inquiry approach alone in addressing the complex nature of sustainable development (Pretty, 1995).

5.2.1. Case Study Analysis (SWOT)
The following analysis (Table 7) highlights the strengths, weaknesses, opportunities and threats (SWOT) of the various R, D and E approaches (TOT, AL and PAR). Assessed on their impact on the quality of participation, stakeholder’s skill development (ie learning process, and communication); and influence on decision making as participants became more aware of the content and meaning of competing constructions.
<table>
<thead>
<tr>
<th>TOT</th>
<th>AL</th>
<th>PAR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>Information is systematic &amp; orderly</td>
<td>Information is systematic &amp; orderly</td>
</tr>
<tr>
<td></td>
<td>Goals/objectives clearly defined</td>
<td>Goals/objectives clearly defined</td>
</tr>
<tr>
<td></td>
<td>Time efficient</td>
<td>Bilateral communication</td>
</tr>
<tr>
<td></td>
<td>Clear explanation of cause &amp; effect</td>
<td>Facilitative structure to reach predetermined endpoints</td>
</tr>
<tr>
<td></td>
<td>Provides awareness of information &amp; clarification</td>
<td>More effective adoption of technology by providing opportunity for involvement</td>
</tr>
<tr>
<td></td>
<td>Technical focus</td>
<td>Prescriptive solutions</td>
</tr>
<tr>
<td></td>
<td>Prescriptive solutions</td>
<td></td>
</tr>
<tr>
<td><strong>Weaknesses</strong></td>
<td>Unilateral communication</td>
<td>Unilateral planning and diagnosis of problem/issue</td>
</tr>
<tr>
<td></td>
<td>Information is easily forgotten (Single loop learning)</td>
<td>Issues/goals predetermined by scientists</td>
</tr>
<tr>
<td></td>
<td>Process, issues &amp; goals predetermined by scientists</td>
<td>Little support for adapting to change</td>
</tr>
<tr>
<td></td>
<td>Non lasting impact</td>
<td>Time consuming</td>
</tr>
<tr>
<td></td>
<td>Dependency on authority to function</td>
<td>Learning is bound by propositional framework with some opportunity to influence predetermined outcomes</td>
</tr>
<tr>
<td></td>
<td>Prescriptive focus does not support learning to improve decision making</td>
<td>Can provide understanding to test principles</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td>Information can be generalised</td>
<td>Opportunity for debate/discussion</td>
</tr>
<tr>
<td></td>
<td>Highlights economic incentives to encourage adoption</td>
<td>Some opportunity to influence outcomes</td>
</tr>
<tr>
<td></td>
<td>Information is accessible</td>
<td>Partial integration of indigenous &amp; propositional knowledge</td>
</tr>
<tr>
<td></td>
<td>Quick and clear solutions to some problems</td>
<td>Acknowledges multiple constructs but does not influence predetermined endpoints</td>
</tr>
<tr>
<td><strong>Threats</strong></td>
<td>Lack of relevance to site-specific conditions</td>
<td>Involvement generates enthusiasm for on going activities</td>
</tr>
<tr>
<td></td>
<td>Not recognising multiple constructions</td>
<td>Undisclosed assumptions</td>
</tr>
<tr>
<td></td>
<td>Learning process is propositionally bound</td>
<td>Scientists are not obligated to incorporate multiple constructs</td>
</tr>
<tr>
<td></td>
<td>Goals are competitively structured around economic incentives</td>
<td>Communication is often a systematic contest of opposing views (ie debate)</td>
</tr>
<tr>
<td></td>
<td>Participants are given little or no opportunity to influence decisions by power holders</td>
<td>Dependency on authority to function</td>
</tr>
<tr>
<td></td>
<td>Provides limited understanding of principles</td>
<td>Incentive driven</td>
</tr>
</tbody>
</table>

Table 7: SWOT analysis of three R, D and E approaches, based on analysis of the case studies

*Reflection on Research Process and Practice*
The aim of the SWOT analysis is to summarise the emerging issues discussed in the conclusion of chapter four and to support discussions of the research theme and research questions in the following sections.

Eight key criteria are identified from the SWOT analysis that indicate prominent developments in process and content learning, and which are attributed to the level of participation. These principles are summarised in Table 8.

The criteria presented in Table 8 highlight key points that indicate changes in stakeholders' interaction across the group learning activities. These criteria may serve as useful indicators for observing the effect of improving the opportunity for participation in R, D and E programs as stakeholders integrate knowledge cultures and experiences with other approaches for learning. These are discussed in more detail in the following sections that examine the research questions.

Table 8: Key criteria that indicate progressive changes in process.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Local knowledge</th>
<th>TOT</th>
<th>AL</th>
<th>PAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aim</td>
<td>Maintaining life style and economic viability</td>
<td>Sustained yield</td>
<td>Innovations to improve the adoption of sustain yield</td>
<td>Improve decision making process</td>
</tr>
<tr>
<td>Source of innovation (ie motivation)</td>
<td>Farmers</td>
<td>External organisations</td>
<td>External organisations</td>
<td>Multiple initiation</td>
</tr>
<tr>
<td>Nature of knowledge</td>
<td>Farmers own experience</td>
<td>Propositional (ie scientific)</td>
<td>Partial integration between propositional and local</td>
<td>Multiple constructs (emergent)</td>
</tr>
<tr>
<td>Learning approach</td>
<td>Comparison over space and time</td>
<td>Empirical verification objectivity</td>
<td>Empirical verification objectivity, modified in natural settings</td>
<td>Multiple system based on dialogue and dialectical development</td>
</tr>
<tr>
<td>Communication</td>
<td>Farmers network</td>
<td>Extension/research organisation</td>
<td>Extension/research organisation</td>
<td>Bilateral (ie appreciation of multiple constructs)</td>
</tr>
<tr>
<td>Process of communication</td>
<td>Informal</td>
<td>Formal (unilateral structured learning process)</td>
<td>Semi-formal (debating)</td>
<td>Semi-formal (dialogical)</td>
</tr>
<tr>
<td>Farmer’s participation</td>
<td>Developing, communicating and using knowledge</td>
<td>Passive recipient (adopter)</td>
<td>Modifier</td>
<td>Developer, communicator and evaluator</td>
</tr>
<tr>
<td>Scientist’s participation</td>
<td>None</td>
<td>Expert (teacher)</td>
<td>Facilitator (trainer)</td>
<td>Facilitator (co-learner and co-worker)</td>
</tr>
</tbody>
</table>
5.3. Adequate Identification of Levels of Participation

a) Is Pretty’s (1995) typology of participation adequate to identify levels of participation?

Pretty’s (1995) typology on participation defines various levels (ie benchmarks) of participation, and provides useful general descriptions of participation at each level. These levels of participation highlight the difficulties of understanding effective and efficient participation in learning groups, and have helped me to develop more specific criteria for observing and differentiating between levels of participation.

However, it was difficult to differentiate the level of participation that occurred in any activity using Pretty’s (1995) typology alone. Using Pretty’s (1995) typology as reference point and then reflecting on the experiences of the case study activities, I developed more specific and detailed criteria to help me assess the levels of participation in learning activities (Table 9). Four discriminant factors were used in this process. These included: a) communication (eg unilateral versus bilateral); b) types of learning cultures used (eg local, propositional and/or experiential knowledge); c) process or content orientated (eg predetermined and/or emergent outcomes); and d) decision-making process (eg co-learning/co-working versus predetermined or unilateral). The criteria developed from this study may be useful in improving future programs by assisting stakeholders in analysing their interaction and developing processes to improve the efficacy of participatory approaches.

Multiple levels of participation were a feature of all case studies. At lower levels, minimal opportunity was provided for farmers to be involved in influencing the process and/or outcomes. At higher levels participants had greater opportunity to be involved by influencing outcomes with a superficial impact on process. These levels of participation were initially governed by predetermined processes and end points, which were mostly controlled by scientists. However, levels of participation changed over time, reflecting changes in stakeholders’ behaviour where shared decision-making and control over process development was observed.

The benchmarks and discriminating factors in Table 9 were useful in identifying the impact of participation on a scale between a high and low intervention. For example low levels of participation occurred when the process and content were controlled and directed by the scientist. Therefore the activity was observed as being highly intrusive with little or no co-working and co-learning. Compared to more bilateral control and decision making at higher levels of participation. Examples of this distinction are recognised over time within the TOT activities (eg ‘newsletter’ and ‘exploring the soils’ activity). Similarly, levels of participation varied between AL and PAR (eg pre-planting workshops and POFR studies) which indicated a fluxing state between levels of participation.

A major learning outcome in terms of understanding levels of participation was that the development of effective participation is a process that emerges and continually changes over time. That is, more participation does not necessarily equal better outcomes. Therefore one needs to traverse through various modes of participation. It requires practitioners to develop skills in understanding and appreciating the usefulness of various levels and inquiry positions in diverse situations.
Table 9: Discriminating factors for levels of participation that evolved from this study

<table>
<thead>
<tr>
<th>Levels/Benchmarks of Participation</th>
<th>Discriminating Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive</td>
<td>- Awareness, providing information, clarification</td>
</tr>
<tr>
<td></td>
<td>- Unilateral communication/decision making/needs</td>
</tr>
<tr>
<td></td>
<td>- Initiatives directed by external influences</td>
</tr>
<tr>
<td></td>
<td>- Information, needs, experiences, belongs to external agents</td>
</tr>
<tr>
<td></td>
<td>- No opportunity to influence</td>
</tr>
<tr>
<td>Consultation</td>
<td>- Unilateral communication/decision making/needs</td>
</tr>
<tr>
<td></td>
<td>- Problems, issues, needs &amp; process defined externally</td>
</tr>
<tr>
<td></td>
<td>- Some opportunity to influence by volunteering views</td>
</tr>
<tr>
<td></td>
<td>- Goals are competitively structured</td>
</tr>
<tr>
<td></td>
<td>- Decisions always made by highest authority</td>
</tr>
<tr>
<td></td>
<td>- Dependency on leader to function</td>
</tr>
<tr>
<td>Functional</td>
<td>- Issues/goals predetermined</td>
</tr>
<tr>
<td></td>
<td>- Processes given but opened to influence and change</td>
</tr>
<tr>
<td></td>
<td>- Structured learning processes</td>
</tr>
<tr>
<td></td>
<td>- Debating as a form of communication</td>
</tr>
<tr>
<td></td>
<td>- Partial integration of knowledge systems (ie propositional/local knowledge)</td>
</tr>
<tr>
<td></td>
<td>- I know the answer, you’ve got to find out for yourself</td>
</tr>
<tr>
<td>Interactive</td>
<td>- Initiated by the institution or other stakeholders</td>
</tr>
<tr>
<td></td>
<td>- Co-working/learning</td>
</tr>
<tr>
<td></td>
<td>- Acknowledgment that everyone has the right to contribute</td>
</tr>
<tr>
<td></td>
<td>- Dialogue development</td>
</tr>
<tr>
<td></td>
<td>- Systemic and structured learning processes</td>
</tr>
<tr>
<td></td>
<td>- High levels of ownership over learning direction</td>
</tr>
<tr>
<td></td>
<td>- Sharing experiences/knowledge</td>
</tr>
<tr>
<td></td>
<td>- Interdependent</td>
</tr>
<tr>
<td></td>
<td>- Accepting and understanding of differences/criticisms</td>
</tr>
<tr>
<td></td>
<td>- Discloser of assumptions/values/feelings</td>
</tr>
<tr>
<td></td>
<td>- Allows for emergent issues/needs</td>
</tr>
<tr>
<td>Self Mobilisation</td>
<td>- Initiated independently</td>
</tr>
<tr>
<td></td>
<td>- Independent of external resources/organisations</td>
</tr>
<tr>
<td></td>
<td>- Self governing/directed</td>
</tr>
<tr>
<td></td>
<td>- Unilateral or bilateral interactions</td>
</tr>
</tbody>
</table>

(Source: modified from Pretty, 1995)

Benchmarks for evaluating and understanding the appropriateness of various levels of participation are critical in determining the efficacy of R, D and E programs. Continuing future development will be required to refine indicators for quantitative and qualitative ethnographic assessment.

Identifying adequate levels of participation is not a case of ‘for’ or ‘against’ a particular mode because no single mode alone necessarily ensures the development of interdependency or learning efficacy. Essentially participative approaches can be utilised from a number of different inquiry positions as observed in the case study analysis. The main lesson learned is that participation may be used as a means to communicate predetermined needs or realities, or used to identify and understand multiple realities and needs. Emphasis should be on providing opportunity for all stakeholders to influence both process and content.
5.4. The Impact of Increased Participation

b) *Who does increased participation impact on, and how does it impact?*

Increased participation\(^{51}\) impacts on stakeholders learning development by providing opportunity for all stakeholders to influence process, practice and outcomes. Increased participation adds a different dimension for improving decision-making by utilising both instructional and practical learning concepts within a net of ontological discovery. Therefore increased participation provides not only the opportunity for involvement, but also to direct and challenge content through collective reflection on process. This can result in greater intellectual development and practical support for dealing with change by improving the qualities of stakeholders' decision-making.

5.4.1. Impact of participation on practice

Scientists, farmers and other stakeholders in agriculture often provide or seek formulas or packaged products to solve problems or address issues. Such an approach is prescriptive with the farmer as a passive adopter. Increased participation in my research has highlighted to stakeholders the importance of evaluating alternative solutions to problems and issues. This approach has focused on encouraging stakeholders to critique cause and effect relations, and to manage change as opposed to the passive adoption of prescriptive solutions.

Therefore increased participation has helped stakeholders evaluate options and understand risk in dealing with change. An example of such learning was observed in farmers' nitrogen management strategies, where they investigated alternative management approaches and discussed both biophysical and economic implications compared to their normal practices. This increase in participation occurred firstly by providing opportunities for collaborative interaction to direct, manage and evaluate research. Secondly, increased participation assisted farmers to adapt generalisations to their situations through group learning activities. Through this process farmers developed confidence in the adaptation of new information and technology.

The increased participation had an effect on stakeholders awareness of the importance of how they reflected, which influenced how and what they learned. Stakeholders were conscious that they reflected on information and experience, but never considered it as something they could control or develop as a learning tool. This became clear during a series of group meetings in March 1999 that focused on facilitating reflection on POFR studies and action learning activities. Farmers, scientists and private consultants became aware of the natural underlying elements that influenced their reflective process, as they became more aware of their individual worldviews. This developed an appreciative outlook on the value of multiple constructs and the significance of co-learning and co-working. This particular outcome of increased participation is now evident because stakeholders interactively organise to meet formally or informally to observe and discuss their ideas and practices.

Increased participation resulted in changes in:

- The frequency of farmer led activities (eg farm walks, crop tours);
- Discloser of assumptions during more formally initiated activities (eg workshops);

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\(^{51}\) Increased participation refers to the quality of participation, which is an appropriate level of interaction between stakeholders in a given context that is determined by dialogue and dialectical reasoning amongst all participating stakeholders.
• Stakeholders self-confidence in the value of their own ideas and knowledge (farmer lead research and openly discussing experiences);
• Experimental skills (eg number of POFR activities and the quality of design, management and interactive analysis);
• Leadership (farmers developing ownership for coordinating activities); and
• Resource development (attracting private industry resources, farmer’s contribution of time and resources to activities).

The impact of improved participation on learning practice is the bringing to consciousness of the learning process (ie being transparent) which develops a process for more effective bilateral planning, acting and learning. This is accomplished by initiating reflection on learning needs and outcomes.

The conclusions reached suggest that increased participation promoted an important mixture of predetermined, opportunistic and unexpected discoveries. This required a learning framework which can significantly improve the level of learning beyond single loop learning by encouraging greater interaction amongst stakeholders, and collectively reflecting on espoused theories versus theories in practice (Argyris, 1982).

5.4.2. The impact of participation on the process of learning

The impact of increased participation has encouraged, not so much the development of a particular reality but a readiness to see and value and respond to a situation in particular ways (Vickers, 1984). It accommodates the complexity that derives from different worldviews and this encourages new insights and new ways of thinking about issues which may challenge and reinforce our own worldviews (Vickers, 1984). In this sense the impact of participation influences a paradigmatic interdependency where positivism is but one perception within a constructivist paradigm. Therefore to improve R, D and E practices, the practitioner is required to take into account all stakeholders’ needs, objectives and problems. But even more importantly, all stakeholders have the opportunity to influence both content and process and thereby incorporate multiple constructs into the process.

The models in Figure 16 and Figure 17 illustrate the relationship of the various activities and processes used in the case studies. Figure 16 illustrates the interaction of the case study activities under the wider canopy of an interdependent multi-method approach. Figure 17 illustrates the potential outcomes from this relationship in developing understandings on biophysical principles, communication skills and learning processes by all stakeholders. Both models also indicate that the aim of sustainable development is to develop a process concerned with improving stakeholders’ learning in dealing with dynamic complexity involving socio-economic, ecological and cultural interactions.

The diagrams illustrate that the impact of participation is linked with more effective learning and epistemological progression towards a “learning paradigm”. The distinction observed as a result of increased participation is between learning as a process by which behaviour is shaped or controlled, compared to developing skills in making more informed decisions. This assertion is validated by Kilpartick (1996) and Pretty and Chambers (1994) who also identify the impact of increased participation with better learning by supporting stakeholders in dealing with changes in agricultural practices towards sustainable development processes.
This relationship between the quality of participation and its impact on the efficacy of R, D and E programs is represented by the merging of three cycles in the diagrams below.

![Diagram](image)

**PARTICIPATIVE LEARNING**

Figure 16: Interdependent research framework.

![Diagram](image)

**PARTICIPATIVE PROCESSES**

Figure 17: Potential outcomes from an interdependent framework.

Studying the impact of increased participation changed my understanding of sustainable development from a perceived end point, towards a process (ie a means) that is locally and socially embedded. It is a process of adaptability in dealing with change for improving stakeholders’ understanding of the relationships between social, economic and ecological development. The objective is to assist stakeholders in developing skills for making more informed decisions. Therefore, epistemological progression towards a learning paradigm calls for an interdependent ethos for integrating different sources of information and experience. This epistemological progression requires a participatory foundation not a dualistic basis.
Meaningful interaction or exchange between participants at the junction where all three cycles meet represents an interdependent ethos between stakeholders. This ethos extends learning beyond transfer of technology or problem solving. It focuses on learning to improve how we learn for improving decision-making.

The observed impact of increased participation on process is in:

- Integrating technology development with farmers experience and knowledge of the environment (ie systemic and structured learning integration);
- Assisting stakeholders to address site-specific issues and conditions facing farmer’s decision-making;
- Supporting stakeholders adaptation to change (ie dealing with the implications of change);
- Encouraging scientists, farmers and private industry to interact more frequently; and
- Providing equity and equality of participation (ie for purpose, control, and power).

Participation increases as the different cycles merge (Figure 17) which then influences the principal methodological and operational components of R, D and E programs. These concepts are summarised in Table 10.

Table 10: The impact of increased participation.

<table>
<thead>
<tr>
<th>Key Principles</th>
<th>Conceptual Components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Methodological issues</strong></td>
<td></td>
</tr>
<tr>
<td>Who decides on research, learning needs/planning?</td>
<td>Emerges over time through dialogue development amongst participating stakeholders</td>
</tr>
<tr>
<td>Who manages research?</td>
<td>Joint management (co-working)</td>
</tr>
<tr>
<td>Who evaluates the research?</td>
<td>Farmer and researcher in light of group and individual aims. Learning outcomes should be rewarding to all participants. Collaborative planning, analysis and interpretation.</td>
</tr>
<tr>
<td>Farmer/scientist relations?</td>
<td>Partnership, co-working and co-learning (mutual dependency)</td>
</tr>
<tr>
<td>What characterises the research process?</td>
<td>Focused on content and process. Reflecting on assumption to improve the process of learning and decision-making.</td>
</tr>
<tr>
<td><strong>Operational issues</strong></td>
<td></td>
</tr>
<tr>
<td>Interaction between other learning approaches</td>
<td>Multi-method integrates propositional and local knowledge and different ways of knowing to develop more informed constructions.</td>
</tr>
<tr>
<td>Role of farmers.</td>
<td>Opportunity to be equal participants at all levels</td>
</tr>
<tr>
<td>Role of scientist.</td>
<td>Opportunity to be equal participants at all levels</td>
</tr>
<tr>
<td>In what detail should scientists monitor the agro-ecological and socio-economic environment</td>
<td>It is an emergent process and will depend on the purpose and character of the investigation based on the learning need of the stakeholders.</td>
</tr>
</tbody>
</table>

(Source: modified from Farrington and Martin, 1988)

Increased participation encouraged the development of dialogue amongst stakeholders. As a result it provides an opportunity for all stakeholders to influence process and content. Dialogue development was critical in revealing the underlying assumptions or the undisclosed issues that concern people’s learning needs. If this is ignored, the process becomes dominated by content and becomes self-determining. Alternatively, by disclosing the underlying assumptions early (ie transparency of process), initiation of activities (ie by whom or how) becomes arbitrary provided there is opportunity for all stakeholders to influence outcomes by contributing towards process, implementation, analysis and interpretation.
5.5. Costs and Benefits of Increased Participation

c) What are the costs and benefits of increased participation?

The costs associated with increased participation are the demands on human resources and time in developing collaborative relationships between stakeholders. Other difficulties that emerged were developing direction and motivation to learn in situations that often lacked direction because of the emergent nature of participatory processes. This difficulty was compounded by unclear outcomes. Often there were multiple outcomes and multiple solutions to problems which made generalisations difficult to establish.

Participative approaches have an emergent nature, which is both beneficial and detrimental in improving R, D and E programs. This emergent characteristic focuses on utilising ongoing activities (e.g., workshops, group meetings, field days, on-farm research, etc.) which use propositional and local knowledge (i.e., structured and systemic learning) to help participants identify and address learning needs while providing the opportunity to critique the process in use and influence outcomes.

In essence, ‘emergence’ itself becomes an indicator of group maturity, of dialogue development and dialectical interchange because it is nourished by collaborative interaction. The discovery that emerges between stakeholders when they critique their experiences and personal beliefs leads to more sophisticated constructions. This level of learning progress can be observed in participants’ ability and comfort in discussing issues or interests at the group level and their ability to critique their own practices, openly discuss their findings and be receptive to feedback. This type of behaviour needs to grow and develop; it can take a great deal of time for individuals to acquire these interpersonal skills.

The initial introduction of participative activities resulted in escalating development of stakeholder involvement in R, D and E programs and group activities. Regression in stakeholder interest and motivation in continuing with group development and in collaborative research activities was also observed. This decline in interest and involvement, particularly by farmers, was fuelled by the lack of clear direction and sufficient drawing out of learning outcomes. These observations indicated that the major difficulty with the application of participative processes was dealing with stakeholders’ culturally embedded focus on quick fix technological solutions, which are often the unspoken incentive for applying or being involved in participative approaches. A focus on content dominates many participatory activities, and as a result, underlying learning needs are undisclosed and not met, which accounts for many farmers’ declining interest.

In participative approaches (i.e., Al and PAR) difficulties were also experienced in progressing beyond single loop learning. Despite claims by many practitioners that these approaches are more efficacious (i.e., by promoting double loop learning) than traditional approaches. The operational difficulty is dealing with cultural predispositions that concentrate primarily on content and ignore the significance of understanding process. The difference is between content methodologies that focus on communicating, and transferring information and skill training, which is often culturally expected. Compared to process methodology, the focus of learning is to provide procedures and resources for helping stakeholders acquire information and skills (Knowles, 1984) in dealing with change which requires an emerging appreciation of multiple constructions.

Reflection on Research Process and Practice
The difficulty in dealing with cultural norms arises from the images we self-impose which limit us to familiar ways of thinking and acting. Senge et al. (1994) refers to this phenomenon as the problem of the ladder of inference. They suggest because we live in a world of self-generating beliefs derived from inferences we make from what we observe: “it erodes our ability to achieve the results we truly desire”. This erosion stems from our feelings that our beliefs are truth based on real data and restricts our ability to understand alternative constructs.

Dewey (1933) and Knowles (1984) suggest that the problem with improving the efficacy of learning is associated with our embedded pedagogical nature and liken this to many of our educational experiences. For example, at school we become familiar with the spoken and written language and with the concepts of mathematics, but these are only the tools for learning. The distinction is between “possessing” and “having” knowledge. That is between “having learned one’s letter and being engaged in reading” (Socrates in Guthrie, 1986). Socrates articulates learning efficacy by drawing attention to the important need for the mixture of experience and propositional insights, and thereby infers the vital need for mutual dependence between learning approaches and stakeholders’ experience.

The benefit of increased participation assisted stakeholders in making more informed decisions by developing skills in communication, planning and analysis of information and multiple experiences. However, the difficulty with implementing participatory approaches is that participation can often be simply a means to increase the effectiveness of what is for all intensive purposes the adoption of goals predetermined by external agents. A paradox therefore emerges, between rhetoric that is used to justify and promote participatory processes and the way many participatory activities are implemented and used in shaping or controlling change. This reflects the practitioner’s poor understanding of process and its application. This restricts emergent learning outcomes because participants are only given the opportunity to learn what the authority figure already knows.

All scientists use some technical terms and other jargon specific to their disciplines. Farmers also use local terms and other jargon specific to their local environment. Increased participation encouraged stakeholders to invest time in learning each others language, which has improved dialogue between stakeholders. Developing common language is necessary for efficient communication, and was recognised in this study as a vital component for improving R, D and E programs.

A further benefit of increased participation was that it allowed for a diverse range of stakeholders to be involved in the research process. This provided the opportunity for a range of stakeholders to establish and address their learning needs. This benefited stakeholders’ individual decision-making by allowing them to capture the synergy that emerged from shared knowledge.

Therefore, a major benefit from increased participation is for individuals to recognise that in practice it is a very difficult and demanding (both physically and mentally) process to develop and improve inquiry approaches. It requires individuals to suspend their judgements, to understand their predispositions and challenge the coherence of their own mental models. Essentially the nature of participatory approaches rests on a continuum of understanding and dealing with successive changes. Unlike traditional approaches it is a state of uncertainty and
an absence of clearly directed action that makes high quality of participation difficult and costly to achieve in of R, D and E programs.

A major concern that emerged for me was recognising that if the objective for improving the efficacy of R, D and E programs is to be achieved through improved participation, do we merely initiate self-mobilisation so farmers become more independent in the use and application of technology for problem-solving. Because this process is dependent on others for innovation, disengagement of scientists from farmers may only result in the clients mirroring current sustained yield concepts. That is, in our attempt to provide opportunity to a wider stakeholder group in influencing R, D and E programs and escape the confines of dependency are we inadvertently envisioning independency to be our new goal and once again finding ourselves surrendering to the nature of pedagogy?

The lesson is that more involvement is not sufficient in developing stakeholders’ skills in learning to deal with change. Attention should be directed to constructively challenging stakeholders’ predispositions through dialogical and dialectical practice.

The benefit of increased participation was to help stakeholders recognise that knowledge is made up of diverse experiences and that one should recognise the benefits and costs of these experiences to improve their decision making. This would ensure that learning is not an endpoint but a continuum across time and space. Pretty, (1995) refers to the concept of multiple construct interaction as, “true sensibility” which “lies in the way opposites are synthesised”, and is the foundation for developing more informed constructs (Guba and Lincoln, 1994).

Therefore the basis of an interdependent process rests on developing participation towards a dialectic52/hermeneutic53 process by encouraging dialogue for synergy to emerge. By bringing various stakeholders’ experiences together to help address and/or understand issues (common or otherwise), it can encourage individuals to re-evaluate some of their own beliefs and/or predispositions. This can result in more informed decision-making and may lead towards developing a learning paradigm which the experiences of this study suggest is more efficacious than any single approach acting alone.

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52 Dialectic refers to discussion and reasoning by dialogue as a method of intellectual investigation which compares and contrasts opposition through discussion and reasoning. It is used as a process for building common understanding.

53 Hermeneutics is to represent or describe individual constructions as accurately as possible, while the dialectic aspect compares and contrasts these individual constructions so each participant must confront the constructions of others and come to terms with them. Together dialectic/hermeneutic methodology aims to produce as informed and sophisticated constructions as possible.
5.6. Development of Participatory Approaches

i) Does the level of participation of stakeholders in R, D and E processes lead to more informed decision-making?

Tarnas (1991) in his historical account of the “Western Mind” presents a comprehensive analysis of the evolution of worldviews and reveals some of the elements that can influence the emergence of a new paradigm. Tarnas’s account reflects the dominance of the positivistic epistemological position in the modern mind but also that, at the height of its development, a radically different epistemological position began to emerge. Tarnas implicates the work of several eminent thinkers who recognised the concept of this emerging position from their own distinct perspectives, but who also highlight that “common to all was a fundamental conviction that the relation of the human mind to the world was ultimately not dualistic but participatory”. The significance of this “was not to oppose the positivistic epistemology but to evolve beyond it by encompassing it in a larger and subtler understanding of human knowledge”.

Perhaps such a position is reflected in Wilber’s (1996) concept of a ‘transcendental paradigm’ that can exploit various worldviews within a more comprehensive position, which in essence advocates an interdependent ethos. Therefore “the new paradigm will not be a closer approximation to truth; it will simply be more informed and sophisticated than those we are now entertaining” (Guba, 1990).

The model in Figure 18 illustrates the interdependent relationship between framework, methodology, method and learning, and essentially summarises the focus of the thesis (does the level of participation of stakeholders in R, D and E processes lead to more informed decision-making?). The model also illustrates Tarnas’ (1991) point that a learning paradigm encompasses the positivistic epistemology in a more dynamic frame of reference.

Vickers (1984) asserts that, to achieve the potential benefits from an interdependent learning process (ie from increased participation), we must ask “what causes an individual to see and value and respond to a situation in ways, which are characteristic and enduring, yet capable of growth and change?” He claimed that a “rational ideology, a professional ethic, or an individual personality, resides not in a particular set of images, but in a set of readiness to see and value and respond to its situation in particular ways”. Vickers (1984) called this the “appreciative system.” In the context of this model it is referred to as the ontological appreciative system and highlights the need to be aware of how values influence actions and how something is known.

In Vickers’ (1984) reasoning, he claimed that “even our eyes tell us nothing until we have learned to recognise and classify objects in particular ways, and so equally are our values and our patterns of action”. The “appreciative system grows and changes with every exercise of image and information but like all systems, it is resistant to change of a kind or at a rate which might endanger its coherence”. Therefore the significance of increased participation is to challenge stakeholders predispositions for creating new learning experiences.
Figure 18: A conceptual model for developing an interdependent process.
The model in Figure 18 represents a complex mixture of inquiry and learning processes. It is intended to show that a change in any one learning level can have an effect at the other two levels and further to indicate that the degree of this change is subjected to one’s level of appreciation of the relationship between the various methodologies. The model assisted me to appreciate the complexity associated with developing interdependent approaches (ie systems approaches) and to understand the interrelatedness between the diverse inquiry principles.

The various cycles in the model (Figure 18), also summarised in Table 11, illustrate how interdependency encapsulates a diverse range of learning approaches in a dynamic frame of reference. The lower cycle illustrates discovering or receiving information, then assimilating and planning to take action on the information specific to addressing a problem or issue. An example is farmer participants acting on information concerning nitrogen management and/or tillage practices. As a co-participant and researcher, this level represents my investigations and action in the practice of participative approaches with other stakeholders by developing environments for co-working and co-learning.

The second level cycle (ie meta learning level) is reflecting on how methods (ie tools, skills and knowledge) are used while investigating content related issues. It is a mechanism used to critique learning outcomes and the inquiry process to improve decision-making for both actions and the process of taking action.

For farmers this level involved examining propositional knowledge and multiple experiences of nitrogen and/or tillage management. This initially led to unclear outcomes but also developed an appreciation for understanding alternative strategies for addressing specific issues. For examples, farmers learned to collaboratively organise their resources and experiences to develop processes for researching common issues in POFR activities.

My experiences at this level involved examining my practice in developing participative approaches in group activities. Through this reflective learning experience I learned to appreciate that the method in use and who initiates a learning activity is an arbitrary issue, provided opportunity exists for all stakeholders to influence both process and content.

The third level cycle I describe as “the mind that observes how it observes what it is doing”. It is referred to as the ontological appreciative system and is related to learning and practice efficacy. Bateson (1972) describes ontology as the “universal sense in which all human beings are guided by highly abstract principles. These principles combine the nature of one’s reality, which influences how one relates what is researched and how knowledge is gained about the world. These principles shape how we see the world and how we act in it. Therefore we are bound within a net of epistemological and ontological premises and regardless of the ultimate truth or falsity, become partially self validating”.

This level serves as a means to reflect on how one is reflecting. That is to understand how one understands what they know about how they know. The aim is to assist one in being able to transcend beyond the confines of their value and belief structure by learning to recognise how values and beliefs influence what and how we learn. This provides insights for refining process and content learning. It was impossible to be certain that farmers or other stakeholders fully understood their initial underlying assumptions and it is equally difficult to be certain whether they fully disclose these assumptions at later stages. However if stakeholders became
consciously aware of how their value principles affect their actions and learning process it may be reflected by changes in their action. An example is choosing to work in group learning activities compared to no involvement. It may also be reflected in the level of dialogue between stakeholders where participants openly and constructively challenge each others views.

It is difficult to be certain how the ontological learning level is shaped. I have hypothesised, based on some basic observations from my experiences how this level may have influenced other stakeholder’s frame of reference. My personal example of this level of learning involves a critical examination of my values in practising participative approaches. I recognised that my assumptions concerning the inefficiency of TOT approaches was inhibiting developments in participative processes and that these assumption were causing me to mirror the very ontological notions that I was espousing to progress beyond. I learned that the challenge confronting the development of participative approaches rests not only on the understanding of the benefits and costs of various methodologies, but requires a mutual dependency between inquiry and learning approaches that is transparent to all stakeholders.

I recognised what Schwant (1990) has highlighted as the challenge for participative approaches to go beyond the integration of tools and methods alone. There is an ontological confrontation between the paradigms, which contest not only the exercise of methods but also a need to subject a critical ontological assessment on the notions that guide the exercise of their methods and interpretations that must challenge stakeholders’ predispositions.

The linkages between the three cycles illustrates that the essence of increased participation is concerned not solely with the pursuit of knowledge itself, because knowledge is always fixed in time and space. It is to develop better learning skills because learning skill development ensures the continual growth of knowledge (Habermas, 1971) for improving decision-making.

Table 11 below summarises the principles illustrated in Figure 18 and highlights that two major ontological positions influence the practice and interpretation of participation. I describe these positions as dependent/independent and interdependent systems. I learned that understanding these differences can improve the practice of participative R, D and E programs.

Put simply, participation can mean the action of taking part in an activity with others (ie involvement). The aim of this level of participation is to improve the adoption of prescribed solutions, through communication and involvement. The nature of participation is characterised by dependency and independency. This characteristic incorporates awareness of information and training through either propositional or practical instruction in the application of technology.

Alternatively, participation can be used to provide equity and equality (ie for purpose, control and power) towards collective action and learning. Therefore it becomes a means to improve dialogue by encouraging participants to reflect on their assumptions to improve the process of learning and decision making. Interdependency (ie mutual dependency) characterises the nature of participation. It progresses beyond involvement, by providing stakeholders with the opportunity (ie the participative intent) to influence process and content.
Table 11: Consensual summary of a complex learning map.

<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent/ independent approaches</td>
<td>Detailed Complexity</td>
<td>Propositional</td>
<td>TOT</td>
<td>Persuasive Extension</td>
<td>Manipulative</td>
<td>Passive</td>
<td>Telling Awareness, providing information &amp; clarification</td>
<td></td>
</tr>
<tr>
<td>Interdependent approaches</td>
<td>Dynamic Complexity</td>
<td>Single Loop Praxis Reflective to Affective</td>
<td>Technical Cognition</td>
<td>Problem Solving</td>
<td>Informative Extension</td>
<td>Consultation Material incentives Functional</td>
<td>Teaching and training (Instructional) Adult Education (Practical)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Double Loop Meta Discriminant to Conceptual</td>
<td>Practical Cognition</td>
<td>Informal Education</td>
<td>Formative Extension</td>
<td>Interactive</td>
<td>Adult Learning Developing understanding (Facilitating)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher order loop Epistemic Psychic</td>
<td>Emancipatory Cognition</td>
<td>Human Development</td>
<td>Emancipatory Extension</td>
<td>Self Mobilisation</td>
<td>Systems thinking Reflecting on assumptions to improve the process of learning</td>
<td></td>
</tr>
</tbody>
</table>

Interdependency is considered to be a more advanced state of learning and participating. It is a level that has an appreciative understanding of all learning stages but is a significantly higher order of learning because it is concerned with reflecting on the implications of beliefs and values for improving the process of learning. This is similar to that described by Argyris (1976) as double loop learning. The critical thinking skills needed to understand what is distinctly shared human experience (ie an ontological appreciative system), rests on the quality\(^5\) of participation.

The main learning outcome was recognising that participation is an emerging process that provides an opportunity to all stakeholders to act and bring about change by generating knowledge through rational reflection on personal experience. Freire (1970) confirms that participation develops not from the passing of a message, but emerges from dialogue as all stakeholders “bring both their objective situation and their awareness of that situation, various levels of perception of themselves and the world in which and with which they exist”.

Participatory approaches are therefore a type of socialisation process, which by nature are difficult to maintain and operate because of the challenges continually presented to stakeholders as they recognise the vulnerability and often the limitations of their constructs. The way we have become accustomed to ‘think’ is often the basis of this vulnerability, the limitation to our development and sometimes can impair our ability to progress (Senge, 1990). However by creating a setting where participants become more aware of the context of their experience, and the processes of thoughts and feelings that created the experience, it can open new ground for learning.

\(^5\) Quality of participation refers to an appropriate level of interaction between stakeholders in a given context that is determined by dialogue and dialectical reasoning amongst all participating stakeholders.
5.7. Improving my practice

In this final section it is my intent to do two things. First, to outline steps that might be taken to improve future participatory processes through the momentum this study has generated. Secondly, I will concurrently identify some themes that seem to me to have emerged from this thesis and have major implications for improving the efficacy of participative R, D and E programs. These themes are summarised as group learning and participative development.

5.7.1. Group learning and participative development.

All the stakeholder groups throughout the study area were faced with similar problems that affected the efficacy of learning development. These problems are serious because they can "lead groups to make flawed or undemocratic decisions, prevent groups from reaching decisions, or cause groups to dissolve" (Gastil, 1997). The challenge for facilitators and/or group coordinators is to learn to recognise and address these common problems to help individuals improve group cohesiveness, to improve decision making and to become active learning bodies.

Among the many problems groups encounter the most common and serious observed during this study included:

- Developing and prioritising goals;
- Developing processes;
- Long meetings;
- Unequal involvement and commitment;
- Different communication styles and
- Poor group memory.

These problems are not new and are well documented throughout the literature on group dynamics. The challenge is to understand why these issues consistently emerge and hamper the development of participative R, D and E programs. Two possible views have been highlighted in this thesis that may explain why groups encounter these problems and why these issues affect group and participative development. Firstly, are these issues deliberately overlooked because they are culturally confronting, or could it be that people lack the skills and confidence to operationalise the theories?

5.7.1.1. Developing and prioritising goals.

One of the most significant and common problems in group development that affects the quality of participation and therefore stakeholders' learnings is the failure to identify a clear and consistent set of goals (Mann, 1976). A group without basic objectives results in unclear outcomes and unproductive interaction, but a group with a well defined purpose can be very innovative and effective (Dick, 1991).

The primary purpose of groups is to assist stakeholders in making more informed decisions by supporting members in adapting to change. However, facilitators or organising bodies should not assume that group members have a clear and shared understanding of this goal, nor should they assume this is the only goal that the group members have. Douglas (1983) suggests that such assumptions may only induce vague or conflicting goals and will limit group learning development. To improve group and participative development the facilitator or group
coordinator should ensure individuals have the opportunity to discuss their expectations and learning needs early on during the first meetings. These needs should also be recorded and reflected upon in future meetings to capture changes in learning and to ensure the group and its goals continually evolves as the individuals develop.

This could be as simple as asking members why do they want to be involved in a group and what do they hope to achieve. For future meetings and specific learning activities, the facilitator could ask members what did they learn and did this learning help to address the initial goals, why or why not and how can future activities be improved. This process ensures general goals and more individual learning needs are reflected and acted upon, which improves stakeholders’ commitment and involvement to group and participative development.

Setting group goals

Dick (1991) describes goal setting as any activity that assists a group to determine what it wants to accomplish and how. Facilitators should not assume that all group members share clear and common goals. What is important is for the facilitator to provide opportunity to group members to participate and encourage group members to discuss their goals at one of the first meetings. This can be more effective for group development rather than assuming group members already share a common vision. The experiences of this study indicated that assumptive goal setting often led to the imposition of goals and this approach limited group development.

The facilitator can simply encourage stakeholders to state briefly what objectives they hope to achieve by being involved in the group. The facilitator should first encourage participants to speak in simple and broad terms, instead of specifics. For example improving income or lifestyle, instead of improving grain quality or yield. Gastil (1997) suggests that if stakeholders have difficulty identifying goals, the facilitator can prompt members by asking them “what is important to them”. That is, “what do they value in their lives?”. It is important for the facilitator to appreciate that stakeholders may or may not have the same goals and goals will evolve and change over time as the group develops. The objectives of openly identifying and clarifying goals in a meeting is to provide the group with an initial focus which helps to improve group commitment and involvement.

Ultimately, the group needs to carry out specific learning activities to develop. The aim of broad or general goals is to help stakeholders understand why they are working together (Dick, 1991). Later when the group develops, members will decide upon more specific objectives within this initial broader vision and learn to recognise the synergistic benefits that can emerge by utilising multiple constructs.

The cost of uncertain goals can result in stakeholders’ loss of motivation and interest to function and focus on developing collaborative relationships. Group meetings will be disorganised, unclear discussions of future plans with questions about the group’s objective. The group may also drift from one activity to another without effectively addressing either. Therefore group learning will be less effective if stakeholders have different personal objectives without recognising their common basic goal (Gastil, 1997). In this study the cost of undisclosed learning needs or not providing opportunity to discuss general goals often resulted in group members having fragment visions which damaged the potential for stakeholders in capturing the benefits of the synergistic effects between learning cultures.
Changing or emerging goals

Some groups may focus on the same goals over extensive periods and other groups may change their goals. Stakeholders need to decide when and how they will re-examine or evaluate their goals. A process for reflecting on past activities and learning outcomes must be part of the group learning development process. In this study I incorporated a modified version of Kolbs (1984) experiential learning framework which prompted stakeholders to examine their learning needs and to reflect on learning activities.

This framework can be used throughout the goal and process development stages. This framework involved: a) planning (eg identify learning needs); b) developing a learning process (eg discussing how group members wanted to find out); c) observations (eg recording and discussing observations in the context of biophysical and socio-economic issues); d) analysis and interpretation (eg encouraging reflection on individual and collective analysis in relation to the initial learning goals); and e) future vision (eg discussing what can change as a result of new learning outcomes and identifying new goals).

If the group identifies more than one goal, the group needs to prioritise these goals as clearly as possible. The facilitator can encourage group members to rank goals in order of importance. A voting procedure to place goals in priority order may assist group members in prioritising goals. Alternatively, the group may decide to address more than one goal. Therefore it is essential for the facilitator to provide the opportunity for group members to address individual goals and report their learning outcomes back to the wider group. This approach encourages individuals to develop their self direction which promotes dialogue development by providing opportunity for all stakeholders to influence content and process.

Whether groups deal with a single goal or multiple goals it is important for the facilitator to help members clearly identify and prioritise their specific learning needs and discuss how members are going to participate in achieving these goals. By providing the opportunity to all group members to participate in planning, acting analysing and reflecting on learning needs and activities, it improves stakeholders’ involvement, commitment and communication.

5.7.1.2. Developing processes

Once a group has identified their goals, it needs to decide how to achieve these goals. Group decision making is not generally equal and democratic and the facilitator needs to create the opportunity for all stakeholders to participate. However some group members may be reluctant to discuss process development because it does not produce immediate results. The facilitator needs to explain to the group that unclear and unorganised processes can significantly limit a group’s learning development.

Failure to develop effective process can result in the group reaching decisions in a disorganised and inconsistent manner (Gastil, 1997). The outcome of poor process development is observed in the group’s inability to identify learning outcomes and draw out generalisations that can assist members in improving decision making (Knowles, 1984).

Stakeholders need to recognise the kinds of decisions they will make together. For example, will they make collaborative decisions about only general activities, or will they reach agreement on the specific details of their projects? Stakeholders must therefore consider at what level they wish to participate.
Although genuine democratic participation has long term implications for improving learning efficacy and decision making it can sometimes limit short-term efficiency. Stakeholders need to recognise the benefits and cost of participation and understand the advantages and disadvantages of decision-making procedures. Essentially, the most important issue for process development is to maintain a flexible approach that is transparent to all stakeholders (ie commitment towards developing equality and equity knowledge) and to provide opportunity for bilateral planning, acting, observing and reflecting. Therefore the quality of participative intent is a critical element for process development and is more important than stakeholder’s ability to mix and match methods to relative situations. This means the method in use and the initiation of activities (ie by whom or how) becomes arbitrary provided the participative intent provides an opportunity for all stakeholders to influence outcomes by contributing towards process development, implementation, analysis and interpretation.

5.7.1.3. Long meetings

A major problem for group development is long meetings. When meetings operate for too long, group members become frustrated and too tired to think clearly. If long meetings become common practice group members may begin to show up late or miss meetings.

Concise meetings are more productive. A rotating chairperson, who is responsible for facilitating meetings, can encourage group members to stay focused on the agenda items and also develops individual communication skills and commitment towards group development. It is important to always agree when the meeting will end before proceeding with the agenda and try to finish the meeting on time. This gives group members confidence that the meeting is well organised and if the agenda is not addressed in time they will learn the importance of being efficient during meetings. Time limits for discussing agenda items can help the facilitator monitor progression.

5.7.1.4. Unequal involvement and commitment

Group development relies on equal involvement and commitment among all stakeholders. This was found to be the most difficult issue for group development because involvement and commitment varied among individuals and there is no simple way to ensure all stakeholders contribute the same amount of energy into group activities. Unequal involvement and commitment can result in meetings which are dominated by the most active members. Other group members may become intimidated, causing isolation, segregation and communication problems between group members.

To balance stakeholder involvement the facilitator needs to help the group to decide what amount of involvement is required. It may also be necessary for the group to re-examine their basic goals or vision as some uncommitted members may disagree with the group’s initial goals. Alternatively less committed members may increase their involvement if they are given clearer or more specific tasks.

5.7.1.5. Communication styles

In many groups, members will have different levels of communication skills. There are also cultural differences between members within a group, especially between men and women that influence communication styles. Some members will be better at reading, speaking in public, listening and reflecting, while others are accustomed (or expected) to remain passive and quiet in public.
The best solution for developing communication skills is for the facilitator to highlight differences in communication styles. The facilitator can develop stakeholders’ communication skills by encouraging them to utilise their strengths, which later provides confidence for them to address their weaknesses. For example some group members are good at organising activities but reluctant to speak during meetings. By providing an opportunity for them to organise activities it allows them to communicate to group members and develop their sense of ownership over the activity, which can significantly improve the way they interact in future meetings. Once members understand communication differences, it may be easier to respect and appreciate member’s strengths and weaknesses. Furthermore, the facilitator can encourage the more skilled members to provide reassurance and encouragement to other members. Providing opportunity for all group members to participate in content analysis and process development will continually benefit stakeholders’ communication skills.

5.7.1.6. Poor group memory

Throughout the duration of this study group and participative development was hampered by ineffective group memory. Poor group memory was observed by members’ inability to recall the outcome of past group learning activities and the goals developed for future meetings and this indirectly limited stakeholders’ learning and level of interaction.

An effective group keeps detailed written records of group activities and meetings. When groups fail to keep records, it is more difficult for members to recall what ideas, learning needs, how to achieve learning needs, observations and learning outcomes were previously discussed. Poor memory of the groups past will limit both group cohesion and the quality of participation and therefore inhibit members’ abilities to improve decision-makings.

To improve group memory and stakeholders’ levels of participation, facilitators or group coordinators need to record group discussions. Recording group discussions on “butchers” paper during the meeting captures important themes and ideas this can be recorded by the facilitator or group coordinator after the meeting and distributed to members for their records. Group memory can also be improved by briefly reviewing the objectives and outcomes of previous meetings. Effective group memory and efficient recording can be integrated with participatory monitoring and evaluation processes (Gastil, 1997).

5.7.1.7. Conclusion

The themes identified in this section highlight some of the major issues observed during this research that contribute to building a group identity and therefore developing group cohesion. Establishing group cohesion and developing a group identity are recognised as the major issues for developing participative R, D and E programs (Dick, 1991). Developing an environment where group members understand and empathise with each other, not merely for the sake of involvement but as a means to improve decision making through democratic participation remains a challenge for improving the efficacy of participative R, D and E programs.
5.7.2. Personal reflection

In preparing for dissertation, I defined my area of interest as developing processes to improve participatory approaches to help stakeholders (ie farmers, scientists and private industry persons) to make more informed decisions and thereby improve farming systems in the Balonne Shire.

I tried to encapsulate my focus in the main question:
“does the level of participation of stakeholders in R, D and E processes lead to more informed decision-making?”

I formulated three sub-objectives (listed in section 5.1) which I hoped would assist me to answer this main question. In the process of working through the case studies the focus of my research changed and I discovered new questions concerning the quality of participation and the subsequent implications on the equality and equity of knowledge for improving stakeholders decision making.

Those emerging insights challenged me to re-examine the essence of my own reality in relation to what I believed and practised. Ontologically, my own concept of reality developed. The critical self-reflective aspect of my research required me to look at who I was and where I was situated, both personally and professionally.

I discovered there was a time I would have rejected the value of TOT approaches for improving one’s skills in learning as such concerns were outside the concept for improving participatory approaches and decision-making. However, I no longer believe that improving learning and decision-making involves a case of “for” or “against” certain methodologies. I realised that, while I more easily rejected the positivist methodology, this in fact reflected my innate positivist ontology.

The writings of Freire (1970) facilitated a mind shift on my part. I was challenged by the idea of the emancipatory role for the scientist. I recognise that in my quest to improve participatory approaches by promoting the utilisation of multiple constructs, I was ignoring the fundamental principles of constructivism and as a result began to mirror the very ontological underpinnings that I was espousing to progress beyond.

I came to realise, through working with groups, that practising constructivism is a difficult and somewhat an unnatural human characteristic. People naturally like to make judgments and maintain control. They like to believe that although variability exists, our universe is primarily an orderly system and that empiricism offers us a naive security for the validity of knowledge. I learned that constructivism requires constant critical reflection on action, process and on the underlying basis of reflection itself.

I now began to understand the significance of a prominent lecturer’s words when I was an undergraduate at university. That is, the distinctions between the various forms of knowing “add to the richness of the process of learning” and the different emphasis “in philosophies and in methods provide useful and alternative perspectives to guide strategies for education and research” (Bawden, 1989).
In my thinking I learned not to advocate any single approach but to foster the development of an interdependent ethos. That is, a higher ordered ontological position that appreciates the mutual dependence among different knowledge cultures which aims to utilise the emerging synergy from co-working and co-learning to improve stakeholder’s decision-making on both content and process learning. Hence the institution of positivism is encompassed in a more dynamic frame of reference of constructivism where the positivistic assumptions form part of the rich picture of knowledge.

I believe the study encouraged stakeholders to focus more clearly on dealing with change, by providing support in trying new ideas. Participation encouraged personal responsibility for learning. In the end, I realised that it was not important what method was used or who initiated the activity. What became more important were the issues of ownership of learning and providing opportunity (ie the participative intent) for people to be involved throughout the process (ie issue identification, project design, implementation, observations and analysis).

I learned to appreciate that participation is not a “on-off” switch such as in being involved versus not involved. Degrees of participation reside in all inquiry approaches. Learning to appreciate that these levels of participation are mutually dependent highlighted the linkage between approaches. That is, there are various methods and methodologies conducive to lower levels of participation. Learning to work at higher levels of participation allows practitioners to incorporate a diverse range of methods and methodologies with much greater emphasis on valuing multiple constructs and sharing control, power, and purpose. This type of approach is more efficacious for improving stakeholders’ decision-makings compared to operating from any single approach alone. Furthermore, determining the appropriateness of these levels in different situations, and recognising when to improve the quality of participation, appears to be the major challenge for improving participative R, D and E programs.

Another important influence on my understanding of participative approaches emerged from critical reflection on my research. Many stakeholders indicated that participatory approaches are demanding on their time and resources and required a high level of commitment. Difficulties were also experienced in developing direction and motivation to learn in situations that often lacked direction because of the emergent nature of participative approaches. This complexity was often compounded by unclear outcomes or by multiple outcomes and solutions. I learned that the strength and weakness of participative approaches is their systemic and dynamic nature, and by integrating a systematic framework within these processes it can improve the operational efficacy of these approaches. This challenge was addressed by incorporating a learning framework (section 4.3.2.2) that assisted stakeholders in organising, addressing and evaluating their learning needs.

When I decided to enrol in postgraduate studies my initial priority was to improve my education in the content related issues such as soil and plant sciences so I could be more effective in providing learning support to my clients. However, I now believe that learning is much less about communicating specific content related issues such as the accuracy in calculating crop nitrogen requirements or predicting yield outcomes than about dealing with change and its implications. It does not neglect the importance of content learning, but emphasises content learning development through understanding choices, prioritising learning needs and developing alternative strategies in dealing with issues or problems. McNiff (1993)
suggests that learning is “the process of opening the doors in my clients’ minds that will make them aware of their own processes of development, and of their own potential for unlimited acts of creation”. I learned to view learning not as an end product but as the beginning of a multitude of new questions and new conditions that exist on an evolving continuum.

This thesis has been both a tremendous opportunity and challenge for me. The experience encouraged me to critique what I have learned about improving participative approaches and to develop my skills in communication, research and extension. My initial idea when developing my theme for this study focused on dealing with the poverty of participation. This theme was based on what I believed to be the rhetoric used to justify participative approaches for improving the adoption of pre-determined outcomes. I hypothesised that improving stakeholders’ levels of participation (i.e., shared control, power and purpose) in R, D and E programs it could markedly improve stakeholders’ decision makings.

I learned through my experience with group learning activities that improving participative approaches require transparency of process and a mutual dependence between inquiry approaches and stakeholders as compared to advocating “for or ‘against’” for any single approach alone.

I learned that the foundation for improving decision-making rests on the potential for increasing the quality of participation, which is directed towards an interdependent ethos. Adopting such an inquiry approach can generate an ontological/epistemic shift. This shift relates to changes in underlying assumptions of one’s knowledge. It is needed to accommodate a higher level of learning for dealing with the implications of change in an environment that is confronted with the confounding ramifications of problem solving and technology transfer.

Essentially an interdependent process is a holistic system that can work collaboratively from diverse positions with a critical consciousness to challenge one’s self-validating notions of reality through dialogical practice and provide avenues to refine both process and content learning.

In conclusion, this study identifies the need for an emerging new professionalism in agricultural R, D and E. This new professionalism will integrate a diverse range of knowledge systems. It will show greater appreciation for the value of ontological diversity, including approaches that emphasise the process of learning (and unlearning) itself. The study has shown that stakeholders in R, D and E programs must dedicate themselves to new ways of learning when dealing with change to address the problematic issues of today and the challenges of the future. Perhaps this vision calls for a new inquiry paradigm or perhaps it suggests the current inquiry positions need to come to new and higher levels of understanding.
## Conceptual Features of the Principles for Participatory Approaches

<table>
<thead>
<tr>
<th>Tripp</th>
<th>Hardwood</th>
<th>Rhoades &amp; Booth</th>
<th>Chambers &amp; Ghildyal Chambers &amp; Jiggins</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Methodological issues</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Who decides on trial design / concept?</td>
<td>Researcher incorporating farmers's view on content.</td>
<td>Farmer and researcher jointly.</td>
<td>Principally farmer with consultative inputs from research, if required.</td>
</tr>
<tr>
<td>Who manages the trial?</td>
<td>Researcher manages the variables being tested, farmer manages the remainder.</td>
<td>Farmer and researcher jointly.</td>
<td>Farmer.</td>
</tr>
<tr>
<td>Who evaluates the trial?</td>
<td>Not indicated</td>
<td>Researcher and farmer, in the light of farmer's goals.</td>
<td>Farmer.</td>
</tr>
<tr>
<td>What should characterise farmer/researcher relations?</td>
<td>Honest curiosity by researchers.</td>
<td>Farmer and researcher equal.</td>
<td>ITK and farmer goals fundamentally important; reversals required if researcher is to learn from farmer; researcher as consultant.</td>
</tr>
<tr>
<td>What should characterise the research process?</td>
<td>OFT as iterative multi-season process; time needed to gain farmer confidence, and test new hypotheses arising from trial results and his views of them.</td>
<td>OFT as iterative multi-season process; farmer to decide whether / in what form he wishes to continue trial; important to test through inter-year climatic variations.</td>
<td>Farmer to dominate all decisions on research process. Apparently unstructured.</td>
</tr>
<tr>
<td><strong>Institutional issues</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What should be the interaction between OFR and more basic or commodity/factor orientated research?</td>
<td>Ideas for OFR testing to be obtained in part from other components of research, and trial results to feed back to them.</td>
<td>OFR teams should be based at the same stations as other research to facilitate interchanges. Unproductive to send basic researchers to field for long periods.</td>
<td>Other research to provide ideas as one component in constructive conflict process of defining researchable problems. Station-based research should complement OFR.</td>
</tr>
<tr>
<td>What is the role of extension worker in OFR?</td>
<td>Help identify sites; to help run trials which may eventually become demonstrations.</td>
<td>Flexibility needed: consult farmer through research process and change design where necessary. May be useful to conduct an experiment before a survey.</td>
<td>Other research should have a purely referral role. No indication that it should provide ideas for OFR testing or that OFR results usefully be fed back into it.</td>
</tr>
<tr>
<td>How far should OFR researchers monitor the agro-ecological and socio-economic environment with a view to introducing the technology elsewhere?</td>
<td>In detail, to facilitate dissemination.</td>
<td>Involved throughout research, especially in spreading technology among farmers.</td>
<td>None defined</td>
</tr>
</tbody>
</table>

**Source:** Farrington and Martin, 1988.
APPENDIX 2 CLIMATIC ANALYSIS OF THE BALONNE SHIRE

Long term trends in annual rainfall

The rainfall data was analysed for trends in annual rainfall—decreases or increases for nine selected locations (St George, Surat, Dirranbandi, Thallon, Bollon, Talwood, Mungindi, Hebel and Walgett). St George is considered as the central station while the other locations were distributed north, south-west, south, east and west. The analysis illustrated asymmetric patterns of dry and wet periods, reflecting the high variation and unpredictability of rainfall throughout the region.

![Graph of Rainfall Trends](image)

Figure 19: Trends in annual rainfall at St George

The average annual rainfall ranged from a minimum of 401mm at Hebel in the south; to 550mm at Talwood in the south east; to 450mm at Bollon in the west; and a maximum of 582 mm at Surat in the north. In the far south Walgett had an average of 480mm. The results indicate various periods of below average and above average rainfall in an unsystematic pattern with no indication of a continuing trend.

The constraint of this analysis is its use of the 5-year mean when one of the years in the period has an extreme rainfall event. Such an analysis needs to be used with caution. It is also important to recognise the relevance of research in such a highly variable environment. For example, how useful is research during relatively wet periods and how appropriate is it in drier or more average seasons (and vice-versa) in assisting management with decision-making (Huda, et al, 1993).

Rainfall trends also parallel many socio-economic issues. For example the district is traditionally and predominantly made up of grazing enterprises. However, with the concurrence of extensive drought and variable wet periods, combined with economic variability of industries and increased mechanisation, graziers have diversified into a wide range of cropping systems. Today the farming enterprises in the region are a reflection of growers’ progressive diversification. The development of the cropping systems in the district was most significant in the mid to late 1950s. The influence of favourable climate patterns coupled with developments in mechanisation and agricultural advances, saw the growth of cropping enterprises in the region. The 1970s further highlighted the strong link between farming development and favourable climatic patterns, economic forces, and technological development, reflecting possible trade-offs between short term viability and long term sustainability as well as the emergence of second generation problems or issues that are surfacing today.
Variation in seasonal rainfall
Rainfall data was analysed from nine locations to determine seasonal variation and the pattern of rainfall distribution in the region. Figure 20 indicates the position of the rainfall stations used in the analysis in relation to St George.

This analysis aimed to discover the:
- Variation of rainfall in relation to north, south, east and west of St George;
- Average differences of seasonal rainfall amongst the selected locations; and
- Percentage of seasonal variation between the selected locations.

This will provide understanding of:
- Good versus bad seasons in relation to production; and
- Risks associated with management decisions.

Figure 20: The major centres in the region and their direction from to St George

Maximum, minimum, mean and coefficient of variation (CV) for monthly and seasonal rainfall are given in Table 12 and Table 13 for St George. South east from St George at Talwood seasonal variability decreases by 7 percent, and during the fallow period there is a 3 percent decrease in variability at Talwood. Continuing further south at Mungindi seasonal variability decreases by 6.1 percent, while only a 0.6 percent decrease in variation during the fallow.

Table 12: St George rainfall statistics for the growing season (May-Oct)

<table>
<thead>
<tr>
<th>Month</th>
<th>Max</th>
<th>Min</th>
<th>Med</th>
<th>Mean</th>
<th>Ave. Raindays</th>
<th>St Dev</th>
<th>cv%</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>310.0</td>
<td>0</td>
<td>25.6</td>
<td>38.4</td>
<td>4</td>
<td>42.4</td>
<td>110.3</td>
</tr>
<tr>
<td>Jun</td>
<td>151.7</td>
<td>0</td>
<td>24.0</td>
<td>33.4</td>
<td>4</td>
<td>31.1</td>
<td>93.1</td>
</tr>
<tr>
<td>Jul</td>
<td>261.2</td>
<td>0</td>
<td>26.7</td>
<td>32.6</td>
<td>4</td>
<td>37.5</td>
<td>114.8</td>
</tr>
<tr>
<td>Aug</td>
<td>136.9</td>
<td>0</td>
<td>16.1</td>
<td>24.5</td>
<td>4</td>
<td>25.2</td>
<td>102.9</td>
</tr>
<tr>
<td>Sep</td>
<td>128.2</td>
<td>0</td>
<td>21.0</td>
<td>27.1</td>
<td>4</td>
<td>28.3</td>
<td>104.3</td>
</tr>
<tr>
<td>Oct</td>
<td>156.8</td>
<td>0</td>
<td>28.5</td>
<td>37.7</td>
<td>5</td>
<td>33.4</td>
<td>88.5</td>
</tr>
<tr>
<td>Seasonal</td>
<td>544.8</td>
<td>47.1</td>
<td>181.2</td>
<td>193.7</td>
<td>25</td>
<td>93.6</td>
<td>48.3</td>
</tr>
</tbody>
</table>

Table 13: St George rainfall statistics for the fallow period (Nov-Apr)

<table>
<thead>
<tr>
<th>Month</th>
<th>Max</th>
<th>Min</th>
<th>Med</th>
<th>Mean</th>
<th>Ave. Raindays</th>
<th>St Dev</th>
<th>cv%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov</td>
<td>181.8</td>
<td>0</td>
<td>33.3</td>
<td>45.1</td>
<td>5</td>
<td>40.7</td>
<td>90.3</td>
</tr>
<tr>
<td>Dec</td>
<td>172.7</td>
<td>0</td>
<td>44.1</td>
<td>52.5</td>
<td>5</td>
<td>40.7</td>
<td>77.6</td>
</tr>
<tr>
<td>Jan</td>
<td>415.7</td>
<td>0</td>
<td>52.2</td>
<td>73.1</td>
<td>6</td>
<td>69.3</td>
<td>94.8</td>
</tr>
<tr>
<td>Feb</td>
<td>292.7</td>
<td>0</td>
<td>40.4</td>
<td>60.7</td>
<td>5</td>
<td>62.6</td>
<td>103.1</td>
</tr>
<tr>
<td>Mar</td>
<td>360.2</td>
<td>0</td>
<td>38.4</td>
<td>55.8</td>
<td>5</td>
<td>58.1</td>
<td>104.1</td>
</tr>
<tr>
<td>Apr</td>
<td>203.8</td>
<td>0</td>
<td>16.9</td>
<td>34.0</td>
<td>3</td>
<td>44.3</td>
<td>130.2</td>
</tr>
<tr>
<td>Seasonal</td>
<td>654.4</td>
<td>51.8</td>
<td>300.3</td>
<td>321.1</td>
<td>29</td>
<td>139.7</td>
<td>43.5</td>
</tr>
</tbody>
</table>

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Figure 21: Seasonal CV distribution between rainfall stations

At Bollon variability increases during the growing season by 2.5 percent, and during the fallow period variability increases by 9.3 percent. At Surat variability during the growing season is relatively similar to St George with only 1.3 percent decrease in variability, while during the fallow period variation at Surat is 3.4 percent less than what is experienced at St George. South west of St George at Hebel seasonal variability increases by 1.3 percent and fallow variability increases by 7.1 percent. Continuing further south towards Walgett seasonal variability decreases by 4.7 percent, while during the fallow period rainfall variability is similar to St George. At Dirrabandi and Thallon seasonal and fallow variability is similar to St George, the variability trend indicated slight decreases towards the south easterly direction and increase in variability towards a south westerly direction. This seasonal CV distribution between locations is illustrated in Figure 21.

Variation in monthly temperatures and evaporation
Temperatures were examined at three locations (St George Post office, the irrigation area station approx 15km south of St George and an on-farm research site 50 kms east of St George) and evaporation was examined at St George. Data analysed and compiled from daily values (source Bureau of Meteorology). The highest daily maximum, lowest daily minimum, average daily maximum, and average daily minimum temperatures were calculated to analyse the levels of variance at different times of the day and to further assess the variation between locations.

The temperature analysis indicated low variation of maximum temperatures. However, minimum temperatures indicated considerable variation notably in the growing season for winter cereals. The influence of these variations on crop production raises a number of concerns. Initially the results reflect the reliability of radiation for plant growth. However, the variable nature of the temperature trends also suggests it may have considerable detrimental effects on the efficiency of plant growth, grain development, and therefore management operations. This may translate into either warmer temperatures during plant growth resulting in crops maturing too early in the season and then crops at critical stages (flowering) being subjected to very low temperatures. The outcome of this temperature variability could affect anticipated production.
The temperature comparison between the two locations also indicates a considerable contrast of temperature over distances. Although there is minimal difference between the variations of maximum temperatures, there is considerable contrast between the variation of daily minimum temperatures from June to September. Figure 22 illustrates the differences in average daily minimum temperature between the three sites - approximately 2 degrees. These results suggest that growers should be careful when planning ground operations based on centralised temperature data. This challenges the potential of generalised information alone and presents a further challenge concerning the potential of site-specific monitoring, not only for climate information but for biophysical and socio-economic variables. This could better inform management decisions.

Figure 22: Average daily minimum temperature comparison between three stations (St George post office, Irrigation area station (1985-1994) and POFR site (1997-98)

Evaporation
Evaporation was examined at St George post office. These results were calculated to provide an assessment of evaporation at different times of the year or season. Furthermore they provided a comparative assessment of moisture loss with mean monthly rainfall.

The analysis showed low monthly and annual variation in evaporation rates, indicating reasonable uniformity in the evaporation patterns. However, the higher level of evaporation and generally low rainfall does raise some concern for management operations, such as fallow management (weed control, tillage practices, and timing of operations), and planting operations (plant populations and varieties). These decisions may affect the efficiency of soil water storage over the fallow, water use efficiency by crops and ultimately grain production.

Figure 23: Mean monthly rainfall & evaporation at St George

Appendices
Weekly rainfall probability analysis

To evaluate the cropping risk in the district it is important to determine the length and reliability of the rainy season by examining the probabilities of receiving critical amounts of rainfall in a given week (Huda, et al 1993). Daily rainfall data for five locations was used to calculate the probabilities of receiving critical amounts of rainfall in a given week (5 mm, 15 mm & 25 mm). The planting times selected are based on growers’ practices and are considered by them as the crucial periods when some decisions will be made on planting. These planting times are the week of the 15th of April (very early planting), week of the 1st of May (early planting), week of the 15th of May (conventional planting), week of the 1st of June (conventional planting), week of the 15th of June (conventional planting), and the week of the 1st of July (late planting).

The initial examination of the analysis indicates no defined rainy season at any of the locations. Based on the calculated probabilities there is a lack of dependability of rainfall in any given week and as a result an unreliable growing season. This is reflected in low probability levels of receiving critical amounts of rainfall (5 mm, 15 mm & 25 mm) defined by growers as the requirements for ground preparation, establishment and plant development. However, the unreliable winter growing season is different compared to the reliability of rainfall during the summer months (Nov-Feb). The dependability of rainfall increases during the summer months, indicating a summer dominant rainfall pattern.

It was assumed that a 30% - 50% probability of receiving at least 5 mm of rain was required to consider the cropping weeks dependable, provided there is a continuity of weeks with a 30% - 50% probability of receiving 5 mm of rainfall (Huda et al, 1993). The decision to choose the limits of 30% and 50% probabilities are somewhat arbitrary, however farmers make decisions on much higher levels of risk. The analysis indicated at the beginning of the cropping season (week of the 15th of April) a probability of 21% (Bollon), 27% (Thallon), 25% (Dirranbandi), 27% (Surat) and 25% (St George) of receiving at least 5 mm of rainfall in any given week. The probability of subsequent weeks receiving similar rainfall were below the selected criteria except for Bollon which indicated a 37% probability of continuing rainfall events.

Planting rains (5 mm rain in 30-50% of years) were received in the 20th week at all locations ranging in probabilities between 30% to 38% of years. The number of weeks having at least 5 mm rain in 50% of years during the winter cereal season was nil for all locations. However during the summer period the number of weeks having at least 5 mm rain in 50% of years is 4 in St George, 7 in Surat, 1 in Dirranbandi, 4 in Thallon and 1 in Bollon.

The number of weeks when conditional probabilities of receiving 5 mm rain in a week followed by a similar rainfall event in the following week was 50% or greater is, 2 in St George, 5 in Surat, 0 in Dirranbandi, 1 in Thallon and 0 in Bollon. All these events were recorded during the summer months. Therefore the analysis infers that it is very unlikely for rainfall to continue over extended weeks, however if it does occur, it is more likely to occur during the summer months (fallow period).
APPENDIX 3 WORKSHOP PROGRAM (PRE-PLANTING WORKSHOPS 1996)

Introduction
- Welcome and overview of the meeting

Fallow management and water storage principles
- How water is stored in the soil
  - runoff, infiltration, evaporation, crop use, drainage
  - plant available water and things that affect it
- How fallows work
  - stubble affects on infiltration, erosion, evaporation
  - keeping the soil rough
  - are cracks good or bad?
  - How much water is stored in a fallow?

Document paddock history on butchers paper
- Paddock descriptions, how much wet soil do you have?
- Average seasonal and fallow rainfall
- Typical yields of paddocks.
- Paddock history for the last three years, crops grown, yields, and proteins
- Plans for this coming season.

Calculating how much yield is produced from each millimetre of your rainfall

Morning Tea

Understanding nitrogen in the cropping soils
- Organic matter and soil fertility decline
- Forms of nitrogen in the soil, their availability

Distribute soil test results
- Work through worksheets
  - expected yield
  - expected nitrogen removal in grain harvested
  - nitrogen needed to grow crop
  - nitrogen currently available in the soil (from soil test results)
  - nitrogen budget (ie extra nitrogen needed or sufficient nitrogen supply)
- Estimating soil nitrogen by using past yields and protein records

Long term nitrogen strategies
- Fertiliser
- Grain legumes
- Pasture legumes
- Grass/legume pasture

Lunch

Soil water and nitrogen linkage
- How much water can plants get from the soil and how does this influence nitrate nitrogen supply?
- How much rain can you expect while the crop is growing?
- What total water supply can you expect for the crop?
- What gross margins could you expect this season?

End of day discuss interests in follow up meetings

(Source: Modified from Lawrence, et al 1997).
APPENDIX 4 EVALUATION OF THE SOIL WORKSHOPS, SOIL WATER AND NITROGEN

(please circle the appropriate number)

[ ] Nindigully   [ ] Thallon   [ ] Rocky Crossing

Q1. Which soil workshop did you attend?

Q2. Please indicate how strongly you agree or disagree with the following statements in relation to the soil workshops.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Uncertain</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Soil workshop was very useful.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The workshop really helped me better understand nitrogen in the soil.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The workshop was very relevant to my farming system.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The workshop was too complex.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The workshop was a very effective way of looking at nitrogen.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The workshop was a very effective way of looking at soil water.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I have always found soil test results difficult to interpret.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I can now confidently use crop yield and protein to check my soil's nitrogen status</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The workshop really helped with nutrition decisions for my winter crop.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I can now make much more sense of nitrogen soil test results</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>The workshop really helped me better understand soil water storage in the soil</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I can confidently estimate soil water available to plants using a Push Probe</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I can confidently estimate soil water available to plants using a Soil Core</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Assessing soil moisture would be useful to aid fertiliser decisions</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Assessing soil moisture would be useful to aid in what area to plant</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
(please circle the appropriate number)

<table>
<thead>
<tr>
<th>strongly disagree</th>
<th>disagree</th>
<th>uncertain</th>
<th>agree</th>
<th>strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Cores are interesting but time consuming push probes are adequate</td>
<td>. . . . . . . . . 1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I will use rainfall records to assess fallow soil water storage</td>
<td>. . . . . . . . . . 1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Did the workshop suggest you needed more, about the same or less fertiliser than you expected?

- More [ ]
- same [ ]
- less [ ]

Q3. Have you had any more soil tests done since the workshops?
- [ ] yes [ ] no

Q4. Have you used the nitrogen worksheets since the workshop?
- [ ] yes [ ] no

   if yes, what have you used the worksheets for?
   - [ ] redo the calculations with different yields
   - [ ] interpret soil tests done since the workshop
   - [ ] check recommendations from agronomists
   - [ ] other ..................................................

Q5. Did the workshops influence your decisions for the winter crop?
- [ ] yes [ ] no

   if yes, what decisions did it influence?
   - [ ] crop choice - whether to plant wheat, barley or chickpea
   - [ ] fertiliser type - whether I needed nitrogen, phosphorus or zinc fertilisers
   - [ ] fertiliser rate - what rate of nitrogen fertiliser to use
   - [ ] rotations - whether to use pasture rotations (eg lucerne, medic or grass and legume)
   - [ ] other ..................................................

Q6. Would you like to see the DPI provide more of this type of activity in the future?
- [ ] yes [ ] no

Q7. For the paddock you used at the workshop, what crop did you plant and what rate of fertiliser (if any) did you use?

crop: ..................................................................................................................
fertiliser rates: .............................................................................................
Q8. Do you find the concept of Water Use Efficiency (WUE) (kg of grain/mm water) useful for assessing?

(a) target yield
   [ ] yes        [ ] no
(b) evaluating pass crop monitoring performance
   [ ] yes        [ ] no

Q9. Which month would be best for a follow-up meeting after harvest to review crop performance?

 [ ] December    [ ] January    [ ] February    [ ] March
 [ ] follow-up not needed

Q10. The DPI charged $50 for the workshops and soil tests. What do you think would be a reasonable charge for future workshops?

 [ ] less than $50    [ ] about $50    [ ] more than $50

Are there any other comments you would like to make?

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If you would like a copy of the survey results please print your name and postal address below:

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

Thank you very much for your time and effort!

(Source: Modified from Lawrence, et al 1997).
APPENDIX 5  EVALUATION RESULTS ON SOIL WATER AND NITROGEN

<table>
<thead>
<tr>
<th>Statement</th>
<th>strongly disagree</th>
<th>disagree</th>
<th>uncertain</th>
<th>agree</th>
<th>strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Soil workshop was very useful</td>
<td></td>
<td></td>
<td>5</td>
<td>75</td>
<td>20</td>
</tr>
<tr>
<td>The workshop really helped me better understand nitrogen in the soil</td>
<td></td>
<td></td>
<td>6</td>
<td>72</td>
<td>22</td>
</tr>
<tr>
<td>The workshop was very relevant to my farming system</td>
<td></td>
<td></td>
<td>9</td>
<td>70</td>
<td>21</td>
</tr>
<tr>
<td>The workshop was too complex</td>
<td>28</td>
<td>72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The workshop was a very effective way of looking at nitrogen</td>
<td>-</td>
<td></td>
<td>5</td>
<td>62</td>
<td>33</td>
</tr>
<tr>
<td>The workshop was a very effective way of looking at soil water</td>
<td>-</td>
<td></td>
<td>8</td>
<td>70</td>
<td>22</td>
</tr>
<tr>
<td>I have always found soil test results difficult to interpret</td>
<td>40</td>
<td>30</td>
<td>30</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I can now confidently use crop yield and protein to check my soil's nitrogen status</td>
<td>-</td>
<td>11</td>
<td>28</td>
<td>33</td>
<td>28</td>
</tr>
<tr>
<td>The workshop really helped with nutrition decisions for my winter crop</td>
<td>28</td>
<td>11</td>
<td>50</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>I can now make much more sense of nitrogen soil test results</td>
<td>-</td>
<td></td>
<td>16</td>
<td>78</td>
<td>6</td>
</tr>
<tr>
<td>The workshop really helped me better understand soil water storage in the soil</td>
<td>-</td>
<td></td>
<td>14</td>
<td>59</td>
<td>27</td>
</tr>
<tr>
<td>I can confidently estimate soil water available to plants using a Push Probe</td>
<td>9</td>
<td>29</td>
<td>32</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td>I can confidently estimate soil water available to plants using a Soil Core</td>
<td>5</td>
<td>20</td>
<td>45</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Assessing soil moisture would be useful to aid fertiliser decisions</td>
<td></td>
<td></td>
<td>9</td>
<td>18</td>
<td>59</td>
</tr>
<tr>
<td>Assessing soil moisture would be useful to aid in what area to plant</td>
<td></td>
<td></td>
<td>5</td>
<td>-</td>
<td>73</td>
</tr>
<tr>
<td>Soil Cores are interesting but time consuming push probes are adequate</td>
<td></td>
<td></td>
<td>14</td>
<td>80</td>
<td>6</td>
</tr>
<tr>
<td>I will use rainfall records to assess fallow soil water storage</td>
<td>-</td>
<td></td>
<td>5</td>
<td>18</td>
<td>68</td>
</tr>
<tr>
<td>Did the workshop suggest you needed more, about the same or less fertiliser than you expected?</td>
<td>More [ ]</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>same [ ]</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>less [ ]</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendices 142
Q3. Have you had any more soil tests done since the workshops?
   [ ] yes  57  [ ] no  43

Q4. Have you used the nitrogen worksheets since the workshop?
   [ ] yes  44  [ ] no  56

Q5. Did the workshops influence your decisions for the winter crop?
   [ ] yes  44  [ ] no  56

Q6. Would you like to see the DPI provide more of this type of activity in the future?
   [ ] yes  100  [ ] no

Q8. Do you find the concept of Water Use Efficiency (WUE) (kg of grain/mm water) useful for assessing?
   (a) target yield
       [ ] yes  63  [ ] no  37
   (b) evaluating pass crop monitoring performance
       [ ] yes  58  [ ] no  42

Q9. Which month would be best for a follow-up meeting after harvest to review crop performance?

Q10. The DPI charged $50 for the workshops and soil tests. What do you think would be a reasonable charge for future workshops?
    [ 10 ] less than $50  [90 ] about $50  [ - ] more than $50

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APPENDIX 6 FOCUS GROUP AND INTERVIEW ANALYSIS

Introduction
The evaluation of the WFSP was conducted during April 1998 as part of the projects on going activities. It was designed to assist stakeholders with understanding the dynamic complexity of such a project by providing feedback on the efficacy of it activities that can be used to refine future decision making.

Aim
The focus group analysis was carried out by the WFSP team to:
Provide some preliminary feedback on the WFSP activities;
Provide support, direction and focus for future activities;
Provide the opportunity to develop further feedback and evaluation mechanisms for future project activities.

Methodology
The design of this evaluation was done by the project team to provide feedback on the four most important areas the team was interested in getting feedback on. These theme areas were identified as:
1) The value of groups and group development;
2) Benefits and costs of participation;
3) The value of on-farm research; and
4) Outcomes from the project.

Qualitative data was collected by using a combination of:
- Twenty semi-structured interviews; and
- Two focus groups.

People were selected in order to represent a range of levels and types of farmer and agribusiness involvement with the WFSP. The qualitative data was then analysed individually then collectively by the project team for scope and frequency of comment and reported by Cawley and Lawrence, 1998 unpublished.

Interview guide
The interview guide was developed from a number of project team meetings. The objective was to provide scientists with key prompts that open discussions and set the scene for the interview or focus group discussion.

Debrief
The debriefing sessions were designed to assist interviewers in developing an interview summary directly after each interview and focus group discussion. The aimed was to encourage interviewers to document their first impressions by reflecting on their impressions of the farmer’s perceptions of the main themes.
## APPENDIX 7  PAWC OF THE MAJOR SOIL GROUPS

### SOIL: RED KANDOSOL
Vegetation Includes: Silver Tea Tree, Brush Box and Mallee Yellow, Yellow Ironbark, Mulga, Box and Mallee.
Characterisation Site: Nickleby District.

<table>
<thead>
<tr>
<th>Soil Depth (cm)</th>
<th>0-15</th>
<th>15-30</th>
<th>30-60</th>
<th>60-90</th>
<th>90-120</th>
<th>PAWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUL %Vol Water</td>
<td>16</td>
<td>15</td>
<td>14</td>
<td>16</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Bulk Density g/cc</td>
<td>1.63</td>
<td>1.59</td>
<td>1.53</td>
<td>1.58</td>
<td>1.64</td>
<td></td>
</tr>
<tr>
<td>15 Bar LL % Vol water</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>LL under crop % Vol water</td>
<td>14</td>
<td>13</td>
<td>20</td>
<td>19</td>
<td>25</td>
<td>90</td>
</tr>
<tr>
<td>PAWC mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SOIL: RED SODDOX
Vegetation Includes: Belah, Poplar Box, Karri, gum and Willow trees.
Characterisation Site: Rockreach and District.

<table>
<thead>
<tr>
<th>Soil Depth (cm)</th>
<th>0-15</th>
<th>15-30</th>
<th>30-60</th>
<th>60-90</th>
<th>90-120</th>
<th>PAWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUL %Vol Water</td>
<td>29</td>
<td>31</td>
<td>33</td>
<td>34</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Bulk Density g/cc</td>
<td>1.47</td>
<td>1.36</td>
<td>1.46</td>
<td>1.60</td>
<td>1.63</td>
<td></td>
</tr>
<tr>
<td>15 Bar LL % Vol water</td>
<td>14</td>
<td>22</td>
<td>24</td>
<td>25</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>LL under crop % Vol water</td>
<td>23</td>
<td>15</td>
<td>30</td>
<td>25</td>
<td>22</td>
<td>115</td>
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<tr>
<td>PAWC mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SOIL: GREY VERTOSOL
Vegetation Includes: Coolibah woodland, Brigalow, Box Ironbark.
Characterisation Sites: Mundeky, Kindee Downs, Murrumbidgee and St George Districts.

<table>
<thead>
<tr>
<th>Soil Depth (cm)</th>
<th>0-15</th>
<th>15-30</th>
<th>30-60</th>
<th>60-90</th>
<th>90-120</th>
<th>PAWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUL %Vol Water</td>
<td>47</td>
<td>47</td>
<td>46</td>
<td>45</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Bulk Density g/cc</td>
<td>1.27</td>
<td>1.33</td>
<td>1.40</td>
<td>1.47</td>
<td>1.53</td>
<td></td>
</tr>
<tr>
<td>15 Bar LL % Vol water</td>
<td>22</td>
<td>26</td>
<td>30</td>
<td>32</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>LL under crop % Vol water</td>
<td>34</td>
<td>33</td>
<td>50</td>
<td>38</td>
<td>25</td>
<td>180</td>
</tr>
<tr>
<td>PAWC mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SOIL: GREY VERTOSOL: MELON HOLE GILGAI
Vegetation Includes: Belah, Coolibah, Poplar Box, Melon Holes, Grand Poplar Box, Box, Buxes.
Characterisation Site: Paynes and Murray Districts.

<table>
<thead>
<tr>
<th>Soil Depth (cm)</th>
<th>0-15</th>
<th>15-30</th>
<th>30-60</th>
<th>60-90</th>
<th>90-120</th>
<th>PAWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUL %Vol Water</td>
<td>41</td>
<td>41</td>
<td>40</td>
<td>41</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Bulk Density g/cc</td>
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<td>1.41</td>
<td>1.47</td>
<td>1.57</td>
<td>1.57</td>
<td></td>
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<tr>
<td>15 Bar LL % Vol water</td>
<td>21</td>
<td>24</td>
<td>31</td>
<td>33</td>
<td>35</td>
<td></td>
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<tr>
<td>LL under crop % Vol water</td>
<td>30</td>
<td>26</td>
<td>27</td>
<td>21</td>
<td>26</td>
<td>130</td>
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<tr>
<td>PAWC mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SOIL: GREY HERMOSOL
Vegetation Includes: Belah, Coolibah, Poplar Box, Wattle trees, Belah, Black, Box Buxes.
Characterisation Site: Paynes and Murray Districts.

<table>
<thead>
<tr>
<th>Soil Depth (cm)</th>
<th>0-15</th>
<th>15-30</th>
<th>30-60</th>
<th>60-90</th>
<th>90-120</th>
<th>PAWC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUL %Vol Water</td>
<td>33</td>
<td>36</td>
<td>37</td>
<td>38</td>
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<tr>
<td>Bulk Density g/cc</td>
<td>1.26</td>
<td>1.36</td>
<td>1.40</td>
<td>1.48</td>
<td>1.53</td>
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<td>15 Bar LL % Vol water</td>
<td>18</td>
<td>21</td>
<td>25</td>
<td>25</td>
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<tr>
<td>LL under crop % Vol water</td>
<td>20</td>
<td>22</td>
<td>35</td>
<td>39</td>
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<td>PAWC mm</td>
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APPENDIX 8  SOIL PROPERTIES AND SOIL WATER RELATIONS OF THE FIVE MAJOR SOIL GROUPS

Red Kandosol (Grouped)

Grey Vertosol (Grouped)

Red Sodosol (Grouped)

Grey Dermosol (Grouped)

Grey Vert Gilgai (Grouped)

Legend:
- DUL
- LL
- Clay %
- F.Sand %
- C.Sand %
- BD
- Silt

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### APPENDIX 10  CHARACTERISTICS OF ACTION RESEARCH: A CONSENSUAL SUMMARY

(Source: Peters and Robinson, 1984)

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<tr>
<th>General</th>
<th>Idiosyncratic</th>
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<td>(a) Problem focused</td>
<td></td>
</tr>
<tr>
<td>(b) Action oriented</td>
<td></td>
</tr>
<tr>
<td>(c) Organic process (ie “cyclical”)</td>
<td></td>
</tr>
<tr>
<td>(d) Collaborative/Participative</td>
<td></td>
</tr>
<tr>
<td>(e) Ethically based</td>
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<tr>
<td>(f) Experimental</td>
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<tr>
<td>(g) Scientific</td>
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<tr>
<td>(h) Naturalistic</td>
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<tr>
<td>(i) Normative</td>
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<tr>
<td>(j) Re-educative</td>
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<tr>
<td>(k) Emancipatory</td>
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</tr>
<tr>
<td>(l) Stresses group dynamic</td>
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</tr>
<tr>
<td>(m) Concretely critical</td>
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</tr>
<tr>
<td>(n) Low a priori precision with high accuracy</td>
<td></td>
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<tr>
<td>(o) Unconstrained dialogue</td>
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* A check mark in brackets [✓] indicates that the author has mentioned this characteristic, but has not highlighted it.

** A check mark indicates that the author has explicitly highlighted this characteristic.

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