Part 1 - Summary Details

CRDC Project Number: **DAN167C**

Project Title: Cotton Industry Development Officer- Upper and Lower Namoi Valleys

Project Commencement Date: 1 July 2002 **Project Completion Date:** 30 June 2005

CRDC Program: Capacity & Community

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Part 3 – Final Report Guide

Background

The Industry Development Officer (IDO) for the Lower Namoi (Project DAN167C) commenced in July 2002 covering the region from Narrabri to Walgett. In July 2004 the project expanded and was combined with the Upper Namoi to cover the entire Namoi valley. There was no full time IDO based in the Lower Namoi prior to July 2002.

IDO positions in other valleys had been successful in increasing adoption of technology by local growers. An IDO was based at the Australian Cotton Research Institute (ACRI) to provide direct assistance to growers in the Lower Namoi. The position filled a recognised gap in the Cotton Cooperative Research Centre (CRC) National Extension Team. The position was to work with local growers and consultants, as well as playing a role in national extension activities, to develop extension programs focusing on local production issues. The position was critical for the promotion of Integrated Pest Management (IPM) systems. This role has been particularly important with the introduction of Bollgard II®. This position was to link with local research to promote IPM strategies as part of a national extension focus.

A number of Area Wide Management (AWM) groups formed in the Namoi district by 2001. This position was to provide direct assistance to these groups to develop regional IPM strategies. Grower group activities were to include the use of comparative analysis techniques to help groups examine their faming practises. Assisting the development of new AWM groups was also an objective of the position. Water reforms across northwest NSW have placed increasing demands for growers to examine their water use efficiency. The position has assisted NSW Agriculture's District Agronomist at Narrabri to promote cropping systems that optimise water use and rainfall efficiency. Ground water salinity has developed in a number of regions west of Narrabri and the IDO was to work with researchers at ACRI to ensure that growers were aware of management options when using poor quality water.

The position was also to assist in the delivery of water use efficiency and IPM training programs developed by the Australian Cotton CRC. To ensure growers in the district received timely information on crop performance throughout the district the position has produced regular newsletters such as CottonTales. The promotion of the Australia Cotton Best Management Practice Guidelines (BMP) to growers and the local community were also key components.

The establishment of large scale farm trials or demonstrations form a critical component of extension activities. This allowed strong links to be established between growers, consultants and researchers. During this period Annie Johnson, who held the IDO position, took 6 months study leave to Wageningen University in The Netherlands. The outcomes of this period are outlined in a separate final report titled 'Change Management and Extension Methodologies'.

Objectives

Research issues that have been covered between July 2002 and June 2005 include;
Bollgard II® management, biology and ecology of beneficial insects, biology and ecology of problem weeds, insect resistance management, integrated disease management including farm hygiene, improved management of Roundup Ready® technology including the reduction of residual herbicides, integrated pest management including pupae busting, irrigation

management including water management under limited water situations, soils management and salinity research.

To extend this research into the Namoi valley the team used various methodologies (see question 3) to cater for different learning styles and farming situations. Meetings held with regional reference groups twice a year assigned priorities to issues.

To coordinate the adoption of research requires a good knowledge of current and past research carried out not only in the Namoi but across the industry. The communication linkages within the extension team and at the ACRI have helped to facilitate this but also attendance at industry updates, Australian Cotton Growers Research Association cotton conferences, commercial and Cotton Consultants Association (CCA) seminars has also a good understanding of research.

There was a high rate of uptake of new research in the Namoi mainly due to the convenience of the ACRI. Many of the researchers have good relationships with growers and consultants in the area, and regularly exchange information on issues and research going on in the Namoi.

Growers from Harparary region at a field day on monitoring Bollgard II®. Photo: Annie Johnson

- *To develop a framework of regional trials/demonstrations (in liaison with researchers) as part of the adoption process and to facilitate better communication between farmers, advisers and researchers from government and agribusiness.*

Demonstration trials were run during the three seasons in coordination with growers, researchers and consultants. Two seasons of trials were carried out looking at the compensation ability of Bollgard II®. These were carried out in both irrigated and dryland farming systems and were coordinated with trials carried out by other members of the extension team across the industry.

A demonstration trial was run in 2005 on the best management practice for control of Roundup Ready® volunteer in fallow situations. This work was relevant to both irrigated and dryland farming systems.

A trial was run in 2004 with HydroLOGIC in coordination with Dirk Richards and Auscott Narrabri. This provided the opportunity promote the decision support system as well as test how the program was best used in commercial situations. Assistance was given to the running and promotion of research carried out on properties in the Namoi valley. This included mirid damage and compensation trials, weed competition trials, Black Root Rot and residual herbicides trials as well as disease surveys.

- *To work with Upper and Lower Namoi Cotton Growers Associations (CGA) to determine gaps in the local research and extension needs as well as adapting existing technology to meet local needs.*

The Upper and Lower Namoi CGA's have been very involved in assisting the extension team to determine gaps in local research and extension. This provides two benefits to the extension team. The regular interaction ensured that activities were relevant and timely but it also provided some ownership of the extension process to the members of the CGA which increased their interest and involvement.

Each year a local reference group meeting was been held. The reference groups have been made up of members of the CGA's as well as representatives from Cotton Australia, the CCA and facilitated by the IDO or District Agronomist. These reference groups have provided feedback on past activities as well as direction for future activities.
For more regular communication with the CGA's, one or more members of the Namoi extension team attended the monthly CGA executive meetings as often as possible. This allowed the extension team to keep the CGA up-to-date with activities as well as keeping in touch with all issues affecting cotton growers in the Namoi valley.

The members of the extension team were also on the organisational committees for CGA sponsored events such as annual field days, crop competitions and awards dinner. The extension team used these events to promote the uptake of best management practice and new research.

- *To assist in the implementation of cotton industry BMP program.*

The uptake of BMP has increased in the Namoi over the past three years mainly due to the one-on-one time that the local Cotton Australia Grower Services Manager (GSM) has spent with individual growers helping them implement the program on their properties. The assistance that the extension team has provided to the BMP program has been more peripheral with the promotion of individual practices through CottonTales and field days. The extension team gave constant exposure to BMP through promotion of farming practices that fit in with the BMP guidelines. An example of this is the condensed version of the IPM guidelines II that were written for the *Cotton Pest Management Guide 2004 – 2005*. The IPM guidelines now follow the BMP objectives so that growers who wish to follow the IPM guidelines are also following the BMP guidelines.

The Lower Namoi Crop Competition was revived in 2004. This provided an opportunity to revise the crop competition judging criteria so that they closely followed BMP and the latest research. Best Management Practice is promoted through the winning growers, and their

practices that results in high yielding crops. This is also the case with the Upper Namoi crop competition and grower of the year competition.

The extension team has also worked with the GSM to launch both the riparian guidelines and the BMP Land and Water module. In the coming seasons the extension team will work to help grower groups implement the Land and Water module.

- *To assist in the development and implementation of IPM practices for the management on insects, weeds and diseases.*

There were many activities that were covered by this objective. Each year the *Cotton Pest Management Guide* has been reviewed and updated by the Namoi extension team. This book provides the most up-to-date information on all aspects of pest control. Sections were added on insect biology and ecology, weed management, including management of Roundup Ready®, and a condensed version of the IPM guidelines II. A new section on disease management has been included in the 2005 – 2006 *Guide*.

Numerous CottonTales have been written and distributed to most cotton growers, consultants, agronomists and other industry members. The CottonTales have included information on insect, weed and disease ecology and management. Other publications for the whole of the industry such as Cottongrower articles have also be developed in the area of weeds and disease management.

Farm walks have been held covering topics such as weed competition, reductions in residual herbicides, pupae busting, black root rot management, the management of Bollgard II®, the damage and compensation of cotton, and the management of Roundup Ready® volunteers.

Seminars or talks associated with the CCA or grower groups have been conducted in the areas of insect management, comparative analysis of IPM, insect resistance management, weed management and disease identification.
Pest, weed and disease management trials have been visited at the annual field days in the Upper and the Lower Namoi as well as discussions held on the use of refuges, weed control and rotations.

Trials that were carried out in the Lower Namoi over 2001- 2004 were complied in the three trial books published in the course of this project. These books gave growers access to trial results in the areas of weed, disease and insect management as well as various agronomy trials.

An IPM short course has been held in the Lower Namoi every season. This course allowed participants to increase their confidence in pest management and former participants have reported a reduction in pesticide costs after completing the course.

Mark Hickman discussing beat sheet sampling with IPM short course participants at Wee Waa. Photo: Annie Johnson.

- *To promote decision support systems (DSS) such as CottonLOGIC and HydroLOGIC and information packages such as SOILpak and SPRAYpak.*

The extension team have a promotional and training tour for the *paks* and DSS each year. The IDO assisted with running the training workshops with growers and consultants. The IDO is also assisted growers using any of these products at other times in the year. Promotion of the DSS was also carried out using scenarios created by the programs in the CottonTales to show examples of planting time or first irrigation with limited water.

A commercial HydroLOGIC trial was run in 2003-2004 with the IDO and researchers working with the grower. This trial was also promoted in the Lower Namoi trial book, CottonTales, and at grower and consultant meetings.

The *paks* are distributed through the Technology Resource Centre and by the extension team. Additional promotion of the contents and uses of the *paks* was through CottonTales. The *paks* are used by the extension team as an information resource at grower group meetings and for one-on-one inquiries.

- *To promote farming systems to optimise whole farm water use.*

In 2003 workshops were run in the Upper and the Lower Namoi on growing cotton in limited water situations. These workshops were followed up with limited water scenarios shown in CottonTales. These workshops allowed growers to understand their options in the drought season.
In 2004 WATER*pak* was launched and distributed. Workshops to introduce WATER*pak* were organised with grower groups and facilitated by the water extension team. Water trials were published in the trials books, giving most growers access to information on water management that was being carried out on commercial farms.

- *Increase awareness of salinity monitoring and management.*

Salinity issues were discussed with one AWM group. Researchers were invited to speak to the group and EC meters were used to test various farm water sources including the river and

various bores. This resulted in the members of the group understanding the potential risks of salinity developing and their fields and the management options for minimising these risks.

Nilantha Hulugalle's salinity management research was discussed at field days. This allowed growers to hear about the rotation options for managing sodicity and salinity and which options were financially the best. This work was also promoted through CottonTales and the Trial books which gave the most growers in the valley access to this information. Trials that were carried out on commercial using gypsum to reduce sodicity problems were also published in the trial books.

Cotton growing on the Breeza plain. Photo: Annie

Methods

A variety of different extension methods were incorporated into their project to accommodate the different learning styles of growers and other industry members. Activities also required varied levels of participation (Figure 1) to accommodate grower's varied amounts of time and other resources.

AWM groups are the most effective for creating situations where people can learn collectively to solve problems and improve their skills and management. However growers and extension staff do not have enough time to cover every situation through an AWM group. Some issues are most suited to distribution of information that does not require a response from growers such as in CottonTales newsletters. Reporting moth activity in pheromone traps is one example that would not require a response. Other issues, such as reporting on new research, fits better into field day situations where there is an information exchange between growers and researchers.

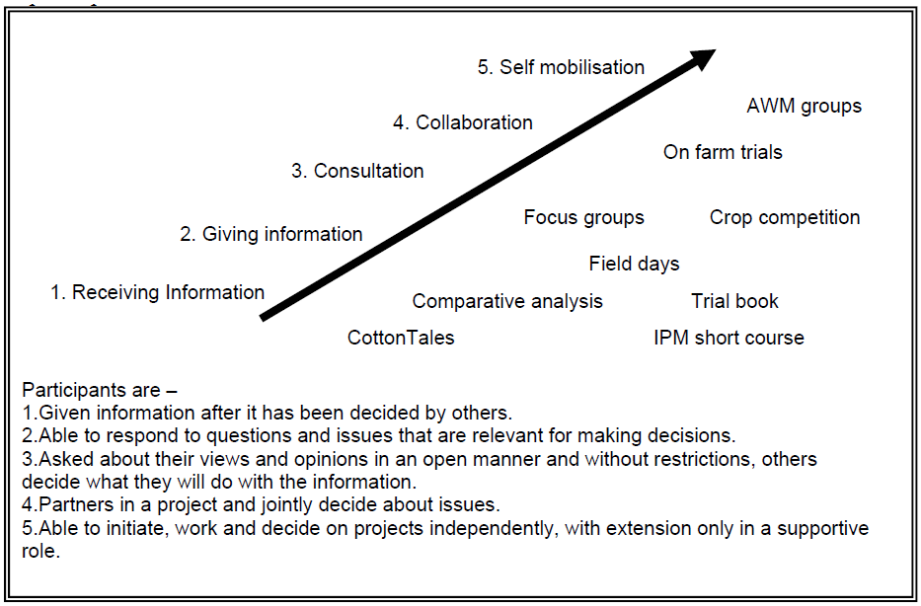

Figure 1. Activities carried out within the project and how they fit into the theoretical levels of participation.

Determining priorities

It is important that industry members are involved in the process for determining extension priorities for a region. The reference group for the extension priorities involved members of the CGA, the CCA, Cotton Australia and members of the extension team. The reference group met every 6 to 12 months. The reference group not only determined the important local issues but also the best ways these issues could be addressed.

This method of consultation and collaboration ensured that priorities were relevant and timely but also gave some ownership of the extension activities to the growers. It is important that growers feel some ownership of activities as they then place value on the activities and are more motivated to making them a success.

Focus groups

Focus groups are a consultative process that allows the extension team to assess and understand the attitudes of growers towards certain issues. Growers also found the activity useful as they could share experiences with a group of people they might not have necessarily discussed these issues with before. By hearing other opinions about issues they gained more confidence and knowledge in their own actions.

Newsletters

CottonTales provide timely information on issues relevant to cotton growers and other industry members. The newsletters are short (mostly one page) sent out by fax or email. The CottonTales are aimed at promoting awareness in a format that does not take much time for a busy person to read. They are easy to read and understand. CottonTales often included information presented at a field day or other extension event so that if a grower is unable to make an event they are kept informed.

Field days and farm walks

Field days are a great way to get researcher, grower and consultant interaction as well as showing the practical side of research and management innovations. Field days not only give

the industry members a chance to look at a trial or demonstration in the field but give the opportunity for one-on-one time with researchers. The field days are usually consultative or collaborative efforts with growers which usually makes certain the event is relevant and timely.
The Upper Namoi and Lower Namoi CGA's each host an annual field day around March. Regular field days of varying sizes have been organised as-needs-be or by demand. The shorter field days are usually referred to as 'farm walks' and are usually focused on one issue. The farm walks are used to accommodate growers who do not have a lot of time. They allow the researcher and grower to focus on one issue that is timely.

Crop competitions
The Upper and Lower Namoi CGA's support an annual crop competition. Supporting these competitions gives the opportunity to highlight best practice as well as encouraging and promoting growers who are doing things which may be innovative and environmentally sound as well as good practice.

On farm trials
Farm trials are usually collaborative activities which allow growers to see things for themselves by comparing different treatments and become interested in new practices. The purpose of these trials is not to have new research but to communicate already existing knowledge and experience. Demonstrating results of a particular practice promoted to a wider group as well as the grower, usually making use of visual effects of a trial.

IPM short course
The IPM short course allows growers to achieve formal training in IPM. The course is an interactive course which allows growers to focus on areas that are important to them. The small size of each group allows growers to be able to individually learn and question at the same time the group can discuss ideas. The course uses a number different learning styles so that all participants are able to learn according to their style. The IPM course allows growers to gain confidence in their current practices as well as encourages them to try some new practices.

AWM groups
AWM groups are the most participatory activities of all extension activities and require time and dedication by the members of the group. The AWM model is very successful in achieving change amongst a group of growers however many growers do not have the time to use this model for achieving change in all priority areas.
The main driver of the AWM groups that formed was the acknowledgement of a problem situation that needed a group dedicated to solving the problem together. The groups that formed were very successful in reducing their pesticide usage as well by working together and committing to the IPM form of management.
The reason that more AWM groups did not form or groups formed but did not continue is that there was no real problem commonly identified amongst the growers. Many of these growers have learned to practice IPM very successfully; they did not need to learn it as a group. Many of these growers already had good communication with their neighbours and were able to work out issues on an informal basis.
The Two Rivers Area Wide Management Support (TRAMS) group has been very successful in practicing IPM across a wide area. The group has been so successful that they no longer

have a crisis with pests and hence have no reason for regular meetings. TRAMS still exists but regular meetings have been discontinued until another crisis arises.

Comparative analysis
Comparative analysis is a review process. Reviewing what has been done is an important step in the adult learning cycle. Comparative analysis of pest management systems were run to allow growers to assess their management decisions by comparing them with other management regimes and their results. Growers were able to determine that IPM systems were more financially sound. This gave them confidence to maintain their IPM practices.

Trial books
Many growers regularly carry out very practical on-farm trials. These trials are often basic on the scale of research but are very valuable to growers in the region as they help determine management practices like rates of fertiliser, growth regulators or water. The trial books give other growers access to the results of these trials so that they might use the results to make decisions on their farm. The growers can also build on these trials with a variation of the trial on their own farm. This saves the equivalent of years of research if each farm had to do all it own trials.

Results
It is very difficult to determine direct outcomes from each extension activity. The irrigation knowledge management evaluation (Callan *et al*. 2004) showed that growers use information from many different sources before they make a change in management. Some of the management changes that have occurred in the Namoi over the past three seasons included increased priorities toward using 'soft' pesticides over 'hard' chemistry. Overall pest control spending has decreased due to the introduction of Ingard® and Bollgard II®.

In 2004 three dryland growers also participated in the IPM short course. Most of the growers in the industry have been exposed to the latest information in pest management in one form or another. The uptake of IPM in the Namoi valley has been widespread and many growers are using best practice for IPM. The last two seasons have seen an increased amount of late planting of cotton to avoid the damage by Black Root Rot.

Many of growers have trialled spray oils or salt with reduced rates of pesticide to reduce the impact of pesticides on beneficial insects, as well as reducing costs. All growers were familiar with the terms of soft and hard chemistry and recognised that preserving beneficial insects has a benefit to their pest management.

There has been an increased use of a variety of insect sampling methods such as beat sheets or sweep nets as well as visual checks by consultants. There has been an increased amount of sampling for disease identification either through the IDO or direct to QDPI&F at Indooroopilly. Many growers are planting later to minimise the damage from Black Root Rot.

Rotations with cotton are more common; however this is more a factor of water shortages than any extension effort. There has been regular testing of aphids for resistance by some growers before sprays were applied. Most agronomists have reassessed which chemical they will apply after the resistance sampling.

Some researchers were much more confident in their research after receiving feedback from growers about their management practices and how the research affected them.
Better soils and sodocity management resulted in increased yields for growers, making their management more cost effective.

Outcomes
All three key outputs are addressed by the project. Comparative analysis carried out by AWM groups, NSW DPI and CSIRO research has shown IPM systems to be more economic than conventional pest control systems. The increased adoption of IPM strategies for insect, weed and disease management not only allowed growers to reduce their costs, but also lead to a decrease in the volume of pesticides used, which was better for our soil and riverine environments. Adoption of research outcomes for better soil and water management also provided an economic and environmental benefit.

The increased adoption of IPM and environmentally sound practices benefited not only the cotton growers but the entire community. Through groups and individually, growers are gaining increasing confidence in their knowledge of farming systems and the environment. Practicing environmentally sound farming improved the image of farming in the broader community.

Conclusion
The Namoi extension team were not the sole information providers to growers in the Namoi valley. However our work is seen as a valuable resource by the CGA's, the CCA and the researchers based the ACRI and other cotton research stations.

The members of the extension team have empowered other members of the industry to ensure that our activities are timely, relevant and designed to suit each situation and the variety of growers in the valley.
The most effective extension is when growers, research and extension combine to solve a problem or crisis. This ensures rapid uptake of change.

Extension Opportunities
To further develop the project
The extension team will continue to promote research results and best management practice through their current networks in the industry. The new Cotton Catchment Communities CRC and environmental specialist and extension officers based in the Namoi will change the focus of many activities that are carried out in the future. However new technology that is entering the industry such as Roundup Ready Flex® and Bollgard II®, will still need basic agronomy and management extension while the new management plans are being developed.

Future projects
- Best practice management for control of mirids.

Many growers are uncertain about how to manage mirids. New research is being conducted in the area of damage and compensation, ecology and predators for mirids.
IDO's can facilitate growers and researchers and determining best practice.

- Integrated Weed Management (IWM) for Roundup Ready Flex®.

The introduction of Roundup Ready Flex® will further change the way that many growers practice weed management. New research into thresholds and current knowledge of IWM can be integrated to form best management packages for Roundup Ready Flex®. It will be important to communicate best practice with growers to prevent weed species shift to glyphosate tolerant weeds or the development of glyphosate resistant weeds.

- Best practice for Bollgard II® management.

Bollgard II® has changed not only our pest management creative an insect species shift. Many growers are changing planting dates and damage thresholds. However in limited water conditions, some growers are not taking advantage of cotton's compensational ability. It will be important to work with growers is to determine best practice with Bollgard II® and to carry out some comparative analysis for key management points not just pest management. Comparative analysis has been successful in the past with growers as they have a personal involvement because the analysis contains their own data.

- Assisting growers to implement the BMP Land and Water module.

Cotton Australia and the extension team have been developing plans to help growers implement the Land and Water module on a farm and community scale so that it is a simplified process for all involved. The IDO's role in this process would be to assist and promote agronomy and crop management tools to help growers follow the BMP guidelines.

- Increase the usefulness of on-farm research.

Many growers conduct farm trials or experiments. Most of this work is wasted if the trials are not set up properly, not replicated or just not harvested as a trial. Julie O'Halloran and Penny van Dongen have written guidelines for conducting trials on farm. These could be followed up with direct assistance to growers, providing advice on farm trial layout or the best ways to collect or interpret results.

- Continue to promote ongoing research.

The cotton industry carries out a lot of research much of which would be without value if it were not taken up by growers in management. There are several reasons why research is sometimes not taken up. This includes poor communication of results or management suggestions which are not practical.
The interaction between growers and researchers which is often facilitated by extension ensures that results are communicated to growers and the resulting management solutions are practical. The extension team should continue to increase this interaction. The fastest way to ensure that growers will uptake technology is by giving growers a role in the development of the research outcomes because when they feel they have ownership of an outcome they are more likely to act on that outcome.

- Continue to explore effective extension methods.

Extension must ensure that the right tool or activity is used to fit the purpose. The assumptions behind each objective must also be explored. For example a lack of pupae busting could be due to a lack of labour rather than a lack of awareness. The reference group for the extension team is an important part of determining priority issues for the extension team and for also determining the right tools.

Future presentation and dissemination of the project outcomes
As the current officer in the position of IDO, Annie Johnson, will not be continuing after June 2005 there are no plans to promote the outcomes of this project.

However avenues exist for other members of the extension team to promote awareness of activities at cotton conferences, CCA seminars, and CRC reviews or through extension networks such as the Asian Pacific Extension Network.

There is often misunderstanding with researchers about the role of the extension team. It is important that the extension team is able to communicate to the industry, including researchers about extension methodology.

Future research.
IDO's play an important role in facilitating links between on-and off-farm research. Future areas of significance include nutrition management, rotations management and disease and weed management. As these are areas where only a small amount of research is funded it is important to coordinate and extend on-farm developments and innovations with research to increase the value of the results.

Publications
Conference Proceedings (Refereed)
Johnson, A. and Salmond, G. (2004) 'Extension of weed research outcomes in the Australian Cotton Industry'. *Proceedings of the 14th Australian Weeds Conference*. 6 - 10 September, Wagga Wagga.

Final Reports
Johnson, A. (2005) Change Management and Extension Methodologies: Study report.

Industry Publications and Media
- **Johnson, A** and Farrell, T. (due winter 2005) *2005 – 2006 Cotton Pest Management Guide*. NSW Department of Primary Industries, Narrabri.
- **Johnson, A** and Farrell, T (2005) *2004 Lower Namoi Trial Book*, Cotton CRC, Narrabri.
- Nehl, D. and **Johnson, A** (submitted for publication) 'Black Root Rot' Research Review for *Integrated Disease Management Guidelines*. Cotton CRC, Narrabri.
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- **Johnson, A.** (2002 – 2005) Various articles in 'Courier' and 'Times' Wee Waa and Narrabri newspapers.

- **Johnson, A.,** Farrell, T. (2002- 2005) *CottonTales*. Newsletter distributed to the Upper and Lower Namoi.

Online Resources
• CottonTales
www.cotton.crc.org.au □News\CottonTales
• Cotton Pest Management Guide
www.agric.nsw.gov.au/reader/pe-insect/cotton-guide-splash.htm

Impact on the Australian Cotton Industry
This project has filled a recognised gap in the Cotton CRC national extension team, allowing growers in the Namoi valley access to all the activities and services provided by the extension team.

During the three years of this project many activities have been carried out which have increased the value of many research projects. Research projects and their results have been promoted to the cotton industry in the Namoi valley allowing growers to examine and uptake some of the results. Without the extension team, research would take considerable longer to be taken up by the industry. Also by allowing growers in the Namoi to examine various research projects, growers have been able to provide feedback to researchers allowing them to adjust their research projects and management suggestions increasing the value of the output by research.

The position has allowed the extension team wider coverage of the industry when carrying out evaluation activities on issues such as IPM, water and nutrition management. Without this position the input of growers in the Lower and Upper Namoi (one of the largest cotton production areas) would have been limited. These evaluation activities provided feedback to the extension team so that they could tailor their activities to and increase the value of their activities to growers.

The position carried out activities that assisted in the uptake of IPM which saved the industry millions of dollars every year. These activities included research presentations, comparative analysis with AWM groups and the IPM short course. All these activities are aimed at increasing growers' confidence in IPM practices. During the three years 35 cotton growers participated in the IPM short course with was over 10% of growers in the Lower Namoi. Many participants in the IPM short course have stated that they have saved money on pest management following participation in the IPM short course.

During the drought growers were able to increase their knowledge of managing cotton with limited water through workshops and newsletters which ensured that growers could maximise production during the limited water seasons.

Growers are changing agronomy practices such as planting date, disease and water management resulting in increased yields and cost effectiveness. The position also cooperated with the Cotton Australia Grower Services Manager for the Namoi to promote industry events and BMP. This cooperation increased the efficiency and value of both positions.

References
Callan V, Christiansen I and Harris G (2004) Knowledge Management in Cotton and Grain Irrigation. Australian Cotton CRC Occasional

Part 4 – Final Report Executive Summary

The Industry Development Officer (IDO) for the Lower Namoi (Project DAN167C) commenced in July 2002 and in July 2004 the project was expanded and was combined with the Upper Namoi to cover the entire Namoi valley. During this period, Annie Johnson, who held the IDO position took six months study leave to Wageningen University in The Netherlands. The outcomes from that period are outlined in a separate final report titled 'Change Management and Extension Methodologies'.

The objectives of the IDO have been to coordinate the adoption of research into sound management practices through trials and other extension activities. The extension objectives were in the areas of insect, weed and disease management, water use and salinity as well as promoting decision support systems and information *paks*. These objectives have been achieved through trials, field days and farm walk, newsletters, comparative analysis, focus groups, crop competitions, courses, seminars, grower groups, and publications such as the

Trial books and Cotton Pest Management Guide.
A variety of different extension methods were incorporated into the project to accommodate the different learning styles growers and other industry members. Objective were achieved using varied levels of grower participation to accommodate grower's varied amounts of time and other resources.

The IDO has worked in cooperation with the Narrabri District Agronomist, Cotton Australia's Grower Services Manager, Namoi Irrigation Officer, Lower and Upper Namoi Cotton Growers Association, and the Upper and Lower Namoi Cotton Consultants Association to bring relevant, timely and accurate research information to the cotton industry in the Namoi Valley. The extension team covered issues such as cotton diseases, volunteer cotton management, insect pest and beneficial identification, management of weeds, farming systems to manage sodic soils, compensation of cotton to insect damage, irrigation management, and implementation of Best Management Practices.

The extension team were not the sole source of information for growers in the Namoi so it is difficult to detail specific changes that have occurred due to extension team activities. However growers who have participated in the IPM short course and comparative analysis techniques have increased confidence in pest management. Many have stated, and comparative analysis results show, that pesticide usage has decreased for these growers. Also better management of weeds, soils, and disease has resulted in more cost effective and environmentally friendly management in the cotton industry.

Future areas of extension include better management of Bollgard II® including mirid management. The Land and Water module for the BMP guidelines will be a focus along with increased use of IWM with Roundup Ready Flex® and more cooperation between research and growers with on- and off- farm trials.

The strength in the extension team is the variety of different methodology that is used to cater for the different learning styles and situations of the growers throughout the Namoi.

Change Management and Extension Methodologies

LEAFSE exchange program
University of New England, Armidale and
Wageningen University and Research Centre, The Netherlands
16th January 2004 – 17th July 2004

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NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Australian Government

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A final report on the student exchange to Wageningen University and Research Centre in The Netherlands.

Signed Dated

Executive Summary

In many areas of the world extension agents are no longer seen as experts providing advice, but act as facilitators of farmers' learning processes (Leeuwis 1999). The cotton industry could benefit from many of the modern extension theories and practices that have been used not only around the world but also here in Australia. The extension theories use the assumption that for sustainable agriculture to occur, farmers need to have an increased capacity to learn and experiment (individually and collectively) and decrease their reliance and dependence on external advice (Leeuwis 1999). This requires a paradigm shift on the side of farmers, researchers and extension agents (Leeuwis 1999).

In this changing environment for extension and research, extension agents need to be equipped with knowledge of facilitation and managing participatory processes as well as models for capacity building. This report is a summary of studies in extension and change practices that were undertaken at Wageningen University and Research Centre between January and July 2004.

The report explores the area of participatory processes, the use of facilitation, and the interaction between research and extension and methodologies that could be used for encouraging the uptake of sustainable practices within the cotton industry.

This report finishes by describing methods that could be used by cotton extension staff in Australia to make our extension more efficient and have a greater ability to help growers build their capacity to continue to develop and adopt sustainable practices now and in the future.

Introduction

This report outlines studies that were completed at the Wageningen University and Research Centre (WUR), The Netherlands and The Royal Veterinary and Agricultural University (KVL), Denmark as part of the Learning through Exchange, Agriculture, Food Systems and Environment (LEAFSE) program. LEAFSE is an Australian and European Union student exchange scholarship program funded by the Australian and EU governments. The scholarship formed part of a masters degree and covered issues such as agricultural sustainability, education of environmental issues, personality and learning styles, group dynamics, facilitation, extension methodologies and managing people and change.

Wageningen University and Research Centre is a world leader in extension science. Australian agriculture features many of the extension methodologies that have been used and taught at Wageningen. However the cotton industry could benefit from many of the modern extension theories and practices that have been used not only by WUR but all around the world. There is a large amount of literature and other information available on extension practices and methodologies, many of which could be easily incorporated into our current extension practices.

Chapter one outlines the studies that were undertaken during the scholarship, contacts that were made during this period and the benefits of this period.

Chapter two explores participatory process, the background, their uses and considerations when managing these processes.

Chapter three reviews facilitation, what it is and can be and the areas of importance for a facilitator to understand

Chapter four defines and explores a model for a problem solving in agriculture that extension agents could use to facilitate change for sustainable outcomes. This model uses participatory processes and facilitation covers seven steps that need to be considered in this process.

Chapter five looks at taking this knowledge further. How we can introduce these concepts into our work and the support that is needed to develop these processes.

Chapter one – Outline of study and learning

"We don't strive to provide solutions for problems of communicators, but to provide methods to systematically analyse their problems and to look for solutions themselves" Anne W. van den Ban (department chair, retired).

The learning styles of WUR encourage analysis of current practices from a different perspective. A lot of my previous extension practices are carried out 'on the run' and there is very little time to analyse if the methodologies that were used were appropriate for the situation.

Area of study	Topics Covered
LEAFSE Common Unit (The Royal Veterinary and Agricultural University, Denmark)	Learning styles, group dynamics/styles, European farming systems and sustainability.
Management of Change (Wageningen University and Research Centre, WUR)	Communication, strategic planning, understanding organisational behaviour, group dynamics, managing people and change.
Technology Social Choice and Development (WUR)	Institutional concepts and attitudes, fair trade, organic agriculture, genetic modification (GM), pesticides, standards and policy, social and market values that affect change.
Facilitating Interactive Process of Change (WUR)	Theoretical foundations of facilitation, building institutional support, design / structuring processes, facilitation practice.
Environment Education for Sustainable Living. (WUR)	Evolution of Environmental Education (EE), values, ethics of EE, education for sustainability, methodology and theoretic foundations of EE, actions of EE.

The choice of subjects selected related very closely to my position as cotton industry development officer. I have a strong preference for learning in areas that I can associate with concrete experiences with, and was able to build on past experiences in extension to increase my understanding. I enjoyed being able to get a broader perspective on extension and facilitation, what has been done in the past, what the current practices are and where extension may go in the future. I came to understand that since we make assumptions in extension and facilitation that we need to understand and challenge these assumptions as well as our values and learning styles.

The other area that I have benefited from in my studies is a greater understanding of global issues such as GM, fair trade, pesticides and international standards. I not only have a greater understanding of other perspectives on these issues but reasons why various institutions may hold these perspectives.

Persons visited

Name	Position	Department	University
Prof Nadarajah Sriskandarajah	Associate Professor in Education and Extension Studies	Unit for Learning and Bioethics	Royal Veterinary and Agricultural University, Copenhagen, Denmark.
Prof Arjen Wals	Associate Professor of Education and Competence Studies.	Communication and Innovation Science	Wageningen University and Research Centre (WUR), The Netherlands
Prof. Paul Richards	Department Chair	Technology and Agrarian Development	WUR
Aarti Gupta	PhD student	Technology and Agrarian Development	WUR
Dr. Noelle Aarts	Lecturer	Communication and Innovation Science	WUR
Prof. Anne Van der Ban	Retired (department chair and author)	Communication and Innovation Science	WUR
Prof. Cees Leeuwis	Department Head and author	Communication and Innovation Science	WUR
Dr. Jim Woodhill	Department Chair	Centre for International Agriculture	WUR
Dr Kees Jansen	Lecturer	Technology and Agrarian Development	WUR
Dr Annemarie Paassen	Lecturer	Communication and Innovation Science	WUR

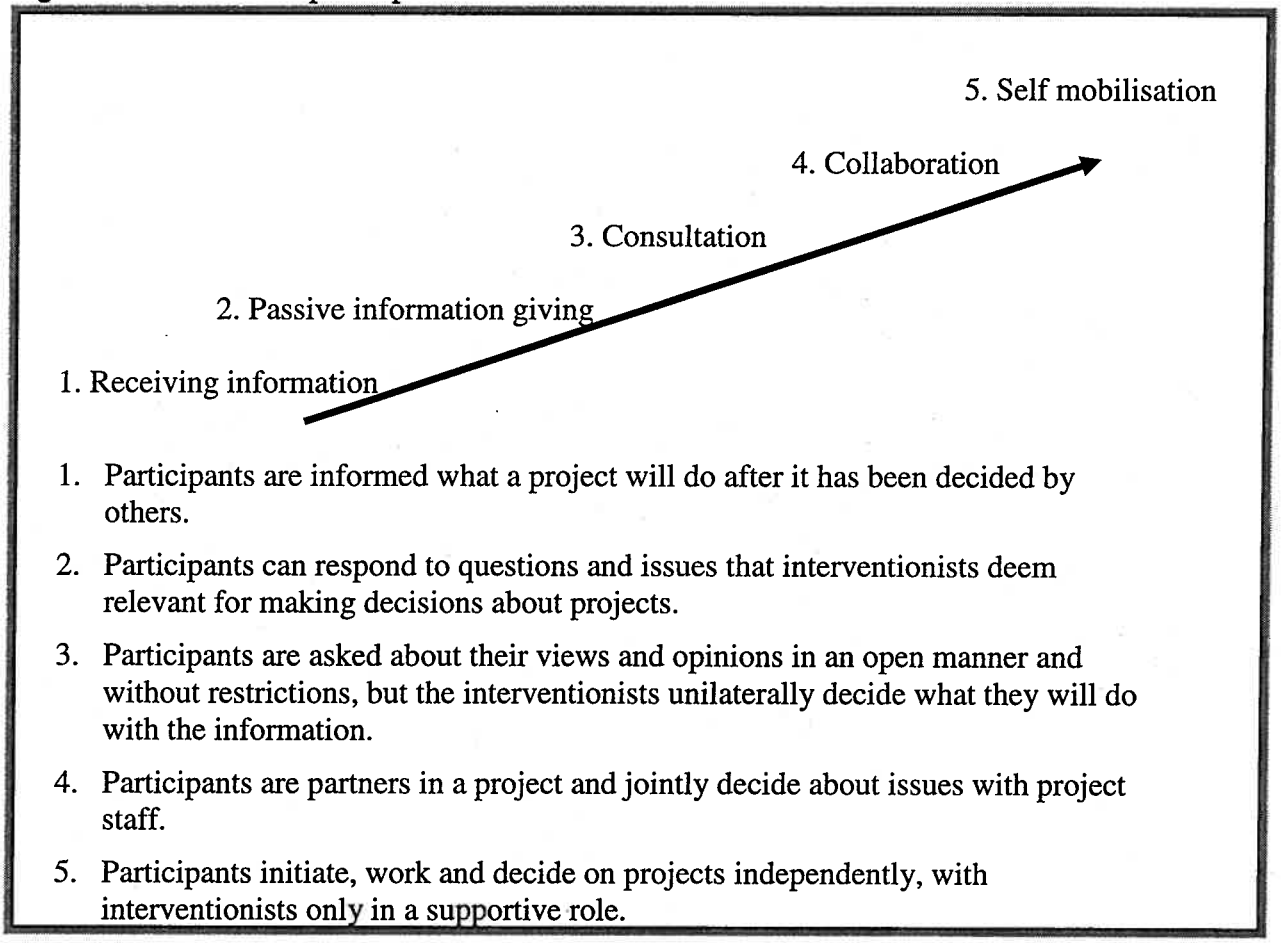
Chapter two – Participatory Approaches

Participatory processes are often used to achieve change. This idea is based on the philosophy that change can only come about through a transformation in human conduct (Leeuwis 1999). Literally speaking, someone is participating when they 'take part in' or are 'involved in' an activity (Leeuwis and Van der Ban 2004). The World Bank defines participation as;

> "a process through which stakeholders influence and share control over development initiatives and the decisions and resources which affect them" (Leeuwis and Van der Ban 2004).

It follows from this definition then that a process cannot be labelled 'participatory' if 'influencing and sharing of initiatives, decisions and resources' does not occur (Leeuwis and Van der Ban 2004). However there is a much wider range participation used in change management processes (Figure 1).

Figure 1. The levels of participation



Participatory approaches are used for strategic and communication purposes. Participatory approaches can be used strategically for their ability to change the behaviour of the beneficiaries so that predetermined objectives can be achieved more easily (Groot and Maarleveld 2000). The

communication approach where participatory approaches are used to strengthen people's capabilities to learn individually and collectively, and to develop solutions (Groot and Maarleveld 2000). Participatory approaches are usually a combination of both.

Where participatory processes are used in problem solving, the resulting management solutions are less likely to be artificial and imposed and will have an increased level of adoption and increased period for which the technology and/or practices are used (Leeuwis and Van den Ban 2004). Participatory approaches are used so that all stakeholders can exchange ideas, knowledge and values in seeking solutions to complex situations (Salomon and Engel 1997). When people work together in a process they tend to emerge with a joint commitment to change (Salomon and Engel 1997).

It is not possible to have the maximum level of participation all the time. Participation is a scare resource. It requires energy from the participants. Participatory activities must be well prepared so that optimal use can be made of the available time. Also it is not efficient to repeat the participatory process with many groups over and over once the innovation has been discovered.

Managing participatory processes

It is important to consider all parts of the process (this is not a comprehensive list) to ensure that a participatory process can achieve its aims.

a) Expectations

Problems occur with participatory approaches when participants' expectations of potential outcomes are too high. The group loses its effectiveness as the group 'runs out of steam'. This can occur if participants feel they are not making a difference, if the problem changes, or if the problem is partly resolved and is no longer as important as it once was. Groups can be disappointed if the problem seems to be too large to solve and that they can not make a difference (Stapp *et al.* 1996). Community meetings where a 'shopping list' of problems is generated can lead to disappointment when these issues are not addressed later on.

Before the process starts the facilitator needs to reach a common understanding with at least some of the stakeholders on where they can play a meaningful role. That is, to have sensible preliminary boundaries in time and space, as well as topic, without placing too many limitations on the project (Leeuwis and Van der Ban 2004). In addition, clear goals need to be defined so that participants do not get frustrated with a program that seems to go nowhere (Stapp *et al.* 1996).

b) Implementation

The philosophy and principles of participatory approaches make them useful but implementation is also important. The facilitators must have adequate training, and appropriate attitudes and behaviour

to encourage participants (Pijnenburg 2004). When participatory approaches follow predefined steps, procedures and methodologies, the same pitfalls occur as 'top-down' approaches as the facilitator is assuming that change is something that can be planned (Leeuwis and Van der Ban 2004).

For interactive processes to be productive the participants (instead of the facilitator) need to develop the feeling of ownership and responsibility of the process at an early stage (Leeuwis and Van der Ban 2004). It is important to recognise initiatives and experiments that participants have already taken and/or thought about rather than repeating areas that have already been explored (Leeuwis and Van der Ban 2004).

Methodologies are needed so that a diverse set of people and organisations with an ill-defined sense of purpose can turn into a group with a shared perspective, whose members have agreed upon a number of tasks and responsibilities and have learned to respect each other (Salomon and Engel 1997). Participants need to determine how they will communicate, organise themselves, learn new practices and improve their capacity to innovate (Salomon and Engel 1997). In facilitating social learning, ideas and assumptions about change should be made explicit within the group. This improves the group's acceptance of the process. It is also important to explore existing social arrangements and their capacity to form the basis of a new process (Leeuwis and Van der Ban 2004).

A facilitator needs a good grasp of the theoretical, methodological and institutional aspects of participatory process. Unfortunately, many facilitators are simply given a bag of participatory methods but their lack of understanding leads to a mechanical application of methods in inappropriate and ineffective ways (Woodhill 2004).

c) Equality

It is important that everyone is represented as equal partners during the process. Unfortunately some agricultural participatory approaches show goals and actions that are designed by scientists and are later 'agreed' on by farmers. There is no real change in this approach as there is not a change in attitude or knowledge. When all participants feel ownership of the decisions they are more likely to make changes in practice (Leeuwis 1999).

d) Power relationships and facilitation

One of the criticisms of participatory approaches is that they neglect issues of power and conflict and over-simplify dynamics of social change. When naively implemented, such approaches can indeed easily be captured and dominated by more powerful individuals or groups (Woodhill 2004). Empowerment of some groups may be required for them to participate effectively and equitably (Woodhill 2004). Procedural issues, such as meeting rules, tend to be important for the participants

as well as the facilitator in dealing with conflicts and power relationships. An important condition for people to continue to participate in a process is often that there is a sense of purpose and direction (Leeuwis and Van der Ban 2004). Moreover without ambitions for the group it is impossible to facilitate a process that develops initiatives (Leeuwis and Van der Ban 2004). Ambitions need not necessarily be objectives as objectives may change throughout a process.

The way that scientists, politicians, policy makers and business leaders interact is important. This does not mean trying to involve all stakeholders in all forums and decisions – this would be inefficient. A facilitated social learning process does not always gather all interested stakeholders in one place at a time but can run over months, if not years, and will involve different combinations of stakeholders working in diverse ways (Woodhill 2004).

e) Evaluation

There are two types of evaluation that are important to sustain a program that continues to attract support (from industry, research and the community): process evaluation and product evaluation. Process evaluation refers to assessing the quality of the process: Does the group value the program? What are the strengths/weaknesses and areas in need of improvement? (Wals and Stapp 1996). This type of evaluation needs to be conducted periodically throughout the program and the results incorporated in the process to improve the overall program (Wals and Stapp 1996).

The product evaluation would include questions like has the original problem changed? What changes have been made in practice? This part of the evaluation needs to be considered at the start of the process, i.e. during the design of the program, and also when action is determined (Wals and Stapp 1996).

f) Organisational Support

Interactive processes often only make sense if there is a fair chance that the wider institutional policy environment will react positively to innovative results from the process. The facilitator needs to organise the process in cooperation with relevant policy institutions. It must be clear to what extent there is a commitment by other organisations in the policy environment to follow up on outcomes of the interactive process (Leeuwis and Van der Ban 2004).

Traditionally participatory approaches have focused primarily on the communication process between stakeholders and less on the institutional dimension. It is important to have some form of platform that will enable different actors to come together, which gives legitimacy to a process of interactive learning. The process also needs support from appropriate organisations to respond effectively to the changes that might be developed by the facilitated process (Woodhill 2004).

Summary

Participatory approaches are based on the idea that change comes about through a change in human conduct. Changes in human conduct come about through changes in attitudes, values and ideas (Leeuwis 1999). However despite these assumptions the process of participation is quite complex and there are many factors that must be taken into consideration for a participatory process to be successful. Effective participation can only come about when participants feel that they can make a difference. This comes about through their own attitude towards their ability to contribute as well as having appropriate support from institutions as well as from within the group. For an effective process the participants need to be able to contribute to the process as well as contributing within the process. Therefore, methodologies are important so that all the above factors are considered but it is important for the facilitator not to rely too heavily on a single method and be willing to change for the benefit of the process.

Chapter three – Facilitation

Facilitation is a term that can be defined in many different ways. It is used to describe many different processes such as conflict management, mediation, leadership, teaching, guiding or supporting. Facilitation is often associated in a limited way with coordinating and running a meeting, workshop or seminar. However facilitation can more broadly refer to a process that may run over several years which designs and establishes arrangements to make social learning possible (Woodhill 2004).

a) Methodologies

A skilled facilitator will adapt such methodologies to create their own unique methodology to meet the unique circumstances of the particular situation (Woodhill 2004). A key part of facilitation is to use methods and tools that enable people to visualise and understand issues, to communicate with each other, analyse options and reach decisions in a structured way (Woodhill 2004). At the heart of facilitating social learning lies the capacity to design a process in which different stakeholder groups engage diverse forums and activities so that knowledge is generated; ideas, values and perspectives are shared and contested; conflicts are negotiated; principles for action defined and collectively binding decisions made (Woodhill 2004). The skill and art of facilitation social learning is to create situations where people can learn collectively how to improve their situations. A facilitated social learning process does not always gather all interested stakeholders in one place at one time but can run over months, if not years, and will involve different combinations of stakeholders working in diverse ways (Woodhill 2004).

A variety of methods and skills are essential. For example:

- Ability to built good rapport and show respect for other people;
- Knowledge of when to 'unlearn', to relax, listen, learn from local people and not always be in control;
- Flexibility. Only useful information and relevant tools should be used, recipes should be avoided;
- To be able to sharing information without lecturing;
- Embrace mistakes; criticism should be handled in a constructive manner;
- The tool has to be used for the purpose it was designed for and should not be an end in itself.
- Acknowledgement of group dynamics and different personality types.

A facilitator needs to be able to develop and use diverse methodologies that may range from reductionist scientific research to creative artistic expression as a means of developing community understanding (Woodhill 2004).

b) Conflict and paradigms

Unfortunately people are often not conscious of the particular paradigm in which they operate. Conflict is often a clash of paradigms. People act and rationalise things in a way that does not make sense to others because they are operating with a different set of assumptions, values and beliefs. The facilitator needs to resolve this conflict through allowing those involved to make their paradigms explicit and for them to see the other paradigms (Woodhill 2004). 'Improvement will often require not just trying to solve the problems with the boundaries of the paradigm that created them but rather recognising the need for an alternative paradigm' (Woodhill 2004). This is also referred to as double loop learning.

c) Role of facilitator

Facilitation should not be looked at as something that need to be done by one person only, and neither as something that is performed only by outsiders. An external facilitator would best play a role in circumstances where outcomes are conflictive and involve outside initiatives and new forms of organisation. Playing a significant role is not about being the centre of attention, rather it means creating conducive conditions for others to participate in the process, by supporting the use of creative working methods and maintaining process agreements (Leeuwis and Van der Ban 2004). Facilitation ability need to be seen not just as the skills to facilitate a workshop but as the ability to understand the culture and the politics of a situation and to design and manage a long term social learning process (Woodhill 2004). A good facilitator needs a good understanding of the theoretical, methodological and institutional aspects. Unfortunately many facilitators are simply given a bag of participatory methods but their lack of understanding leads to a mechanical application of methods in inappropriate and ineffective ways (Woodhill 2004).

d) Facilitating group decision-making

When a group needs to make decisions it is important to encourage critical evaluation and to seek feedback from outside the group. Groups that are too self-centred can form a group-think situation where members have a convergence in opinions which then polarise in perspective with the real world. Sometimes groups give limited attention to other options or goals, cost-benefit appraisals and can fail to consult with anyone outside the group. If consensus within a group is highly prized, then individual members who have doubts often fail to voice them (Haslam 2001). A facilitator's role in a situation where group decision making is important is to make sure that all actors are given a chance to voice doubts and opinions as well as encouraging critical evaluation of all the options.

e) Facilitating communication.

Ensuring that effective communication takes place in an organisation is a leadership role as well as a facilitator's role (the facilitator is not always the leader of a group). Pepper (1995) states that

without communication there is no organisation. The way a group or an organisation is structured is more as a result of working relationships, experiences and interpretations and power relationships than the 'administration' structure. Communication problems can develop when message sending is not considered carefully. Participants bring biases and assumptions, feelings and experiences, attitudes and skills into every communication situation. These individual differences will colour message reception, and taint message sending. Misunderstandings in message sending and receiving can easily cause communication failures and lead to relationship breakdown (Pepper 1995). The facilitator's role is to use methods and tools to ensure that effective communication takes place within a group.

f) Facilitating Participation

Programs that are not based on local priorities or local ways of doing things will leave local workers frustrated because they are not achieving their desired goals, and locals frustrated because they feel that nobody is really trying to help them solve their problems (Hounkonnou 2002). Everyone has basic needs that need to be fulfilled and the deprivation of social and egotistic needs can lead to passivity, hostility or refusal to accept responsibility (Bolman and Deal 1991). Everyone has positive emotions in situations that are fulfilling and experience negative emotions in situations where important needs are frustrated. People need to be able to develop and define their own goals, or the way in which they might achieve those goals. In this way people find meaningful and satisfying work, and organisations gets the human talent and energy that it needs. It is important for people to be provided with positive feedback so that they feel valued and/or needed in a process. They will then be more motivated to achieve than in situations when they are always frustrated (Bolman and Deal 1991). A facilitator's role is to ensure that people feel valued in a process, that they feel that they are able to make their own contributions to a situation and take ownership of a process. In that way they will be more motivated towards the outcome than if they feel they have not made any contribution to the process.

Summary

Facilitation is not only about the tools, skills and methodologies but also about people and people dynamics. Power relationships and equality are important considerations in a process if the outcome is to be favourable to all participants. Goals and effective communication are critical in any facilitated process. Facilitators must have knowledge of people and methodologies that are appropriate for each situation. Experience and flexibility is needed in a good facilitator.

Chapter four – Extension for sustainability

There are many definitions, descriptions, meanings and interpretations of sustainability (Wals and Bawden 2000). '"Sustainable" is such an elusive concept it almost defies definition, and is so value laden as to once again bring the science of understanding human interactions into contention' (Brazil 2002). Education for sustainability must include space for autonomous thinking and self-determination for the learner to decide for themselves what counts as sustainability (Wals and Bawden 2000).

Problem solving in agriculture is never a straight forward process. Technology and science are developing so rapidly that there are often conflicting issues in every solution which make problem solving complex (Leeuwis and Van den Ban 2004). Extension can no longer just disseminate knowledge and solutions that are developed by science or industry (Leeuwis and Van den Ban 2004). Education must meet the needs of sustainable development by training *human* resources to optimise productivity, encouraging technical progress and promoting cultural conditions conductive to social and economic change (Wals and Bawden 2000). Environmental education is to help trigger *people* to seek solutions in problems. In doing so they will create a solution more suitable to their situation (Orellana and Fauteux 1998). The lessons learnt in this type of education are more sustainable in the long term.

In many areas of the world extension agents are no longer seen as experts or teachers providing recipes or advice, but act as facilitators of farmers' learning processes (Leeuwis 1999). For sustainable agriculture to occur, farmers need to have an increased capacity to learn and experiment (individually and collectively) and decrease their reliance and dependence on external advice (Leeuwis 1999). This requires a paradigm shift on the side of farmers, researchers and extension agents (Leeuwis 1999).

Extension

Often extension methodologies are clearly directed towards developing ideal farming practices. The objectives for uptake of practice is aimed at selected farmers (Leeuwis 1999). The terms used in the cotton industry coincide with the classifications frequently used elsewhere of 'forerunners, followers and laggards'. As Leeuwis (1999) states, this implies that there is only one development path which sooner or later all farmers will have to walk if they wish to survive. However, in reality, research has shown (and cotton industry farmers have proven) that there are a variety of viable patterns for farmer development and that there are a great deal of diversity amongst farmers (Leeuwis 1999).

Some extension methods are based around compiling a comprehensive technological package of research and distributing it to farmers. Providing such a package for sustainable farming will not necessarily bring about significant change unless it is imposed in a military-like fashion, or a radical change of the social environment occurs, both of which are unlikely (Leeuwis 1999). Farmers have a variety of reasons for managing their farms the way they do and any change in a farming system will only come about by a change in human conduct (Leeuwis 1999). Hence a more gradual approach which starts with existing social and technical system technologies and practices may in the end be more productive in bringing about sustainable forms of agriculture. The approach needs to be gradual and not forceful as in practice there will be a maximum degree of change and learning that farmers can accommodate at a particular point in time (Leeuwis 1999). An example of which this has taken place has been in Area wide management groups within the cotton industry which have been very successful way of implementing IPM practices in local areas. An other example is of the Sustainable Grazing Systems program which over the period of 1996 to 2002 achieved a change of practice for 81% out of nearly 10000 graziers in Australia (Andrew *et al.* 2004).

Changes

In the Australian cotton industry, and in many other industries world wide, there are efforts to expand the principles of sustainable IPM systems in areas such as nutrient, weed, disease and water management.

To achieve this, the following challenges will need to be overcome

- to extend the paradigm shift implied by IPM to these other areas,
- to deal with an increasingly complex learning process at farm level,
- to adapt extension models and tools,
- to alter the management and organisation of agricultural knowledge and information systems,
- to create a conducive political and socio-economic environment for sustainable agriculture

The theories of innovation design (Leeuwis and Van den Ban 2004, Leeuwis 1999) and action research (Stapp *et al.* 1996, Wals 1996, Wals and Stapp 1996) take a different approach to current cotton industry extension. Their ideas include involving farmers much earlier in the process of designing research and extension.

a) Action research

In Action Research (AR) growers are given the responsibility for planning their own opportunities to investigate and act upon an issue that concerns them. In doing so, farmers gain more confidence in developing their own solutions and 'better ways' of doing things (Wals 1996). Farmers come to

assume greater responsibility for learning as they become engaged in tackling and acting on issues of sustainability they themselves have identified and recognised to be important (Wals 1996). While experts often have a valuable perspective on a problem, they may not know the problem first hand, or many not need to live with the consequences of actions they implement. Action research assumes that the people who live with a particular situation are usually more qualified to identify the problems associated with it and to develop solutions that meet their needs.

The AR approach to problem solving differs from the standard way of problem solving, which is to first thoroughly understand a problem and then consider what actions, if any, to take (Wals 1996). The drawback of traditional problem solving is that it tends to delay action while endless study is done, and it fails to recognise that an understanding of the situation is only gained through taking action and evaluating the consequences of that action (Wals 1996).

b) Innovation design

The innovation design (ID) process is based on the concept that all parties, including growers, researchers, extension officers, policy makers and consultants contribute to the solution development process. The innovations that are developed out of this process would include elements of social, technical and natural elements that are important to all the participants (Leeuwis and Van den Ban 2004).

The ID approach uses the assumption that innovation is not primarily about 'doing scientific research'. Innovation is the development of an idea, research is analysis of that idea, but doing research and gathering data should involve researchers and stakeholders. Innovation processes are not likely to be successful if they are 'scientist-owned' or initiated (Leeuwis and Van den Ban 2004). The most successful innovations are where knowledge is generated in various places, for example when on farm trials and research station trials are integrated. In the innovation processes scientists play an active role in the discussion and the innovation process. The resulting management solutions are then less likely to be artificial and imposed (Leeuwis and Van den Ban 2004).

Innovation design is not a straight-forward process; rather it is a process of network building, social learning and negotiation that takes place in an evolutionary context. The 'design' or solution may originally have been a rather abstract idea that gradually forms into a coherent practice (Leeuwis and Van den Ban 2004).

Action

Steps to be taken in developing an AR and/or ID process.

1. Institutional support

Innovation does not match well with bureaucracy (Leeuwis 1999). Support needs to be provided to the process described below so that the solutions are not met with endless procedural difficulties when they come to be implemented (Leeuwis 1999).

The goals, objectives and the structure of the methodology (not the research) need to be presented using theory and examples from elsewhere. It will be important to ask for input and feedback into the process in order to allow improvement of the plans and to have shared ownership of the process from the very beginning. At this stage there would hopefully be some agreement in which ways various actors can support the project and contribute to this future development (Wals and Stapp 1996).

Assumptions

For this process to be successful, participants need know that they can be forces of constructive change and that their involvement is needed (Stapp *et al.* 1996). The program should not be perceived as something extra – but as an alternative way to reach many existing goals and objectives (Wals 1996).

Program ownership

Many programs are successful as a result of an individual's enthusiasm, energy, ambitions and aspirations. Such individuals are necessary for getting programs started. However when such individuals leave the education program often weakens and sometimes disappears completely. In order avoid this dependency on single individuals it is crucial that an education program be characterised by shared ownership (Wals and Stapp 1996).

2. Planning

The planning stage involves bringing the group together and setting program outlines (Leeuwis 1999). The process would involve the facilitator asking questions to reveal the current shortcomings, how to address these and how to include all the relevant actors (Stapp *et al.* 1996). At this stage the program process can be defined as in the example in Figure 2. Guidelines for evaluation would also be determined at this stage (Wals and Stapp 1996).

3. Choosing problems/defining the research agenda

This stage involves brainstorming problems, but then also researching these problems to develop a problem statement that clearly defines the project. People have a tendency to act quickly to achieve solutions. To avoid disappointment and to find workable solutions, it is important that the group research the topics to gain a deeper understanding of the problem. It is also important not to narrow the problem too much, as this might result in possible causes for the problem and solutions might be missed (Wals 1996). For example, instead of just stating that 'Sodicity is a problem' we need to

more clearly define what the issue is, such as 'increasing sodicity in the soil is resulting in decreased yields'.

Assumptions

That the growers are given a chance to investigate and act upon a problem of their choice to increase their motivation to learn (Wals 1996). This stage is not just about generating a shopping list of problems, this would only raise false expectations of the program.

4. Defining Action/Generating Possible Solutions

Effective action requires brainstorming alternative strategies for addressing the problem and establishing criteria to narrow alternatives to one strategy that the group will implement to affect change. This should include not just information gathering but also some initial experiences of problem solving (that is trial and error). When a group takes action in the early stages of the project they are likely to discover that they lack information or have set unrealistic goals. This will then involve going back to get more information in order to be more effective in the future action (Figure 2) (Wals 1996). Although this trial and error may seem a waste of time, the participants learn more during this process than just information gathering.

Assumptions

For the group to be able to plan and take action there needs to be appropriate resources, such as equipment for trials available.

5. Implementing

In many Action Research projects, for example in the Sustainable Grazing Systems project (Andrew *et al.* 2004), the point is not that the groups completely resolve the problem but that they can take effective action to alleviate it (Wals 1996). "The most appropriate way to improve the farmers' stock of knowledge is not in knowledge transfer but in improving farmers' capacity to learn and experiment themselves" (Leeuwis 1999).

Action or implementing the results of research can take place at any stage of the process, they do not have to occur only at the end (Wals 1996). The evaluation and re-evaluation of the plan (Figure 2) will allow room for changes that occur over time for example, experiments might show that a different area needs to be looked at to help solve a problem. This is where action research differs from traditional research projects that establish objectives at the start of the project that are the same objectives at the end of the project (Leeuwis 1999). It is important to note that "A scientific approach may unnecessarily slow down an innovation process" (Leeuwis 1999).

Figure 2. Model for a innovation design process

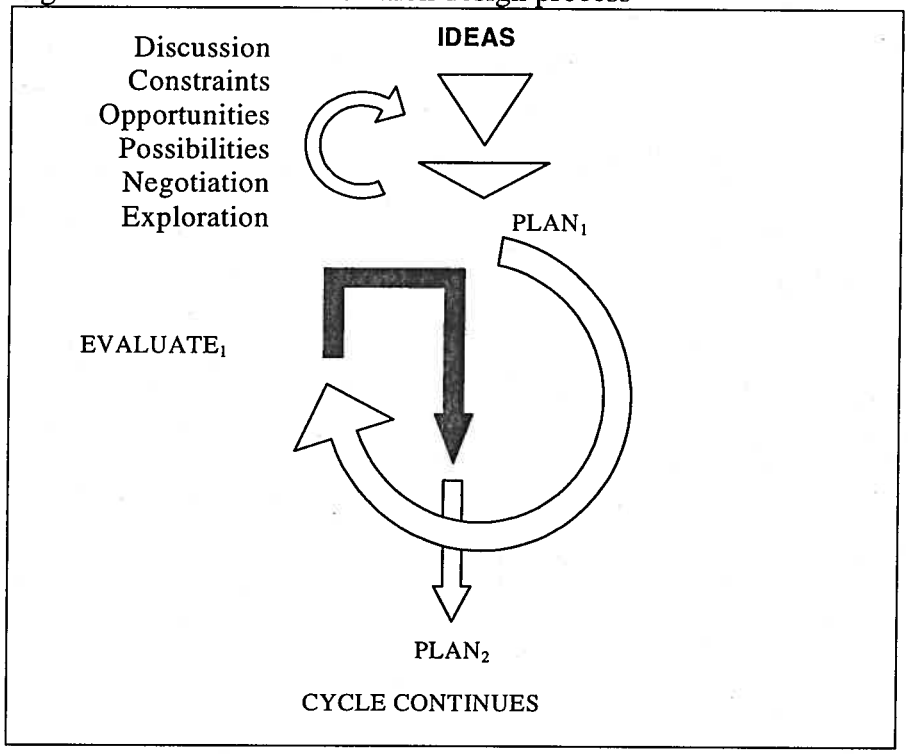


Figure adapted from Stapp *et al.* 1996.

Table 1. Differences between current research and extension practice and AR and ID

ROLES	Current approach in the Australian Cotton Industry	Approach suggested AR and ID
Scientists	Dominant, owners of a research process.	Resource persons in an innovation process.
Extension	Disseminate new production systems, technologies and practices.	Facilitate the process of learning, negotiation and project decision making, and transferring the learning process.
Growers	Innovators, followers or laggards.	Actors in the development of the methodology for the design and learning process of innovation.

Assumptions

It is important that during the process that everyone is represented as equal partners (Table 1). In other cases it was shown that goals and actions that were designed by scientists and later 'agreed' on by farmers, over time, were considered less useful than when all participants had ownership of the decisions (Leeuwis 1999). It is important that farmers be able to take their own actions and not only those determined by a program. The aim of the program is to move away from the idea of there being one perfect farming system (Leeuwis 1999).

6. Communicating

Networking and communication are essential tools for strengthening the organisational and educational components of such a program. Communication within the group will involve good listening, clear expression of thought, withholding judgement, developing a common understanding and being open minded (Wals and Stapp 1996).

In old extension methodologies the impression was given that knowledge and technology generation was primarily the task of scientists. When these technologies and practices were complete they were then handed over to extension agents to disseminate (Leeuwis 1999). The communication step should not be the closing step of the approach however since continuous communication needs to be built with those who will benefit from the innovations. Hence the extension needs to run parallel to the whole procedure (Leeuwis 1999).

7. Program Evaluation

There are two types of evaluation that are important to sustain a program that continues to attract support (from industry, research and the community): process evaluation and product evaluation. Process evaluation refers to assessing the quality of the process: Does the group value the program? What are the strengths/weaknesses and areas in need of improvement?

This type of evaluation needs to be conducted periodically throughout the program and the results incorporated in the process to improve the overall program (Wals and Stapp 1996). The product evaluation would include questions like has the original problem changed? What changes have been made in practice? This part of evaluation needs to be considered at the start of the process, i.e. during the design of the program, and also when the action is determined. This will feed back into the action cycle (Figure 2) (Wals and Stapp 1996).

Summary

This model only broadly outlines a suggested process for participatory research and learning. For the process to be truly participatory the process would need to be modified to suit the participants. The process outlined above however does cover the major issues that need to be considered. These include building industry support for the program, designing the process to suit participants, having a dynamic action, communication and evaluation process that suits the participants and allows for re-visioning of the problem, process and/or the actions that are taken.

The dynamic process should be designed so that all participants have a feeling of not only being involved but needed, as well as being able to gain benefits such as increased knowledge, skills and hopefully some solutions to problems.

Chapter five – Taking it further.

Whilst it is quite easy speak of participatory approaches, facilitation and to develop a theoretical extension model from a distance it is quite different when it comes to implementing this in practice. To implement these sort of extension methodologies would require institutional support for the processed. This process would also require the willing cooperation of growers or grower groups. Meaningful change does not occur without leadership for example someone to push the process or to propose that something new is tried.

Some of the methodologies requires a paradigm shift in the way research and extension is done and this cannot be done overnight. The process of Action Research has been trialled before in Australia and has not always succeeded due to lack of support from scientists as it is not a 'scientific process' that they can then report on. Leeuwis (1999) acknowledges that while scientific processes are still important but with agricultural development "a scientific approach may unnecessarily slow down an innovation process" (Leeuwis 1999). This means that it is often inefficient for farmers to wait to implement new practices while scientists discuss the risks if outcomes are not scientifically valid. They usually go ahead if they believe something works (Leeuwis and Van den Ban 2004).

An example that could be used is the Sustainable Grazing Systems program which ran between 1996 and 2002 used the process of action learning to increase graziers knowledge as well as learning capacity that resulted in an outstanding percentage of change within and industry (Andrews *et al.* 2004).

The process of building institutional support has already begun. A paper titled *'Extension of weed research outcomes through the Australian cotton industry'* was presented at the Australian weeds conference in Wagga Wagga in September 2004. This paper described these processes and why we would benefit from implementing these processes (See Appendix 1). Further steps in developing institutional support include this report which will be distribute to NSW DPI, CRDC, and other members of the extension team. A presentation will be made at the NSW DPI research review in November 2004.

The process of increasing the participation of growers in research and in learning processes will be gradually introduced to grower groups through out the coming season. For the participatory approach to be truly participatory a willingness of the grower groups to be involved in such a process will be required. Once such a process has been developed on a small scale for a group, or a number of groups, the idea can be further developed and the process introduced to other willing groups. Whilst industry can provide support to growers who wish to participate in these processes, grower groups should not be overused as data gathering groups or as a means to implement change

in every area. Change will come once participants feel that they have an increased capacity to make changes. Participatory processes can fall down when they are used to create a change that is pre-defined from outside the group eg a 'industry wide' issue might not be of importance to that group.

Networking and communication are essential tools for strengthening the organisational and educational components of such a program. The methodologies that are used to include such processes into a group would need to change to suit each individual group and extension officer. These processes would not require extra work but would incorporate many of our current activities to make solving problems (and extending them) more efficient. The current extension team is a good network for building such processes. However it is important that the extension network not always examine the 'what' we extend but examine the 'how' we do things and analyse if each method is appropriate for each situation. This does not necessarily mean more evaluation as methods have often been evaluated in other situations around Australia and the world. By studying these evaluations done by other groups the team could learn a lot about the effectiveness of various methods a learn a few new ones.

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Appendix one – Weeds Conference Paper 6 – 10 September 2004

Extension of weed research outcomes through the Australian cotton industry

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Summary This paper describes a theoretical approach to extension strategies and the structure of weeds extension for the Australian cotton industry. The approach to be discussed is based on the concept of *innovation design* by Leeuwis and Van den Ban (2004), that all stakeholders interact to develop solutions to problems. While the cotton extension team currently uses aspects of this approach, this paper describes why a more coordinated approach to solution development needs to be used.

Weeds are a significant problem in the Australian cotton industry as they result in loss of production efficiency. Technological and agronomic developments in the cotton industry have led to the emergence of other significant issues related to weeds. Weeds can be hosts for soil borne disease and insect hosts. Another emerging issue is the management of glyphosate-tolerant cotton varieties when they become weeds in following crops.

The Australian cotton industry has invested a considerable amount of money to research weed problems and to develop integrated weed management strategies for the cotton production system. These research outcomes will only be effective if adopted by growers. The processes for successful adoption of this research present real challenges for all sectors of industry – not just for extension personnel.

The key to the management and adoption of these research outcomes is cooperation between cotton growers, research and extension staff in the Australian Cotton Cooperative Research Centre (CRC). The CRC ethic is to have collaboration, communication and cooperation between all researchers, extension officers and industry stakeholders.

Extension staff in the Australian cotton industry use various methods of technology transfer and group facilitation to achieve the goals of sustainable cotton production. An improved understanding of extension techniques will provide improved effectiveness of personnel employed and resources available.

Keywords Communication, Cotton CRC, Extension, Innovation, Design.

INTRODUCTION

Rapidly changing problems and technologies in agriculture mean that problem solving is not a straightforward process. There are often conflicting issues that make solutions complex. Leeuwis and Van den Ban (2004) state that extension is no longer a process of disseminating knowledge, as quite often the knowledge, directions and policies are not pre-defined.

Complex Problems Changing technological opportunities and environmental values in the cotton industry have changed industry perceptions and priorities for weed management in the following areas:

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1. **Weeds as alternate hosts for pests** The introduction of Bt cotton and highly selective insecticides in cotton has changed the insect pest complex resulting in an increased occurrence of what were previously secondary pests such as green mirids (Wilson 2002). An important aspect of management of secondary pests such as mirids is the control of alternative hosts (weeds) during winter (Mensah and Wilson 1999). However weeds play a role in promoting natural insect predators of these pests so it can be beneficial to maintain winter weeds (Murray 2002). Weeds can also be alternative hosts of fusarium wilt (*Fusarium oxysporum* f.sp. *vasinfectum*) a fungal soil-borne disease that has developed relatively recently in the Australian cotton industry (Kochman *et al.* 2002)

2. Residual herbicides have an important role in cotton production systems. There has been increasing concern over the effect of residual herbicides on soil health and in riverine systems (Taylor *et al.* 2002). However if residual herbicides are removed from the production system an important tool in integrated weed management is reduced or lost.
3. The introduction of glyphosate-tolerant cotton has been an important management tool for many problem weeds and in high weed density fields. Using this tool correctly is important for preventing or controlling any unintended results including species shift, the development of glyphosate-resistant weeds and the development of volunteer cotton as a weed (Roberts 2002; Taylor *et al.* 2002).

It is in these problem areas where innovation is needed to develop solutions. While it is easy to recognise the problems through industry feedback and grower experience, the solutions are not so easily determined (Leeuwis and Van den Ban 2004). Extension activities are increasingly geared towards designing new innovations (solutions). When extension is needed to diffuse new innovations this cannot be done without an element of re-design of the innovation to suit individuals (Leeuwis and Van den Ban 2004). This is more commonly referred to as localising solutions, and is the basis of the placement of extension officers in most cotton growing valleys.

Solution development or the 'innovation process' is a two way process in which all parties can be expected to contribute, including growers, consultants, researchers, extension officers, policy makers and other members of the agricultural industry. The purpose of this paper is to describe ways in which the concept of innovation design could be used to improve problem solving in the cotton industry.

INNOVATION DESIGN

Innovation should not be primarily scientific research. Developing solutions should involve all stakeholders. Research is the analysis of these solutions, but doing research and gathering data should involve interactions between researchers and stakeholders that results in learning for both. Solutions are not likely to be successful if they are scientist owned or initiated (Leeuwis and Van den Ban 2004). The most successful innovations are where knowledge is generated in various places, for example when on-farm trials and research trials are integrated. In the innovation processes scientists and farmers play an active role in the discussion and the innovation process. The resulting management solutions to the problems are then less likely to be artificial and imposed (Leeuwis and Van den Ban 2004).

Innovation design is not a straight-forward process; rather it is a process of network building, social learning and negotiation that takes place in an evolutionary context. The 'design' or solution may originally have been a rather abstract idea that gradually forms into a coherent practice (Leeuwis and Van den Ban 2004). The tradition of 'adoption' of a solution or practice is not difficult to extend when the solution is yet to be designed.

In order to arrive at coherent practices, all stakeholders need to somehow develop a shared understanding of the problem as the basis for effective coordinated action (Leeuwis and Van den Ban 2004). Once the awareness of this problem has developed there needs to be mobilisation of interest for action within a network of stakeholders (Leeuwis and Van den Ban 2004).

In the case of the Australian cotton industry this means bringing together a group of researchers, extension officers, farmers, agronomists, consultants and the funding organisations. Once the various stakeholders are involved there is a process of experimentation, research, trial and error and careful adaptation including a negotiation period where various ideas are formulated and reformulated. In the learning process knowledge can be generated in the field, on the research station by researchers or by growers and can be integrated together. The process can take many years. For innovation to become mature there needs to be space and time for experimentation and the development of the design. For example this can be done through small scale trials which over time gradually move through to larger field scale trials and offer a learning period for all involved. After this period there is a gradual expansion of the experimental design and implementation. This design is then either evolved to fit various systems, or in the case of failure, redesigned. (Leeuwis and Van den Ban 2004).

CONFLICTING SOLUTIONS

Whenever different stakeholders groups are involved in the process of meaningful change conflicts are likely to emerge since such changes may have consequences that

effect values and interest of many stakeholders (Leeuwis and Van den Ban 2004). For example, controlling winter weeds in cotton fields is recommended to prevent the over-wintering and early build up of pests such as aphids and mirids, especially if it is suspected that there could be resistant individuals present. However, weeds are also a host for beneficial insects and can act as a nursery for the build up of beneficial insects (Murray 2002). To follow IWM principles it is important to prevent weed seed set, but to maintain biodiversity for beneficial insects it is important that weeds remain. The action taken by the grower will depend on their understanding of the problem and their individual preferences.

The effectiveness of a reduction or the removal of residual herbicides in the cotton production system is dependent on the weed pressure in each individual cotton field. However determining the weed pressure in individual fields and thresholds for the reduction of residual herbicides needs to be a negotiated process between growers, agronomists and researchers. Individual growers have different attitudes towards risk and labour management that will necessitate a redesign of thresholds for each individual farmer.

THE ROLE OF EXTENSION

The role of the extension team is to guide the innovation process and to ensure effective interaction of all stakeholders. Although extension officers do not need to be directly involved in all the innovation process, that is they do not need present for every grower-researcher discussion, they are in a position to monitor the process and to facilitate critical feedback.

The existing focus team is the focal point for weeds and disease extension. The focus team currently collects information about problem areas to provide feedback for continued research and have a key role in determining knowledge gaps that weaken the extension process. This includes putting together weeds information for distribution and communicating the progress of on going innovation development.

Traditional extension and research practices do not cope well with the complexity of these multiple paths of sustainability. The role of extension needs to be in connecting relevant stakeholders and guiding the interactive process. The process of innovation design is not designed to be extra work but to incorporate many processes to make solving problems (and extending them) more efficient.

CONCLUSIONS

Dissemination of solutions developed by research implies that there is only one development path which sooner or later all farmers will have to walk if they wish to survive (Leeuwis 1999). These solutions are difficult to extend as they tend not to suit all growers and situations. In reality there is a great deal of diversity of sustainable practices (Leeuwis 1999). Solutions to the complex problems mentioned above requires coordinated and interactive action of all stakeholders.

Communication and coordination are roles that the national cotton extension team attempts to carry out. However all stakeholders, growers, research and other industry members are equally important in this process and need to operate together in developing solutions rather than separately. The approach needs to be gradual and not forceful as in practice there will be a maximum degree of change and learning that farmers and research can accommodate at a particular point in time (Leeuwis 1999). However this process allows growers, consultants and researchers to gain more confidence in developing solutions and thinking about better practices (Leeuwis and Van der Ban 2004).

Various parts of this method are currently in practice in many parts of the cotton industry. For extension to be more effective, coordinated processes need to be designed. There should not be a specific design but rather one that suits all the stakeholders involved in the processes. This implementation of such processes will require a change not only for extension staff but research and growers too.

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